

# European Materials Modelling Ontology

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European Materials Modelling Council (EMMC)



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Analytical Philosophy  
(e.g. mereotopology, semiotics, logic)



Information and Communication  
Technologies  
(e.g. reasoners, platforms, formats)

## Abstract

EMMO is an ontology that is created by the European Materials Modelling Council (EMMC) to provide a formal way to describe the fundamental concepts of physics, chemistry and materials science. EMMO is designed to pave the road for semantic interoperability providing a generic common ground for describing materials, models and data that can be adapted by all domains.

It is a representational framework of predefined classes and axioms (ontology) provided by experts (EMMC) that enables end users (industry, research, academy) to represent real life physical entities (materials, devices), models and properties using ontological signs (individuals) in a standard way to facilitate interactions and exchanges (data, software, knowledge) between all involved material modelling and characterization communities and stakeholders.

**Keywords:** EMMO, materials science, modelling, characterisation, materials, ontology

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# Chapter 1

## Introduction

EMMO is a multidisciplinary effort to develop a standard representational framework (the ontology) based on current materials modelling knowledge, including physical sciences, analytical philosophy and information and communication technologies. This multidisciplinaryity is illustrated by the figure on the title page. It provides the connection between the physical world, materials characterisation world and materials modelling world.



Figure 1.1: EMMO provides the connection between the physical world, materials characterisation world and materials modelling world.

EMMO is based on and is consistent with the [Review of Materials Modelling](#), [CEN Workshop Agreement](#) and [MODA template](#). However, while these efforts are written for humans, EMMO is defined using the [Web Ontology Language \(OWL\)](#), which is machine readable and allows for machine reasoning. In terms of semantic representation, EMMO brings everything to a much higher level than these foundations.

As illustrated in the figure below, EMMO covers all aspects of materials modelling and characterisation, including:

- the **material** itself, which must be described in a rigorous way
- the **observation process** involving an observer that perceives the real world (characterisation)
- the **properties** that are measured or modelled
- the **physics laws** that describe the material behaviour
- the **physical models** that approximate the physics laws
- the **solver** including the numerical discretisation method that leads to a solvable mathematical representation under certain simplifying assumptions
- the **numerical solver** that performs the calculations
- the **post processing** of experimental or simulated data



Figure 1.2: The aspects of materials modelling and characterisation covered by EMMO.

EMMO is released under the [Creative Commons license](#) and is available at [emmo.info/](http://emmo.info/). The OWL2-DL sources are available in RDF/XML format.

## What is an ontology

In short, an ontology is a specification of a conceptualization. The word *ontology* has a long history in philosophy, in which it refers to the subject of existence. The so-called [ontological argument](#) for the existence of God was proposed by Anselm of Canterbury in 1078. He defined God as “*that than which nothing greater can be thought*”, and argued that “*if the greatest possible being exists in the mind, it must also exist in reality. If it only exists in the mind, then an even greater being must be possible – one which exists both in the mind and in reality*”. Even though this example has little to do with today’s use of ontologies in e.g. computer science, it illustrates the basic idea; the ontology defines some basic premises (concepts and relations between them) from which it is possible reason to gain new knowledge.

For a more elaborated and modern definition of the ontology we refer the reader to the one provided by [Tom Gruber \(2009\)](#). Another useful introduction to ontologies is the paper [Ontology Development 101: A Guide to Creating Your First Ontology](#) by Noy and McGuinness (2001), which is based on the [Protege](#) software, with which EMMO has been developed.

A taxonomy is a hierarchical representation of classes and subclasses connected via **is\_a** relations. Hence, it is a subset of the ontology excluding all but the **is\_a** relations. The main use of taxonomies is for the organisation of classifications. The figure shows a simple example of a taxonomy illustrating a categorisation of four classes into a hierarchy of more higher of levels of generality.



Figure 1.3: Example of a taxonomy.

In EMMO, the taxonomy is a rooted directed acyclic graph (DAG). This is important since many classification methods relies on this property, see e.g. [Valentini \(2014\)](#) and [Robison et al \(2015\)](#). Note, that EMMO is a DAG does not prevent some classes from having more than one parent. A **Variable** is for instance both a **Mathematical** and a **Symbol**. See [appendix](#) for the full EMMO taxonomy.

# Primitive elements in EMMO

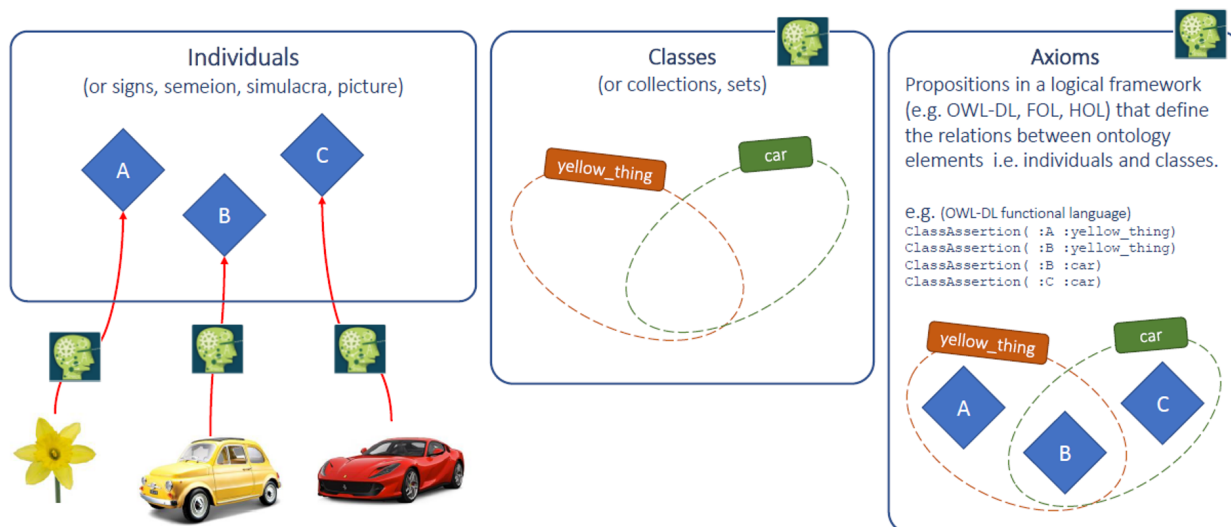


Figure 1.4: The primitive building blocks of EMMO.

## Individuals

Individuals are the basic, “ground level” components of EMMO. They may include concrete objects such as cars, flowers, stars, persons and molecules, as well as abstract individuals such as a measured height, a specific equation and software programs.

Individuals possess attributes in form of axioms that are defined by the user (interpreter) upon declaration.

## Classes

Classes represent concepts. They are the building blocks that we use to create an ontology as a representation of knowledge. We distinguish between *defined* and *non-defined* classes.

Defined classes are defined by the requirements for being a member of the class. In the graphical representations of EMMO, defined classes are orange. For instance, in the graph of the top-level entity branch below, The root EMMO and a defined class (defined to be the disjoint union of *Item* and *Collection*).

Non-defined classes are defined as an abstract group of objects, whose members are defined as belonging to the class. They are yellow in the graphical representations.

## Axioms

Axioms are propositions in a logical framework that define the relations between the individuals and classes. They are used to categorise individuals in classes and to define the *defined* classes.

The simplest form of a class axiom is a class description that just states the existence of the class and gives it a unique identifier. In order to provide more knowledge about the class, class axioms typically contain additional components that state necessary and/or sufficient characteristics of the class. OWL contains three language constructs for combining class descriptions into class axioms:

- *Subclass* (`rdfs:subClassOf`) allows one to say that the class extension of a class description is a subset of the class extension of another class description.
- *Equivalence* (`owl:equivalentClass`) allows one to say that a class description has exactly the same class extension (i.e. the individuals associated with the class) as another class description.
- *Disjointness* (`owl:disjointWith`) allows one to say that the class extension of a class description has no members in common with the class extension of another class description.

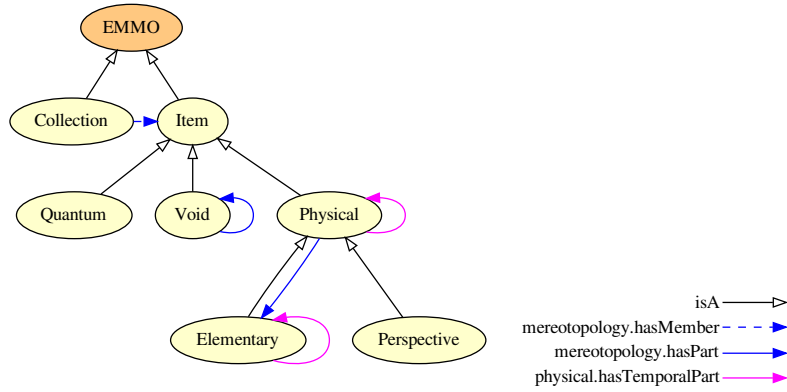


Figure 1.5: Example of the top-level branch of EMMO showing some classes and relationships between them.

See the section about **Description logic** for more information about these language constructs. Axioms are also used to define relations between relations. These are further detailed in the chapter on **Relations**.

## Theoretical foundations

EMMO build upon several theoretical frameworks.

### Semiotics

Semiotics is the study of meaning-making. It is the dicipline of formulating something that possibly can exist in a defined space and time in the real world.

### Mereotopology

Mereotopology is the combination of **mereology** (science of parthood) and **topology** (mathematical study of the geometrical properties and conservation through deformations). It is introduced via the **Item** class and based on the **mereotopological** relations. Items in EMMO are always topologically connected in space and time. EMMO makes a strong distinction between membership and parthood relations. In contrast to collections, items can only have parts that are themselves items. For further information, see [Casati and Varzi “Parts and Places” \(1999\)](#).

### Physics

EMMO is strongly based on physics, with the aim of being able to describe all aspects and all domains of physics, from quantum mechanics to continuum, engeneering, chemistry, etc. EMMO is compatible with both the De Broglie - Bohm and the Copenhagen interpretation of quantum mechanics (see **Physical** for more comments).

EMMO defines a physics-based parthood hierachy under **Physical** by introducing the following concepts (illustrated in the figure below):

- **Elementary** is the fundamental, non-divisible constituent of entities. In EMMO, elementaries are based on the standard model of physics.
- **State** is a **Physical** whose parts does not change during its life time (at the chosen level of granularity). This is consistent with a state within e.g. thermodynamics.
- **Existent** is a succession of states.



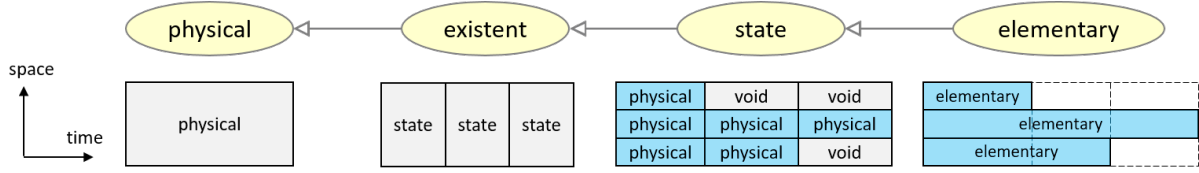


Figure 1.6: Parthood hierarchy under `Physical`.

## Metrology

Metrology is the science of measurements. It introduces units and links them to properties. The description of metrology in EMMO is based on the standards of [International System of Quantities \(ISQ\)](#) and [International System of Units \(SI\)](#).

## Description logic

[Description logic \(DL\)](#) is a formal knowledge representation language in which the *axioms* are expressed. It is less expressive than [first-order logic \(FOL\)](#), but commonly used for providing the logical formalism for ontologies and semantic web. EMMO is expressed in the [Web Ontology Language \(OWL\)](#), which in turn is based on DL. This brings along features like reasoning.

Since it is essential to have a basic notion of OWL and DL, we include here a very brief overview. For a proper introduction to OWL and DL, we refer the reader to sources like [Grau et.al. \(2008\)](#), [OWL2 Primer](#) and [OWL Reference](#).

OWL distinguishes between six types of class descriptions:

1. a class identifier (a IRI reference)
2. an exhaustive enumeration of individuals that together form the instances of a class (`owl:oneOf`)
3. a property restriction (`owl:someValuesFrom`, `owl:allValuesFrom`, `owl:hasValue`, `owl:cardinality`, `owl:minCardinality`, `owl:maxCardinality`)
4. the intersection of two or more class descriptions (`owl:intersectionOf`)
5. the union of two or more class descriptions (`owl:unionOf`)
6. the complement of a class description (`owl:complementOf`)

Except for the first, all of these refer to *defined classes*. The table below shows the notation in OWL, DL and the [Manchester OWL syntax](#), all commonly used for the definitions. The Manchester syntax is used by [Protege](#) and is designed to not use DL symbols and to be easy and quick to read and write. Several other syntaxes exist for DL. An interesting example is the pure Python syntax proposed by [Lamy \(2017\)](#), which is used in the open source [Owlready2](#) Python package. The [Python API for EMMO](#) is also based on Owlready2.

Table 1.1: Notation for DL and Protege.  $A$  and  $B$  are classes,  $R$  is an active relation,  $S$  is a passive relation,  $a$  and  $b$  are individuals and  $n$  is a literal. Inspired by the [Great table of Description Logics](#).

DL	Manchester	Python + Owlready2	Read	Meaning
<b>Constants</b>				
$\top$		Thing	top	A special class with every individual as an instance
$\perp$		Nothing	bottom	The empty class
<b>Axioms</b>				
$A \doteq B$			A is defined to be equal to B	Class <i>definition</i>
$A \sqsubseteq B$	A subclass_of B	class A(B): ... issubclass(A, B)	all A are B	Class <i>inclusion</i> Test for <i>inclusion</i>
$A \equiv B$	A equivalent_to B	A.equivalent_to.append(B) B in A.equivalent_to	A is equivalent to B	Class <i>equivalence</i> Test for <i>equivalence</i>

DL	Manchester	Python + Owlready2	Read	Meaning
$a : A$	a is_a A	$a = A()$  isinstance(a, A)	a is a A	Class <i>assertion</i> ( <i>instantiation</i> ) Test for instance of
$(a, b) : R$	a object property assertion b	a.R.append(b)	a is R-related to b	Property <i>assertion</i>
$(a, n) : R$	a data property assertion n	a.R.append(n)	a is R-related to n	Data <i>assertion</i>
<b>Constructions</b>				
$A \sqcap B$	A and B	A & B	A and B	Class <i>intersection</i> ( <i>conjunction</i> )
$A \sqcup B$	A or B	A   B	A or B	Class <i>union</i> ( <i>disjunction</i> )
$\neg A$	not A	Not(A)	not A	Class <i>complement</i> ( <i>negation</i> )
$\{a, b, \dots\}$	{a, b, ...}	OneOf([a, b, ...])	one of a, b, ...	Class <i>enumeration</i>
$S \equiv R^{-}$	S inverse_of R	Inverse(R) S.inverse == R	S is inverse of R	Property <i>inverse</i> Test for <i>inverse</i>
$\forall R.A$	R only A	R.only(A)	all A with R	<i>Universal restriction</i>
$\exists R.A$	R some A	R.some(A)	some A with R	<i>Existential restriction</i>
$= nR.A$	R exactly n A	R.exactly(n, A)		<i>Cardinality restriction</i>
$\leq nR.A$	R min n A	R.min(n, A)		<i>Minimum cardinality restriction</i>
$\geq nR.A$	R max n A	R.max(n, A)		<i>Minimum cardinality restriction</i>
$\exists R\{a\}$	R value a	R.value(a)		<i>Value restriction</i>
<b>Decompositions</b>				
$A \sqcup B \sqsubseteq \perp$	A disjoint with B	AllDisjoint([A, B])  B in A.disjoints()	A disjoint with B	Disjoint  Test for disjointness
$\exists R.\top \sqsubseteq A$	R domain A	R.domain = [A]		Classes that the restriction applies to
$\top \sqsubseteq \forall R.B$	R range B	R.range = [B]		All classes that can be the value of the restriction

## Examples

Here are some examples of different class descriptions using both the DL and Manchester notation.

### Equivalence (`owl:equivalentTo`)

Equivalence ( $\equiv$ ) defines necessary and sufficient conditions.

Parent is equivalent to mother or father

**DL:** `parent  $\equiv$  mother  $\vee$  father`

**Manchester:** `parent equivalent_to mother or father`

### **Inclusion (`rdf:subClassOf`)**

Inclusion ( $\sqsubseteq$ ) defines necessary conditions.

An employee is a person.

**DL:** `employee  $\sqsubseteq$  person`

**Manchester:** `employee is_a person`

### **Enumeration (`owl:oneOf`)**

The color of a wine is either white, rose or red:

**DL:** `wine_color  $\equiv$  {white, rose, red}`

**Manchester:** `wine_color equivalent_to {white, rose, red}`

### **Existential restriction (`owl:someValuesFrom`)**

A mother is a woman that has a child (some person):

**DL:** `mother  $\equiv$  woman  $\sqcap$   $\exists$ has_child.person`

**Manchester:** `mother equivalent_to woman and has_child some person`

### **Universal restriction (`owl:allValuesFrom`)**

All parents that only have daughters:

**DL:** `parents_with_only_daughters  $\equiv$  person  $\sqcap$   $\forall$ has_child.woman`

**Manchester:** `parents_with_only_daughters equivalent_to person and has_child only woman`

### **Value restriction (`owl:hasValue`)**

The `owl:hasValue` restriction allows to define classes based on the existence of particular property values. There must be at least one matching property value.

All children of Mary:

**DL:** `Marys_children  $\equiv$  person  $\sqcap$   $\exists$ has_parent.{Mary}`

**Manchester:** `Marys_children equivalent_to person and has_parent value Mary`

### **Property cardinality (`owl:cardinality`)**

The `owl:cardinality` restrictions ( $\geq$ ,  $\leq$  or  $\equiv$ ) allow to define classes based on the maximum (`owl:maxCardinality`), minimum (`owl:minCardinality`) or exact (`owl:cardinality`) number of occurrences.

A person with one parent:

**DL:** `half_orphant  $\equiv$  person and  $=$ 1has_parent.person`

**Manchester:** `half_orphant equivalent_to person and has_parent exactly 1 person`

### **Intersection (`owl:intersectionOf`)**

Individuals of the intersection ( $\sqcap$ ) of two classes, are simultaneously instances of both classes.

A man is a person that is male:

**DL:** `man  $\equiv$  person  $\sqcap$  male`

**Manchester:** `man equivalent_to person and male`

### Union (`owl:unionOf`)

Individuals of the union ( $\sqcup$ ) of two classes, are either instances of one or both classes.

A person is a man or woman:

**DL:** `person`  $\equiv$  `man`  $\sqcup$  `woman`

**Manchester:** `person` `equivalent_to` `man` or `woman`

### Complement (`owl:complementOf`)

Individuals of the complement ( $\neg$ ) of a class, are all individuals that are not member of the class.

Not a man:

**DL:** `female`  $\equiv$   $\neg$  `male`

**Manchester:** `female` `equivalent_to` not `male`

## The structure of EMMO

The EMMO ontology is structured in shells, expressed by specific ontology fragments, that extends from fundamental concepts to the application domains, following the dependency flow.

### Top Level

The [EMMO top level](#) is the group of fundamental axioms that constitute the philosophical foundation of the EMMO. Adopting a physicalistic/nominalistic perspective, the EMMO defines real world objects as 4D objects that are always extended in space and time (i.e. real world objects cannot be spaceless nor timeless). For this reason abstract objects, i.e. objects that does not extend in space and time, are forbidden in the EMMO.

EMMO is strongly based on the analytical philosophy dicipline semiotic. The role of abstract objects are in EMMO fulfilled by semiotic objects, i.e. real world objects (e.g. symbol or sign) that stand for other real world objects that are to be interpreted by an agent. These symbols appear in actions (semiotic processes) meant to communicate meaning by establishing relationships between symbols (signs).

Another important building block of from analytical philosophy is atomistic mereology applied to 4D objects. The EMMO calls it ‘quantum mereology’, since the there is a epistemological limit to how fine we can resolve space and time due to the uncertainty principles.

The [mereotopology](#) module introduces the fundamental mereotopological concepts and their relations with the real world objects that they represent. The EMMO uses mereotopology as the ground for all the subsequent ontology modules. The concept of topological connection is used to define the first distinction between ontology entities namely the *Item* and *Collection* classes. Items are causally self-connected objects, while collections are causally disconnected. Quantum mereology is represented by the *Quantum* class. This module introduces also the fundamental mereotopological relations used to distinguish between space and time dimensions.

The [physical](#) module, defines the *Physical* objects and the concept of *Void* that plays a fundamental role in the description of multiscale objects and quantum systems. It also define the *Elementary* class, that restricts mereological atomism in space.

In EMMO, the only univocally defined real world object is the *Item* individual called **Universe** that stands for the universe. Every other real world object is a composition of elementaries up to the most comprehensive object; the **Universe**. Intermediate objects are not univocally defined, but their definition is provided according to some specific philosophical perspectives. This is an expression of reductionism (i.e. objects are made of sub-objects) and epistemological pluralism (i.e. objects are always defined according to the perspective of an interpreter, or a class of interpreters).

The *Perspective* class collects the different ways to represent the objects that populate the conceptual region between the elementary and universe levels.



Figure 1.7: The EMMO top level.

## Middle Level

The middle level ontologies act as roots for extending the EMMO towards specific application domains.

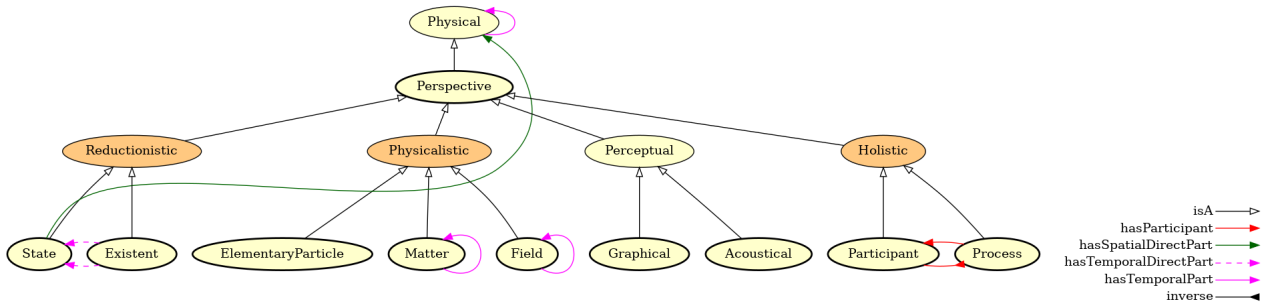


Figure 1.8: The EMMO perspectives.

The *Reductionistic* perspective class uses the fundamental non-transitive parthood relation, called direct parthood, to provide a powerful granularity description of multiscale real world objects. The EMMO can in principle represents the **Universe** with direct parthood relations as a direct rooted tree up to its elementary constituents.

The *Phenomenic* perspective class introduces the concept of real world objects that express of a recognisable pattern in space or time that impress the user. Under this class the EMMO categorises e.g. formal languages, pictures, geometry, mathematics and sounds. Phenomenic objects can be used in a semiotic process as signs.

The *Physicalistic* perspective class introduces the concept of real world objects that have a meaning for the under applied physics perspective.

The *Holistic* perspective class introduces the concept of real world objects that unfold in time in a way that has a meaning for the EMMO user, through the definition of the classes *Process* and *Participant*. The [semiotics](#) module introduces the concepts of semiotics and the *Semiosis* process that has a *Sign*, an *Object* and an *Interpreter* as participants. This forms the basis in EMMO to represent e.g. models, formal languages, theories, information and properties.

## EMMO relations

All EMMO relations are subrelations of the relations found in the two roots: *mereotopological* and *semiotical*. The relation hierarchy extends more vertically (i.e. more subrelations) than horizontally (i.e. less sibling relations), facilitating the categorisation and inferencing of individuals. See also the chapter [EMMO Relations](#).

Imposing all relations to fall under mereotopology or semiotics is how the EMMO force the developers to respect its perspectives. Two entities are related only by contact or parthood (mereotopology) or by standing one for another (semiosis): no other types of relation are possible within the EMMO.

A unique feature in EMMO, is the introduction of *direct parthood*. As illustrated in the figure below, it is a mereological relation that lacks transitivity. This makes it possible to entities made of parts at different levels



Figure 1.9: The semiotic level, showing both the taxonomy (open black arrows) and other relations as listed in the caption. The inverted arrows corresponds to inverse relations.

of granularity and to go between granularity levels in a well-defined manner. This is paramount for cross scale interoperability. Every material in EMMO is placed on a granularity level and the ontology gives information about the direct upper and direct lower level classes using the non-transitive direct parthood relations.

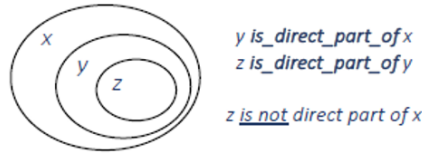


Figure 1.10: Direct parthood.

## Annotations

All entities and relations in EMMO have some attributes, called *annotations*. In some cases, only the required *International Resource Identifier* (IRI) and *relations* are provided. However, descriptive annotations, like *elucidation* and *comment*, are planned to be added for all classes and relations. Possible annotations are:

- **Elucidation** is a human readable explanation and clarification of the documented class or relation.
- **Example** clarifies the elucidation through an example. A class may have several examples, each addressing different aspects.
- **Comment** is a clarifying note complementing the definition and elucidation. A class may have several comments, each clarifying different aspects.
- **IRI** stands for *international resource identifier*. It is an identifier that uniquely identifies the class or relation. IRIs are similar to URIs, but are not restricted to the ASCII character set. In EMMO, the IRIs are now valid URLs pointing to the stable version of EMMO.
- **Relations** is a list of relations applying to the current class or relation. The relations for relations are special and will be elaborated on in the introduction to chapter [Relations]. Some of the listed relations are defined in the OWL sources, while other are inferred by the reasoner. The relations are expressed using the Manchester OWL syntax introduced in section [Description logic](#).

## Chapter 2

# EMMO Relations

In the language of OWL, relations are called *properties*. However, since relations describe relations between classes and individuals and since **properties** has an other meaning in EMMO, we only call them *relations*.

[Resource Description Framework \(RDF\)](#) is a W3C standard that is widely used for describing informations on the web and is one of the standards that OWL builds on. RDF expresses information in form of *subject-predicate-object* triplets. The subject and object are resources (aka items to describe) and the predicate expresses a relationship between the subject and the object.

In OWL are the subject and object classes or individuals (or data) while the predicate is a relation. An example of an relationship is the statement *dog is\_a animal*. Here **dog** is the subject, **is\_a** the predicate and **animal** the object.

OWL distinguishes between *object properties*, that link classes or individuals to classes or individuals, and *data properties* that link individuals to data values. Since EMMO only deals with classes, we will only be discussing object properties. However, in actual simulation or characterisation applications build on EMMO, datatype properties will be important.

The characteristics of the different properties are described by the following *property axioms*:

- **rdf:subPropertyOf** is used to define that a property is a subproperty of some other property. For instance, in the figure below showing the relation branch, we see that **active\_relation** is a subproperty of **relation**. The **rdf:subPropertyOf** axioms forms a taxonomy-like tree for relations.
- **owl:equivalentProperty** states that two properties have the same property extension.
- **owl:inverseOf** axioms relate active relations to their corresponding passive relations, and vice versa. The root relation **relation** is its own inverse.
- **owl:FunctionalProperty** is a property that can have only one (unique) value *y* for each instance *x*, i.e. there cannot be two distinct values *y1* and *y2* such that the pairs (*x,y1*) and (*x,y2*) are both instances of this property. Both object properties and datatype properties can be declared as “functional”.
- **owl:InverseFunctionalProperty**
- **owl:TransitiveProperty** states that if a pair (*x,y*) is an instance of *P*, and the pair (*y,z*) is instance of *P*, then we can infer that the pair (*x,z*) is also an instance of *P*.
- **owl:SymmetricProperty** states that if the pair (*x,y*) is an instance of *P*, then the pair (*y,x*) is also an instance of *P*. A popular example of a symmetric property is the **siblingOf** relation.
- **rdfs:domain** specifies which classes the property applies to. Or said differently, the valid values of the *subject* in a *subject-predicate-object* triplet.
- **rdfs:range** specifies the property extension, i.e. the valid values of the *object* in a *subject-predicate-object* triplet.

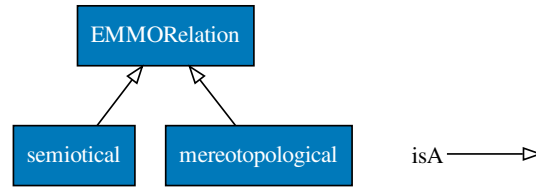


Figure 2.1: Top-level of the EMMO relation hierarchy.

## Root of EMMO relations

### EMMORelation

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_ec2472ae\\_cf4a\\_46a5\\_8555\\_1556f5a6c3c5](http://emmo.info/emmo/top/mereotopology#EMMO_ec2472ae_cf4a_46a5_8555_1556f5a6c3c5)

**Relations:**

- `is_a owl:ObjectProperty`
- `is_a owl:SymmetricProperty`
- `is_a owl:TransitiveProperty`
- `is_a owl:topObjectProperty`
- `inverse_of mereotopology.EMMORelation`
- `domain mereotopology.EMMO`
- `range mereotopology.EMMO`

## Mereotopological branch

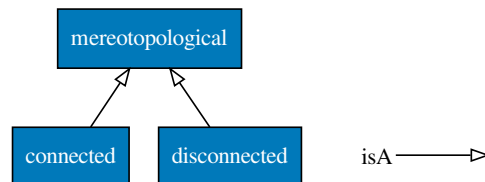


Figure 2.2: Mereotopological branch.

### mereotopological

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_03212fd7\\_abfd\\_4828\\_9c8e\\_62c293052d4b](http://emmo.info/emmo/top/mereotopology#EMMO_03212fd7_abfd_4828_9c8e_62c293052d4b)

**Comment:** Mereotopology merges mereological and topological concepts and provides relations between wholes, parts, boundaries, etc.

**Relations:**

- `is_a owl:ObjectProperty`
- `is_a owl:SymmetricProperty`
- `is_a owl:TransitiveProperty`
- `is_a mereotopology.EMMORelation`
- `Inverse(mereotopology.EMMORelation)`
- `inverse_of mereotopology.mereotopological`



## disconnected

IRI: [http://emmo.info/emmo/top/mereotopology#EMMO\\_517dfaf9\\_4970\\_41ac\\_81ee\\_d031627d2c7c](http://emmo.info/emmo/top/mereotopology#EMMO_517dfaf9_4970_41ac_81ee_d031627d2c7c)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:SymmetricProperty
- is\_a mereotopology.mereotopological
- Inverse(mereotopology.mereotopological)
- inverse\_of mereotopology.disconnected

## Connected branch

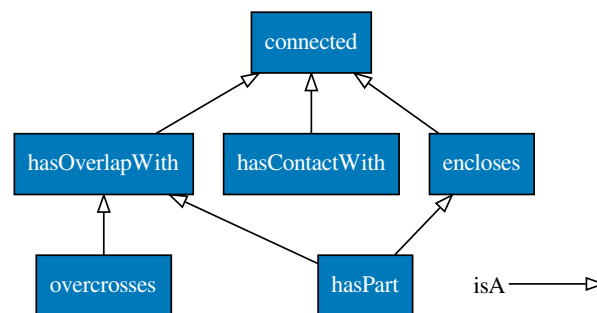


Figure 2.3: Connected branch.

## overcrosses

IRI: [http://emmo.info/emmo/top/mereotopology#EMMO\\_9cb984ca\\_48ad\\_4864\\_b09e\\_50d3fff19420](http://emmo.info/emmo/top/mereotopology#EMMO_9cb984ca_48ad_4864_b09e_50d3fff19420)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:SymmetricProperty
- is\_a mereotopology.hasOverlapWith
- Inverse(mereotopology.hasOverlapWith)
- inverse\_of mereotopology.overcrosses

## hasContactWith

IRI: [http://emmo.info/emmo/top/mereotopology#EMMO\\_4d6504f1\\_c470\\_4ce9\\_b941\\_bbbbec9ab05d](http://emmo.info/emmo/top/mereotopology#EMMO_4d6504f1_c470_4ce9_b941_bbbbec9ab05d)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:SymmetricProperty
- is\_a mereotopology.connected
- Inverse(mereotopology.connected)
- inverse\_of mereotopology.hasContactWith

## connected

IRI: [http://emmo.info/emmo/top/mereotopology#EMMO\\_6703954e\\_34c4\\_4a15\\_a9e7\\_f313760ae1a8](http://emmo.info/emmo/top/mereotopology#EMMO_6703954e_34c4_4a15_a9e7_f313760ae1a8)

**Comment:** Causality is a topological property between connected items.

**Comment:** Items being connected means that there is a topological contact or “interaction” between them.

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:SymmetricProperty
- is\_a mereotopology.mereotopological
- Inverse(mereotopology.mereotopological)
- inverse\_of mereotopology.connected

## encloses

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_8c898653\\_1118\\_4682\\_9bbf\\_6cc334d16a99](http://emmo.info/emmo/top/mereotopology#EMMO_8c898653_1118_4682_9bbf_6cc334d16a99)

**Comment:** Enclosure is reflexive and transitive.

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.connected
- Inverse(mereotopology.connected)

## hasOverlapWith

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_d893d373\\_b579\\_4867\\_841e\\_1c2b31a8d2c6](http://emmo.info/emmo/top/mereotopology#EMMO_d893d373_b579_4867_841e_1c2b31a8d2c6)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:SymmetricProperty
- is\_a mereotopology.connected
- Inverse(mereotopology.connected)
- inverse\_of mereotopology.hasOverlapWith

## Has Part branch

### hasTemporalDirectPart

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_65a2c5b8\\_e4d8\\_4a51\\_b2f8\\_e55effc0547d](http://emmo.info/emmo/middle/reductionistic#EMMO_65a2c5b8_e4d8_4a51_b2f8_e55effc0547d)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:InverseFunctionalProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a physical.hasTemporalPart
- domain reductionistic.Existent
- range reductionistic.State

### hasSpatioTemporalPart

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_6e046dd0\\_9634\\_4013\\_b2b1\\_9cc468087c83](http://emmo.info/emmo/top/physical#EMMO_6e046dd0_9634_4013_b2b1_9cc468087c83)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.hasProperPart

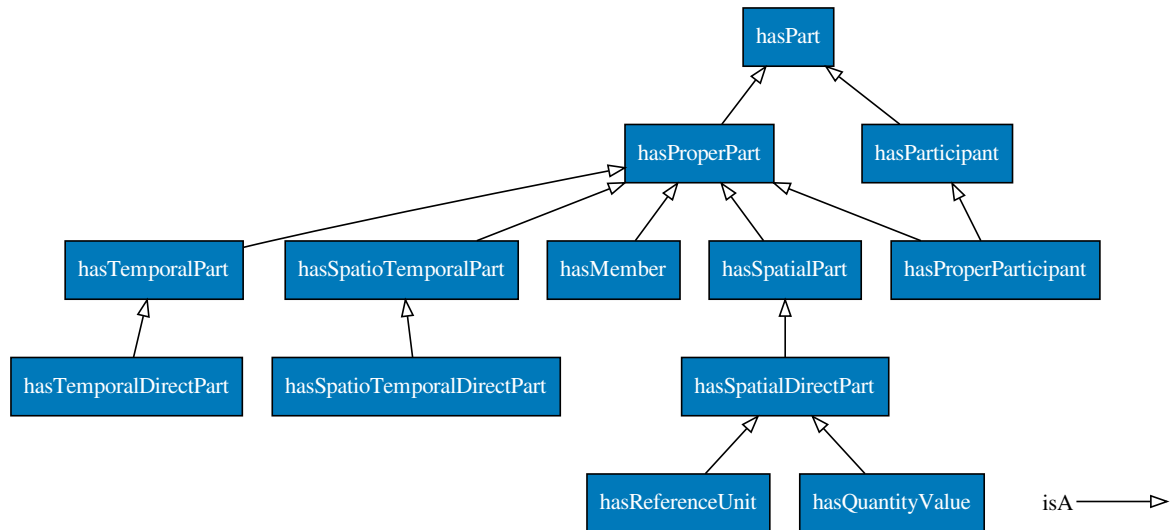


Figure 2.4: Has Part branch.

- domain mereotopology.Item
- range mereotopology.Item

## hasTemporalPart

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_7afbed84\\_7593\\_4a23\\_bd88\\_9d9c6b04e8f6](http://emmo.info/emmo/top/physical#EMMO_7afbed84_7593_4a23_bd88_9d9c6b04e8f6)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.hasProperPart
- domain mereotopology.Item
- range mereotopology.Item

## hasSpatioTemporalDirectPart

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_663859e5\\_add3\\_4c9e\\_96fb\\_c99399de278d](http://emmo.info/emmo/middle/reductionistic#EMMO_663859e5_add3_4c9e_96fb_c99399de278d)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:InverseFunctionalProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a physical.hasSpatioTemporalPart

## hasPart

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_17e27c22\\_37e1\\_468c\\_9dd7\\_95e137f73e7f](http://emmo.info/emmo/top/mereotopology#EMMO_17e27c22_37e1_468c_9dd7_95e137f73e7f)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.encloses
- is\_a mereotopology.hasOverlapWith

- Inverse(mereotopology.hasOverlapWith)

## hasReferenceUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_67fc0a36\\_8dcb\\_4ffa\\_9a43\\_31074efa3296](http://emmo.info/emmo/middle/metrology#EMMO_67fc0a36_8dcb_4ffa_9a43_31074efa3296)

**Comment:** Relates the physical quantity to its unit through spatial direct parthood.

**Versioninfo:** In EMMO version 1.0.0-alpha2, physical quantities used the hasReferenceUnit object property to relate them to their units via physical dimensionality. This was simplified in 1.0.0-alpha3 in order to make reasoning faster.

The restriction (e.g. for the physical quantity Length)

`Length hasReferenceUnit only (hasPhysicsDimension only LengthDimension)`

was in 1.0.0-alpha3 changed to

`Length hasPhysicsDimension some LengthDimension`

Likewise were the universal restrictions on the corresponding unit changed to existential. E.g.

`Metre hasPhysicsDimension only LengthDimension`

was changed to

`Metre hasPhysicsDimension some LengthDimension`

The label of this class was also changed from PhysicsDimension to PhysicalDimension.

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:InverseFunctionalProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a reductionistic.hasSpatialDirectPart
- domain metrology.Quantity
- range metrology.ReferenceUnit

## hasQuantityValue

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_8ef3cd6d\\_ae58\\_4a8d\\_9fc0\\_ad8f49015cd0](http://emmo.info/emmo/middle/metrology#EMMO_8ef3cd6d_ae58_4a8d_9fc0_ad8f49015cd0)

**Comment:** Relates a quantity to its reference unit through spatial direct parthood.

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:InverseFunctionalProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a reductionistic.hasSpatialDirectPart
- domain metrology.Quantity
- range math.Numerical

## hasMember

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_6b7276a4\\_4b9d\\_440a\\_b577\\_0277539c0fc4](http://emmo.info/emmo/top/mereotopology#EMMO_6b7276a4_4b9d_440a_b577_0277539c0fc4)

### Relations:

- is\_a owl:ObjectProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a mereotopology.hasProperPart
- domain mereotopology.Collection

- range mereotopology.Item

## hasProperParticipant

**IRI:** [http://emmo.info/emmo/middle/holistic#EMMO\\_c5aae418\\_1622\\_4d02\\_93c5\\_21159e28e6c1](http://emmo.info/emmo/middle/holistic#EMMO_c5aae418_1622_4d02_93c5_21159e28e6c1)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a holistic.hasParticipant
- is\_a mereotopology.hasProperPart

## hasProperPart

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_9380ab64\\_0363\\_4804\\_b13f\\_3a8a94119a76](http://emmo.info/emmo/top/mereotopology#EMMO_9380ab64_0363_4804_b13f_3a8a94119a76)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.hasPart

## hasSpatialDirectPart

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_b2282816\\_b7a3\\_44c6\\_b2cb\\_3feff1ceb7fe](http://emmo.info/emmo/middle/reductionistic#EMMO_b2282816_b7a3_44c6_b2cb_3feff1ceb7fe)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:InverseFunctionalProperty
- is\_a owl:AsymmetricProperty
- is\_a owl:IrreflexiveProperty
- is\_a physical.hasSpatialPart
- domain reductionistic.State

## hasParticipant

**IRI:** [http://emmo.info/emmo/middle/holistic#EMMO\\_ae2d1a96\\_bfa1\\_409a\\_a7d2\\_03d69e8a125a](http://emmo.info/emmo/middle/holistic#EMMO_ae2d1a96_bfa1_409a_a7d2_03d69e8a125a)

**Comment:** Participation is a parthood relation: you must be part (and then be connected) of the process to contribute to it.

**Comment:** Participation is not under direct parthood since a process is not strictly related to reductionism, but it's a way to categorize temporal regions by the interpreters.

**Relations:**

- is\_a owl:ObjectProperty
- is\_a mereotopology.hasPart
- domain holistic.Process
- range holistic.Participant

## hasSpatialPart

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_f68030be\\_94b8\\_4c61\\_a161\\_886468558054](http://emmo.info/emmo/top/physical#EMMO_f68030be_94b8_4c61_a161_886468558054)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a owl:TransitiveProperty
- is\_a mereotopology.hasProperPart
- domain mereotopology.Item

- range mereotopology.Item

## Semiotical branch

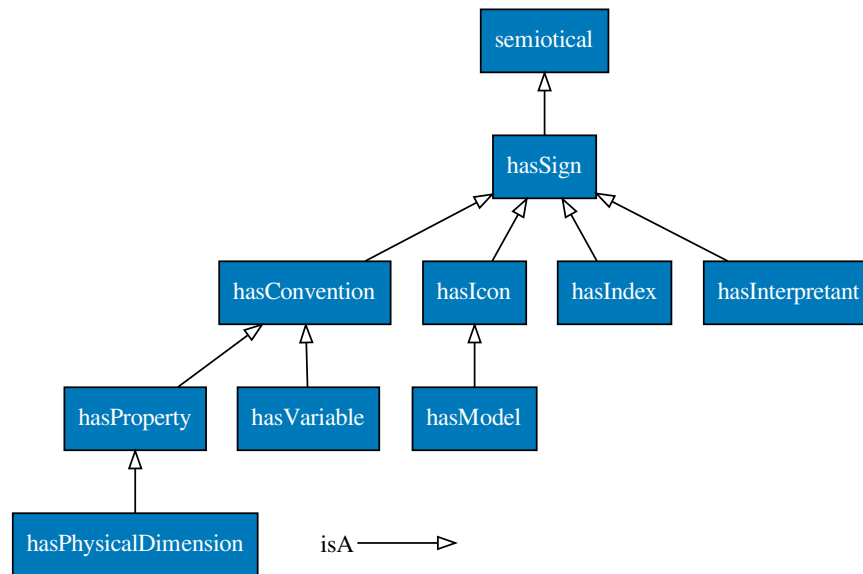


Figure 2.5: Semiotical branch.

### hasPhysicalDimension

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_bed1d005\\_b04e\\_4a90\\_94cf\\_02bc678a8569](http://emmo.info/emmo/middle/metrology#EMMO_bed1d005_b04e_4a90_94cf_02bc678a8569)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a properties.hasProperty
- range metrology.PhysicalDimension

### hasIcon

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_39c3815d\\_8cae\\_4c8f\\_b2ff\\_eeba24bec455](http://emmo.info/emmo/middle/semiotics#EMMO_39c3815d_8cae_4c8f_b2ff_eeba24bec455)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasSign
- range semiotics.Icon

### hasIndex

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_297999d6\\_c9e4\\_4262\\_9536\\_bd524d1c6e21](http://emmo.info/emmo/middle/semiotics#EMMO_297999d6_c9e4_4262_9536_bd524d1c6e21)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasSign
- range semiotics.Index

## hasModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_24c71baf\\_6db6\\_48b9\\_86c8\\_8c70cf36db0c](http://emmo.info/emmo/middle/models#EMMO_24c71baf_6db6_48b9_86c8_8c70cf36db0c)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasIcon

## semiotical

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_2337e25c\\_3c60\\_43fc\\_a8f9\\_b11a3f974291](http://emmo.info/emmo/middle/semiotics#EMMO_2337e25c_3c60_43fc_a8f9_b11a3f974291)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a mereotopology.EMMORelation
- Inverse(mereotopology.EMMORelation)

## hasInterpretant

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_7fb7fe7e\\_bdf9\\_4eeb\\_adad\\_e384dd5285c6](http://emmo.info/emmo/middle/semiotics#EMMO_7fb7fe7e_bdf9_4eeb_adad_e384dd5285c6)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasSign
- range semiotics.Interpretant

## hasSign

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_60577dea\\_9019\\_4537\\_ac41\\_80b0fb563d41](http://emmo.info/emmo/middle/semiotics#EMMO_60577dea_9019_4537_ac41_80b0fb563d41)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.semiotical
- domain semiotics.Object
- range semiotics.Sign

## hasVariable

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_3446e167\\_c576\\_49d6\\_846c\\_215bb8878a55](http://emmo.info/emmo/middle/math#EMMO_3446e167_c576_49d6_846c_215bb8878a55)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasConvention
- domain math.Mathematical
- range math.Variable

## hasConvention

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_eb3518bf\\_f799\\_4f9e\\_8c3e\\_ce59af11453b](http://emmo.info/emmo/middle/semiotics#EMMO_eb3518bf_f799_4f9e_8c3e_ce59af11453b)

**Relations:**

- is\_a owl:ObjectProperty
- is\_a semiotics.hasSign
- range semiotics.Conventional

## hasProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_e1097637\\_70d2\\_4895\\_973f\\_2396f04fa204](http://emmo.info/emmo/middle/properties#EMMO_e1097637_70d2_4895_973f_2396f04fa204)

### Relations:

- is\_a owl:ObjectProperty
- is\_a semiotics.hasConvention
- domain semiotics.Object
- range properties.Property



## Chapter 3

# EMMO Classes

*emmo* is a class representing the collection of all the individuals (signs) that are used in the ontology. Individuals are declared by the EMMO users when they want to apply the EMMO to represent the world.

### EMMO branch

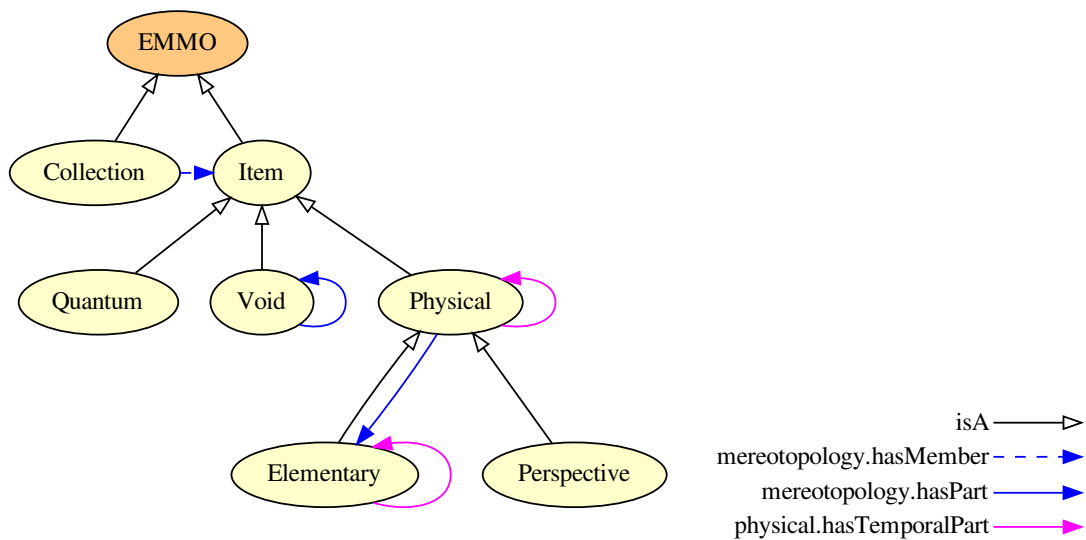


Figure 3.1: EMMO branch.

The root of all classes used to represent the world. It has two children; *collection* and *item*.

*collection* is the class representing the collection of all the individuals (signs) that represents a collection of non-connected real world objects.

*item* Is the class that collects all the individuals that are members of a set (it's the most comprehensive set individual). It is the branch of mereotopology.

### Item

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_eb3a768e\\_d53e\\_4be9\\_a23b\\_0714833c36de](http://emmo.info/emmo/top/mereotopology#EMMO_eb3a768e_d53e_4be9_a23b_0714833c36de)

**Comment:** A real world object is self-connected if any two parts that make up the whole are connected to each other (here the concept of connection is primitive).

Alternatively, using the primitive path-connectivity concept we can define a self-connected real world object as an object for which each couple of points is path-connected.

**Comment:** An ‘Item’ individual stands for a real world self-connected object which can be represented as a whole made of connected parts (e.g. a car made of components).

In the EMMO, connectivity is the topological foundation of causality.

All physical systems, i.e. systems whose behaviour is explained by physics laws, are represented only by ‘Item’-s.

Members of a ‘Collection’ lack of causality connection, i.e. they do not constitute a physical system as a whole.

**Comment:** From Latin item, “likewise, just so, moreover”.

**Relations:**

- is\_a mereotopology.EMMO
- disjoint\_union\_of physical.Void, physical.Physical

## Collection

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_2d2ecd97\\_067f\\_4d0e\\_950c\\_d746b7700a31](http://emmo.info/emmo/top/mereotopology#EMMO_2d2ecd97_067f_4d0e_950c_d746b7700a31)

**Elucidation:** The class of all individuals that stand for a real world not self-connected object.

**Comment:** A ‘Collection’ individual stands for a non-self-connected real world object.

A ‘Collection’ individual is related to each ‘Item’ individuals of the collection (i.e. the members) through the membership relation.

An ‘Item’ individual stands for a real world self-connected object which can be represented as a whole made of connected parts (e.g. a car made of components).

**Comment:** Formally, ‘Collection’ is axiomatized as the class of individuals that hasMember some ‘Item’.

A ‘Collection’ cannot have as member another ‘Collection’.

**Comment:** From Latin collectio, from colligere ‘gather together’.

**Comment:** e.g. the collection of users of a particular software, the collection of atoms that have been part of that just dissociated molecule, or even the collection of atoms that are part of a molecule considered as single individual non-connected objects and not as a mereotopological self-connected fusion.

**Relations:**

- is\_a mereotopology.EMMO
- mereotopology.hasMember some mereotopology.Item

## Void

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_29072ec4\\_ffcb\\_42fb\\_bdc7\\_26f05a2e9873](http://emmo.info/emmo/top/physical#EMMO_29072ec4_ffcb_42fb_bdc7_26f05a2e9873)

**Elucidation:** A ‘Item’ that has no ‘Physical’ parts.

**Comment:** From Latin vacuus, “empty”.

**Comment:** The void concept is paramount for the representation of physical systems according to quantum theory.

**Relations:**

- is\_a mereotopology.Item
- mereotopology.hasPart only physical.Void

## EMMO

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_802d3e92\\_8770\\_4f98\\_a289\\_ccaaab7fdddf](http://emmo.info/emmo/top/mereotopology#EMMO_802d3e92_8770_4f98_a289_ccaaab7fdddf)

**Elucidation:** The class representing the collection of all the individuals declared in this ontology standing for real world objects.

**Comment:** ‘EMMO’ is the disjoint union of ‘Item’ and ‘Collection’ (covering axiom).

The union implies that ‘EMMO’ individuals can only be ‘Item’ individuals (standing for self-connected real world objects) or ‘Collection’ individuals (standing for a collection of disconnected items).

Disjointness means that a ‘Collection’ individual cannot be an ‘Item’ individual and viceversa, representing the fact that a real world object cannot be self-connected and non-self connected at the same time.

**Comment:** For the EMMO ontologist the whole universe is represented as a 4D path-connected topological manifold (i.e. the spacetime).

A real world object is then a 4D topological sub-region of the universe.

A universe sub-region is isolated and defined as a real world object by the ontologist. Then, through a semiotic process that occurs at meta-ontological level (i.e. outside the ontology). an EMMO ontology entity (e.g. an OWL individual) is assigned to represent that real world object.

The fundamental distinction between real world objects, upon which the EMMO is based, is self-connectedness: a real world object can be self-connected xor not self-connected.

**Comment:** In the EMMO we will refer to the universe as a Minkowski space, restricting the ontology to special relativity only. However, extension to general relativity, will adding more complexity, should not change the overall approach.

**Comment:** Mereotopology is the fundamental logical representation used by the EMMO ontologist to characterize the universe and to provide the definitions to connect real world objects to the EMMO concepts.

Parthood relations do not change dimensionality of the real world object referred by an ‘EMMO’ individual, i.e. every part of a real world object always retains its 4D dimensionality.

The smallest part of a real world object (i.e. a part that has no proper parts) is referred in the EMMO by a ‘Quantum’ individual.

It follows that, for the EMMO, real world objects of dimensionality lower than 4D (e.g. surfaces, lines) do not exist.

### Relations:

- `is_a owl:Thing`
- `equivalent_to mereotopology.hasPart some mereotopology.Quantum`
- `equivalent_to Inverse(mereotopology.hasPart) value mereotopology.Universe`
- `disjoint_union_of mereotopology.Collection, mereotopology.Item`

## Physical

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_c5ddfdbba\\_c074\\_4aa4\\_ad6b\\_1ac4942d300d](http://emmo.info/emmo/top/physical#EMMO_c5ddfdbba_c074_4aa4_ad6b_1ac4942d300d)

**Elucidation:** A ‘Item’ that has part some ‘Elementary’ and whose temporal proper parts are only ‘Physical’-s (i.e. it can be perceived without interruptions in time).

**Comment:** A ‘Physical’ is the class that contains all the individuals that stand for real world objects that interact physically with the ontologist, i.e. physical objects.

A physical object must be perceived through physical interaction by the ontologist. Then the ontologist can declare an individual standing for the physical object just perceived.

Perception is a subcategory of physical interactions. It is an interaction that stimulate a representation of the physical object within the ontologist (the agent).

**Comment:** A ‘Physical’ must include at least an ‘Elementary’ part, and can include ‘Void’ parts.

A ‘Physical’ may include as part also the ‘Void’ surrounding or enclosed by its ‘Physical’ sub parts.

There are no particular criteria for ‘Physical’-s structure, except that is made of some ‘Elementary’-s as proper parts and not only ‘Void’.

This is done in order to take into account the quantum nature of physical systems, in which the actual position of sub-components (e.g. electrons in an atom) is not known except for its probability distribution function (according to the Copenhagen interpretation.)

e.g. a real world object that has spatial parts an atom and a cubic light year of void, extending for some time, can be a physical object.

**Comment:** A ‘Physical’ with dimensions other than 4D cannot exist, following the restriction of the parent ‘EMMO’ class.

It follows from the fact that perception is always unfolding in time.

e.g. you always have an aperture time when you take a picture or measure a property. Instantaneous perceptions are idealizations (abstractions) or a very small time measurement.

**Comment:** From Latin physica “study of nature” (and Ancient Greek φυσικός, “natural”).

Here the word relates to things perceived through the senses as opposed to the mind; tangible or concrete.

**Comment:** In the EMMO there are no relations such as occupiesSpace, since ‘Physical’-s are themselves the 4D regions.

**Comment:** The EMMO can be used to represent real world entities as ‘Physical’-s that are easy to connect to classical or quantum mechanical based models.

Classical mechanics poses no representational issues, for the EMMO: the 4D representation of ‘Physical’-s is consistent with classical physics systems.

However, the representation of ‘Physical’-s that are typically analyzed through quantum mechanics (e.g. molecules, atoms, clusters), is not straightforward.

- 1) De Broglie - Bohm interpretation The most simple approach is to rely on Bohmian mechanics, in which each particle is supposed to exist in a specific position between measurements (hidden variables approach), while its trajectory is calculated using a Guiding Equation based on a quantum field calculated with the Schroedinger Equation.

While this approach is really easy to implement in an ontology, since each entity has its own well defined 4D region, its mathematical representation failed to receive large consensus due to the difficulties to include relativistic effects, to be extended to subnuclear scale and the strong non-locality assumption of the quantum field.

Nevertheless, the Bohmian mechanics is a numerical approach that is used in electronic models to reduce the computational effort of the solution of Schroedinger Equation.

In practice, an EMMO user can declare a ‘physical’ individual that stand for the whole quantum system to be described, and at the same time all sub-parts individuals can be declared, having them a well defined position in time, according to De Broglie - Bohm interpretation. The Hamiltonian can be calculated by considering the sub-part individuals.

‘physical’-s are then made of ‘physical’ parts and ‘void’ parts that stand for the space between ‘physical’-s (e.g. the void between electrons and nucleus in an atom).

- 2) Copenhagen interpretation In this interpretation the properties (e.g. energy level, position, spin) of a particle are not defined in the interval between two measurements and the quantum system is entangled (i.e. properties of particles in the system are correlated) and described by a global wavefunction obtained solving the Schroedinger Equation.

Upon measurement, the wavefunction collapses to a combination of close eigenstates that provide information about bservables of the system components (e.g. position, energy).

The EMMO can be used to represent ‘physical’-s that can be related to Copenhagen based models. In practice, the user should follow these steps:

- a) define the quantum system as a ‘physical’ individual (e.g. an H2 molecule) under a specific class (e.g. ‘h2\_molecule’). This individual is the whole.

- b) define the axioms of the class that describe how many sub-parts are expected for the whole and their class types (e.g. 'h2\_molecule' has axioms 'has\_proper\_part exactly 2 electron' and 'has\_proper\_part exactly 2 nucleus')
- c) the user can now connect the whole to a Schrodinger equation based model whose Hamiltonian is calculated through the information coming only from the axioms. No individuals are declared for the subparts!
- d) a measurement done on the quantum system that provides information on the sub-part observables is interpreted as wavefunction collapse and leads to the end of the whole and the declaration of the sub-parts individuals which can be themselves other quantum systems

e.g. if the outer electron of the H2 molecule interacts with another entity defining its state, then the whole that stands for the entangled H2 molecule becomes a 'physical' made of an electron individual, a quantum system made of one electron and two nuclei and the void between them.

e.g. in the Born-Oppenheimer approximation the user represents the atom by un-entangling nucleus and electronic cloud. The un-entanglement comes in the form of declaration of individual as parts.

e.g. the double slit experiment can be represented in the EMMO as: a) before the slit: a 'physical' that extends in space and has parts 'electron' and 'void', called 'single\_electron\_wave\_function'. 'electron' and 'void' are only in the axioms and not declared individuals. b) during slit passage: a 'physical' made of one declared individual, the 'electron'. c) after the slit: again 'single\_electron\_wave\_function' d) upon collision with the detector: 'physical' made of one declared individual, the 'electron'.

**Comment:** The purpose of the 'Physical' branch is to provide a representation of the real world objects, while the models used to name, explain or predict the behaviour of the real world objects lay under the 'Semiotic' branch.

More than one semiotic representation can be connected to the same 'Physical'.

e.g. Navier-Stokes or Euler equation applied to the same fluid are an example of mathematical model used to represent a physical object for some specific interpreter.

#### Relations:

- is\_a mereotopology.Item
- mereotopology.hasPart some physical.Elementary
- physical.hasTemporalPart only physical.Physical

#### Individuals:

- mereotopology.Universe

## Quantum

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_3f9ae00e\\_810c\\_4518\\_aec2\\_7200e424cf68](http://emmo.info/emmo/top/mereotopology#EMMO_3f9ae00e_810c_4518_aec2_7200e424cf68)

**Elucidation:** The class of 'EMMO' individuals that stand for real world objects that can't be further divided in time nor in space.

**Example:** For a physics based ontology the 'Quantum' can stand for the smallest identifiable portion of spacetime defined by the Planck limit in length (1.616e-35 m) and time (5.39e-44 s).

However, the quantum mereotopology approach is not restricted only to physics. For example, in a manpower management ontology, a 'Quantum' can stand for an hour (time) of a worker (space) activity.

**Comment:** A 'Quantum' is the most fundamental subclass of 'Item', since its individuals stand for the smallest possible self-connected 4D real world objects.

The quantum concept recalls the fact that there is lower epistemological limit to our knowledge of the universe, related to the uncertainty principle.

**Comment:** A 'Quantum' stands for a 4D real world object.

**Comment:** A quantum is the EMMO mereological 4D a-tomic entity.

To avoid confusion with the concept of atom coming from physics, we will use the expression quantum mereology, instead of a-tomistic mereology.

**Comment:** From Latin quantum (plural quanta) “as much as, so much as;”, introduced in physics directly from Latin by Max Planck, 1900.

**Relations:**

- is\_a mereotopology.Item
- is\_a mereotopology.EMMO
- mereotopology.hasProperPart only owl:Nothing

## Elementary branch

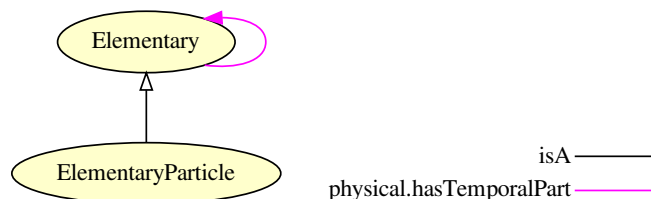


Figure 3.2: Elementary branch.

## Elementary

**IRI:** [http://emmo.info/emmo/top/physical#EMMO\\_0f795e3e\\_c602\\_4577\\_9a43\\_d5a231aa1360](http://emmo.info/emmo/top/physical#EMMO_0f795e3e_c602_4577_9a43_d5a231aa1360)

**Elucidation:** The basic constituent of ‘item’-s that can be proper partitioned only in time up to quantum level.

**Comment:** According to mereology, this should be call ‘a-tomistic’ in the strict etimological sense of the word (from greek, a-tomos: un-divisible).

Mereology based on such items is called atomistic mereology.

However, in order not to confuse the lexicon between mereology and physics (in which an atom is a divisible physical entity) we prefer to call it ‘elementary’, recalling the concept of elementary particle coming from the standard particles model.

**Comment:** From Latin elementārius (“elementary”), from elementum (“one of the four elements of antiquity; fundamentals”)

**Comment:** While a ‘Quantum’ is a-tomistic in time and space, an ‘elementary’ is a-tomistic only in space, recalling the concept of elementary particle.

**Relations:**

- is\_a physical.Physical
- physical.hasTemporalPart only physical.Elementary
- physical.hasSpatialPart only owl:Nothing

## Perspective branch

### Perspective

**IRI:** [http://emmo.info/emmo/top#EMMO\\_49267eba\\_5548\\_4163\\_8f36\\_518d65b583f9](http://emmo.info/emmo/top#EMMO_49267eba_5548_4163_8f36_518d65b583f9)

**Elucidation:** The class of individuals that stand for real world objects according to a specific representational perspective.

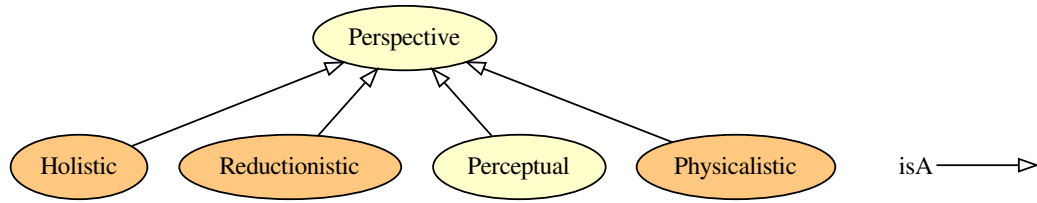


Figure 3.3: Perspective branch.

**Comment:** This class is the practical implementation of the EMMO pluralistic approach for which the only objective categorization is provided by the Universe individual and all the Quantum individuals.

Between these two extremes, there are several subjective ways to categorize real world objects, each one provide under a ‘Perspective’ subclass.

**Relations:**

- is\_a physical.Physical

## Holistic branch

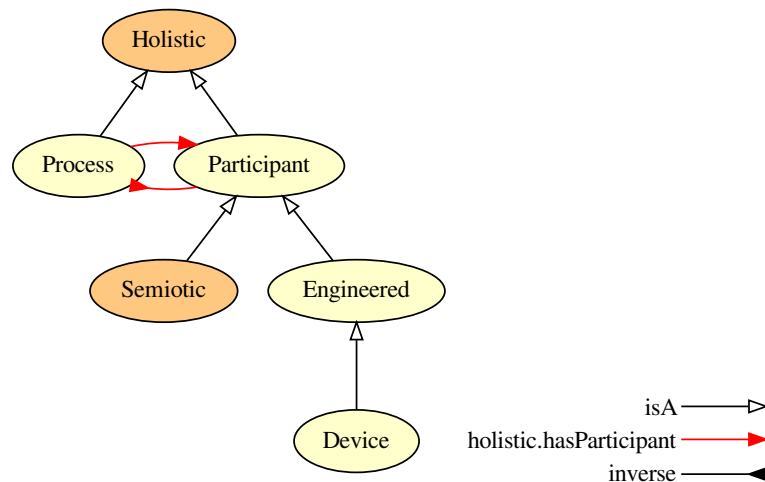


Figure 3.4: Holistic branch.

## Holistic

**IRI:** [http://emmo.info/emmo/middle/holistic#EMMO\\_0277f24a\\_ea7f\\_4917\\_81b7\\_fb0406c8fc62](http://emmo.info/emmo/middle/holistic#EMMO_0277f24a_ea7f_4917_81b7_fb0406c8fc62)

**Elucidation:** A union of classes that categorize physicals under a holistic perspective: the interest is on the whole 4D object (process) and the role of its 4D parts (participants) without going further into specifying the spatial hierarchy or the temporal position of each part.

**Comment:** An holistic perspective considers each part of the whole as equally important, without the need of a granularity hierarchy (in time or space).

A molecule of a body can have role in the body evolution, without caring if its part of a specific organ and without specifying the time interval in which this role occurred.

This class allows the picking of parts without necessarily going through a rigid hierarchy of spatial compositions (e.g. body → organ → cell → molecule) or temporal composition.

**Comment:** Holism (from Greek ὅλος holos “all, whole, entire”)

**Relations:**

- is\_a top.Perspective
- equivalent\_to holistic.Process or holistic.Participant

## Device

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_494b372c\\_cfd\\_47d3\\_a4de\\_5e037c540de8](http://emmo.info/emmo/middle/manufacturing#EMMO_494b372c_cfd_47d3_a4de_5e037c540de8)

**Elucidation:** An engineered object which is instrumental for reaching a particular purpose through its characteristic functioning process, with particular reference to mechanical or electronic equipment.

**Comment:** From Old French “deviser”, meaning: arrange, plan, contrive.

Literally “dispose in portions,” from Vulgar Latin “divisare”, frequentative of Latin dividere, meaning “to divide”

**Relations:**

- is\_a manufacturing.Engineered
- Inverse(holistic.hasProperParticipant) some manufacturing.DiscreteManufacturing

## EngineeredMaterial

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_ec7464a9\\_d99d\\_45f8\\_965b\\_4e9230ea8356](http://emmo.info/emmo/middle/manufacturing#EMMO_ec7464a9_d99d_45f8_965b_4e9230ea8356)

**Comment:** A material that is synthesized within a manufacturing process.

**Relations:**

- is\_a manufacturing.Engineered
- is\_a physicalistic.Material
- Inverse(holistic.hasProperParticipant) some manufacturing.ContinuousManufacturing

## Engineered

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_86ca9b93\\_1183\\_4b65\\_81b8\\_c0fcd3bba5ad](http://emmo.info/emmo/middle/manufacturing#EMMO_86ca9b93_1183_4b65_81b8_c0fcd3bba5ad)

**Elucidation:** A ‘physical’ that stands for a real world object that has been designed and manufactured for a particular purpose.

**Example:** Car, tire, composite material.

**Comment:** The ‘Engineered’ branch represents real world objects that show some level of complexity/heterogeneity in their composition, and are made for a specific use.

**Relations:**

- is\_a holistic.Participant
- Inverse(holistic.hasProperParticipant) some manufacturing.Manufacturing

## Participant

**IRI:** [http://emmo.info/emmo/middle/holistic#EMMO\\_49804605\\_c0fe\\_4538\\_abda\\_f70ba1dc8a5d](http://emmo.info/emmo/middle/holistic#EMMO_49804605_c0fe_4538_abda_f70ba1dc8a5d)

**Elucidation:** A portion of a ‘Process’ that participates to the process with a specific role.

**Comment:** In the EMMO the relation of participation to a process falls under mereotopology.



Since topological connection means causality, then the only way for a real world object to participate to a process is to be a part of it.

#### Relations:

- is\_a holistic.Holistic
- is\_a physical.Physical
- Inverse(holistic.hasParticipant) some holistic.Process

## Semiotic branch

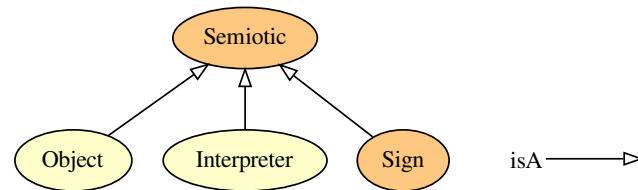


Figure 3.5: Semiotic branch.

### Semiotic

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_b803f122\\_4acb\\_4064\\_9d71\\_c1e5fd091fc9](http://emmo.info/emmo/middle/semiotics#EMMO_b803f122_4acb_4064_9d71_c1e5fd091fc9)

**Elucidation:** The class of individuals that stands for semiotic objects, i.e. objects that take part on a semiotic process.

**Comment:** Semiotic subclasses are defined using Peirce's semiotic theory.

“Namely, a sign is something, A, which brings something, B, its interpretant sign determined or created by it, into the same sort of correspondence with something, C, its object, as that in which itself stands to C.” (Peirce 1902, NEM 4, 20–21).

The triadic elements: - ‘sign’: the sign A (e.g. a name) - ‘interpretant’: the sign B as the effects of the sign A on the interpreter (e.g. the mental concept of what a name means) - ‘object’: the object C (e.g. the entity to which the sign A and B refer to)

This class includes also the ‘interpreter’ i.e. the entity that connects the ‘sign’ to the ‘object’

#### Relations:

- is\_a holistic.Participant
- Inverse(holistic.hasProperParticipant) some semiotics.Semiosis
- equivalent\_to semiotics.Interpreter or semiotics.Object or semiotics.Sign

## Sign branch

### Sign

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_b21a56ed\\_f969\\_4612\\_a6ec\\_cb7766f7f31d](http://emmo.info/emmo/middle/semiotics#EMMO_b21a56ed_f969_4612_a6ec_cb7766f7f31d)

**Elucidation:** An ‘Physical’ that is used as sign (“semeion” in greek) that stands for another ‘Physical’ through an semiotic process.

**Example:** A novel is made of chapters, paragraphs, sentences, words and characters (in a direct parthood mereological hierarchy).

Each of them are ‘sign’-s.

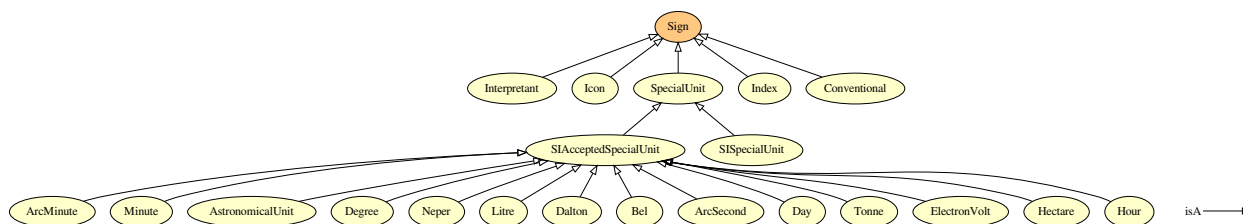


Figure 3.6: Sign branch.

A character can be the a-tomistic ‘sign’ for the class of texts.

The horizontal segment in the character “A” is direct part of “A” but it is not a ‘sign’ itself.

For plain text we can propose the ASCII symbols, for math the fundamental math symbols.

**Comment:** A ‘Sign’ can have temporal-direct-parts which are ‘Sign’ themselves.

A ‘Sign’ usually have ‘sign’ spatial direct parts only up to a certain elementary semiotic level, in which the part is only a ‘Physical’ and no more a ‘Sign’ (i.e. it stands for nothing). This elementary semiotic level is peculiar to each particular system of signs (e.g. text, painting).

Just like an ‘Elementary’ in the ‘Physical’ branch, each ‘Sign’ branch should have an a-tomistic mereological part.

**Comment:** According to Peirce, ‘Sign’ includes three subcategories: - symbols: that stand for an object through convention - indeces: that stand for an object due to causal contiguity - icon: that stand for an object due to similitudes e.g. in shape or composition

**Relations:**

- is\_a semiotics.Semiotic
- equivalent\_to semiotics.Index or semiotics.Conventional or semiotics.Icon

## ArcMinute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_1e0b665d\\_db6c\\_4752\\_a6d4\\_262d3a8dbb46](http://emmo.info/emmo/middle/units-extension#EMMO_1e0b665d_db6c_4752_a6d4_262d3a8dbb46)

**Definition:** Measure of plane angle defined as 1/60 of a degree.

**Altlabel:** MinuteOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCMIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## Interpretant

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_054af807\\_85cd\\_4a13\\_8eba\\_119dfdaaf38b](http://emmo.info/emmo/middle/semiotics#EMMO_054af807_85cd_4a13_8eba_119dfdaaf38b)

**Elucidation:** The interpreter’s internal representation of the object in a semiosis process.

**Relations:**

- is\_a semiotics.Sign

## Minute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cabb20f0\\_05c7\\_448f\\_9485\\_e129725f15a4](http://emmo.info/emmo/middle/units-extension#EMMO_cabb20f0_05c7_448f_9485_e129725f15a4)

**Definition:** Non-SI time unit defined as 60 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Minute>

**Qudtentry:** <http://qudt.org/vocab/unit/MIN>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “min”

## SpecialUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3ee80521\\_3c23\\_4dd1\\_935d\\_9d522614a3e2](http://emmo.info/emmo/middle/metrology#EMMO_3ee80521_3c23_4dd1_935d_9d522614a3e2)

**Elucidation:** A unit symbol that stands for a derived unit.

**Example:** Pa stands for N/m<sup>2</sup> J stands for N m

**Comment:** Special units are semiotic shortcuts to more complex composed symbolic objects.

### Relations:

- is\_a metrology.DerivedUnit
- is\_a metrology.UnitSymbol
- is\_a semiotics.Sign
- Inverse(semiotics.hasSign) some metrology.DerivedUnit

## AstronomicalUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_053648ea\\_3c0a\\_468c\\_89cb\\_eb009239323a](http://emmo.info/emmo/middle/units-extension#EMMO_053648ea_3c0a_468c_89cb_eb009239323a)

**Definition:** One astronomical unit is defined as exactly 149597870700 m, which is roughly the distance from earth to sun.

**Dbpediaentry:** [http://dbpedia.org/page/Astronomical\\_unit](http://dbpedia.org/page/Astronomical_unit)

**Qudtentry:** <http://qudt.org/vocab/unit/PARSEC>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Astronomical\\_unit](https://en.wikipedia.org/wiki/Astronomical_unit)

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “au”

## Index

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_0cd58641\\_824c\\_4851\\_907f\\_f4c3be76630c](http://emmo.info/emmo/middle/semiotics#EMMO_0cd58641_824c_4851_907f_f4c3be76630c)

**Elucidation:** A ‘Sign’ that stands for an ‘Object’ due to causal contingency.

**Example:** Smoke stands for a combustion process (a fire). My facial expression stands for my emotional status.

### Relations:

- is\_a semiotics.Sign

## Degree

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b8830065\\_3809\\_41b7\\_be3c\\_e33795567fd9](http://emmo.info/emmo/middle/units-extension#EMMO_b8830065_3809_41b7_be3c_e33795567fd9)

**Definition:** Degree is a measurement of plane angle, defined by representing a full rotation as 360 degrees.

**Dbpediaentry:** [http://dbpedia.org/page/Degree\\_\(angle\)](http://dbpedia.org/page/Degree_(angle))

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01560>

**Qudtentry:** <http://qudt.org/vocab/unit/DEG>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “°”

## Neper

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b41515a9\\_28d8\\_4d78\\_8165\\_74b2fc72f89e](http://emmo.info/emmo/middle/units-extension#EMMO_b41515a9_28d8_4d78_8165_74b2fc72f89e)

**Definition:** Unit of measurement for quantities of type level or level difference, which are defined as the natural logarithm of the ratio of power- or field-type quantities.

The value of a ratio in nepers is given by  $\ln(x_1/x_2)$  where  $x_1$  and  $x_2$  are the values of interest (amplitudes), and  $\ln$  is the natural logarithm. When the values are quadratic in the amplitude (e.g. power), they are first linearised by taking the square root before the logarithm is taken, or equivalently the result is halved.

Wikipedia

**Dbpediaentry:** <http://dbpedia.org/page/Neper>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N04106>

**Qudtentry:** <http://qudt.org/vocab/unit/NP>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Neper>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “Np”

## Litre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_a155dc93\\_d266\\_487e\\_b5e7\\_2a2c72d5ebf9](http://emmo.info/emmo/middle/units-extension#EMMO_a155dc93_d266_487e_b5e7_2a2c72d5ebf9)

**Definition:** A non-SI unit of volume defined as 1 cubic decimetre (dm<sup>3</sup>),

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03594>

**Qudtentry:** <http://qudt.org/vocab/unit/L>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.VolumeDimension
- perceptual.hasSymbolData value “l”

## Dalton

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_00dd79e0\\_31a6\\_427e\\_9b9c\\_90f3097e4a96](http://emmo.info/emmo/middle/units-extension#EMMO_00dd79e0_31a6_427e_9b9c_90f3097e4a96)

**Definition:** One dalton is defined as one twelfth of the mass of an unbound neutral atom of carbon-12 in its nuclear and electronic ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Unified\\_atomic\\_mass\\_unit](http://dbpedia.org/page/Unified_atomic_mass_unit)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01514>

**Qudtentry:** <http://qudt.org/vocab/unit/Dalton>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “Da”

## Bel

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6c7160fc\\_cc64\\_46f0\\_b43b\\_aba65e9952e3](http://emmo.info/emmo/middle/units-extension#EMMO_6c7160fc_cc64_46f0_b43b_aba65e9952e3)

**Definition:** One bel is defined as  $\frac{1}{2} \ln(10)$  neper.

**Elucidation:** Unit of measurement for quantities of type level or level difference.

**Comment:** Today decibel (one tenth of a bel) is commonly used instead of bel.

**Comment:** bel is used to express the ratio of one value of a power or field quantity to another, on a logarithmic scale, the logarithmic quantity being called the power level or field level, respectively.

**Qudtentry:** <http://qudt.org/vocab/unit/B>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Decibel>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “B”

## ArcSecond

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6a4547ab\\_3abb\\_430d\\_b81b\\_ce32d47729f5](http://emmo.info/emmo/middle/units-extension#EMMO_6a4547ab_3abb_430d_b81b_ce32d47729f5)

**Definition:** Measure of plane angle defined as 1/3600 or a degree.

**Altlabel:** SecondOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCSEC>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## Day

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_28ef05a7\\_ecc1\\_4df6\\_8116\\_c53251fbd4a8](http://emmo.info/emmo/middle/units-extension#EMMO_28ef05a7_ecc1_4df6_8116_c53251fbd4a8)

**Definition:** A measure of time defined as 86 400 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Day>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01527>

**Qudtentry:** <http://qudt.org/vocab/unit/DAY>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “d”

## Tonne

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f8b92999\\_3cde\\_46e3\\_99d5\\_664da3090a02](http://emmo.info/emmo/middle/units-extension#EMMO_f8b92999_3cde_46e3_99d5_664da3090a02)

**Definition:** A non-SI unit defined as 1000 kg.

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06394>

**Qudtentry:** [http://qudt.org/vocab/unit/TON\\_M](http://qudt.org/vocab/unit/TON_M)

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Tonne>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “t”

## SIAcceptedSpecialUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6795a4b8\\_ffd0\\_4588\\_a581\\_a9413fe49cac](http://emmo.info/emmo/middle/units-extension#EMMO_6795a4b8_ffd0_4588_a581_a9413fe49cac)

**Elucidation:** Non-SI units mentioned in the SI.

**Comment:** This is a list of units that are not defined as part of the International System of Units (SI), but are otherwise mentioned in the SI brochure, because either the General Conference on Weights and Measures (CGPM) accepts their use as being multiples or submultiples of SI-units, they have important contemporary application worldwide, or are otherwise commonly encountered worldwide.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Non-SI\\_units\\_mentioned\\_in\\_the\\_SI](https://en.wikipedia.org/wiki/Non-SI_units_mentioned_in_the_SI)

**Relations:**

- is\_a metrology.SpecialUnit
- is\_a metrology.OffSystemUnit
- disjoint\_union\_of units-extension.Dalton, units-extension.AstronomicalUnit, units-extension.ArcMinute, units-extension.Hour, units-extension.Day, units-extension.ArcSecond, units-extension.Bel, units-extension.Litre, units-extension.Neper, units-extension.Degree, units-extension.Minute, units-extension.Hectare, units-extension.ElectronVolt, units-extension.Tonne

## ElectronVolt

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e29f84db\\_4c1c\\_46ae\\_aa38\\_c4d47536b972](http://emmo.info/emmo/middle/units-extension#EMMO_e29f84db_4c1c_46ae_aa38_c4d47536b972)

**Definition:** The amount of energy gained (or lost) by the charge of a single electron moving across an electric potential difference of one volt.

**Dbpediaentry:** <http://dbpedia.org/page/Electronvolt>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02014>

**Qudtentry:** <http://qudt.org/vocab/unit/EV>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit

- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.EnergyDimension
- perceptual.hasSymbolData value “eV”

## Hectare

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_d6eb0176\\_a0d7\\_4b4e\\_8df0\\_50e912be2342](http://emmo.info/emmo/middle/units-extension#EMMO_d6eb0176_a0d7_4b4e_8df0_50e912be2342)

**Definition:** A non-SI metric unit of area defined as the square with 100-metre sides.

**Dbpediaentry:** <http://dbpedia.org/page/Hectare>

**Qudtentry:** <http://qudt.org/vocab/unit/HA>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Hectare>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.AreaDimension
- perceptual.hasSymbolData value “ha”

## Hour

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_21ef2ed6\\_c086\\_4d24\\_8a75\\_980d2bcc9282](http://emmo.info/emmo/middle/units-extension#EMMO_21ef2ed6_c086_4d24_8a75_980d2bcc9282)

**Definition:** Measure of time defined as 3600 seconds.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02866>

**Qudtentry:** <http://qudt.org/vocab/unit/HR>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “h”

## Interpreter branch

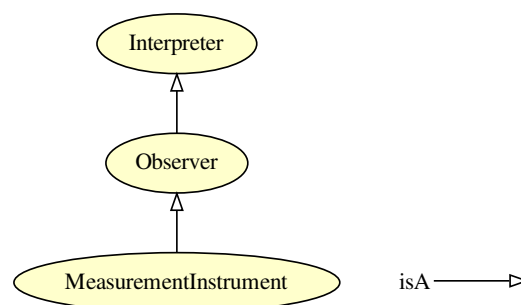


Figure 3.7: Interpreter branch.

## MeasurementInstrument

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_f2d5d3ad\\_2e00\\_417f\\_8849\\_686f3988d929](http://emmo.info/emmo/middle/properties#EMMO_f2d5d3ad_2e00_417f_8849_686f3988d929)

**Relations:**

- is\_a properties.Observer

## Interpreter

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_0527413c\\_b286\\_4e9c\\_b2d0\\_03fb2a038dee](http://emmo.info/emmo/middle/semiotics#EMMO_0527413c_b286_4e9c_b2d0_03fb2a038dee)

**Elucidation:** The entity (or agent, or observer, or cognitive entity) who connects ‘Sign’, ‘Interpretant’ and ‘Object’.

**Relations:**

- is\_a semiotics.Semiotic
- physical.hasSpatialPart some semiotics.Interpretant

## Observer

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_1b52ee70\\_121e\\_4d8d\\_8419\\_3f97cd0bd89c](http://emmo.info/emmo/middle/properties#EMMO_1b52ee70_121e_4d8d_8419_3f97cd0bd89c)

**Elucidation:** An ‘interpreter’ that perceives another ‘entity’ (the ‘object’) through a specific perception mechanism and produces a ‘property’ (the ‘sign’) that stands for the result of that particular perception.

**Relations:**

- is\_a semiotics.Interpreter
- Inverse(holistic.hasParticipant) some properties.Observation

## Object branch

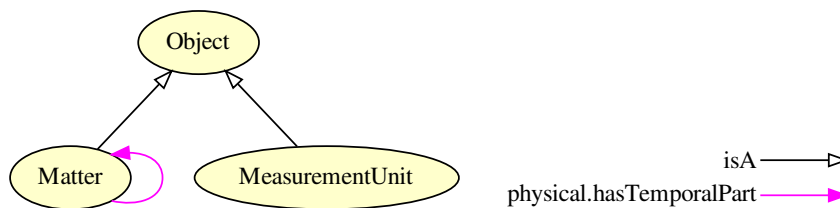


Figure 3.8: Object branch.

## Object

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_6f5af708\\_f825\\_4feb\\_a0d1\\_a8d813d3022b](http://emmo.info/emmo/middle/semiotics#EMMO_6f5af708_f825_4feb_a0d1_a8d813d3022b)

**Elucidation:** The object, in Peirce semiotics.

**Comment:** Here is assumed that the concept of ‘object’ is always relative to a ‘semiotic’ process. An ‘object’ does not exist per se, but it’s always part of an interpretation.

The EMO relies on strong reductionism, i.e. everything real is a formless collection of elementary particles: we give a meaning to real world entities only by giving them boundaries and defining them using ‘sign’-s.



In this way the ‘sign’-ed entity become and ‘object’, and the ‘object’ is the basic entity needed in order to apply a logical formalism to the real world entities (i.e. we can speak of it through its sign, and use logics on it through its sign).

**Relations:**

- is\_a semiotics.Semiotic

## Conventional branch

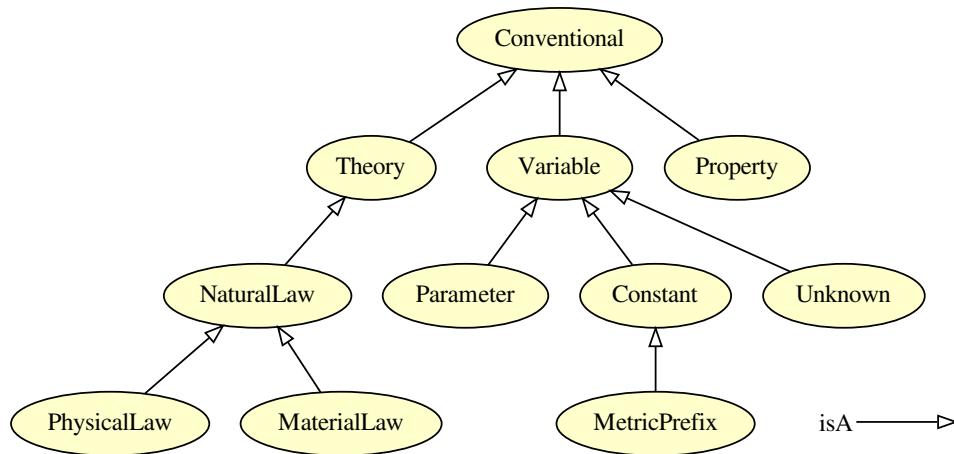


Figure 3.9: Conventional branch.

### PhysicalLaw

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_9c32fd69\\_f480\\_4130\\_83b3\\_fb25d9face14](http://emmo.info/emmo/middle/models#EMMO_9c32fd69_f480_4130_83b3_fb25d9face14)

**Relations:**

- is\_a models.NaturalLaw

### Parameter

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_d1d436e7\\_72fc\\_49cd\\_863b\\_7bfb4ba5276a](http://emmo.info/emmo/middle/math#EMMO_d1d436e7_72fc_49cd_863b_7bfb4ba5276a)

**Example:** viscosity in the Navier-Stokes equation

**Comment:** A ‘variable’ whose value is assumed to be known independently from the equation, but whose value is not explicitated in the equation.

**Relations:**

- is\_a math.Variable

### NaturalLaw

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_db9a009e\\_f097\\_43f5\\_9520\\_6cbc07e7610b](http://emmo.info/emmo/middle/models#EMMO_db9a009e_f097_43f5_9520_6cbc07e7610b)

**Relations:**

- is\_a models.Theory

## Theory

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_8d2d9374\\_ef3a\\_47e6\\_8595\\_6bc208e07519](http://emmo.info/emmo/middle/models#EMMO_8d2d9374_ef3a_47e6_8595_6bc208e07519)

**Elucidation:** A ‘conventional’ that stand for a ‘physical’.

**Comment:** The ‘theory’ is e.g. a proposition, a book or a paper whose sub-symbols suggest in the mind of the interpreter an interpretant structure that can represent a ‘physical’.

It is not an ‘icon’ (like a math equation), because it has no common resemblance or logical structure with the ‘physical’.

In Peirce semiotics: legisign-symbol-argument

**Relations:**

- is\_a semiotics.Conventional

## Constant

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_ae15fb4f\\_8e4d\\_41de\\_a0f9\\_3997f89ba6a2](http://emmo.info/emmo/middle/math#EMMO_ae15fb4f_8e4d_41de_a0f9_3997f89ba6a2)

**Elucidation:** A ‘variable’ that stand for a well known constant.

**Example:**  $\pi$  refers to the constant number  $\sim 3.14$

**Relations:**

- is\_a math.Variable
- Inverse(math.hasVariable) only math.Numerical

## Unknown

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_fe7e56ce\\_118b\\_4243\\_9aad\\_20eb9f4f31f6](http://emmo.info/emmo/middle/math#EMMO_fe7e56ce_118b_4243_9aad_20eb9f4f31f6)

**Elucidation:** The dependent variable for which an equation has been written.

**Example:** Velocity, for the Navier-Stokes equation.

**Relations:**

- is\_a math.Variable

## MaterialLaw

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_f19ff3b4\\_6bfe\\_4c41\\_a2b2\\_9affd39c140b](http://emmo.info/emmo/middle/models#EMMO_f19ff3b4_6bfe_4c41_a2b2_9affd39c140b)

**Relations:**

- is\_a models.NaturalLaw

## Variable

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_1eed0732\\_e3f1\\_4b2c\\_a9c4\\_b4e75eeb5895](http://emmo.info/emmo/middle/math#EMMO_1eed0732_e3f1_4b2c_a9c4_b4e75eeb5895)

**Elucidation:** A ‘Variable’ is a symbolic object that stands for a numerical defined ‘Mathematical’ object like e.g. a number, a vector, a matrix.

**Example:**  $x$   $k$

**Relations:**

- is\_a math.Mathematical
- is\_a semiotics.Conventional
- Inverse(math.hasVariable) some math.Mathematical

## Conventional

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_35d2e130\\_6e01\\_41ed\\_94f7\\_00b333d46cf9](http://emmo.info/emmo/middle/semiotics#EMMO_35d2e130_6e01_41ed_94f7_00b333d46cf9)

**Elucidation:** A ‘Sign’ that stands for an ‘Object’ through convention, norm or habit, without any resemblance to it.

**Comment:** In Peirce semiotics this kind of sign category is called symbol. However, since symbol is also used in formal languages, the name is changed in conventional.

**Relations:**

- is\_a semiotics.Sign

## Property branch

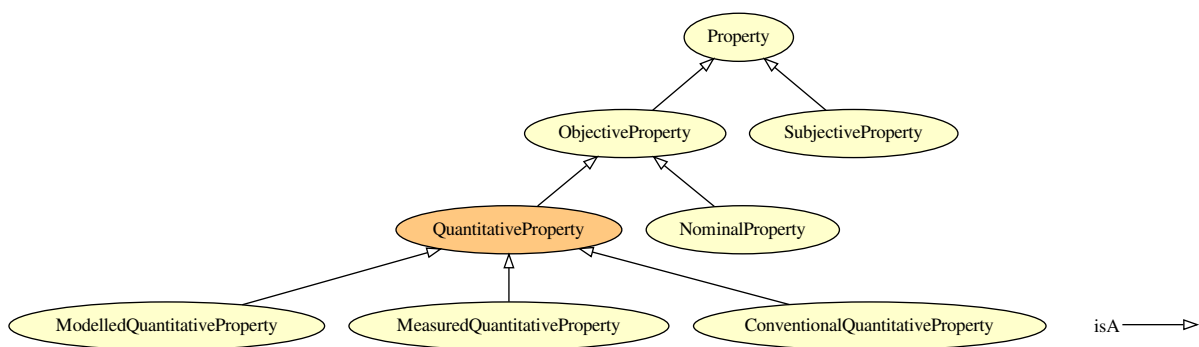


Figure 3.10: Property branch.

## ModelledQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_d0200cf1\\_e4f4\\_45ae\\_873f\\_b9359daea3cd](http://emmo.info/emmo/middle/properties#EMMO_d0200cf1_e4f4_45ae_873f_b9359daea3cd)

**Relations:**

- is\_a metrology.QuantitativeProperty

## MeasuredQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_873b0ab3\\_88e6\\_4054\\_b901\\_5531e01f14a4](http://emmo.info/emmo/middle/properties#EMMO_873b0ab3_88e6_4054_b901_5531e01f14a4)

**Relations:**

- is\_a metrology.QuantitativeProperty

## QuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_dd4a7f3e\\_ef56\\_466c\\_ac1a\\_d2716b5f87ec](http://emmo.info/emmo/middle/metrology#EMMO_dd4a7f3e_ef56_466c_ac1a_d2716b5f87ec)

**Definition:** “A property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed by means of a number and a reference” ISO 80000-1

“A reference can be a measurement unit, a measurement procedure, a reference material, or a combination of such.” International vocabulary of metrology (VIM)

**Elucidation:** A ‘Quantity’ that can be quantified with respect to a standardized reference physical instance (e.g. the prototype meter bar, the kg prototype) or method (e.g. resilience) through a measurement process.

**Comment:** A quantitative property is always expressed as a quantity (i.e. a number and a reference unit). For the EMMO, a nominalistic ontology, there is no property as abstract object.

A property is a sign that stands for an object according to a specific code shared by some observers.

For quantitative properties, one possible code that is shared between the scientific community (the observers) is the SI system of units.

**Comment:** Subclasses of ‘QuantitativeProperty’ classify objects according to the type semiosis that is used to connect the property to the object (e.g. by measurement, by convention, by modelling).

**Relations:**

- is\_a metrology.Quantity
- is\_a properties.ObjectiveProperty
- equivalent\_to properties.MeasuredQuantitativeProperty or properties.ModelledQuantitativeProperty or properties.ConventionalQuantitativeProperty

## SubjectiveProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_251cfb4f\\_5c75\\_4778\\_91ed\\_6c8395212fd8](http://emmo.info/emmo/middle/properties#EMMO_251cfb4f_5c75_4778_91ed_6c8395212fd8)

**Elucidation:** A ‘Property’ that cannot be univocally determined and depends on an agent (e.g. a human individual, a community) acting as black-box.

**Example:** The beauty of that girl. The style of your clothing.

**Comment:** The word subjective means that a non-well defined or an unknown procedure is used for the definition of the property.

This happens due to e.g. the complexity of the object, the lack of a underlying model for the representation of the object, the non-well specified meaning of the property symbols.

A ‘SubjectiveProperty’ cannot be used to univocally compare ‘Object’-s.

e.g. you cannot evaluate the beauty of a person on objective basis.

**Relations:**

- is\_a properties.Property

## NominalProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_909415d1\\_7c43\\_4d5e\\_bbeb\\_7e1910159f66](http://emmo.info/emmo/middle/properties#EMMO_909415d1_7c43_4d5e_bbeb_7e1910159f66)

**Elucidation:** An ‘ObjectiveProperty’ that cannot be quantified.

**Example:** CFC is a ‘sign’ that stands for the fact that the morphology of atoms composing the microstructure of an entity is predominantly Cubic Face Centered

A color is a nominal property.

Sex of a human being.

**Comment:** “Property of a phenomenon, body, or substance, where the property has no magnitude.”

“A nominal property has a value, which can be expressed in words, by alphanumerical codes, or by other means.”

International vocabulary of metrology (VIM)

**Relations:**

- is\_a properties.ObjectiveProperty

## Property

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_b7bcff25\\_ffc3\\_474e\\_9ab5\\_01b1664bd4ba](http://emmo.info/emmo/middle/properties#EMMO_b7bcff25_ffc3_474e_9ab5_01b1664bd4ba)

**Elucidation:** A ‘Perceptual’ referring to a specific code that is used as ‘Conventional’ sign to represent an ‘Object’ according to a specific interaction mechanism by an ‘Observer’.

(A property is always a partial representation of an ‘Object’ since it reflects the ‘Object’ capability to be part of a specific ‘Observation’ process)

**Example:** Hardness is a subclass of properties.

Vickers hardness is a subclass of hardness that involves the procedures and instruments defined by the standard hardness test.

**Example:** Let’s define the class ‘colour’ as the subclass of the properties that involve photon emission and an electromagnetic radiation sensible observer.

An individual C of this class ‘colour’ can be defined by declaring the process individual (e.g. daylight illumination) and the observer (e.g. my eyes)

Stating that an entity E hasProperty C, we mean that it can be observed by such setup of process + observer (i.e. observed by my eyes under daylight).

This definition can be generalized by using a generic human eye, so that the observer can be a generic human.

This can be used in material characterization, to define exactly the type of measurement done, including the instrument type.

**Comment:** A ‘Property’ is a sort of name or label that we put upon objects that interact with an observer in the same specific way.

e.g. “hot” objects are objects that interact with an observer through a perception mechanism aimed to perceive an heat source.

**Comment:** We know real world entities through observation/perception.

A non-perceivable real world entity does not exist (or it exists on a plane of existence that has no intersection with us and we can say nothing about it).

Perception/observation of a real world entity occurs when the entity stimulates an observer in a peculiar way through a well defined perception channel.

For this reason each property is related to a specific observation process which involves a specific observer with its own perception mechanisms.

The observation process (e.g. a look, a photo shot, a measurement) is performed by an observer (e.g. you, a camera, an instrument) through a specific perception mechanism (e.g. retina impression, CMOS excitation, piezoelectric sensor activation) and involves an observed entity.

An observation is a semiotic process, since it stimulates an interpretant within the interpreter who can communicate the perception result to other interpreters through a sign which is the property.

Property subclasses are specializations that depend on the type of observation processes.

e.g. the property ‘colour’ is related to a process that involves emission or interaction of photon and an observer who can perceive electromagnetic radiation in the visible frequency range.

Properties usually rely on symbolic systems (e.g. for colour it can be palette or RGB).

### Relations:

- is\_a semiotics.Conventional
- Inverse(holistic.hasParticipant) some properties.Observation
- Inverse(properties.hasProperty) some semiotics.Object
- disjoint\_union\_of properties.SubjectivProperty, properties.ObjectivProperty

## ObjectiveProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_2a88cdf\\_ec4a\\_4ec5\\_af1c\\_0343372fc978](http://emmo.info/emmo/middle/properties#EMMO_2a88cdf_ec4a_4ec5_af1c_0343372fc978)

**Elucidation:** A ‘Property’ that is determined by each ‘Observer’ following a well defined ‘Observation’ procedure through a specific perception channel.

**Comment:** The word objective does not mean that each observation will provide the same results. It means that the observation followed a well defined procedure.

**Comment:** This class refers to what is commonly known as physical property, i.e. a measurable property of physical system, whether is quantifiable or not.

**Relations:**

- is\_a properties.Property

## ConventionalQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_d8aa8e1f\\_b650\\_416d\\_88a0\\_5118de945456](http://emmo.info/emmo/middle/properties#EMMO_d8aa8e1f_b650_416d_88a0_5118de945456)

**Elucidation:** A quantitative property attributed by agreement to a quantity for a given purpose.

**Example:** The thermal conductivity of a copper sample in my laboratory can be assumed to be the conductivity that appears in the vendor specification. This value has been obtained by measurement of a sample which is not the one I have in my laboratory. This conductivity value is then a conventional quantitative property assigned to my sample through a semiotic process in which no actual measurement is done by my laboratory.

If I don’t believe the vendor, then I can measure the actual thermal conductivity. I then perform a measurement process that semiotically assign another value for the conductivity, which is a measured property, since is part of a measurement process.

Then I have two different physical quantities that are properties thanks to two different semiotic processes.

**Comment:** A property that is associated to an object by convention, or assumption.

**Relations:**

- is\_a metrology.QuantitativeProperty

## Icon branch

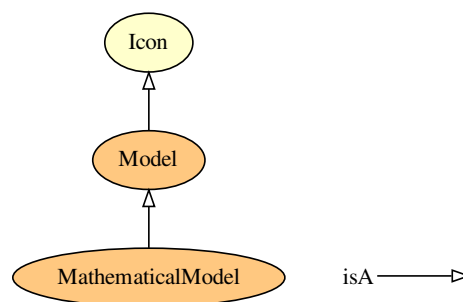


Figure 3.11: Icon branch.

## Icon

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_d7788d1a\\_020d\\_4c78\\_85a1\\_13563fcec168](http://emmo.info/emmo/middle/semiotics#EMMO_d7788d1a_020d_4c78_85a1_13563fcec168)

**Elucidation:** A ‘Sign’ that stands for an ‘Object’ by resembling or imitating it, in shape or by sharing a similar logical structure.

**Example:** A picture that reproduces the aspect of a person.

An equation that reproduces the logical connection of the properties of a physical entity.

**Comment:** Three subtypes of icon are possible:

- (a) the image, which depends on a simple quality (e.g. picture)
- (b) the diagram, whose internal relations, mainly dyadic or so taken, represent by analogy the relations in something (e.g. math formula, geometric flowchart)
- (c) the metaphor, which represents the representative character of a sign by representing a parallelism in something else

[Wikipedia]

**Relations:**

- is\_a semiotics.Sign

## Model

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_939483b1\\_0148\\_43d1\\_8b35\\_851d2cd5d939](http://emmo.info/emmo/middle/models#EMMO_939483b1_0148_43d1_8b35_851d2cd5d939)

**Elucidation:** A ‘sign’ that not only stands for a ‘physical’ or a ‘process’, but it is also a simplified representation, aimed to assist calculations for its description or for predictions of its behaviour.

A ‘model’ represents a ‘physical’ or a ‘process’ by direct similitude (e.g. small scale replica) or by capturing in a logical framework the relations between its properties (e.g. mathematical model).

**Comment:** A ‘model’ prediction is always a prediction of the properties of an entity, since an entity is known by an interpreter only through perception.

**Relations:**

- is\_a semiotics.Icon
- equivalent\_to Inverse(models.hasModel) some physical.Physical

## Process branch

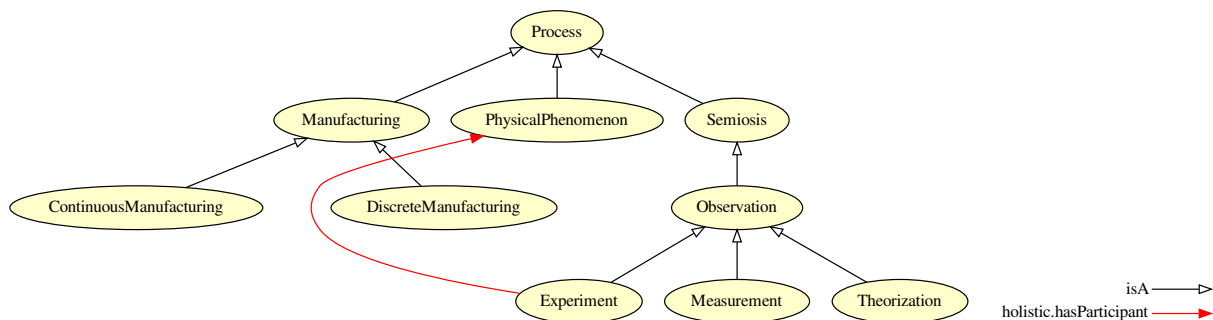


Figure 3.12: Process branch.

## ContinuousManufacturing

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_71d1c8f0\\_c6e3\\_44b5\\_a4b6\\_1b74ff35698a](http://emmo.info/emmo/middle/manufacturing#EMMO_71d1c8f0_c6e3_44b5_a4b6_1b74ff35698a)

**Elucidation:** A manufacturing process whose product is the result of the combination of more substances.

**Example:** Synthesis of materials, the preparation of a cake.

**Relations:**

- is\_a manufacturing.Manufacturing

## Process

**IRI:** [http://emmo.info/emmo/middle/holistic#EMMO\\_43e9a05d\\_98af\\_41b4\\_92f6\\_00f79a09bfce](http://emmo.info/emmo/middle/holistic#EMMO_43e9a05d_98af_41b4_92f6_00f79a09bfce)

**Elucidation:** A temporal part of a physical that identifies a particular type of evolution in time.

**Comment:** A ‘Process’ is always a ‘Physical’, since a ‘Void’ does not have elements that evolves in time.

**Comment:** Following the common definition of process, the reader may think that every ‘Physical’ should be a process, since every 4D object always has a time dimension.

However, in the EMMO we restrict the meaning of the word process to ‘Physical’-s whose evolution in time have a particular meaning for the ontologist (i.e. every 4D object unfolds in time, but not every 4D object may be of interest for the ontologist).

A ‘Process’ is not only something that unfolds in time (which is automatically represented in a 4D ontology), but something that has a meaning for the ontologist (i.e. that the ontologist can separate from the rest of the 4D physical for any reason).

### Relations:

- is\_a holistic.Holistic
- is\_a physical.Physical
- holistic.hasParticipant some holistic.Participant

## Measurement

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_463bcfda\\_867b\\_41d9\\_a967\\_211d4d437cfb](http://emmo.info/emmo/middle/properties#EMMO_463bcfda_867b_41d9_a967_211d4d437cfb)

**Elucidation:** An ‘observation’ that results in a quantitative comparison of a ‘property’ of an ‘object’ with a standard reference.

### Relations:

- is\_a properties.Observation
- holistic.hasParticipant some metrology.QuantitativeProperty
- holistic.hasParticipant some properties.MeasurementInstrument

## Theorization

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_6c739b1a\\_a774\\_4416\\_bb31\\_1961486fa9ed](http://emmo.info/emmo/middle/models#EMMO_6c739b1a_a774_4416_bb31_1961486fa9ed)

**Elucidation:** The ‘semiosis’ process of interpreting a ‘physical’ and provide a complec sign, ‘theory’ that stands for it and explain it to another interpreter.

### Relations:

- is\_a properties.Observation

## PhysicalPhenomenon

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_314d0bd5\\_67ed\\_437e\\_a609\\_36d46147cea7](http://emmo.info/emmo/middle/models#EMMO_314d0bd5_67ed_437e_a609_36d46147cea7)

**Elucidation:** A ‘process’ that is recognized by physical sciences and is catogrizd accordingly.

**Comment:** While every ‘process’ in the EMMO involves physical objects, this class is devoted to represent real world objects that express a phenomenon relevant for the ontologist.

### Relations:

- is\_a holistic.Process



## DiscreteManufacturing

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_8786cb47\\_8e1f\\_4968\\_9b15\\_f6d41fc51252](http://emmo.info/emmo/middle/manufacturing#EMMO_8786cb47_8e1f_4968_9b15_f6d41fc51252)

**Elucidation:** A manufacturing process aimed to the production of a device made of specific components.

**Example:** Assembling a bicycle, building a car.

**Relations:**

- is\_a manufacturing.Manufacturing

## Experiment

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_22522299\\_4091\\_4d1f\\_82a2\\_3890492df6db](http://emmo.info/emmo/middle/models#EMMO_22522299_4091_4d1f_82a2_3890492df6db)

**Elucidation:** An experiment is a process that is intended to replicate a physical phenomenon in a controlled environment.

**Relations:**

- is\_a properties.Observation
- holistic.hasParticipant some models.PhysicalPhenomenon

## Manufacturing

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_a4d66059\\_5dd3\\_4b90\\_b4cb\\_10960559441b](http://emmo.info/emmo/middle/manufacturing#EMMO_a4d66059_5dd3_4b90_b4cb_10960559441b)

**Elucidation:** The process of transforming raw materials into a product by the use of manual labor, machinery or chemical/biological processes.

**Comment:** From Latin manufacture: “made by hand”.

**Relations:**

- is\_a holistic.Process
- holistic.hasProperParticipant some manufacturing.Engineered

## Observation

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_10a5fd39\\_06aa\\_4648\\_9e70\\_f962a9cb2069](http://emmo.info/emmo/middle/properties#EMMO_10a5fd39_06aa_4648_9e70_f962a9cb2069)

**Elucidation:** A ‘Semiosis’ that involves an ‘Observer’ that perceives another ‘Physical’ (the ‘Object’) through a specific perception mechanism and produces a ‘Property’ (the ‘Sign’) that stands for the result of that particular perception.

**Relations:**

- is\_a semiotics.Semiosis
- holistic.hasParticipant some properties.Observer
- holistic.hasParticipant some properties.Property

## Semiosis

**IRI:** [http://emmo.info/emmo/middle/semiotics#EMMO\\_008fd3b2\\_4013\\_451f\\_8827\\_52bceab11841](http://emmo.info/emmo/middle/semiotics#EMMO_008fd3b2_4013_451f_8827_52bceab11841)

**Elucidation:** A ‘Process’, that has participant an ‘Interpreter’, that is aimed to produce a ‘Sign’ representing another participant, the ‘Object’.

**Example:** Me looking a cat and saying loud: “Cat!” → the semiosis process

me → interpreter cat → object (in Peirce semiotics) the cat perceived by my mind → interpretant “Cat!” → sign, the produced sign

**Relations:**

- is\_a holistic.Process

- holistic.hasProperParticipant some semiotics.Interpreter
- holistic.hasProperParticipant some semiotics.Object
- holistic.hasProperParticipant some semiotics.Sign

## Perceptual branch

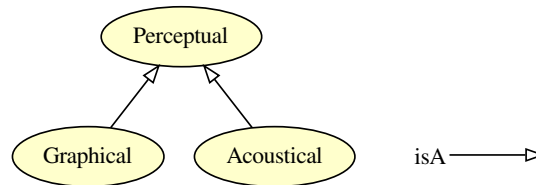


Figure 3.13: Perceptual branch.

## Perceptual

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_649bf97b\\_4397\\_4005\\_90d9\\_219755d92e34](http://emmo.info/emmo/middle/perceptual#EMMO_649bf97b_4397_4005_90d9_219755d92e34)

**Elucidation:** A ‘Physical’ which stands for a real world object that can stimulate a perception (e.g. a mental impression, the excitation of a sensor) to an interpreter (human or non-human).

**Example:** A line scratched on a surface. A sound. A smell. The word ‘cat’ and the sound of the word ‘cat’ (the first one is graphical and the second acoustical).

**Example:** The meta-semiotic process: I see a cloud in the sky. Since I’m an EMMO ontologist, I create an individual named Cloud under the ‘Impression’ class. This semiotic process occurs at meta-level: it’s how I use the EMMO as tool for a direct representation of the world.

The semiotic process within EMMO: My friend looks at the same cloud and says: “It is an elephant”. I use the EMMO to record this experience by declaring: - my friend as MyFriend individual, belonging to ‘Interpreter’ classes - the sound of the word “elephant” as an acoustical impression individual named ElephantWord, belonging to ‘Impression’ - a relation hasSign between Cloud and ElephantWord, that makes ElephantWord also belonging to ‘Sign’ class and Cloud belonging also to ‘Object’ class - a ‘Semiosis’ individual called MyFriendElephantCloud that hasParticipant: Cloud, ElephantWord and MyFriend, respectively as object, sign and interpreter.

**Comment:** ‘Perceptual’ includes real world objects that: - are part of a communication system (e.g. words, speech, alphabets) - are not part of a communication system, but can be identified and referred by an interpreter

**Comment:** A ‘Perceptual’ is a meta-object, meaning that is addressed by the ontologist (the meta-interpreter) in a meta-semiotic process occurring outside the EMMO.

A ‘Perceptual’ becomes an ‘Object’, when it is part of a ‘Semiotic’ process described by the ontologist through the EMMO.

**Comment:** From Latin perceptiō (“a receiving or collecting, perception, comprehension”), from perceptus (“perceived, observed”).

**Comment:** This class is the most general superclass for the categorization of real world objects that are recognizable by an interpreter (agent).

A ‘Perceptual’ can stand for something else in a semiotic process (acting as sign or as object).

However, a perceptual is not necessarily a ‘Sign’ (e.g. a line sketched on a blackboard is a recognizable ‘Perceptual’ but it may stand for nothing).

### Relations:

- is\_a top.Perspective

## Acoustical

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_4b3afb22\\_27cf\\_4ce3\\_88bc\\_492bfccb546b](http://emmo.info/emmo/middle/perceptual#EMMO_4b3afb22_27cf_4ce3_88bc_492bfccb546b)

**Elucidation:** A ‘Perceptual’ which stands for a real world object whose spatiotemporal pattern makes it identifiable by an observer as a sound.

**Comment:** ‘acoustical’ refers to the perception mechanism of the observer that can occur through a microphone, a ear.

### Relations:

- is\_a perceptual.Perceptual

## Graphical branch

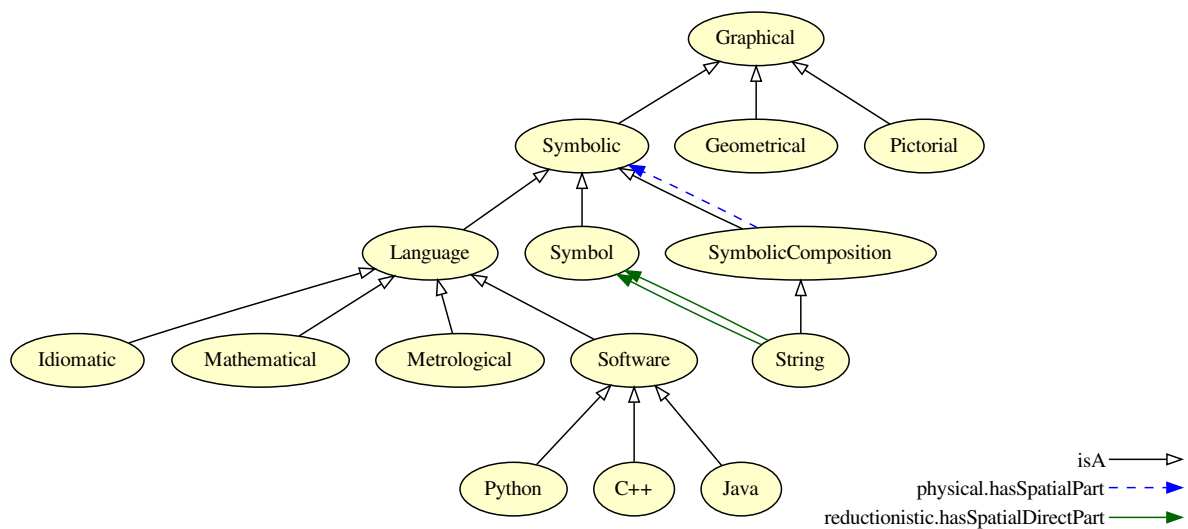


Figure 3.14: Graphical branch.

## IdiomaticSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_0a318776\\_b067\\_4de0\\_a2a6\\_cba2cf6333f8](http://emmo.info/emmo/middle/metrology#EMMO_0a318776_b067_4de0_a2a6_cba2cf6333f8)

### Relations:

- is\_a perceptual.Idiomatic
- is\_a perceptual.Symbol
- equivalent\_to perceptual.Idiomatic and perceptual.Symbol

## Python

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_add2e29d\\_6d87\\_4b78\\_9706\\_588e25557093](http://emmo.info/emmo/middle/perceptual#EMMO_add2e29d_6d87_4b78_9706_588e25557093)

### Relations:

- is\_a perceptual.Software

## Idiomatic

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_48716718\\_225f\\_4c88\\_89e2\\_d819d30c90a2](http://emmo.info/emmo/middle/perceptual#EMMO_48716718_225f_4c88_89e2_d819d30c90a2)

**Elucidation:** A language object that follows syntactic rules of a an idiom (e.g. english, italian).

**Relations:**

- is\_a perceptual.Language

## String

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_50ea1ec5\\_f157\\_41b0\\_b46b\\_a9032f17ca10](http://emmo.info/emmo/middle/perceptual#EMMO_50ea1ec5_f157_41b0_b46b_a9032f17ca10)

**Elucidation:** A physical made of more than one symbol sequentially arranged.

**Example:** The word “cat” considered as a collection of ‘symbol’-s respecting the rules of english language.

In this example the ‘symbolic’ entity “cat” is not related to the real cat, but it is only a word (like it would be to an italian person that ignores the meaning of this english word).

If an ‘interpreter’ skilled in english language is involved in a ‘semiotic’ process with this word, that “cat” became also a ‘sign’ i.e. it became for the ‘interpreter’ a representation for a real cat.

**Comment:** A string is made of concatenated symbols whose arrangement is one-dimensional. Each symbol can have only one previous and one next neighborhood (bidirectional list).

**Comment:** A string is not requested to respect any syntactic rule: it’s simply directly made of symbols.

**Relations:**

- is\_a perceptual.SymbolicComposition
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart some perceptual.Symbol
- reductionistic.hasSpatialDirectPart only perceptual.Symbol

## Inequality

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_0b6ebe5a\\_0026\\_4bef\\_a1c1\\_5be00df9f98e](http://emmo.info/emmo/middle/math#EMMO_0b6ebe5a_0026_4bef_a1c1_5be00df9f98e)

**Elucidation:** A relation which makes a non-equal comparison between two numbers or other mathematical expressions.

**Example:**  $f(x) > 0$

**Relations:**

- is\_a math.MathematicalFormula

## MathematicalFormula

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_88470739\\_03d3\\_4c47\\_a03e\\_b30a1288d50c](http://emmo.info/emmo/middle/math#EMMO_88470739_03d3_4c47_a03e_b30a1288d50c)

**Elucidation:** A mathematical string that can be evaluated as true or false.

**Relations:**

- is\_a math.Mathematical
- is\_a perceptual.SymbolicComposition

## Language

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_d8d2144e\\_5c8d\\_455d\\_a643\\_5caf4d8d9df8](http://emmo.info/emmo/middle/perceptual#EMMO_d8d2144e_5c8d_455d_a643_5caf4d8d9df8)

**Elucidation:** A language object is a symbolic object respecting a specific language syntactic rules (a well-formed formula).

**Relations:**

- is\_a perceptual.Symbolic

**C++**

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_64aba1e5\\_24b7\\_4140\\_8eb4\\_676c35698e79](http://emmo.info/emmo/middle/perceptual#EMMO_64aba1e5_24b7_4140_8eb4_676c35698e79)

**Elucidation:** A language object respectin the syntactic rules of C++.

**Relations:**

- is\_a perceptual.Software

**Java**

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_09007bc0\\_b5f2\\_4fb9\\_af01\\_caf948cf2044](http://emmo.info/emmo/middle/perceptual#EMMO_09007bc0_b5f2_4fb9_af01_caf948cf2044)

**Relations:**

- is\_a perceptual.Software

**FunctionDefinition**

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_4bc29b0f\\_8fcc\\_4026\\_a291\\_f9774a66d9b8](http://emmo.info/emmo/middle/math#EMMO_4bc29b0f_8fcc_4026_a291_f9774a66d9b8)

**Elucidation:** A function defined using functional notation.

**Example:**  $y = f(x)$

**Relations:**

- is\_a math.DefiningEquation

**MaterialRelation**

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_e5438930\\_04e7\\_4d42\\_ade5\\_3700d4a52ab7](http://emmo.info/emmo/middle/models#EMMO_e5438930_04e7_4d42_ade5_3700d4a52ab7)

**Elucidation:** An ‘equation’ that stands for a physical assumption specific to a material, and provides an expression for a ‘physics\_quantity’ (the dependent variable) as function of other variables, physics\_quantity or data (independent variables).

**Example:** The Lennard-Jones potential.

A force field.

An Hamiltonian.

**Comment:** A material\_relation can e.g. return a predefined number, return a database query, be an equation that depends on other physics\_quantities.

**Relations:**

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity

**Symbolic**

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_057e7d57\\_aff0\\_49de\\_911a\\_8861d85cef40](http://emmo.info/emmo/middle/perceptual#EMMO_057e7d57_aff0_49de_911a_8861d85cef40)

**Elucidation:** An ‘Graphical’ that stands for a token or a composition of tokens from one or more alphabets, without necessarily respecting syntactic rules.

**Example:** fe780 emmo !5\*a cat for(i=0;i<N;++i)

**Relations:**

- is\_a perceptual.Graphical

## Software

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_8681074a\\_e225\\_4e38\\_b586\\_e85b0f43ce38](http://emmo.info/emmo/middle/perceptual#EMMO_8681074a_e225_4e38_b586_e85b0f43ce38)

**Elucidation:** A language object that follows syntactic rules of a programming language.

**Relations:**

- is\_a perceptual.Language

## PhysicsEquation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_27c5d8c6\\_8af7\\_4d63\\_beb1\\_ec37cd8b3fa3](http://emmo.info/emmo/middle/models#EMMO_27c5d8c6_8af7_4d63_beb1_ec37cd8b3fa3)

**Elucidation:** An ‘equation’ that stands for a ‘physical\_law’ by mathematically defining the relations between physics\_quantities.

**Example:** The Newton’s equation of motion.

The Schrödinger equation.

The Navier-Stokes equation.

**Relations:**

- is\_a math.Equation
- is\_a models.MathematicalModel
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity
- Inverse(models.hasModel) some models.PhysicalPhenomenon

## SymbolicComposition

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_89a0c87c\\_0804\\_4013\\_937a\\_6fe234d9499c](http://emmo.info/emmo/middle/perceptual#EMMO_89a0c87c_0804_4013_937a_6fe234d9499c)

**Elucidation:** A symbolic entity made of other symbolic entities according to a specific spatial configuration.

**Comment:** This class collects individuals that represents arrangements of strings, or other symbolic compositions, without any particular predefined arrangement schema.

**Relations:**

- is\_a perceptual.Symbolic
- physical.hasSpatialPart some perceptual.Symbolic

## Pictorial

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_1da53c06\\_9577\\_4008\\_8652\\_272fa3b62be7](http://emmo.info/emmo/middle/perceptual#EMMO_1da53c06_9577_4008_8652_272fa3b62be7)

**Elucidation:** A ‘Graphical’ that stands for a real world object that shows a recognizable pictorial pattern without being necessarily associated to a symbolic language.

**Example:** A drawing of a cat. A circle on a paper sheet. The Mona Lisa.

**Relations:**

- is\_a perceptual.Graphical

## Graphical

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_c74da218\\_9147\\_4f03\\_92d1\\_8894abca55f3](http://emmo.info/emmo/middle/perceptual#EMMO_c74da218_9147_4f03_92d1_8894abca55f3)

**Elucidation:** A ‘Perceptual’ which stands for a real world object whose spatial configuration shows a pattern identifiable by an observer.

**Example:** ‘Graphical’ objects include writings, pictures, sketches ...

**Comment:** From the Ancient Greek γράφῃ (graphḗ) which means drawing, painting, writing, a writing, description, and from γράφω (gráphō) which means scratch, carve.

**Relations:**

- is\_a perceptual.Perceptual

## DefiningEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_29afdf54\\_90ae\\_4c98\\_8845\\_fa9ea3f143a8](http://emmo.info/emmo/middle/math#EMMO_29afdf54_90ae_4c98_8845_fa9ea3f143a8)

**Elucidation:** An equation that define a new variable in terms of other mathematical entities.

**Example:** The definition of velocity as  $v = dx/dt$ .

The definition of density as mass/volume.

$$y = f(x)$$

**Relations:**

- is\_a math.Equation

## Equation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_e56ee3eb\\_7609\\_4ae1\\_8bed\\_51974f0960a6](http://emmo.info/emmo/middle/math#EMMO_e56ee3eb_7609_4ae1_8bed_51974f0960a6)

**Elucidation:** The class of ‘mathematical’-s that stand for a statement of equality between two mathematical expressions.

**Example:**  $2+3 = 5$   $x^2 + 3x = 5x$   $dv/dt = a$   $\sin(x) = y$

**Comment:** An equation with variables can always be represented as:

$$f(v_0, v_1, \dots, v_n) = g(v_0, v_1, \dots, v_n)$$

where f is the left hand and g the right hand side expressions and  $v_0, v_1, \dots, v_n$  are the variables.

**Relations:**

- is\_a math.MathematicalFormula
- is\_a reductionistic.State
- is\_a math.Mathematical
- reductionistic.hasSpatialDirectPart some math.Expression

## ArithmeticEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_a6138ba7\\_e365\\_4f2d\\_b6b4\\_fe5a5918d403](http://emmo.info/emmo/middle/math#EMMO_a6138ba7_e365_4f2d_b6b4_fe5a5918d403)

**Example:**  $1 + 1 = 2$

**Relations:**

- is\_a math.Equation

## AlgebraicEquation

IRI: [http://emmo.info/emmo/middle/math#EMMO\\_98d65021\\_4574\\_4890\\_b2fb\\_46430841077f](http://emmo.info/emmo/middle/math#EMMO_98d65021_4574_4890_b2fb_46430841077f)

Example:  $2 * a - b = c$

Comment: An 'equation' that has parts two 'polynomial'-s

Relations:

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some math.AlgebraicExpression

## Geometrical branch

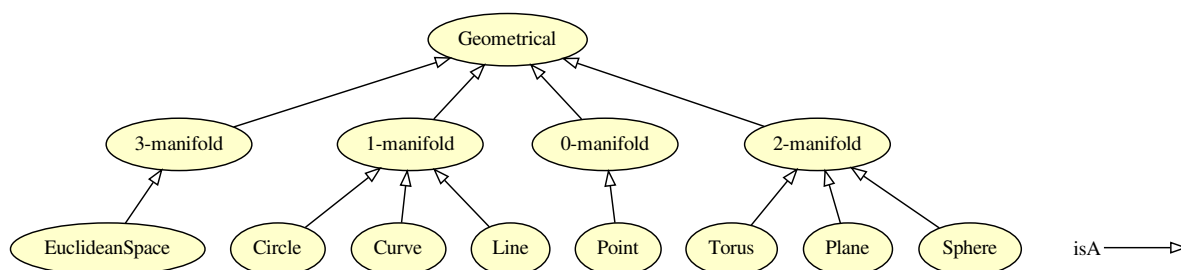


Figure 3.15: Geometrical branch.

## EuclideanSpace

IRI: [http://emmo.info/emmo/middle/perceptual#EMMO\\_5f278af9\\_8593\\_4e27\\_a717\\_ccc9e07a0ddf](http://emmo.info/emmo/middle/perceptual#EMMO_5f278af9_8593_4e27_a717_ccc9e07a0ddf)

Relations:

- is\_a perceptual.3-manifold

## Circle

IRI: [http://emmo.info/emmo/middle/perceptual#EMMO\\_b2a234a8\\_579a\\_422c\\_9305\\_b8f7e72c76cd](http://emmo.info/emmo/middle/perceptual#EMMO_b2a234a8_579a_422c_9305_b8f7e72c76cd)

Relations:

- is\_a perceptual.1-manifold

## Curve

IRI: [http://emmo.info/emmo/middle/perceptual#EMMO\\_0ef4ff4a\\_5458\\_4f2a\\_b51f\\_4689d472a3f2](http://emmo.info/emmo/middle/perceptual#EMMO_0ef4ff4a_5458_4f2a_b51f_4689d472a3f2)

Relations:

- is\_a perceptual.1-manifold

## 3-manifold

IRI: [http://emmo.info/emmo/middle/perceptual#EMMO\\_46f0f8df\\_4dc6\\_418f\\_8036\\_10427a3a288e](http://emmo.info/emmo/middle/perceptual#EMMO_46f0f8df_4dc6_418f_8036_10427a3a288e)

Relations:

- is\_a perceptual.Geometrical



## Point

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_39362460\\_2a97\\_4367\\_8f93\\_0418c2ac9a08](http://emmo.info/emmo/middle/perceptual#EMMO_39362460_2a97_4367_8f93_0418c2ac9a08)

### Relations:

- is\_a perceptual.0-manifold

## 1-manifold

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_0c576e13\\_4ee7\\_4f3d\\_bfe9\\_1614243df018](http://emmo.info/emmo/middle/perceptual#EMMO_0c576e13_4ee7_4f3d_bfe9_1614243df018)

### Relations:

- is\_a perceptual.Geometrical

## 0-manifold

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_0ab0485c\\_9e5b\\_4257\\_a679\\_90a2dfba5c7c](http://emmo.info/emmo/middle/perceptual#EMMO_0ab0485c_9e5b_4257_a679_90a2dfba5c7c)

### Relations:

- is\_a perceptual.Geometrical

## Torus

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_86060335\\_31c2\\_4820\\_b433\\_27c64aea0366](http://emmo.info/emmo/middle/perceptual#EMMO_86060335_31c2_4820_b433_27c64aea0366)

### Relations:

- is\_a perceptual.2-manifold

## Line

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_3e309118\\_e8b7\\_4021\\_80f4\\_642d2df65d94](http://emmo.info/emmo/middle/perceptual#EMMO_3e309118_e8b7_4021_80f4_642d2df65d94)

### Relations:

- is\_a perceptual.1-manifold

## Plane

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_25f5ca8e\\_8f7f\\_44d8\\_a392\\_bd3fe8894458](http://emmo.info/emmo/middle/perceptual#EMMO_25f5ca8e_8f7f_44d8_a392_bd3fe8894458)

### Relations:

- is\_a perceptual.2-manifold

## Geometrical

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_b5957cef\\_a287\\_442d\\_a3ce\\_fd39f20ba1cd](http://emmo.info/emmo/middle/perceptual#EMMO_b5957cef_a287_442d_a3ce_fd39f20ba1cd)

**Elucidation:** A ‘graphical’ aimed to represent a geometrical concept.

**Comment:** A ‘geometrical’ stands for real world objects that express a geometrical concept.

This can be achieved in many different ways. For example, a line can be expressed by: a) an equation like  $y=mx+q$ , which is both an ‘equation’ and a ‘geometrical’ b) a line drawn with a pencil on a paper, which is simply a ‘graphical’ object c) a set of axioms, when the properties of a line are inferred by the interpreter reading them, that are both ‘graphical’ and also ‘formula’

The case a) is a geometrical and mathematical, b) is geometrical and pictorial, while c) is geometrical and a composition of idiomatic strings.

### Relations:

- is\_a perceptual.Graphical

## Sphere

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_d7bf784a\\_db94\\_4dd9\\_861c\\_54f262846fbf](http://emmo.info/emmo/middle/perceptual#EMMO_d7bf784a_db94_4dd9_861c_54f262846fbf)

### Relations:

- is\_a perceptual.2-manifold

## 2-manifold

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_9268958f\\_7f54\\_48ab\\_a693\\_febe2645892b](http://emmo.info/emmo/middle/perceptual#EMMO_9268958f_7f54_48ab_a693_febe2645892b)

### Relations:

- is\_a perceptual.Geometrical

## Symbol branch

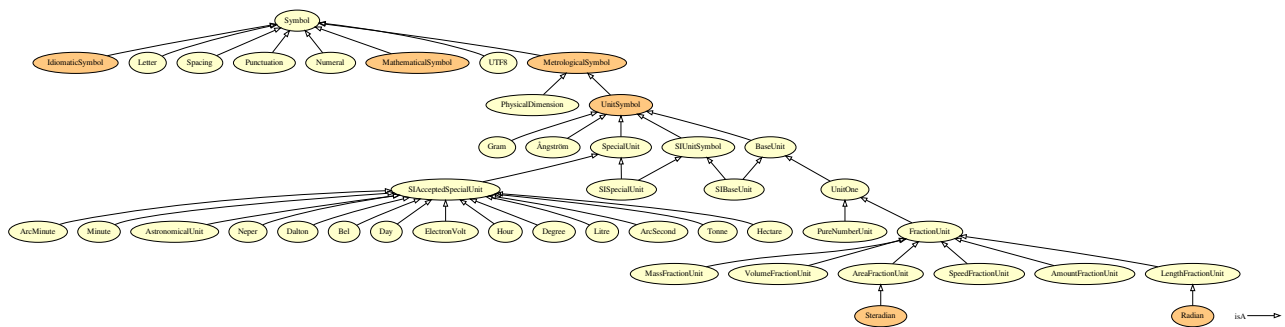


Figure 3.16: Symbol branch.

## LengthFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cdc962d8\\_f3ea\\_4764\\_a57a\\_c7caa4859179](http://emmo.info/emmo/middle/units-extension#EMMO_cdc962d8_f3ea_4764_a57a_c7caa4859179)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two lengths.

**Example:** Unit for plane angle.

### Relations:

- is\_a units-extension.FractionUnit

## MassFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_18448443\\_dcf1\\_49b8\\_a321\\_cf46e2c393e1](http://emmo.info/emmo/middle/units-extension#EMMO_18448443_dcf1_49b8_a321_cf46e2c393e1)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two masses.

**Example:** Unit for mass fraction.

### Relations:

- is\_a units-extension.FractionUnit

## IdiomaticSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_0a318776\\_b067\\_4de0\\_a2a6\\_cba2cf6333f8](http://emmo.info/emmo/middle/metrology#EMMO_0a318776_b067_4de0_a2a6_cba2cf6333f8)

**Relations:**

- is\_a perceptual.Idiomatic
- is\_a perceptual.Symbol
- equivalent\_to perceptual.Idiomatic and perceptual.Symbol

## ArcMinute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_1e0b665d\\_db6c\\_4752\\_a6d4\\_262d3a8dbb46](http://emmo.info/emmo/middle/units-extension#EMMO_1e0b665d_db6c_4752_a6d4_262d3a8dbb46)

**Definition:** Measure of plane angle defined as 1/60 or a degree.

**Altlabel:** MinuteOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCMIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## Symbol

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_a1083d0a\\_c1fb\\_471f\\_8e20\\_a98f881ad527](http://emmo.info/emmo/middle/perceptual#EMMO_a1083d0a_c1fb_471f_8e20_a98f881ad527)

**Elucidation:** The class of individuals that stand for an elementary mark of a specific symbolic code (alphabet).

**Example:** The class of letter “A” is the symbol as idea and the letter A that you see on the screen is the mark.

**Comment:** Subclasses of ‘Symbol’ are alphabets, in formal languages terminology.

A ‘Symbol’ is atomic for that alphabet, i.e. it has no parts that are symbols for the same alphabet. e.g. a math symbol is not made of other math symbols

A Symbol may be a String in another language. e.g. “Bq” is the symbol for Becquerel units when dealing with metrology, or a string of “B” and “q” symbols when dealing with characters.

**Comment:** Symbols of a formal language need not be symbols of anything. For instance there are logical constants which do not refer to any idea, but rather serve as a form of punctuation in the language (e.g. parentheses).

Symbols of a formal language must be capable of being specified without any reference to any interpretation of them. (Wikipedia)

**Comment:** The class is the idea of the symbol, while the individual of that class stands for a specific mark (or token) of that idea.

**Relations:**

- is\_a perceptual.Symbolic

## Minute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cabb20f0\\_05c7\\_448f\\_9485\\_e129725f15a4](http://emmo.info/emmo/middle/units-extension#EMMO_cabb20f0_05c7_448f_9485_e129725f15a4)

**Definition:** Non-SI time unit defined as 60 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Minute>

**Qudtentry:** <http://qudt.org/vocab/unit/MIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “min”

## AstronomicalUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_053648ea\\_3c0a\\_468c\\_89cb\\_eb009239323a](http://emmo.info/emmo/middle/units-extension#EMMO_053648ea_3c0a_468c_89cb_eb009239323a)

**Definition:** One astronomical unit is defined as exactly 149597870700 m, which is roughly the distance from earth to sun.

**Dbpediaentry:** [http://dbpedia.org/page/Astronomical\\_unit](http://dbpedia.org/page/Astronomical_unit)

**Qudtentry:** <http://qudt.org/vocab/unit/PARSEC>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Astronomical\\_unit](https://en.wikipedia.org/wiki/Astronomical_unit)

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “au”

## Gram

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f992dc76\\_f9a6\\_45f6\\_8873\\_c8e20d16fbbe](http://emmo.info/emmo/middle/units-extension#EMMO_f992dc76_f9a6_45f6_8873_c8e20d16fbbe)

**Definition:** Gram is defined as one thousandth of the SI unit kilogram.

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02680>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Gram>

### Relations:

- is\_a metrology.UnitSymbol
- is\_a units-extension.CGSUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “g”

## Radian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a121bb1d\\_5225\\_4c78\\_809b\\_0268c3012208](http://emmo.info/emmo/middle/siunits#EMMO_a121bb1d_5225_4c78_809b_0268c3012208)

**Elucidation:** Measure of plane angle.

**Comment:** Dimensionless measurement unit for plane angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05036>

**Qudtentry:** <http://qudt.org/vocab/unit/RAD>

### Relations:

- is\_a units-extension.LengthFractionUnit
- is\_a owl:Nothing
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “rad”
- equivalent\_to siunits.Steradian

## Neper

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b41515a9\\_28d8\\_4d78\\_8165\\_74b2fc72f89e](http://emmo.info/emmo/middle/units-extension#EMMO_b41515a9_28d8_4d78_8165_74b2fc72f89e)

**Definition:** Unit of measurement for quantities of type level or level difference, which are defined as the natural logarithm of the ratio of power- or field-type quantities.

The value of a ratio in nepers is given by  $\ln(x_1/x_2)$  where  $x_1$  and  $x_2$  are the values of interest (amplitudes), and  $\ln$  is the natural logarithm. When the values are quadratic in the amplitude (e.g. power), they are first linearised by taking the square root before the logarithm is taken, or equivalently the result is halved.

Wikipedia

**Dbpediaentry:** <http://dbpedia.org/page/Neper>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N04106>

**Qudtentry:** <http://qudt.org/vocab/unit/NP>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Neper>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “Np”

## Ångström

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_27c530c4\\_dfcd\\_486e\\_b324\\_54ad4448cd26](http://emmo.info/emmo/middle/units-extension#EMMO_27c530c4_dfcd_486e_b324_54ad4448cd26)

**Definition:** Measure of length defined as 1e-10 metres.

**Altlabel:** Angstrom

**Comment:** Ångström is not mentioned in the SI system and deprecated by the International Bureau of Weights and Measures (BIPM).

Despite of that, it is often used in the natural sciences and technology.

**Dbpediaentry:** <http://dbpedia.org/page/%C3%85ngstr%C3%B6m>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N00350>

**Qudtentry:** <http://qudt.org/vocab/unit/ANGSTROM>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Angstrom>

**Relations:**

- is\_a metrology.UnitSymbol
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “Å”

## FractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_c2f5ee66\\_579c\\_44c6\\_a2e9\\_fa2eaa9fa4da](http://emmo.info/emmo/middle/units-extension#EMMO_c2f5ee66_579c_44c6_a2e9_fa2eaa9fa4da)

**Elucidation:** Unit for fractions of quantities of the same kind, to aid the understanding of the quantity being expressed.

**Comment:** Quantities that are ratios of quantities of the same kind (for example length ratios and amount fractions) have the option of being expressed with units (m/m, mol/mol to aid the understanding of the quantity being expressed and also allow the use of SI prefixes, if this is desirable (µm/m, nmol/mol). – SI Brochure

**Relations:**

- is\_a metrology.UnitOne

## Dalton

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_00dd79e0\\_31a6\\_427e\\_9b9c\\_90f3097e4a96](http://emmo.info/emmo/middle/units-extension#EMMO_00dd79e0_31a6_427e_9b9c_90f3097e4a96)

**Definition:** One dalton is defined as one twelfth of the mass of an unbound neutral atom of carbon-12 in its nuclear and electronic ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Unified\\_atomic\\_mass\\_unit](http://dbpedia.org/page/Unified_atomic_mass_unit)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01514>

**Qudtentry:** <http://qudt.org/vocab/unit/Dalton>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “Da”

## Bel

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6c7160fc\\_cc64\\_46f0\\_b43b\\_aba65e9952e3](http://emmo.info/emmo/middle/units-extension#EMMO_6c7160fc_cc64_46f0_b43b_aba65e9952e3)

**Definition:** One bel is defined as  $\frac{1}{2} \ln(10)$  neper.

**Elucidation:** Unit of measurement for quantities of type level or level difference.

**Comment:** Today decibel (one tenth of a bel) is commonly used instead of bel.

**Comment:** bel is used to express the ratio of one value of a power or field quantity to another, on a logarithmic scale, the logarithmic quantity being called the power level or field level, respectively.

**Qudtentry:** <http://qudt.org/vocab/unit/B>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Decibel>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “B”

## VolumeFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_9fd1e79d\\_41d1\\_44f8\\_8142\\_66dbdf0fc7ad](http://emmo.info/emmo/middle/units-extension#EMMO_9fd1e79d_41d1_44f8_8142_66dbdf0fc7ad)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two volumes.

**Example:** Unit for volume fraction.

### Relations:

- is\_a units-extension.FractionUnit

## BaseUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_db716151\\_6b73\\_45ff\\_910c\\_d182fdcbb4f5](http://emmo.info/emmo/middle/metrology#EMMO_db716151_6b73_45ff_910c_d182fdcbb4f5)

**Elucidation:** A set of units that correspond to the base quantities in a system of units.

### Relations:

- is\_a metrology.UnitSymbol

## AreaFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6f4d704a\\_a7c6\\_4c07\\_b8a7\\_ea0bab04128f](http://emmo.info/emmo/middle/units-extension#EMMO_6f4d704a_a7c6_4c07_b8a7_ea0bab04128f)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two areas.

**Example:** Unit for solid angle.

**Relations:**

- is\_a units-extension.FractionUnit

## Day

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_28ef05a7\\_ecc1\\_4df6\\_8116\\_c53251fbd4a8](http://emmo.info/emmo/middle/units-extension#EMMO_28ef05a7_ecc1_4df6_8116_c53251fbd4a8)

**Definition:** A measure of time defined as 86 400 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Day>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01527>

**Qudtentry:** <http://qudt.org/vocab/unit/DAY>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “d”

## ElectronVolt

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e29f84db\\_4c1c\\_46ae\\_aa38\\_c4d47536b972](http://emmo.info/emmo/middle/units-extension#EMMO_e29f84db_4c1c_46ae_aa38_c4d47536b972)

**Definition:** The amount of energy gained (or lost) by the charge of a single electron moving across an electric potential difference of one volt.

**Dbpediaentry:** <http://dbpedia.org/page/Electronvolt>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02014>

**Qudtentry:** <http://qudt.org/vocab/unit/EV>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.EnergyDimension
- perceptual.hasSymbolData value “eV”

## Letter

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_bed2fe4c\\_dc7e\\_43a8\\_8200\\_6aac44030bff](http://emmo.info/emmo/middle/perceptual#EMMO_bed2fe4c_dc7e_43a8_8200_6aac44030bff)

**Relations:**

- is\_a perceptual.Symbol

## Spacing

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_432192c4\\_111f\\_4e80\\_b7cd\\_c6ce1c1129ea](http://emmo.info/emmo/middle/perceptual#EMMO_432192c4_111f_4e80_b7cd_c6ce1c1129ea)

**Relations:**

- is\_a perceptual.Symbol

## Hour

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_21ef2ed6\\_c086\\_4d24\\_8a75\\_980d2bcc9282](http://emmo.info/emmo/middle/units-extension#EMMO_21ef2ed6_c086_4d24_8a75_980d2bcc9282)

**Definition:** Measure of time defined as 3600 seconds.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02866>

**Qudtentry:** <http://qudt.org/vocab/unit/HR>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “h”

## MetrologicalSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_50a3552e\\_859a\\_4ff7\\_946d\\_76d537cabce6](http://emmo.info/emmo/middle/metrology#EMMO_50a3552e_859a_4ff7_946d_76d537cabce6)

**Elucidation:** A symbol that stands for a concept in the language of the meterological domain of ISO 80000.

### Relations:

- is\_a metrology.Metrological
- is\_a perceptual.Symbol
- mereotopology.hasProperPart only not metrology.Metrological
- equivalent\_to metrology.Metrological and perceptual.Symbol

## PureNumberUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_15d62b55\\_38ea\\_4aec\\_b7c4\\_25db1a2e5a01](http://emmo.info/emmo/middle/units-extension#EMMO_15d62b55_38ea_4aec_b7c4_25db1a2e5a01)

**Elucidation:** Unit for dimensionless units that cannot be expressed as a ‘FractionUnit’.

**Example:** Unit of AtomicNumber

### Relations:

- is\_a metrology.UnitOne

## SpeedFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e7bc8939\\_7ff8\\_4917\\_beb5\\_c42730b390f3](http://emmo.info/emmo/middle/units-extension#EMMO_e7bc8939_7ff8_4917_beb5_c42730b390f3)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two speeds.

**Example:** Unit for refractive index.

### Relations:

- is\_a units-extension.FractionUnit

## Steradian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_cf3dd6cc\\_c5d6\\_4b3d\\_aef4\\_82f3b7a361af](http://emmo.info/emmo/middle/siunits#EMMO_cf3dd6cc_c5d6_4b3d_aef4_82f3b7a361af)

**Elucidation:** Dimensionless measurement unit for solid angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05971>

**Qudtentry:** <http://qudt.org/vocab/unit/SR>

### Relations:

- is\_a units-extension.AreaFractionUnit
- is\_a owl:Nothing



- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “sr”
- equivalent\_to owl:Nothing

## SpecialUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3ee80521\\_3c23\\_4dd1\\_935d\\_9d522614a3e2](http://emmo.info/emmo/middle/metrology#EMMO_3ee80521_3c23_4dd1_935d_9d522614a3e2)

**Elucidation:** A unit symbol that stands for a derived unit.

**Example:** Pa stands for N/m<sup>2</sup> J stands for N m

**Comment:** Special units are semiotic shortcuts to more complex composed symbolic objects.

**Relations:**

- is\_a metrology.DerivedUnit
- is\_a metrology.UnitSymbol
- is\_a semiotics.Sign
- Inverse(semiotics.hasSign) some metrology.DerivedUnit

## Punctuation

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_a817035a\\_3e3c\\_4709\\_8ede\\_3205df3031a3](http://emmo.info/emmo/middle/perceptual#EMMO_a817035a_3e3c_4709_8ede_3205df3031a3)

**Relations:**

- is\_a perceptual.Symbol

## Degree

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b8830065\\_3809\\_41b7\\_be3c\\_e33795567fd9](http://emmo.info/emmo/middle/units-extension#EMMO_b8830065_3809_41b7_be3c_e33795567fd9)

**Definition:** Degree is a measurement of plane angle, defined by representing a full rotation as 360 degrees.

**Dbpediaentry:** [http://dbpedia.org/page/Degree\\_\(angle\)](http://dbpedia.org/page/Degree_(angle))

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01560>

**Qudtentry:** <http://qudt.org/vocab/unit/DEG>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “°”

## AmountFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f76f5a24\\_d703\\_4e8c\\_b368\\_f9a7777cb73a](http://emmo.info/emmo/middle/units-extension#EMMO_f76f5a24_d703_4e8c_b368_f9a7777cb73a)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two amount of substance.

**Example:** Unit for amount fraction.

**Relations:**

- is\_a units-extension.FractionUnit

## Numeral

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_74b05aed\\_66bf\\_43c8\\_aa2c\\_752a9ca8be03](http://emmo.info/emmo/middle/perceptual#EMMO_74b05aed_66bf_43c8_aa2c_752a9ca8be03)

**Relations:**

- is\_a perceptual.Symbol

## Litre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_a155dc93\\_d266\\_487e\\_b5e7\\_2a2c72d5ebf9](http://emmo.info/emmo/middle/units-extension#EMMO_a155dc93_d266_487e_b5e7_2a2c72d5ebf9)

**Definition:** A non-SI unit of volume defined as 1 cubic decimetre (dm<sup>3</sup>),

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03594>

**Qudtentry:** <http://qudt.org/vocab/unit/L>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.VolumeDimension
- perceptual.hasSymbolData value “l”

## UnitOne

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_5ebd5e01\\_0ed3\\_49a2\\_a30d\\_cd05cbe72978](http://emmo.info/emmo/middle/metrology#EMMO_5ebd5e01_0ed3_49a2_a30d_cd05cbe72978)

**Elucidation:** Represents the number 1, used as an explicit unit to say something has no units.

**Example:** Refractive index or volume fraction.

**Example:** Typically used for ratios of two units whos dimensions cancels out.

**Qudtentry:** <http://qudt.org/vocab/unit/UNITLESS>

**Relations:**

- is\_a metrology.BaseUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne

## ArcSecond

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6a4547ab\\_3abb\\_430d\\_b81b\\_ce32d47729f5](http://emmo.info/emmo/middle/units-extension#EMMO_6a4547ab_3abb_430d_b81b_ce32d47729f5)

**Definition:** Measure of plane angle defined as 1/3600 or a degree.

**Altlabel:** SecondOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCSEC>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## UnitSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_216f448e\\_cdbc\\_4aeb\\_a529\\_7a5fe7fc38bb](http://emmo.info/emmo/middle/metrology#EMMO_216f448e_cdbc_4aeb_a529_7a5fe7fc38bb)

**Elucidation:** A symbol that stands for a single unit.

**Example:** Some examples are “Pa”, “m” and “J”.

**Relations:**

- is\_a metrology.MetrologicalSymbol
- is\_a metrology.NonPrefixedUnit
- equivalent\_to metrology.MeasurementUnit and perceptual.Symbol
- disjoint\_union\_of metrology.SpecialUnit, metrology.BaseUnit

## Tonne

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f8b92999\\_3cde\\_46e3\\_99d5\\_664da3090a02](http://emmo.info/emmo/middle/units-extension#EMMO_f8b92999_3cde_46e3_99d5_664da3090a02)

**Definition:** A non-SI unit defined as 1000 kg.

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06394>

**Qudtentry:** [http://qudt.org/vocab/unit/TON\\_M](http://qudt.org/vocab/unit/TON_M)

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Tonne>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “t”

## Hectare

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_d6eb0176\\_a0d7\\_4b4e\\_8df0\\_50e912be2342](http://emmo.info/emmo/middle/units-extension#EMMO_d6eb0176_a0d7_4b4e_8df0_50e912be2342)

**Definition:** A non-SI metric unit of area defined as the square with 100-metre sides.

**Dbpediaentry:** <http://dbpedia.org/page/Hectare>

**Qudtentry:** <http://qudt.org/vocab/unit/HA>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Hectare>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.AreaDimension
- perceptual.hasSymbolData value “ha”

## SIUnitSymbol

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_32129fb5\\_df25\\_48fd\\_a29c\\_18a2f22a2dd5](http://emmo.info/emmo/middle/siunits#EMMO_32129fb5_df25_48fd_a29c_18a2f22a2dd5)

### Relations:

- is\_a metrology.UnitSymbol
- is\_a siunits.SICoherentUnit
- disjoint\_union\_of siunits.SIBaseUnit, siunits.SISpecialUnit

## SIAcceptedSpecialUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6795a4b8\\_ffd0\\_4588\\_a581\\_a9413fe49cac](http://emmo.info/emmo/middle/units-extension#EMMO_6795a4b8_ffd0_4588_a581_a9413fe49cac)

**Elucidation:** Non-SI units mentioned in the SI.

**Comment:** This is a list of units that are not defined as part of the International System of Units (SI), but are otherwise mentioned in the SI brochure, because either the General Conference on Weights and Measures (CGPM) accepts their use as being multiples or submultiples of SI-units, they have important contemporary application worldwide, or are otherwise commonly encountered worldwide.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Non-SI\\_units\\_mentioned\\_in\\_the\\_SI](https://en.wikipedia.org/wiki/Non-SI_units_mentioned_in_the_SI)

### Relations:

- is\_a metrology.SpecialUnit
- is\_a metrology.OffSystemUnit
- disjoint\_union\_of units-extension.Dalton, units-extension.AstronomicalUnit, units-extension.ArcMinute, units-extension.Hour, units-extension.Day, units-extension.ArcSecond, units-extension.Bel, units-extension.Litre, units-extension.Neper, units-extension.Degree, units-extension.Minute, units-extension.Hectare, units-extension.ElectronVolt, units-extension.Tonne

## Mathematical branch

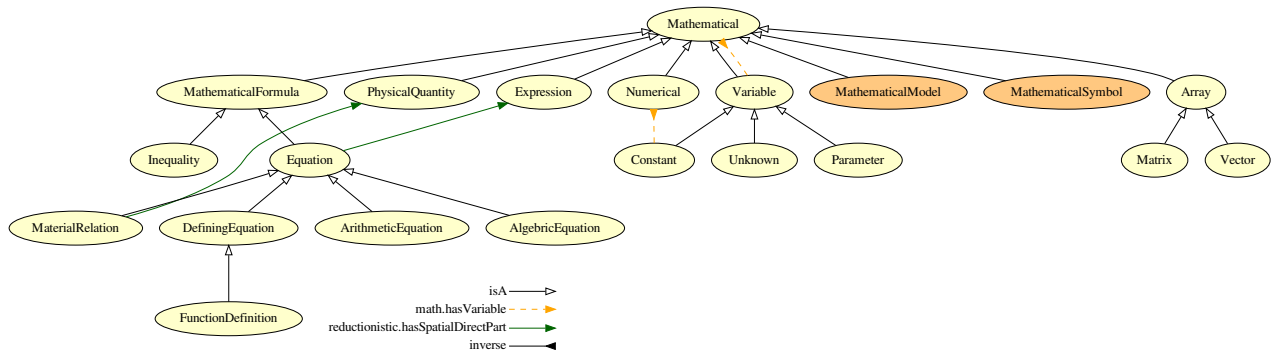


Figure 3.17: Mathematical branch.

### MathematicalFormula

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_88470739\\_03d3\\_4c47\\_a03e\\_b30a1288d50c](http://emmo.info/emmo/middle/math#EMMO_88470739_03d3_4c47_a03e_b30a1288d50c)

**Elucidation:** A mathematical string that can be evaluated as true or false.

### Relations:

- is\_a math.Mathematical
- is\_a perceptual.SymbolicComposition

### Vector

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_06658d8d\\_dcde\\_4fc9\\_aae1\\_17f71c0bcdec](http://emmo.info/emmo/middle/math#EMMO_06658d8d_dcde_4fc9_aae1_17f71c0bcdec)

### Relations:

- is\_a math.Array

### Parameter

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_d1d436e7\\_72fc\\_49cd\\_863b\\_7bfb4ba5276a](http://emmo.info/emmo/middle/math#EMMO_d1d436e7_72fc_49cd_863b_7bfb4ba5276a)

**Example:** viscosity in the Navier-Stokes equation

**Comment:** A ‘variable’ whose value is assumed to be known independently from the equation, but whose value is not explicated in the equation.

### Relations:

- is\_a math.Variable

## DefiningEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_29afdf54\\_90ae\\_4c98\\_8845\\_fa9ea3f143a8](http://emmo.info/emmo/middle/math#EMMO_29afdf54_90ae_4c98_8845_fa9ea3f143a8)

**Elucidation:** An equation that define a new variable in terms of other mathematical entities.

**Example:** The definition of velocity as  $v = dx/dt$ .

The definition of density as mass/volume.

$y = f(x)$

**Relations:**

- is\_a math.Equation

## Matrix

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_1cba0b27\\_15d0\\_4326\\_933f\\_379d0b3565b6](http://emmo.info/emmo/middle/math#EMMO_1cba0b27_15d0_4326_933f_379d0b3565b6)

**Relations:**

- is\_a math.Array

## Constant

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_ae15fb4f\\_8e4d\\_41de\\_a0f9\\_3997f89ba6a2](http://emmo.info/emmo/middle/math#EMMO_ae15fb4f_8e4d_41de_a0f9_3997f89ba6a2)

**Elucidation:** A ‘variable’ that stand for a well known constant.

**Example:**  $\pi$  refers to the constant number  $\sim 3.14$

**Relations:**

- is\_a math.Variable
- Inverse(math.hasVariable) only math.Numerical

## Array

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_28fba28\\_2204\\_4613\\_87ff\\_6d877b855fcd%20](http://emmo.info/emmo/middle/math#EMMO_28fba28_2204_4613_87ff_6d877b855fcd%20)

**Relations:**

- is\_a math.Mathematical

## Unknown

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_fe7e56ce\\_118b\\_4243\\_9aad\\_20eb9f4f31f6](http://emmo.info/emmo/middle/math#EMMO_fe7e56ce_118b_4243_9aad_20eb9f4f31f6)

**Elucidation:** The dependent variable for which an equation has been written.

**Example:** Velocity, for the Navier-Stokes equation.

**Relations:**

- is\_a math.Variable

## Equation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_e56ee3eb\\_7609\\_4ae1\\_8bed\\_51974f0960a6](http://emmo.info/emmo/middle/math#EMMO_e56ee3eb_7609_4ae1_8bed_51974f0960a6)

**Elucidation:** The class of ‘mathematical’-s that stand for a statement of equality between two mathematical expressions.

**Example:**  $2+3 = 5$   $x^2 + 3x = 5x$   $dv/dt = a$   $\sin(x) = y$

**Comment:** An equation with variables can always be represented as:

$f(v_0, v_1, \dots, v_n) = g(v_0, v_1, \dots, v_n)$

where  $f$  is the left hand and  $g$  the right hand side expressions and  $v_0, v_1, \dots, v_n$  are the variables.

**Relations:**

- `is_a math.MathematicalFormula`
- `is_a reductionistic.State`
- `is_a math.Mathematical`
- `reductionistic.hasSpatialDirectPart some math.Expression`

## Inequality

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_0b6ebe5a\\_0026\\_4bef\\_a1c1\\_5be00df9f98e](http://emmo.info/emmo/middle/math#EMMO_0b6ebe5a_0026_4bef_a1c1_5be00df9f98e)

**Elucidation:** A relation which makes a non-equal comparison between two numbers or other mathematical expressions.

**Example:**  $f(x) > 0$

**Relations:**

- `is_a math.MathematicalFormula`

## ArithmeticEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_a6138ba7\\_e365\\_4f2d\\_b6b4\\_fe5a5918d403](http://emmo.info/emmo/middle/math#EMMO_a6138ba7_e365_4f2d_b6b4_fe5a5918d403)

**Example:**  $1 + 1 = 2$

**Relations:**

- `is_a math.Equation`

## Mathematical

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_54ee6b5e\\_5261\\_44a8\\_86eb\\_5717e7fdb9d0](http://emmo.info/emmo/middle/math#EMMO_54ee6b5e_5261_44a8_86eb_5717e7fdb9d0)

**Elucidation:** The class of general mathematical symbolic objects respecting mathematical syntactic rules.

**Relations:**

- `is_a perceptual.Language`

## Variable

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_1eed0732\\_e3f1\\_4b2c\\_a9c4\\_b4e75eeb5895](http://emmo.info/emmo/middle/math#EMMO_1eed0732_e3f1_4b2c_a9c4_b4e75eeb5895)

**Elucidation:** A ‘Variable’ is a symbolic object that stands for a numerical defined ‘Mathematical’ object like e.g. a number, a vector, a matrix.

**Example:**  $x^k$

**Relations:**

- `is_a math.Mathematical`
- `is_a semiotics.Conventional`
- `Inverse(math.hasVariable) some math.Mathematical`

## Numerical

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_4ce76d7f\\_03f8\\_45b6\\_9003\\_90052a79bfaa](http://emmo.info/emmo/middle/math#EMMO_4ce76d7f_03f8_45b6_9003_90052a79bfaa)

**Elucidation:** A ‘Mathematical’ that has no unknown value, i.e. all its ‘Variable“-s parts refers to a ‘Number’ (for scalars that have a built-in datatype) or to another ‘Numerical’ (for complex numerical data structures that should rely on external implementations).

**Relations:**

- is\_a math.Mathematical

## MaterialRelation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_e5438930\\_04e7\\_4d42\\_ade5\\_3700d4a52ab7](http://emmo.info/emmo/middle/models#EMMO_e5438930_04e7_4d42_ade5_3700d4a52ab7)

**Elucidation:** An ‘equation’ that stands for a physical assumption specific to a material, and provides an expression for a ‘physics\_quantity’ (the dependent variable) as function of other variables, physics\_quantity or data (independent variables).

**Example:** The Lennard-Jones potential.

A force field.

An Hamiltonian.

**Comment:** A material\_relation can e.g. return a predefined number, return a database query, be an equation that depends on other physics\_quantities.

**Relations:**

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity

## PhysicsEquation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_27c5d8c6\\_8af7\\_4d63\\_beb1\\_ec37cd8b3fa3](http://emmo.info/emmo/middle/models#EMMO_27c5d8c6_8af7_4d63_beb1_ec37cd8b3fa3)

**Elucidation:** An ‘equation’ that stands for a ‘physical\_law’ by mathematically defining the relations between physics\_quantities.

**Example:** The Newton’s equation of motion.

The Schrödinger equation.

The Navier-Stokes equation.

**Relations:**

- is\_a math.Equation
- is\_a models.MathematicalModel
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity
- Inverse(models.hasModel) some models.PhysicalPhenomenon

## FunctionDefinition

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_4bc29b0f\\_8fcc\\_4026\\_a291\\_f9774a66d9b8](http://emmo.info/emmo/middle/math#EMMO_4bc29b0f_8fcc_4026_a291_f9774a66d9b8)

**Elucidation:** A function defined using functional notation.

**Example:**  $y = f(x)$

**Relations:**

- is\_a math.DefiningEquation

## AlgebraicEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_98d65021\\_4574\\_4890\\_b2fb\\_46430841077f](http://emmo.info/emmo/middle/math#EMMO_98d65021_4574_4890_b2fb_46430841077f)

**Example:**  $2 * a - b = c$

**Comment:** An ‘equation’ that has parts two ‘polynomial’-s

**Relations:**

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some math.AlgebraicExpression

## Mathematical Symbol branch

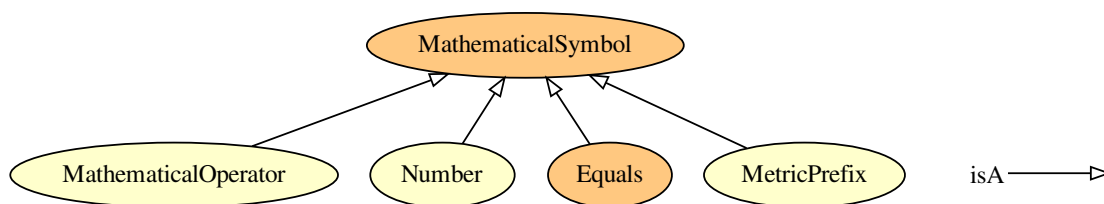


Figure 3.18: Mathematical Symbol branch.

## Equals

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_535d75a4\\_1972\\_40bc\\_88c6\\_ca566386934f](http://emmo.info/emmo/middle/math#EMMO_535d75a4_1972_40bc_88c6_ca566386934f)

**Elucidation:** The equals symbol.

**Relations:**

- is\_a math.MathematicalSymbol
- is\_a math.Mathematical
- is\_a perceptual.Symbol
- equivalent\_to perceptual.hasSymbolData value “=”

## MathematicalSymbol

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_5be83f9c\\_a4ba\\_4b9a\\_be1a\\_5bfc6e891231](http://emmo.info/emmo/middle/math#EMMO_5be83f9c_a4ba_4b9a_be1a_5bfc6e891231)

**Relations:**

- is\_a math.Mathematical
- is\_a perceptual.Symbol
- mereotopology.hasProperPart only not math.Mathematical
- equivalent\_to math.Mathematical and perceptual.Symbol

## Mathematical Model branch

### DataBasedModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_a4b14b83\\_9392\\_4a5f\\_a2e8\\_b2b58793f59b](http://emmo.info/emmo/middle/models#EMMO_a4b14b83_9392_4a5f_a2e8_b2b58793f59b)



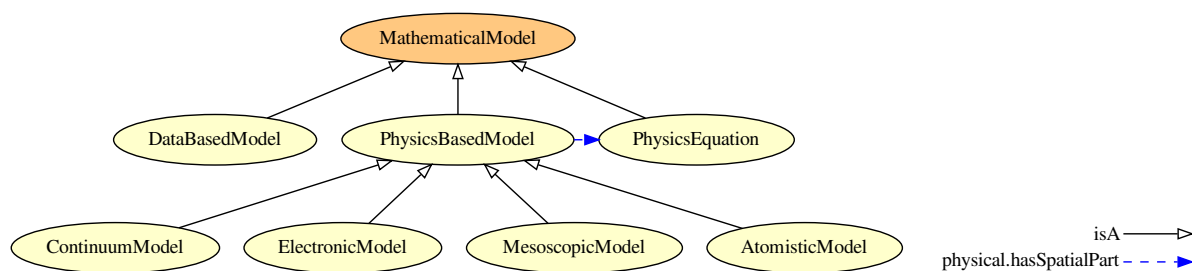


Figure 3.19: Mathematical Model branch.

**Elucidation:** A computational model that uses existing data to create new insight into the behaviour of a system.

**Relations:**

- is\_a models.MathematicalModel

## MathematicalModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_f7ed665b\\_c2e1\\_42bc\\_889b\\_6b42ed3a36f0](http://emmo.info/emmo/middle/models#EMMO_f7ed665b_c2e1_42bc_889b_6b42ed3a36f0)

**Comment:** A mathematical model can be defined as a description of a system using mathematical concepts and language to facilitate proper explanation of a system or to study the effects of different components and to make predictions on patterns of behaviour.

Abramowitz and Stegun, 1968

**Relations:**

- is\_a math.Mathematical
- is\_a models.Model
- equivalent\_to math.Mathematical and models.Model

## ContinuumModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_4456a5d2\\_16a6\\_4ee1\\_9a8e\\_5c75956b28ea](http://emmo.info/emmo/middle/models#EMMO_4456a5d2_16a6_4ee1_9a8e_5c75956b28ea)

**Elucidation:** A physics-based model based on a physics equation describing the behaviour of continuum volume.

**Relations:**

- is\_a models.PhysicsBasedModel

## ElectronicModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_6eca09be\\_17e9\\_445e\\_abc9\\_000aa61b7a11](http://emmo.info/emmo/middle/models#EMMO_6eca09be_17e9_445e_abc9_000aa61b7a11)

**Elucidation:** A physics-based model based on a physics equation describing the behaviour of electrons.

**Example:** Density functional theory. Hartree-Fock.

**Relations:**

- is\_a models.PhysicsBasedModel

## PhysicsBasedModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_b29fd350\\_39aa\\_4af7\\_9459\\_3faa0544cba6](http://emmo.info/emmo/middle/models#EMMO_b29fd350_39aa_4af7_9459_3faa0544cba6)

**Elucidation:** A solvable set of one Physics Equation and one or more Materials Relations.

**Relations:**

- is\_a models.MathematicalModel
- physical.hasSpatialPart some models.PhysicsEquation
- physical.hasSpatialPart some models.MaterialRelation

## PhysicsEquation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_27c5d8c6\\_8af7\\_4d63\\_beb1\\_ec37cd8b3fa3](http://emmo.info/emmo/middle/models#EMMO_27c5d8c6_8af7_4d63_beb1_ec37cd8b3fa3)

**Elucidation:** An ‘equation’ that stands for a ‘physical\_law’ by mathematically defining the relations between physics\_quantities.

**Example:** The Newton’s equation of motion.

The Schrödinger equation.

The Navier-Stokes equation.

**Relations:**

- is\_a math.Equation
- is\_a models.MathematicalModel
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity
- Inverse(models.hasModel) some models.PhysicalPhenomenon

## MesoscopicModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_53935db0\\_af45\\_4426\\_b9e9\\_244a0d77db00](http://emmo.info/emmo/middle/models#EMMO_53935db0_af45_4426_b9e9_244a0d77db00)

**Elucidation:** A physics-based model based on a physics equation describing the behaviour of mesoscopic entities, i.e. a set of bounded atoms like a molecule, bead or nanoparticle.

**Relations:**

- is\_a models.PhysicsBasedModel

## AtomisticModel

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_84cad45\\_6758\\_46f2\\_ba2a\\_5ead65c70213](http://emmo.info/emmo/middle/models#EMMO_84cad45_6758_46f2_ba2a_5ead65c70213)

**Elucidation:** A physics-based model based on a physics equation describing the behaviour of atoms.

**Relations:**

- is\_a models.PhysicsBasedModel

## Mathematical Operator branch

### DifferentialOperator

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_f8a2fe9f\\_458b\\_4771\\_9aba\\_a50e76afc52d](http://emmo.info/emmo/middle/math#EMMO_f8a2fe9f_458b_4771_9aba_a50e76afc52d)

**Relations:**

- is\_a math.MathematicalOperator

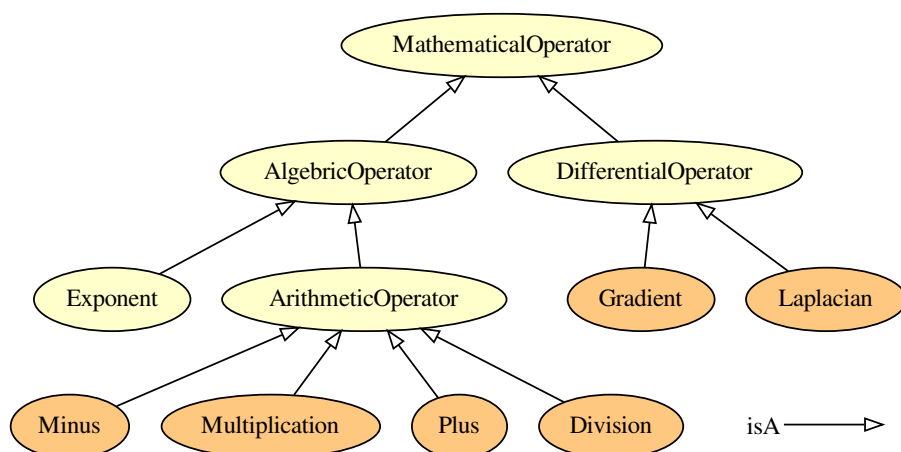


Figure 3.20: Mathematical Operator branch.

## Minus

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_46d5643b\\_9706\\_4b67\\_8bea\\_ed77d6026539](http://emmo.info/emmo/middle/math#EMMO_46d5643b_9706_4b67_8bea_ed77d6026539)

### Relations:

- is\_a math.ArithmeticOperator
- equivalent\_to perceptual.hasSymbolData value “-”

## MathematicalOperator

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_f6d0c26a\\_98b6\\_4cf8\\_8632\\_aa259131faaa](http://emmo.info/emmo/middle/math#EMMO_f6d0c26a_98b6_4cf8_8632_aa259131faaa)

### Relations:

- is\_a math.MathematicalSymbol
- is\_a math.Mathematical
- is\_a perceptual.Symbol

## Multiplication

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_2b1303e8\\_d4c3\\_453b\\_9918\\_76f1d009543f](http://emmo.info/emmo/middle/math#EMMO_2b1303e8_d4c3_453b_9918_76f1d009543f)

### Relations:

- is\_a math.ArithmeticOperator
- equivalent\_to perceptual.hasSymbolData value “\*”

## Plus

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_8de14a59\\_660b\\_454f\\_aff8\\_76a07ce185f4](http://emmo.info/emmo/middle/math#EMMO_8de14a59_660b_454f_aff8_76a07ce185f4)

### Relations:

- is\_a math.ArithmeticOperator
- equivalent\_to perceptual.hasSymbolData value “+”

## Gradient

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_b5c58790\\_fb2d\\_42eb\\_b184\\_2a3f6ca60acb](http://emmo.info/emmo/middle/math#EMMO_b5c58790_fb2d_42eb_b184_2a3f6ca60acb)

**Relations:**

- is\_a math.DifferentialOperator
- equivalent\_to perceptual.hasSymbolData value “ $\nabla$ ”

## Exponent

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_223d9523\\_4169\\_4ecd\\_b8af\\_acad1215e1ff](http://emmo.info/emmo/middle/math#EMMO_223d9523_4169_4ecd_b8af_acad1215e1ff)

**Relations:**

- is\_a math.AlgebraicOperator

## ArithmeticOperator

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_707f0cd1\\_941c\\_4b57\\_9f20\\_d0ba30cd6ff3](http://emmo.info/emmo/middle/math#EMMO_707f0cd1_941c_4b57_9f20_d0ba30cd6ff3)

**Relations:**

- is\_a math.AlgebraicOperator

## Division

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_a365b3c1\\_7bde\\_41d7\\_a15b\\_2820762e85f4](http://emmo.info/emmo/middle/math#EMMO_a365b3c1_7bde_41d7_a15b_2820762e85f4)

**Relations:**

- is\_a math.ArithmeticOperator
- equivalent\_to perceptual.hasSymbolData value “/”

## AlgebraicOperator

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_3c424d37\\_cf62\\_41b1\\_ac9d\\_a316f8d113d6](http://emmo.info/emmo/middle/math#EMMO_3c424d37_cf62_41b1_ac9d_a316f8d113d6)

**Relations:**

- is\_a math.MathematicalOperator

## Laplacian

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_048a14e3\\_65fb\\_457d\\_8695\\_948965c89492](http://emmo.info/emmo/middle/math#EMMO_048a14e3_65fb_457d_8695_948965c89492)

**Relations:**

- is\_a math.DifferentialOperator
- equivalent\_to perceptual.hasSymbolData value “ $\Delta$ ”

## Metrological branch

### LengthFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cdc962d8\\_f3ea\\_4764\\_a57a\\_c7caa4859179](http://emmo.info/emmo/middle/units-extension#EMMO_cdc962d8_f3ea_4764_a57a_c7caa4859179)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two lengths.

**Example:** Unit for plane angle.

**Relations:**

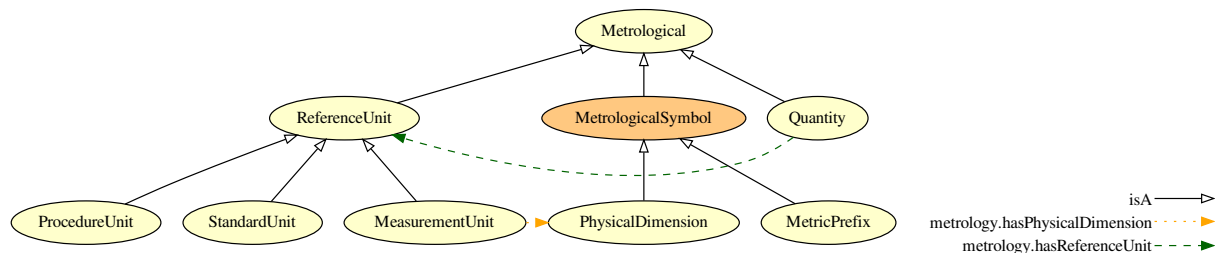


Figure 3.21: Metrological branch.

- is\_a units-extension.FractionUnit

## MassFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_18448443\\_dcf1\\_49b8\\_a321\\_cf46e2c393e1](http://emmo.info/emmo/middle/units-extension#EMMO_18448443_dcf1_49b8_a321_cf46e2c393e1)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two masses.

**Example:** Unit for mass fraction.

**Relations:**

- is\_a units-extension.FractionUnit

## ArcMinute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_1e0b665d\\_db6c\\_4752\\_a6d4\\_262d3a8dbb46](http://emmo.info/emmo/middle/units-extension#EMMO_1e0b665d_db6c_4752_a6d4_262d3a8dbb46)

**Definition:** Measure of plane angle defined as 1/60 or a degree.

**Altlabel:** MinuteOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCMIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## ReferenceUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_18ce5200\\_00f5\\_45bb\\_8c6f\\_6fb128cd41ae](http://emmo.info/emmo/middle/metrology#EMMO_18ce5200_00f5_45bb_8c6f_6fb128cd41ae)

**Comment:** A reference can be a measurement unit, a measurement procedure, a reference material, or a combination of such. International vocabulary of metrology (VIM)

**Comment:** A symbolic is recognized as reference unit also if it is not part of a quantity (e.g. as in the sentence “the Bq is the reference unit of Becquerel”).

For this reason we can’t declare the axiom: ReferenceUnit SubClassOf: inverse(hasReferenceUnit) some Quantity because there exist reference units without being part of a quantity.

This is peculiar to EMMO, where quantities (symbolic) are distinct with properties (semiotics).

**Relations:**

- is\_a metrology.Metrological

## Minute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cabb20f0\\_05c7\\_448f\\_9485\\_e129725f15a4](http://emmo.info/emmo/middle/units-extension#EMMO_cabb20f0_05c7_448f_9485_e129725f15a4)

**Definition:** Non-SI time unit defined as 60 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Minute>

**Qudtentry:** <http://qudt.org/vocab/unit/MIN>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “min”

## AstronomicalUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_053648ea\\_3c0a\\_468c\\_89cb\\_eb009239323a](http://emmo.info/emmo/middle/units-extension#EMMO_053648ea_3c0a_468c_89cb_eb009239323a)

**Definition:** One astronomical unit is defined as exactly 149597870700 m, which is roughly the distance from earth to sun.

**Dbpediaentry:** [http://dbpedia.org/page/Astronomical\\_unit](http://dbpedia.org/page/Astronomical_unit)

**Qudtentry:** <http://qudt.org/vocab/unit/PARSEC>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Astronomical\\_unit](https://en.wikipedia.org/wiki/Astronomical_unit)

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “au”

## Gram

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f992dc76\\_f9a6\\_45f6\\_8873\\_c8e20d16fbbe](http://emmo.info/emmo/middle/units-extension#EMMO_f992dc76_f9a6_45f6_8873_c8e20d16fbbe)

**Definition:** Gram is defined as one thousandth of the SI unit kilogram.

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02680>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Gram>

### Relations:

- is\_a metrology.UnitSymbol
- is\_a units-extension.CGSUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “g”

## Radian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a121bb1d\\_5225\\_4c78\\_809b\\_0268c3012208](http://emmo.info/emmo/middle/siunits#EMMO_a121bb1d_5225_4c78_809b_0268c3012208)

**Elucidation:** Measure of plane angle.

**Comment:** Dimensionless measurement unit for plane angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05036>

**Qudtentry:** <http://qudt.org/vocab/unit/RAD>

### Relations:

- is\_a units-extension.LengthFractionUnit

- is\_a owl:Nothing
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “rad”
- equivalent\_to siunits.Steradian

## Neper

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b41515a9\\_28d8\\_4d78\\_8165\\_74b2fc72f89e](http://emmo.info/emmo/middle/units-extension#EMMO_b41515a9_28d8_4d78_8165_74b2fc72f89e)

**Definition:** Unit of measurement for quantities of type level or level difference, which are defined as the natural logarithm of the ratio of power- or field-type quantities.

The value of a ratio in nepers is given by  $\ln(x_1/x_2)$  where  $x_1$  and  $x_2$  are the values of interest (amplitudes), and  $\ln$  is the natural logarithm. When the values are quadratic in the amplitude (e.g. power), they are first linearised by taking the square root before the logarithm is taken, or equivalently the result is halved.

Wikipedia

**Dbpediaentry:** <http://dbpedia.org/page/Neper>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N04106>

**Qudtentry:** <http://qudt.org/vocab/unit/NP>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Neper>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “Np”

## Ångström

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_27c530c4\\_dfcd\\_486e\\_b324\\_54ad4448cd26](http://emmo.info/emmo/middle/units-extension#EMMO_27c530c4_dfcd_486e_b324_54ad4448cd26)

**Definition:** Measure of length defined as 1e-10 metres.

**Altlabel:** Angstrom

**Comment:** Ångström is not mentioned in the SI system and deprecated by the International Bureau of Weights and Measures (BIPM).

Dispite of that, it is often used in the natural sciences and technology.

**Dbpediaentry:** <http://dbpedia.org/page/%C3%85ngstr%C3%B6m>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N00350>

**Qudtentry:** <http://qudt.org/vocab/unit/ANGSTROM>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Angstrom>

### Relations:

- is\_a metrology.UnitSymbol
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “Å”

## FractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_c2f5ee66\\_579c\\_44c6\\_a2e9\\_fa2eaa9fa4da](http://emmo.info/emmo/middle/units-extension#EMMO_c2f5ee66_579c_44c6_a2e9_fa2eaa9fa4da)

**Elucidation:** Unit for fractions of quantities of the same kind, to aid the understanding of the quantity being expressed.

**Comment:** Quantities that are ratios of quantities of the same kind (for example length ratios and amount fractions) have the option of being expressed with units (m/m, mol/mol to aid the understanding of the quantity being expressed and also allow the use of SI prefixes, if this is desirable ( $\mu\text{m}/\text{m}$ ,  $\text{nmol}/\text{mol}$ ). – SI Brochure

**Relations:**

- is\_a metrology.UnitOne

## Dalton

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_00dd79e0\\_31a6\\_427e\\_9b9c\\_90f3097e4a96](http://emmo.info/emmo/middle/units-extension#EMMO_00dd79e0_31a6_427e_9b9c_90f3097e4a96)

**Definition:** One dalton is defined as one twelfth of the mass of an unbound neutral atom of carbon-12 in its nuclear and electronic ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Unified\\_atomic\\_mass\\_unit](http://dbpedia.org/page/Unified_atomic_mass_unit)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01514>

**Qudtentry:** <http://qudt.org/vocab/unit/Dalton>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “Da”

## Bel

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6c7160fc\\_cc64\\_46f0\\_b43b\\_aba65e9952e3](http://emmo.info/emmo/middle/units-extension#EMMO_6c7160fc_cc64_46f0_b43b_aba65e9952e3)

**Definition:** One bel is defined as  $\frac{1}{2} \ln(10)$  neper.

**Elucidation:** Unit of measurement for quantities of type level or level difference.

**Comment:** Today decibel (one tenth of a bel) is commonly used instead of bel.

**Comment:** bel is used to express the ratio of one value of a power or field quantity to another, on a logarithmic scale, the logarithmic quantity being called the power level or field level, respectively.

**Qudtentry:** <http://qudt.org/vocab/unit/B>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Decibel>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “B”

## VolumeFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_9fd1e79d\\_41d1\\_44f8\\_8142\\_66dbdf0fc7ad](http://emmo.info/emmo/middle/units-extension#EMMO_9fd1e79d_41d1_44f8_8142_66dbdf0fc7ad)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two volumes.

**Example:** Unit for volume fraction.

**Relations:**

- is\_a units-extension.FractionUnit



## BaseUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_db716151\\_6b73\\_45ff\\_910c\\_d182fdcbb4f5](http://emmo.info/emmo/middle/metrology#EMMO_db716151_6b73_45ff_910c_d182fdcbb4f5)

**Elucidation:** A set of units that correspond to the base quantities in a system of units.

**Relations:**

- `is_a metrology.UnitSymbol`

## AreaFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6f4d704a\\_a7c6\\_4c07\\_b8a7\\_ea0bab04128f](http://emmo.info/emmo/middle/units-extension#EMMO_6f4d704a_a7c6_4c07_b8a7_ea0bab04128f)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two areas.

**Example:** Unit for solid angle.

**Relations:**

- `is_a units-extension.FractionUnit`

## Day

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_28ef05a7\\_ecc1\\_4df6\\_8116\\_c53251fbd4a8](http://emmo.info/emmo/middle/units-extension#EMMO_28ef05a7_ecc1_4df6_8116_c53251fbd4a8)

**Definition:** A measure of time defined as 86 400 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Day>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01527>

**Qudtentry:** <http://qudt.org/vocab/unit/DAY>

**Relations:**

- `is_a units-extension.SIAcceptedSpecialUnit`
- `is_a metrology.OffSystemUnit`
- `metrology.hasPhysicalDimension some isq.TimeDimension`
- `perceptual.hasSymbolData value "d"`

## ElectronVolt

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e29f84db\\_4c1c\\_46ae\\_aa38\\_c4d47536b972](http://emmo.info/emmo/middle/units-extension#EMMO_e29f84db_4c1c_46ae_aa38_c4d47536b972)

**Definition:** The amount of energy gained (or lost) by the charge of a single electron moving across an electric potential difference of one volt.

**Dbpediaentry:** <http://dbpedia.org/page/Electronvolt>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02014>

**Qudtentry:** <http://qudt.org/vocab/unit/EV>

**Relations:**

- `is_a units-extension.SIAcceptedSpecialUnit`
- `is_a metrology.OffSystemUnit`
- `metrology.hasPhysicalDimension some isq.EnergyDimension`
- `perceptual.hasSymbolData value "eV"`

## Hour

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_21ef2ed6\\_c086\\_4d24\\_8a75\\_980d2bcc9282](http://emmo.info/emmo/middle/units-extension#EMMO_21ef2ed6_c086_4d24_8a75_980d2bcc9282)

**Definition:** Measure of time defined as 3600 seconds.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02866>

**Qudtentry:** <http://qudt.org/vocab/unit/HR>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “h”

## MetrologicalSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_50a3552e\\_859a\\_4ff7\\_946d\\_76d537cabce6](http://emmo.info/emmo/middle/metrology#EMMO_50a3552e_859a_4ff7_946d_76d537cabce6)

**Elucidation:** A symbol that stands for a concept in the language of the meterological domain of ISO 80000.

### Relations:

- is\_a metrology.Metrological
- is\_a perceptual.Symbol
- mereotopology.hasProperPart only not metrology.Metrological
- equivalent\_to metrology.Metrological and perceptual.Symbol

## PureNumberUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_15d62b55\\_38ea\\_4aec\\_b7c4\\_25db1a2e5a01](http://emmo.info/emmo/middle/units-extension#EMMO_15d62b55_38ea_4aec_b7c4_25db1a2e5a01)

**Elucidation:** Unit for dimensionless units that cannot be expressed as a ‘FractionUnit’.

**Example:** Unit of AtomicNumber

### Relations:

- is\_a metrology.UnitOne

## SpeedFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e7bc8939\\_7ff8\\_4917\\_beb5\\_c42730b390f3](http://emmo.info/emmo/middle/units-extension#EMMO_e7bc8939_7ff8_4917_beb5_c42730b390f3)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two speeds.

**Example:** Unit for refractive index.

### Relations:

- is\_a units-extension.FractionUnit

## Steradian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_cf3dd6cc\\_c5d6\\_4b3d\\_aef4\\_82f3b7a361af](http://emmo.info/emmo/middle/siunits#EMMO_cf3dd6cc_c5d6_4b3d_aef4_82f3b7a361af)

**Elucidation:** Dimensionless measurement unit for solid angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05971>

**Qudtentry:** <http://qudt.org/vocab/unit/SR>

### Relations:

- is\_a units-extension.AreaFractionUnit
- is\_a owl:Nothing

- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “sr”
- equivalent\_to owl:Nothing

## SpecialUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3ee80521\\_3c23\\_4dd1\\_935d\\_9d522614a3e2](http://emmo.info/emmo/middle/metrology#EMMO_3ee80521_3c23_4dd1_935d_9d522614a3e2)

**Elucidation:** A unit symbol that stands for a derived unit.

**Example:** Pa stands for N/m<sup>2</sup> J stands for N m

**Comment:** Special units are semiotic shortcuts to more complex composed symbolic objects.

**Relations:**

- is\_a metrology.DerivedUnit
- is\_a metrology.UnitSymbol
- is\_a semiotics.Sign
- Inverse(semiotics.hasSign) some metrology.DerivedUnit

## Degree

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b8830065\\_3809\\_41b7\\_be3c\\_e33795567fd9](http://emmo.info/emmo/middle/units-extension#EMMO_b8830065_3809_41b7_be3c_e33795567fd9)

**Definition:** Degree is a measurement of plane angle, defined by representing a full rotation as 360 degrees.

**Dbpediaentry:** [http://dbpedia.org/page/Degree\\_\(angle\)](http://dbpedia.org/page/Degree_(angle))

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01560>

**Qudtentry:** <http://qudt.org/vocab/unit/DEG>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “°”

## ProcedureUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_c9c8f824\\_9127\\_4f93\\_bc21\\_69fe78a7f6f2](http://emmo.info/emmo/middle/metrology#EMMO_c9c8f824_9127_4f93_bc21_69fe78a7f6f2)

**Elucidation:** A reference unit provided by a measurement procedure.

**Example:** Rockwell C hardness of a given sample (150 kg load): 43.5HRC(150 kg)

**Relations:**

- is\_a metrology.ReferenceUnit

## AmountFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f76f5a24\\_d703\\_4e8c\\_b368\\_f9a7777cb73a](http://emmo.info/emmo/middle/units-extension#EMMO_f76f5a24_d703_4e8c_b368_f9a7777cb73a)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two amount of substance.

**Example:** Unit for amount fraction.

**Relations:**

- is\_a units-extension.FractionUnit

## Litre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_a155dc93\\_d266\\_487e\\_b5e7\\_2a2c72d5ebf9](http://emmo.info/emmo/middle/units-extension#EMMO_a155dc93_d266_487e_b5e7_2a2c72d5ebf9)

**Definition:** A non-SI unit of volume defined as 1 cubic decimetre (dm<sup>3</sup>),

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03594>

**Qudtentry:** <http://qudt.org/vocab/unit/L>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.VolumeDimension
- perceptual.hasSymbolData value “l”

## StandardUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_acd1a504\\_ca32\\_4f30\\_86ad\\_0b62cea5bc02](http://emmo.info/emmo/middle/metrology#EMMO_acd1a504_ca32_4f30_86ad_0b62cea5bc02)

**Elucidation:** A reference unit provided by a reference material. International vocabulary of metrology (VIM)

**Example:** Arbitrary amount-of-substance concentration of lutropin in a given sample of plasma (WHO international standard 80/552): 5.0 International Unit/l

### Relations:

- is\_a metrology.ReferenceUnit

## Metrological

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_985bec21\\_989f\\_4b9e\\_a4b3\\_735d88099c3c](http://emmo.info/emmo/middle/metrology#EMMO_985bec21_989f_4b9e_a4b3_735d88099c3c)

**Elucidation:** A language object used in metrology.

**Comment:** Metrology includes all theoretical and practical aspects of measurement, whatever the measurement uncertainty and field of application.

– International vocabulary of metrology (VIM)

**Comment:** This language domain makes use of ISO 80000 concepts.

### Relations:

- is\_a perceptual.Language

## UnitOne

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_5ebd5e01\\_0ed3\\_49a2\\_a30d\\_cd05cbe72978](http://emmo.info/emmo/middle/metrology#EMMO_5ebd5e01_0ed3_49a2_a30d_cd05cbe72978)

**Elucidation:** Represents the number 1, used as an explicit unit to say something has no units.

**Example:** Refractive index or volume fraction.

**Example:** Typically used for ratios of two units whos dimensions cancels out.

**Qudtentry:** <http://qudt.org/vocab/unit/UNITLESS>

### Relations:

- is\_a metrology.BaseUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne

## ArcSecond

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6a4547ab\\_3abb\\_430d\\_b81b\\_ce32d47729f5](http://emmo.info/emmo/middle/units-extension#EMMO_6a4547ab_3abb_430d_b81b_ce32d47729f5)

**Definition:** Measure of plane angle defined as 1/3600 or a degree.

**Altlabel:** SecondOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCSEC>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## UnitSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_216f448e\\_cdbc\\_4aeb\\_a529\\_7a5fe7fc38bb](http://emmo.info/emmo/middle/metrology#EMMO_216f448e_cdbc_4aeb_a529_7a5fe7fc38bb)

**Elucidation:** A symbol that stands for a single unit.

**Example:** Some examples are “Pa”, “m” and “J”.

**Relations:**

- is\_a metrology.MetrologicalSymbol
- is\_a metrology.NonPrefixedUnit
- equivalent\_to metrology.MeasurementUnit and perceptual.Symbol
- disjoint\_union\_of metrology.SpecialUnit, metrology.BaseUnit

## Tonne

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f8b92999\\_3cde\\_46e3\\_99d5\\_664da3090a02](http://emmo.info/emmo/middle/units-extension#EMMO_f8b92999_3cde_46e3_99d5_664da3090a02)

**Definition:** A non-SI unit defined as 1000 kg.

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06394>

**Qudtentry:** [http://qudt.org/vocab/unit/TON\\_M](http://qudt.org/vocab/unit/TON_M)

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Tonne>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “t”

## Hectare

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_d6eb0176\\_a0d7\\_4b4e\\_8df0\\_50e912be2342](http://emmo.info/emmo/middle/units-extension#EMMO_d6eb0176_a0d7_4b4e_8df0_50e912be2342)

**Definition:** A non-SI metric unit of area defined as the square with 100-metre sides.

**Dbpediaentry:** <http://dbpedia.org/page/Hectare>

**Qudtentry:** <http://qudt.org/vocab/unit/HA>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Hectare>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.AreaDimension

- perceptual.hasSymbolData value “ha”

## SIUnitSymbol

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_32129fb5\\_df25\\_48fd\\_a29c\\_18a2f22a2dd5](http://emmo.info/emmo/middle/siunits#EMMO_32129fb5_df25_48fd_a29c_18a2f22a2dd5)

**Relations:**

- is\_a metrology.UnitSymbol
- is\_a siunits.SICoherentUnit
- disjoint\_union\_of siunits.SIBaseUnit, siunits.SISpecialUnit

## SIAcceptedSpecialUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6795a4b8\\_ffd0\\_4588\\_a581\\_a9413fe49cac](http://emmo.info/emmo/middle/units-extension#EMMO_6795a4b8_ffd0_4588_a581_a9413fe49cac)

**Elucidation:** Non-SI units mentioned in the SI.

**Comment:** This is a list of units that are not defined as part of the International System of Units (SI), but are otherwise mentioned in the SI brochure, because either the General Conference on Weights and Measures (CGPM) accepts their use as being multiples or submultiples of SI-units, they have important contemporary application worldwide, or are otherwise commonly encountered worldwide.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Non-SI\\_units\\_mentioned\\_in\\_the\\_SI](https://en.wikipedia.org/wiki/Non-SI_units_mentioned_in_the_SI)

**Relations:**

- is\_a metrology.SpecialUnit
- is\_a metrology.OffSystemUnit
- disjoint\_union\_of units-extension.Dalton, units-extension.AstronomicalUnit, units-extension.ArcMinute, units-extension.Hour, units-extension.Day, units-extension.ArcSecond, units-extension.Bel, units-extension.Litre, units-extension.Neper, units-extension.Degree, units-extension.Minute, units-extension.Hectare, units-extension.ElectronVolt, units-extension.Tonne

## Physical Dimension branch

### TimeDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_02e894c3\\_b793\\_4197\\_b120\\_3442e08f58d1](http://emmo.info/emmo/middle/isq#EMMO_02e894c3_b793_4197_b120_3442e08f58d1)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T+1 L0 M0 I0 Θ0 N0 J0”

### EntropyDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_3ecff38b\\_b3cf\\_4a78\\_b49f\\_8580abf8715b](http://emmo.info/emmo/middle/isq#EMMO_3ecff38b_b3cf_4a78_b49f_8580abf8715b)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L+2 M+1 I0 Θ-1 N0 J0”

### SpeedDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4f5c7c54\\_1c63\\_4d17\\_b12b\\_ea0792c2b187](http://emmo.info/emmo/middle/isq#EMMO_4f5c7c54_1c63_4d17_b12b_ea0792c2b187)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to isq.VelocityDimension

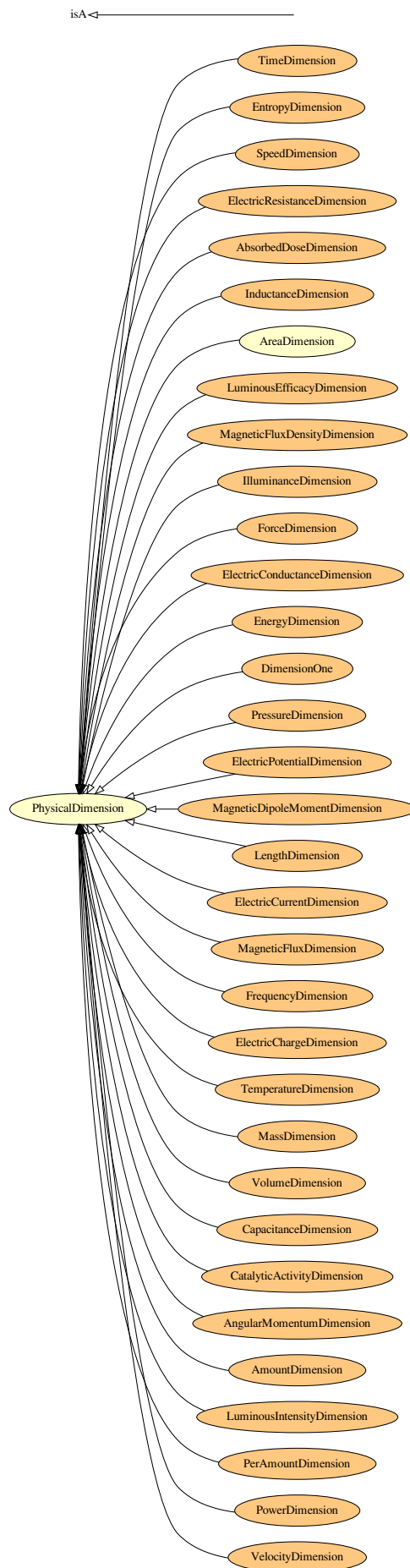


Figure 3.22: Physical Dimension branch.

- `equivalent_to_perceptual.hasSymbolData` value “T-1 L+1 M0 I0 Θ0 N0 J0”

## PhysicalDimension

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_9895a1b4\\_f0a5\\_4167\\_ac5e\\_97db40b8bfcc](http://emmo.info/emmo/middle/metrology#EMMO_9895a1b4_f0a5_4167_ac5e_97db40b8bfcc)

**Elucidation:** A symbol that, following SI specifications, describe the physical dimensionality of a physical quantity and the exponents of the base units in a measurement unit.

**Comment:** All physical quantities, with the exception of counts, are derived quantities, which may be written in terms of base quantities according to the equations of physics. The dimensions of the derived quantities are written as products of powers of the dimensions of the base quantities using the equations that relate the derived quantities to the base quantities. In general the dimension of any quantity  $Q$  is written in the form of a dimensional product,

$$\dim Q = T^{\alpha} L^{\beta} M^{\gamma} I^{\delta} \Theta^{\epsilon} N^{\zeta} J^{\eta}$$

where the exponents  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$  and  $\eta$ , which are generally small integers, which can be positive, negative, or zero, are called the dimensional exponents. (SI brochure)

**Comment:** The conventional symbolic representation of the dimension of a base quantity is a single upper case letter in roman (upright) type. The conventional symbolic representation of the dimension of a derived quantity is the product of powers of the dimensions of the base quantities according to the definition of the derived quantity. The dimension of a quantity  $Q$  is denoted by  $\dim Q$ . ISO 80000-1

**Comment:** The expression used by the EMMO for physical dimensions is a metrological symbol (but a string at meta level, i.e. the ontologist level) like this:

Ta Lb Mc Id Θe Nf Jg

where a, b, c, d, e, f and g are 0 or signed integers.

Regex for the physical dimension symbol for the EMMO is:  $\sim T([+][1-9]|0) L([+][1-9]|0) M([+][1-9]|0) I([+][1-9]|0) \Theta([+][1-9]|0) N([+][1-9]|0) J([+][1-9]|0)\$$

Examples of correspondance between base units and physical dimensions are:  $\text{mol} \rightarrow T0 L0 M0 I0 \Theta0 N+1 J0$   
 $s \rightarrow T+1 L0 M0 I0 \Theta0 N0 J0$   $A/m^2 \rightarrow T0 L0 M-2 I+1 \Theta0 N0 J0$

### Relations:

- `is_a metrology.MetrologicalSymbol`
- `is_a metrology.Metrological`
- `is_a perceptual.Symbol`

## ElectricResistanceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_7610efb8\\_c7c6\\_4684\\_abc1\\_774783c62472](http://emmo.info/emmo/middle/isq#EMMO_7610efb8_c7c6_4684_abc1_774783c62472)

### Relations:

- `is_a metrology.PhysicalDimension`
- `equivalent_to_perceptual.hasSymbolData` value “T-3 L+2 M+1 I-2 Θ0 N0 J0”

## AbsorbedDoseDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_847f1d9f\\_205e\\_46c1\\_8cb6\\_a9e479421f88](http://emmo.info/emmo/middle/isq#EMMO_847f1d9f_205e_46c1_8cb6_a9e479421f88)

### Relations:

- `is_a metrology.PhysicalDimension`
- `equivalent_to_perceptual.hasSymbolData` value “T-2 L+2 M0 I0 Θ0 N0 J0”



## InductanceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_585e0ff0\\_9429\\_4d3c\\_b578\\_58abb1ba21d1](http://emmo.info/emmo/middle/isq#EMMO_585e0ff0_9429_4d3c_b578_58abb1ba21d1)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L+2 M+1 I-2  $\Theta$ 0 N0 J0”

## AreaDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_33433bb1\\_c68f\\_45ee\\_a466\\_f01e2c57b214](http://emmo.info/emmo/middle/isq#EMMO_33433bb1_c68f_45ee_a466_f01e2c57b214)

**Relations:**

- is\_a metrology.PhysicalDimension
- perceptual.hasSymbolData value “T0 L2 M0 I0  $\Theta$ 0 N0 J0”

## LuminousEfficacyDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_5c003f53\\_20a2\\_4bd7\\_8445\\_58187e582578](http://emmo.info/emmo/middle/isq#EMMO_5c003f53_20a2_4bd7_8445_58187e582578)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T+3 L-1 M-1 I0  $\Theta$ 0 N0 J+1”

## MagneticFluxDensityDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ec903946\\_ddc9\\_464a\\_903c\\_7373e0d1eeb5](http://emmo.info/emmo/middle/isq#EMMO_ec903946_ddc9_464a_903c_7373e0d1eeb5)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L0 M+1 I-1  $\Theta$ 0 N0 J0”

## IlluminanceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_668e6ead\\_1530\\_40cc\\_ad5e\\_24b880edff50](http://emmo.info/emmo/middle/isq#EMMO_668e6ead_1530_40cc_ad5e_24b880edff50)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L-2 M0 I0  $\Theta$ 0 N0 J+1”

## ForceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_53e825d9\\_1a09\\_483c\\_baa7\\_37501ebfbe1c](http://emmo.info/emmo/middle/isq#EMMO_53e825d9_1a09_483c_baa7_37501ebfbe1c)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L+1 M+1 I0  $\Theta$ 0 N0 J0”

## ElectricConductanceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_321af35f\\_f0cc\\_4a5c\\_b4fe\\_8c2c0303fb0c](http://emmo.info/emmo/middle/isq#EMMO_321af35f_f0cc_4a5c_b4fe_8c2c0303fb0c)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T+3 L-2 M-1 I+2  $\Theta$ 0 N0 J0”

## EnergyDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f6070071\\_d054\\_4b17\\_9d2d\\_f446f7147d0f](http://emmo.info/emmo/middle/isq#EMMO_f6070071_d054_4b17_9d2d_f446f7147d0f)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L+2 M+1 I0 Θ0 N0 J0”

## DimensionOne

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3227b821\\_26a5\\_4c7c\\_9c01\\_5c24483e0bd0](http://emmo.info/emmo/middle/metrology#EMMO_3227b821_26a5_4c7c_9c01_5c24483e0bd0)

**Comment:** “The unit one is the neutral element of any system of units – necessary and present automatically.”  
SI Brochure

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L0 M0 I0 Θ0 N0 J0”

## PressureDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_53bd0c90\\_41c3\\_46e2\\_8779\\_cd2a80f7e18b](http://emmo.info/emmo/middle/isq#EMMO_53bd0c90_41c3_46e2_8779_cd2a80f7e18b)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-2 L-1 M+1 I0 Θ0 N0 J0”

## ElectricPotentialDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_2e7e5796\\_4a80\\_4d73\\_bb84\\_f31138446c0c](http://emmo.info/emmo/middle/isq#EMMO_2e7e5796_4a80_4d73_bb84_f31138446c0c)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-3 L+2 M+1 I-1 Θ0 N0 J0”

## MagneticDipoleMomentDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1c2226a9\\_22f0\\_40c8\\_8928\\_5a01d398f96e](http://emmo.info/emmo/middle/isq#EMMO_1c2226a9_22f0_40c8_8928_5a01d398f96e)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T+1 L+1 M0 I+1 Θ0 N0 J0”

## LengthDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b3600e73\\_3e05\\_479d\\_9714\\_c041c3acf5cc](http://emmo.info/emmo/middle/isq#EMMO_b3600e73_3e05_479d_9714_c041c3acf5cc)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L+1 M0 I0 Θ0 N0 J0”

## ElectricCurrentDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d5f3e0e5\\_fc7d\\_4e64\\_86ad\\_555e74aaff84](http://emmo.info/emmo/middle/isq#EMMO_d5f3e0e5_fc7d_4e64_86ad_555e74aaff84)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_0 L_0 M_0 I_{+1} \Theta_0 N_0 J_0$ ”

## MagneticFluxDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4c49ab58\\_a6f6\\_409e\\_b849\\_f873ae1dcbee](http://emmo.info/emmo/middle/isq#EMMO_4c49ab58_a6f6_409e_b849_f873ae1dcbee)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_{-2} L_{+2} M_{+1} I_{-1} \Theta_0 N_0 J_0$ ”

## FrequencyDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_515b5579\\_d526\\_4842\\_9e6f\\_ecc34db6f368](http://emmo.info/emmo/middle/isq#EMMO_515b5579_d526_4842_9e6f_ecc34db6f368)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_{-1} L_0 M_0 I_0 \Theta_0 N_0 J_0$ ”

## ElectricChargeDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ab79e92b\\_5377\\_454d\\_be06\\_d61b50db295a](http://emmo.info/emmo/middle/isq#EMMO_ab79e92b_5377_454d_be06_d61b50db295a)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_{+1} L_0 M_0 I_{+1} \Theta_0 N_0 J_0$ ”

## TemperatureDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a77a0a4b\\_6bd2\\_42b2\\_be27\\_4b63cebbb59e](http://emmo.info/emmo/middle/isq#EMMO_a77a0a4b_6bd2_42b2_be27_4b63cebbb59e)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_0 L_0 M_0 I_0 \Theta_{+1} N_0 J_0$ ”

## MassDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_77e9dc31\\_5b19\\_463e\\_b000\\_44c6e79f98aa](http://emmo.info/emmo/middle/isq#EMMO_77e9dc31_5b19_463e_b000_44c6e79f98aa)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_0 L_0 M_{+1} I_0 \Theta_0 N_0 J_0$ ”

## VolumeDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_9141801c\\_c539\\_4c72\\_b423\\_8c74ff6b8f05](http://emmo.info/emmo/middle/isq#EMMO_9141801c_c539_4c72_b423_8c74ff6b8f05)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “ $T_0 L_{+3} M_0 I_0 \Theta_0 N_0 J_0$ ”

## CapacitanceDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b14d9be5\\_f81e\\_469b\\_abca\\_379c2e83feab](http://emmo.info/emmo/middle/isq#EMMO_b14d9be5_f81e_469b_abca_379c2e83feab)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T+4 L-2 M-1 I+2  $\Theta$ 0 N0 J0”

## CatalyticActivityDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ce7d4720\\_aa20\\_4a8c\\_93e8\\_df41a35b6723](http://emmo.info/emmo/middle/isq#EMMO_ce7d4720_aa20_4a8c_93e8_df41a35b6723)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-1 L0 M0 I0  $\Theta$ 0 N+1 J0”

## AngularMomentumDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_501f9b3a\\_c469\\_48f7\\_9281\\_2e6a8d805d7a](http://emmo.info/emmo/middle/isq#EMMO_501f9b3a_c469_48f7_9281_2e6a8d805d7a)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-1 L+2 M+1 I0  $\Theta$ 0 N0 J0”

## AmountDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e501069c\\_34d3\\_4dc7\\_ac87\\_c90c7342192b](http://emmo.info/emmo/middle/isq#EMMO_e501069c_34d3_4dc7_ac87_c90c7342192b)

**Comment:** “In the name “amount of substance”, the word “substance” will typically be replaced by words to specify the substance concerned in any particular application, for example “amount of hydrogen chloride, HCl”, or “amount of benzene, C<sub>6</sub>H<sub>6</sub>”. It is important to give a precise definition of the entity involved (as emphasized in the definition of the mole); this should preferably be done by specifying the molecular chemical formula of the material involved. Although the word “amount” has a more general dictionary definition, the abbreviation of the full name “amount of substance” to “amount” may be used for brevity.” SI Brochure

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L0 M0 I0  $\Theta$ 0 N+1 J0”

## LuminousIntensityDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_14ff4393\\_0f28\\_4fb4\\_abc7\\_c2cc00bc761d](http://emmo.info/emmo/middle/isq#EMMO_14ff4393_0f28_4fb4_abc7_c2cc00bc761d)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L0 M0 I0  $\Theta$ 0 N0 J+1”

## PerAmountDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_af24ae20\\_8ef2\\_435a\\_86a1\\_2ea44488b318](http://emmo.info/emmo/middle/isq#EMMO_af24ae20_8ef2_435a_86a1_2ea44488b318)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T0 L0 M0 I0  $\Theta$ 0 N-1 J0”

## PowerDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_c8d084ad\\_f88e\\_4596\\_8e4d\\_982c6655ce6f](http://emmo.info/emmo/middle/isq#EMMO_c8d084ad_f88e_4596_8e4d_982c6655ce6f)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-3 L+2 M+1 I0 Θ0 N0 J0”

## VelocityDimension

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f84792eb\\_ec64\\_4a6b\\_941f\\_c9f3e9ef052c](http://emmo.info/emmo/middle/isq#EMMO_f84792eb_ec64_4a6b_941f_c9f3e9ef052c)

**Relations:**

- is\_a metrology.PhysicalDimension
- equivalent\_to perceptual.hasSymbolData value “T-1 L+1 M0 I0 Θ0 N0 J0”

## Physical Quantity branch

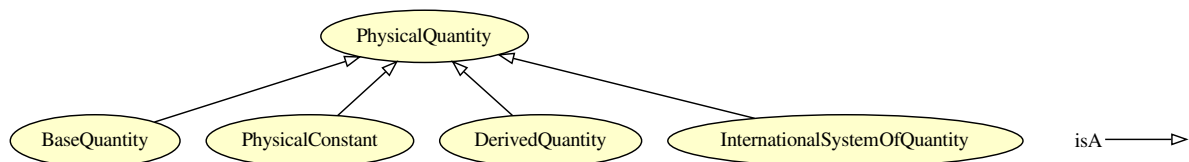


Figure 3.23: Physical Quantity branch.

## Weight

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04cf0295\\_3e8f\\_4693\\_a87f\\_3130d125cf05](http://emmo.info/emmo/middle/isq#EMMO_04cf0295_3e8f_4693_a87f_3130d125cf05)

**Comment:** Force of gravity acting on a body.

**Dbpediaentry:** <http://dbpedia.org/page/Weight>

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06668>

**Physicaldimension:** T-2 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Force

## Permittivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0ee5779e\\_d798\\_4ee5\\_9bfe\\_c392d5bea112](http://emmo.info/emmo/middle/isq#EMMO_0ee5779e_d798_4ee5_9bfe_c392d5bea112)

**Comment:** Measure for how the polarization of a material is affected by the application of an external electric field.

**Dbpediaentry:** <http://dbpedia.org/page/Permittivity>

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04507>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Permittivity>

**Physicaldimension:** T+4 L-3 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## BoltzmannConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ffc7735f\\_c177\\_46a4\\_98e9\\_a54440d29209](http://emmo.info/emmo/middle/isq#EMMO_ffc7735f_c177_46a4_98e9_a54440d29209)

**Elucidation:** A physical constant relating energy at the individual particle level with temperature. It is the gas constant R divided by the Avogadro constant.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.B00695>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ-1 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_BoltzmannConstant](http://physics.nist.gov/cuu/CODATA-Value_BoltzmannConstant)

**Relations:**

- is\_a isq.Entropy
- is\_a isq.SIExactConstant

## VacuumMagneticPermeability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_de021e4f\\_918f\\_47ef\\_a67b\\_11120f56b9d7](http://emmo.info/emmo/middle/isq#EMMO_de021e4f_918f_47ef_a67b_11120f56b9d7)

**Comment:** The DBpedia and IUPAC Gold Book definitions ([http://dbpedia.org/page/Vacuum\\_permeability](http://dbpedia.org/page/Vacuum_permeability), <https://doi.org/10.1351/goldbook.P04504>) are outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of magnetic permeability in a classical vacuum.

**Physicaldimension:** T-2 L+1 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_MagneticConstant](http://physics.nist.gov/cuu/CODATA-Value_MagneticConstant)

**Relations:**

- is\_a isq.Permeability
- is\_a metrology.MeasuredConstant

## MagneticFieldStrength

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b4895f75\\_41c8\\_4fd9\\_b6d6\\_4d5f7c99c423](http://emmo.info/emmo/middle/isq#EMMO_b4895f75_41c8_4fd9_b6d6_4d5f7c99c423)

**Comment:** Strength of a magnetic field. Commonly denoted H.

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_field](http://dbpedia.org/page/Magnetic_field)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03683>

**Physicaldimension:** T0 L-1 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticFlux

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_3b931698\\_937e\\_49be\\_ab1b\\_36fa52d91181](http://emmo.info/emmo/middle/isq#EMMO_3b931698_937e_49be_ab1b_36fa52d91181)

**Elucidation:** Measure of magnetism, taking account of the strength and the extent of a magnetic field.

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_flux](http://dbpedia.org/page/Magnetic_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03684>

**Physicaldimension:** T-2 L+2 M+1 I-1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## InternalEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_830b59f7\\_d047\\_438c\\_90cd\\_62845749efcb](http://emmo.info/emmo/middle/isq#EMMO_830b59f7_d047_438c_90cd_62845749efcb)

**Elucidation:** A state quantity equal to the difference between the total energy of a system and the sum of the macroscopic kinetic and potential energies of the system.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-04-20>

**Altlabel:** ThermodynamicEnergy

**Dbpediaentry:** [http://dbpedia.org/page/Internal\\_energy](http://dbpedia.org/page/Internal_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.I03103>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/InternalEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## Capacitance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_99dba333\\_0dbd\\_4f75\\_8841\\_8c0f97fd58e2](http://emmo.info/emmo/middle/isq#EMMO_99dba333_0dbd_4f75_8841_8c0f97fd58e2)

**Elucidation:** The derivative of the electric charge of a system with respect to the electric potential.

**Altlabel:** ElectricCapacitance

**Dbpediaentry:** <http://dbpedia.org/page/Capacitance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.C00791>

**Physicaldimension:** T+4 L-2 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## RefractiveIndex

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_5eedba4d\\_105b\\_44d8\\_b1bc\\_e33606276ea2](http://emmo.info/emmo/middle/isq#EMMO_5eedba4d_105b_44d8_b1bc_e33606276ea2)

**Comment:** Factor by which the phase velocity of light is reduced in a medium.

**Dbpediaentry:** [http://dbpedia.org/page/Refractive\\_index](http://dbpedia.org/page/Refractive_index)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05240>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.SpeedFractionUnit

## MassFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_7c055d65\\_2929\\_40e1\\_af4f\\_4bf10995ad50](http://emmo.info/emmo/middle/isq#EMMO_7c055d65_2929_40e1_af4f_4bf10995ad50)

**Comment:** Mass of a constituent divided by the total mass of all constituents in the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Mass\\_fraction\\_\(chemistry\)](http://dbpedia.org/page/Mass_fraction_(chemistry))

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03722>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/MassFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.MassFractionUnit

## VonKlitzingConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_eb561764\\_276e\\_413d\\_a8cb\\_3a3154fd9bf8](http://emmo.info/emmo/middle/isq#EMMO_eb561764_276e_413d_a8cb_3a3154fd9bf8)

**Definition:** The von Klitzing constant is defined as Planck constant divided by the square of the elementary charge.

**Comment:** Resistance quantum.

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_VonKlitzingConstant](http://physics.nist.gov/cuu/CODATA-Value_VonKlitzingConstant)

**Relations:**

- is\_a isq.ElectricResistance
- is\_a isq.SIExactConstant

## Permeability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_09663630\\_1b84\\_4202\\_91e6\\_e641104f579e](http://emmo.info/emmo/middle/isq#EMMO_09663630_1b84_4202_91e6_e641104f579e)

**Comment:** Measure for how the magnetization of material is affected by the application of an external magnetic field .

**Dbpediaentry:** [http://dbpedia.org/page/Permeability\\_\(electromagnetism\)](http://dbpedia.org/page/Permeability_(electromagnetism))

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04503>

**Physicaldimension:** T-2 L+1 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticFluxDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_961d1aba\\_f75e\\_4411\\_aaa4\\_457f7516ed6b](http://emmo.info/emmo/middle/isq#EMMO_961d1aba_f75e_4411_aaa4_457f7516ed6b)

**Elucidation:** Strength of the magnetic field.

**Comment:** Often denoted B.

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_field](http://dbpedia.org/page/Magnetic_field)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03686>

**Physicaldimension:** T-2 L0 M+1 I-1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity



## RatioQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_faab3f84\\_e475\\_4a46\\_af9c\\_7d249f0b9aef](http://emmo.info/emmo/middle/isq#EMMO_faab3f84_e475_4a46_af9c_7d249f0b9aef)

**Elucidation:** The class of quantities that are the ratio of two quantities with the same physical dimensionality.

**Example:** refractive index, volume fraction, fine structure constant

**Comment:** Quantities defined as ratios  $Q=A/B$  having equal dimensions in numerator and denominator are dimensionless quantities but still have a physical dimension defined as  $\dim(A)/\dim(B)$ .

Johansson, Ingvar (2010). "Metrological thinking needs the notions of parametric quantities, units and dimensions". *Metrologia*. 47 (3): 219–230. doi:10.1088/0026-1394/47/3/012. ISSN 0026-1394.

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Seealso:** <https://iopscience.iop.org/article/10.1088/0026-1394/47/3/012>

**Relations:**

- is\_a isq.ISQDimensionlessQuantity

## Torque

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_aaf9dd7f\\_0474\\_40d0\\_9606\\_02def8515249](http://emmo.info/emmo/middle/isq#EMMO_aaf9dd7f_0474_40d0_9606_02def8515249)

**Elucidation:** The effectiveness of a force to produce rotation about an axis, measured by the product of the force and the perpendicular distance from the line of action of the force to the axis.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-26>

**Comment:** Even though torque has the same physical dimension as energy, it is not of the same kind and can not be measured with energy units like joule or electron volt.

**Dbpediaentry:** <http://dbpedia.org/page/Torque>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06400>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Torque>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Wavenumber

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d859588d\\_44dc\\_4614\\_bc75\\_5fcd0058acc8](http://emmo.info/emmo/middle/isq#EMMO_d859588d_44dc_4614_bc75_5fcd0058acc8)

**Comment:** The number of waves per unit length along the direction of propagation.

**Dbpediaentry:** <http://dbpedia.org/page/Wavenumber>

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06664>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Wavenumber>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ReciprocalLength

## AreaDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_afea89af\\_ef16\\_4bdb\\_99d5\\_f3b2f4c85a6c](http://emmo.info/emmo/middle/isq#EMMO_afea89af_ef16_4bdb_99d5_f3b2f4c85a6c)

**Comment:** Mass per unit area.

**Dbpediaentry:** [http://dbpedia.org/page/Area\\_density](http://dbpedia.org/page/Area_density)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S06167>

**Physicaldimension:** T0 L-2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1604f495\\_328a\\_4f28\\_9962\\_f4cc210739dd](http://emmo.info/emmo/middle/isq#EMMO_1604f495_328a_4f28_9962_f4cc210739dd)

**Elucidation:** The physical property of matter that causes it to experience a force when placed in an electromagnetic field.

**Altlabel:** Charge

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_charge](http://dbpedia.org/page/Electric_charge)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01923>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalConductivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cde4368c\\_1d4d\\_4c94\\_8548\\_604749523c6d](http://emmo.info/emmo/middle/isq#EMMO_cde4368c_1d4d_4c94_8548_604749523c6d)

**Comment:** Measure of a material's ability to conduct an electric current.

Conductivity is equeal to the reciprocal of resistivity.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistivity\\_and\\_conductivity](http://dbpedia.org/page/Electrical_resistivity_and_conductivity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.C01245>

**Physicaldimension:** T+3 L-3 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PositionVector

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_44da6d75\\_54a4\\_4aa8\\_bd3a\\_156f6e9abb8e](http://emmo.info/emmo/middle/isq#EMMO_44da6d75_54a4_4aa8_bd3a_156f6e9abb8e)

**Definition:** Vector  $r$  characterizing a point  $P$  in a point space with a given origin point  $O$ .

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-12>

**Altlabel:** Position

**Comment:** In the usual geometrical three-dimensional space, position vectors are quantities of the dimension length.

– IEC

**Comment:** Position vectors are so-called bounded vectors, i.e. their magnitude and direction depend on the particular coordinate system used.

– ISO 80000-3

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Length

## ProtonMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8d689295\\_7d84\\_421b\\_bc01\\_d5cceb2c2086](http://emmo.info/emmo/middle/isq#EMMO_8d689295_7d84_421b_bc01_d5cceb2c2086)

**Comment:** The rest mass of a proton.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04914>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ProtonMass](http://physics.nist.gov/cuu/CODATA-Value_ProtonMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## ThermodynamicTemperature

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_affe07e4\\_e9bc\\_4852\\_86c6\\_69e26182a17f](http://emmo.info/emmo/middle/isq#EMMO_affe07e4_e9bc_4852_86c6_69e26182a17f)

**Elucidation:** Thermodynamic temperature is the absolute measure of temperature. It is defined by the third law of thermodynamics in which the theoretically lowest temperature is the null or zero point.

**Dbpediaentry:** [http://dbpedia.org/page/Thermodynamic\\_temperature](http://dbpedia.org/page/Thermodynamic_temperature)

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06321>

**Physicaldimension:** T0 L0 M0 I0 Θ+1 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## Density

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_06448f64\\_8db6\\_4304\\_8b2c\\_e785dba82044](http://emmo.info/emmo/middle/isq#EMMO_06448f64_8db6_4304_8b2c_e785dba82044)

**Comment:** Mass per volume.

**Dbpediaentry:** <http://dbpedia.org/page/Density>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01590>

**Physicaldimension:** T0 L-3 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Energy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_31ec09ba\\_1713\\_42cb\\_83c7\\_b38bf6f9ced2](http://emmo.info/emmo/middle/isq#EMMO_31ec09ba_1713_42cb_83c7_b38bf6f9ced2)

**Elucidation:** A property of objects which can be transferred to other objects or converted into different forms.

**Comment:** Energy is often defined as “ability of a system to perform work”, but it might be misleading since is not necessarily available to do work.

**Dbpediaentry:** <http://dbpedia.org/page/Energy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02101>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Volume

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f1a51559\\_aa3d\\_43a0\\_9327\\_918039f0dfed](http://emmo.info/emmo/middle/isq#EMMO_f1a51559_aa3d_43a0_9327_918039f0dfed)

**Comment:** Extent of an object in space.

**Dbpediaentry:** <http://dbpedia.org/page/Volume>

**Physicaldimension:** T0 L-3 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalResistivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e150fa8d\\_06dc\\_4bb8\\_bf95\\_04e2aea529c1](http://emmo.info/emmo/middle/isq#EMMO_e150fa8d_06dc_4bb8_bf95_04e2aea529c1)

**Comment:** Electric field strength divided by the current density.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistivity\\_and\\_conductivity](http://dbpedia.org/page/Electrical_resistivity_and_conductivity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05316>

**Physicaldimension:** T-3 L+3 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Illuminance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b51fbd00\\_a857\\_4132\\_9711\\_0ef70e7bdd20](http://emmo.info/emmo/middle/isq#EMMO_b51fbd00_a857_4132_9711_0ef70e7bdd20)

**Definition:** The total luminous flux incident on a surface, per unit area.

**Dbpediaentry:** <http://dbpedia.org/page/Illuminance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.I02941>

**Physicaldimension:** T0 L-2 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

## DoseEquivalent

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_3df10765\\_f6ff\\_4c9e\\_be3d\\_10b1809d78bd](http://emmo.info/emmo/middle/isq#EMMO_3df10765_f6ff_4c9e_be3d_10b1809d78bd)

**Elucidation:** A dose quantity used in the International Commission on Radiological Protection (ICRP) system of radiological protection.

**Dbpediaentry:** <http://dbpedia.org/page/Energy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02101>

**Physicaldimension:** T-2 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Entropy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_9bbab0be\\_f9cc\\_4f46\\_9f46\\_0fd271911b79](http://emmo.info/emmo/middle/isq#EMMO_9bbab0be_f9cc_4f46_9f46_0fd271911b79)

**Comment:** Logarithmic measure of the number of available states of a system.

**Comment:** May also be referred to as a measure of order of a system.

**Dbpediaentry:** <http://dbpedia.org/page/Entropy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02149>

**Physicaldimension:** T-2 L+2 M+1 I0  $\Theta$ -1 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Work

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_624d72ee\\_e676\\_4470\\_9434\\_c22b4190d3d5](http://emmo.info/emmo/middle/isq#EMMO_624d72ee_e676_4470_9434_c22b4190d3d5)

**Definition:** Product of force and displacement.

**Dbpediaentry:** <http://dbpedia.org/page/Heat>

**Dbpediaentry:** [http://dbpedia.org/page/Work\\_\(physics\)](http://dbpedia.org/page/Work_(physics))

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06684>

**Physicaldimension:** T-2 L+2 M+1 I0  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.Energy

## CelsiusTemperature

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_66bc9029\\_f473\\_45ff\\_bab9\\_c3509ff37a22](http://emmo.info/emmo/middle/isq#EMMO_66bc9029_f473_45ff_bab9_c3509ff37a22)

**Elucidation:** An objective comparative measure of hot or cold.

Temperature is a relative quantity that can be used to express temperature differences. Unlike ThermodynamicTemperature, it cannot express absolute temperatures.

**Dbpediaentry:** <http://dbpedia.org/page/Temperature>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06261>

**Physicaldimension:** T-1 L0 M0 I0  $\Theta$ 0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## CurrentDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_7c8007b0\\_58a7\\_4486\\_bf1c\\_4772852caca0](http://emmo.info/emmo/middle/isq#EMMO_7c8007b0_58a7_4486_bf1c_4772852caca0)

**Comment:** Electric current divided by the cross-sectional area it is passing through.

**Dbpediaentry:** [http://dbpedia.org/page/Current\\_density](http://dbpedia.org/page/Current_density)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01928>

**Physicaldimension:** T0 L-2 M0 I+1  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Power

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_09b9021b\\_f97b\\_43eb\\_b83d\\_0a764b472bc2](http://emmo.info/emmo/middle/isq#EMMO_09b9021b_f97b_43eb_b83d_0a764b472bc2)

**Elucidation:** Rate of transfer of energy per unit time.

**Dbpediaentry:** [http://dbpedia.org/page/Power\\_\(physics\)](http://dbpedia.org/page/Power_(physics))

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04792>

**Physicaldimension:** T-3 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Vergence

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1e7603a7\\_1365\\_49b8\\_b5e5\\_3711c8e6b904](http://emmo.info/emmo/middle/isq#EMMO_1e7603a7_1365_49b8_b5e5_3711c8e6b904)

**Comment:** In geometrical optics, vergence describes the curvature of optical wavefronts.

**Dbpediaentry:** <http://dbpedia.org/page/Vergence>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Area

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_96f39f77\\_44dc\\_491b\\_8fa7\\_30d887fe0890](http://emmo.info/emmo/middle/isq#EMMO_96f39f77_44dc_491b_8fa7_30d887fe0890)

**Comment:** Extent of a surface.

**Dbpediaentry:** <http://dbpedia.org/page/Area>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00429>

**Physicaldimension:** T0 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ISQDimensionlessQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a66427d1\\_9932\\_4363\\_9ec5\\_7d91f2bfda1e](http://emmo.info/emmo/middle/isq#EMMO_a66427d1_9932_4363_9ec5_7d91f2bfda1e)

**Elucidation:** A quantity to which no physical dimension is assigned and with a corresponding unit of measurement in the SI of the unit one.

**Dbpediaentry:** [http://dbpedia.org/page/Dimensionless\\_quantity](http://dbpedia.org/page/Dimensionless_quantity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01742>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Dimensionless\\_quantity](https://en.wikipedia.org/wiki/Dimensionless_quantity)

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AmountFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04b3300c\\_98bd\\_42dc\\_a3b5\\_e6c29d69f1ac](http://emmo.info/emmo/middle/isq#EMMO_04b3300c_98bd_42dc_a3b5_e6c29d69f1ac)

**Definition:** The amount of a constituent divided by the total amount of all constituents in a mixture.

**Altlabel:** MoleFraction

**Dbpediaentry:** [http://dbpedia.org/page/Mole\\_fraction](http://dbpedia.org/page/Mole_fraction)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00296>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/AmountOfSubstanceFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.AmountFractionUnit

## VolumeFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a8eb87b5\\_4d10\\_4137\\_a75c\\_e04ee59ca095](http://emmo.info/emmo/middle/isq#EMMO_a8eb87b5_4d10_4137_a75c_e04ee59ca095)

**Elucidation:** Volume of a constituent of a mixture divided by the sum of volumes of all constituents prior to mixing.

**Dbpediaentry:** [http://dbpedia.org/page/Volume\\_fraction](http://dbpedia.org/page/Volume_fraction)

**Iupacentry:** <https://doi.org/10.1351/goldbook.V06643>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/VolumeFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.VolumeFractionUnit

## ISQBaseQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1a4c1a97\\_88a7\\_4d8e\\_b2f9\\_2ca58e92dde4](http://emmo.info/emmo/middle/isq#EMMO_1a4c1a97_88a7_4d8e_b2f9_2ca58e92dde4)

**Elucidation:** Base quantities defined in the International System of Quantities (ISQ).

**Wikipediaentry:** [https://en.wikipedia.org/wiki/International\\_System\\_of\\_Quantities](https://en.wikipedia.org/wiki/International_System_of_Quantities)

**Relations:**

- is\_a isq.InternationalSystemOfQuantity
- is\_a metrology.BaseQuantity
- disjoint\_union\_of isq.LuminousIntensity, isq.AmountOfSubstance, isq.ThermodynamicTemperature, isq.ElectricCurrent, isq.Length, isq.Time, isq.Mass

## RybergConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a3c78d6f\\_ae49\\_47c8\\_a634\\_9b6d86b79382](http://emmo.info/emmo/middle/isq#EMMO_a3c78d6f_ae49_47c8_a634_9b6d86b79382)

**Comment:** The Rydberg constant represents the limiting value of the highest wavenumber (the inverse wavelength) of any photon that can be emitted from the hydrogen atom, or, alternatively, the wavenumber of the lowest-energy photon capable of ionizing the hydrogen atom from its ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Rydberg\\_constant](http://dbpedia.org/page/Rydberg_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05430>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_RybergConstant](http://physics.nist.gov/cuu/CODATA-Value_RybergConstant)

**Relations:**

- is\_a isq.Wavenumber
- is\_a metrology.MeasuredConstant

## SolidAngle

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e7c9f7fd\\_e534\\_4441\\_88fe\\_1fec6cb20f26](http://emmo.info/emmo/middle/isq#EMMO_e7c9f7fd_e534_4441_88fe_1fec6cb20f26)

**Elucidation:** Ratio of area on a sphere to its radius squared.

**Dbpediaentry:** [http://dbpedia.org/page/Solid\\_angle](http://dbpedia.org/page/Solid_angle)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05732>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.AreaFractionUnit

## MassConcentration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_16f2fe60\\_2db7\\_43ca\\_8fee\\_5b3e416bfe87](http://emmo.info/emmo/middle/isq#EMMO_16f2fe60_2db7_43ca_8fee_5b3e416bfe87)

**Comment:** Mass of a constituent divided by the volume of the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Mass\\_concentration\\_\(chemistry\)](http://dbpedia.org/page/Mass_concentration_(chemistry))

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03713>

**Physicaldimension:** T0 L-3 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Density

## AbsorbedDose

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8e5dd473\\_808b\\_4a8a\\_b7cd\\_63068c12ff57](http://emmo.info/emmo/middle/isq#EMMO_8e5dd473_808b_4a8a_b7cd_63068c12ff57)

**Definition:** Energy imparted to matter by ionizing radiation in a suitable small element of volume divided by the mass of that element of volume.

**Dbpediaentry:** [http://dbpedia.org/page/Absorbed\\_dose](http://dbpedia.org/page/Absorbed_dose)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00031>

**Physicaldimension:** T-2 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ISQDerivedQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_2946d40b\\_24a1\\_47fa\\_8176\\_e3f79bb45064](http://emmo.info/emmo/middle/isq#EMMO_2946d40b_24a1_47fa_8176_e3f79bb45064)

**Elucidation:** Derived quantities defined in the International System of Quantities (ISQ).

**Relations:**

- is\_a isq.InternationalSystemOfQuantity
- is\_a metrology.DerivedQuantity



## ElectricCurrent

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_c995ae70\\_3b84\\_4ebb\\_bcf6\\_69e6a281bb88](http://emmo.info/emmo/middle/isq#EMMO_c995ae70_3b84_4ebb_bcf6_69e6a281bb88)

**Elucidation:** A flow of electric charge.

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_current](http://dbpedia.org/page/Electric_current)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01927>

**Physicaldimension:** T0 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## PureNumberQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ba882f34\\_0d71\\_4e4f\\_9d92\\_0c076c633a2c](http://emmo.info/emmo/middle/isq#EMMO_ba882f34_0d71_4e4f_9d92_0c076c633a2c)

**Elucidation:** A pure number, typically the number of something.

**Example:** 1, i, π, the number of protons in the nucleus of an atom

**Comment:** According to the SI brochure counting does not automatically qualify a quantity as an amount of substance.

This quantity is used only to describe the outcome of a counting process, without regard of the type of entities.

“There are also some quantities that cannot be described in terms of the seven base quantities of the SI, but have the nature of a count. Examples are a number of molecules, a number of cellular or biomolecular entities (for example copies of a particular nucleic acid sequence), or degeneracy in quantum mechanics. Counting quantities are also quantities with the associated unit one.”

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDimensionlessQuantity

## Heat

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_12d4ba9b\\_2f89\\_4ea3\\_b206\\_cd376f96c875](http://emmo.info/emmo/middle/isq#EMMO_12d4ba9b_2f89_4ea3_b206_cd376f96c875)

**Comment:** Heat is energy in transfer to or from a thermodynamic system, by mechanisms other than thermodynamic work or transfer of matter.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02752>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## LuminousFlux

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e2ee1c98\\_497a\\_4f66\\_b4ed\\_5711496a848e](http://emmo.info/emmo/middle/isq#EMMO_e2ee1c98_497a_4f66_b4ed_5711496a848e)

**Elucidation:** Perceived power of light.

**Dbpediaentry:** [http://dbpedia.org/page/Luminous\\_flux](http://dbpedia.org/page/Luminous_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03646>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

## VacuumElectricPermittivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_61a32ae9\\_8200\\_473a\\_bd55\\_59a9899996f4](http://emmo.info/emmo/middle/isq#EMMO_61a32ae9_8200_473a_bd55_59a9899996f4)

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Vacuum\\_permittivity](http://dbpedia.org/page/Vacuum_permittivity)) is outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of the absolute dielectric permittivity of classical vacuum.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04508>

**Physicaldimension:** T+4 L-3 M-1 I+2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectricConstant](http://physics.nist.gov/cuu/CODATA-Value_ElectricConstant)

**Relations:**

- is\_a isq.Permittivity
- is\_a metrology.MeasuredConstant

## Frequency

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_852b4ab8\\_fc29\\_4749\\_a8c7\\_b92d4fca7d5a](http://emmo.info/emmo/middle/isq#EMMO_852b4ab8_fc29_4749_a8c7_b92d4fca7d5a)

**Elucidation:** Number of periods per time interval.

**Dbpediaentry:** <http://dbpedia.org/page/Frequency>

**Iupacentry:** <https://doi.org/10.1351/goldbook.FT07383>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricPotential

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4f2d3939\\_91b1\\_4001\\_b8ab\\_7d19074bf845](http://emmo.info/emmo/middle/isq#EMMO_4f2d3939_91b1_4001_b8ab_7d19074bf845)

**Elucidation:** Energy required to move a unit charge through an electric field from a reference point.

**Altlabel:** Voltage

**Dbpediaentry:** <http://dbpedia.org/page/Voltage>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00424>

**Physicaldimension:** T-3 L+2 M+1 I-1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AngularMomentum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_66d01570\\_36dd\\_42fd\\_844d\\_29b81b029cd5](http://emmo.info/emmo/middle/isq#EMMO_66d01570_36dd_42fd_844d_29b81b029cd5)

**Comment:** Measure of the extent and direction an object rotates about a reference point.

**Dbpediaentry:** [http://dbpedia.org/page/Angular\\_momentum](http://dbpedia.org/page/Angular_momentum)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00353>

**Physicaldimension:** T-1 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticDipoleMoment

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_81e767f1\\_59b1\\_4d7a\\_bf69\\_17f322241831](http://emmo.info/emmo/middle/isq#EMMO_81e767f1_59b1_4d7a_bf69_17f322241831)

**Elucidation:** Vector quantity  $\mu$  causing a change to its energy  $\Delta W$  in an external magnetic field of field flux density B:

$$\Delta W = -\mu \cdot B$$

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-55>

**Iso80000ref:** 10-9.1

**Comment:** For an atom or nucleus, this energy is quantized and can be written as:

$$W = g \mu M B$$

where g is the appropriate g factor,  $\mu$  is mostly the Bohr magneton or nuclear magneton, M is magnetic quantum number, and B is magnitude of the magnetic flux density.

– ISO 80000

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_moment](http://dbpedia.org/page/Magnetic_moment)

**Iupacentry:** <http://goldbook.iupac.org/terms/view/M03688>

**Physicaldimension:** T<sup>0</sup> L<sup>+2</sup> M<sup>0</sup> I<sup>+1</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Inductance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04cc9451\\_5306\\_45d0\\_8554\\_22cee4d6e785](http://emmo.info/emmo/middle/isq#EMMO_04cc9451_5306_45d0_8554_22cee4d6e785)

**Elucidation:** A property of an electrical conductor by which a change in current through it induces an electromotive force in both the conductor itself and in any nearby conductors by mutual inductance.

**Altlabel:** ElectricInductance

**Dbpediaentry:** <http://dbpedia.org/page/Inductance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M04076>

**Physicaldimension:** T<sup>-2</sup> L<sup>+2</sup> M<sup>+1</sup> I<sup>-2</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.ISQDerivedQuantity

## HyperfineTransitionFrequencyOfCs

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f96feb3f\\_4438\\_4e43\\_aa44\\_7458c4d87fc2](http://emmo.info/emmo/middle/isq#EMMO_f96feb3f_4438_4e43_aa44_7458c4d87fc2)

**Elucidation:** The frequency standard in the SI system in which the photon absorption by transitions between the two hyperfine ground states of caesium-133 atoms are used to control the output frequency.

**Physicaldimension:** T<sup>-1</sup> L<sup>0</sup> M<sup>0</sup> I<sup>0</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.Frequency
- is\_a isq.SIExactConstant

## Probability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0a88be81\\_343d\\_4388\\_92c1\\_09228ff95ada](http://emmo.info/emmo/middle/isq#EMMO_0a88be81_343d_4388_92c1_09228ff95ada)

**Elucidation:** Probability is a dimensionless quantity that can attain values between 0 and 1; zero denotes the impossible event and 1 denotes a certain event.

**Comment:** The propability for a certain outcome, is the ratio between the number of events leading to the given outcome and the total number of events.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04855>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only metrology.UnitOne

## ElementaryCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_58a650f0\\_a638\\_4743\\_8439\\_535a325e5c4c](http://emmo.info/emmo/middle/isq#EMMO_58a650f0_a638_4743_8439_535a325e5c4c)

**Elucidation:** The magnitude of the electric charge carried by a single electron.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02032>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElementaryCharge](http://physics.nist.gov/cuu/CODATA-Value_ElementaryCharge)

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## Luminance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_97589322\\_710c\\_4af4\\_9431\\_1e5027f2be42](http://emmo.info/emmo/middle/isq#EMMO_97589322_710c_4af4_9431_1e5027f2be42)

**Comment:** Measured in cd/m<sup>2</sup>. Not to confuse with Illuminance, which is measured in lux (cd sr/m<sup>2</sup>).

**Comment:** a photometric measure of the luminous intensity per unit area of light travelling in a given direction.

**Dbpediaentry:** <http://dbpedia.org/page/Luminance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03640>

**Physicaldimension:** T0 L-2 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

## KineticEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ac540a9d\\_0131\\_43f6\\_a33b\\_17e5cfc432ed](http://emmo.info/emmo/middle/isq#EMMO_ac540a9d_0131_43f6_a33b_17e5cfc432ed)

**Elucidation:** The energy of an object due to its motion.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-49>

**Dbpediaentry:** [http://dbpedia.org/page/Kinetic\\_energy](http://dbpedia.org/page/Kinetic_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.K03402>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/KineticEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## Time

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d4f7d378\\_5e3b\\_468a\\_baa1\\_a7e98358cda7](http://emmo.info/emmo/middle/isq#EMMO_d4f7d378_5e3b_468a_baa1_a7e98358cda7)

**Definition:** One-dimensional subspace of space-time, which is locally orthogonal to space.

**Elucidation:** The indefinite continued progress of existence and events that occur in apparently irreversible succession from the past through the present to the future.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-03>

**Comment:** Time can be seen as the duration of an event or, more operationally, as “what clocks read”.

**Dbpediaentry:** <http://dbpedia.org/page/Time>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06375>

**Physicaldimension:** T+1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## ElectricResistance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e88f75d6\\_9a17\\_4cfc\\_bdf7\\_43d7cea5a9a1](http://emmo.info/emmo/middle/isq#EMMO_e88f75d6_9a17_4cfc_bdf7_43d7cea5a9a1)

**Elucidation:** Measure of the difficulty to pass an electric current through a material.

**Altlabel:** Resistance

**Comment:** Inverse of ‘ElectricalConductance’.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistance\\_and\\_conductance](http://dbpedia.org/page/Electrical_resistance_and_conductance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01936>

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectronCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cc01751d\\_dd05\\_429b\\_9d0c\\_1b7a74d1f277](http://emmo.info/emmo/middle/isq#EMMO_cc01751d_dd05_429b_9d0c_1b7a74d1f277)

**Definition:** The charge of an electron.

**Comment:** The negative of ElementaryCharge.

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01982>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## Stress

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d1917609\\_db5e\\_4b8a\\_9b76\\_ef1d6f860a81](http://emmo.info/emmo/middle/isq#EMMO_d1917609_db5e_4b8a_9b76_ef1d6f860a81)

**Comment:** Force per unit oriented surface area .

**Comment:** Measure of the internal forces that neighboring particles of a continuous material exert on each other.

**Dbpediaentry:** [http://dbpedia.org/page/Stress\\_\(mechanics\)](http://dbpedia.org/page/Stress_(mechanics))

**Physicaldimension:** T-2 L-1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Pressure

## Length

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cd2cd0de\\_e0cc\\_4ef1\\_b27e\\_2e88db027bac](http://emmo.info/emmo/middle/isq#EMMO_cd2cd0de_e0cc_4ef1_b27e_2e88db027bac)

**Elucidation:** Extend of a spatial dimension.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-19>

**Comment:** Length is a non-negative additive quantity attributed to a one-dimensional object in space.

**Dbpediaentry:** <http://dbpedia.org/page/Length>

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03498>

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## ElectronMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_44fc8c60\\_7a9c\\_49af\\_a046\\_e1878c88862c](http://emmo.info/emmo/middle/isq#EMMO_44fc8c60_7a9c_49af_a046_e1878c88862c)

**Comment:** The rest mass of an electron.

**Dbpediaentry:** [http://dbpedia.org/page/Electron\\_rest\\_mass](http://dbpedia.org/page/Electron_rest_mass)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02008>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectronMass](http://physics.nist.gov/cuu/CODATA-Value_ElectronMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## Speed

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_81369540\\_1b0e\\_471b\\_9bae\\_6801af22800e](http://emmo.info/emmo/middle/isq#EMMO_81369540_1b0e_471b_9bae_6801af22800e)

**Comment:** Length per unit time.

Speed in the absolute value of the velocity.

**Dbpediaentry:** <http://dbpedia.org/page/Speed>

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05852>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Speed>

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

**AtomicMass**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_27367073\\_ed8a\\_481a\\_9b07\\_f836dfe31f7f](http://emmo.info/emmo/middle/isq#EMMO_27367073_ed8a_481a_9b07_f836dfe31f7f)

**Definition:** The mass of an atom in the ground state.

**Comment:** Since the nucleus account for nearly all of the total mass of atoms (with the electrons and nuclear binding energy making minor contributions), the atomic mass measured in Da has nearly the same value as the mass number.

**Comment:** The atomic mass is often expressed as an average of the commonly found isotopes.

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00496>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Atomic\\_mass](https://en.wikipedia.org/wiki/Atomic_mass)

**Relations:**

- is\_a isq.Mass

**AtomicNumber**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_07de47e0\\_6bb6\\_45b9\\_b55a\\_4f238efbb105](http://emmo.info/emmo/middle/isq#EMMO_07de47e0_6bb6_45b9_b55a_4f238efbb105)

**Definition:** Number of protons in an atomic nucleus.

**Dbpediaentry:** [http://dbpedia.org/page/Atomic\\_number](http://dbpedia.org/page/Atomic_number)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00499>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.PureNumberQuantity

**LuminousIntensity**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_50bf79a6\\_a48b\\_424d\\_9d2c\\_813bd631231a](http://emmo.info/emmo/middle/isq#EMMO_50bf79a6_a48b_424d_9d2c_813bd631231a)

**Elucidation:** A measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle. It is based on the luminosity function, which is a standardized model of the sensitivity of the human eye.

**Dbpediaentry:** [http://dbpedia.org/page/Luminous\\_intensity](http://dbpedia.org/page/Luminous_intensity)

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQBaseQuantity

**CentreOfMass**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_9d8f708a\\_f291\\_4d72\\_80ec\\_362c6e6bbca6](http://emmo.info/emmo/middle/isq#EMMO_9d8f708a_f291_4d72_80ec_362c6e6bbca6)

**Elucidation:** The unique point where the weighted relative position of the distributed mass of an Item sums to zero. Equivalently, it is the point where if a force is applied to the Item, causes the Item to move in direction of force without rotation.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-12>

**Comment:** In non-relativistic physics, the centre of mass doesn't depend on the chosen reference frame.

**Dbpediaentry:** [http://dbpedia.org/page/Center\\_of\\_mass](http://dbpedia.org/page/Center_of_mass)

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Center\\_of\\_mass](https://en.wikipedia.org/wiki/Center_of_mass)

**Relations:**

- is\_a isq.PositionVector

## Acceleration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e37ac288\\_aa60\\_415a\\_8cb7\\_c375724ac8e1](http://emmo.info/emmo/middle/isq#EMMO_e37ac288_aa60_415a_8cb7_c375724ac8e1)

**Comment:** Derivative of velocity with respect to time.

**Dbpediaentry:** <http://dbpedia.org/page/Acceleration>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00051>

**Physicaldimension:** T-2 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## CatalyticActivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_bd67d149\\_24c2\\_4bc9\\_833a\\_c2bc26f98fd3](http://emmo.info/emmo/middle/isq#EMMO_bd67d149_24c2_4bc9_833a_c2bc26f98fd3)

**Elucidation:** Increase in the rate of reaction of a specified chemical reaction that an enzyme produces in a specific assay system.

**Iupacentry:** <https://doi.org/10.1351/goldbook.C00881>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PlanckConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_76cc4efc\\_231e\\_42b4\\_be83\\_2547681caed6](http://emmo.info/emmo/middle/isq#EMMO_76cc4efc_231e_42b4_be83_2547681caed6)

**Elucidation:** The quantum of action.

**Dbpediaentry:** [http://dbpedia.org/page/Planck\\_constant](http://dbpedia.org/page/Planck_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04685>

**Physicaldimension:** T-1 L+2 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_PlankConstant](http://physics.nist.gov/cuu/CODATA-Value_PlankConstant)

**Relations:**

- is\_a isq.AngularMomentum
- is\_a isq.SIExactConstant

## Enthalpy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4091d5ec\\_a4df\\_42b9\\_a073\\_9a090839279f](http://emmo.info/emmo/middle/isq#EMMO_4091d5ec_a4df_42b9_a073_9a090839279f)

**Comment:** Measurement of energy in a thermodynamic system.

**Dbpediaentry:** <http://dbpedia.org/page/Enthalpy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02141>



**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## ChemicalPotential

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_88fc5d1b\\_d3ab\\_4626\\_b24c\\_915ebe7400ca](http://emmo.info/emmo/middle/isq#EMMO_88fc5d1b_d3ab_4626_b24c_915ebe7400ca)

**Comment:** Energy per unit change in amount of substance.

**Dbpediaentry:** [http://dbpedia.org/page/Chemical\\_potential](http://dbpedia.org/page/Chemical_potential)

**Iupacentry:** <https://doi.org/10.1351/goldbook.C01032>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N-1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PhysicalQuantity

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_02c0621e\\_a527\\_4790\\_8a0f\\_2bb51973c819](http://emmo.info/emmo/middle/metrology#EMMO_02c0621e_a527_4790_8a0f_2bb51973c819)

**Elucidation:** A ‘Mathematical’ entity that is made of a ‘Numeral’ and a ‘MeasurementUnit’ defined by a physical law, connected to a physical entity through a model perspective. Measurement is done according to the same model.

**Comment:** In the same system of quantities,  $\dim \rho_B = ML^{-3}$  is the quantity dimension of mass concentration of component B, and  $ML^{-3}$  is also the quantity dimension of mass density,  $\rho$ . ISO 80000-1

**Comment:** Measured or simulated ‘physical property’-s are always defined by a physical law, connected to a physical entity through a model perspective and measurement is done according to the same model.

Systems of units suggests that this is the correct approach, since except for the fundamental units (length, time, charge) every other unit is derived by mathematical relations between these fundamental units, implying a physical laws or definitions.

**Comment:** Measurement units of quantities of the same quantity dimension may be designated by the same name and symbol even when the quantities are not of the same kind.

For example, joule per kelvin and J/K are respectively the name and symbol of both a measurement unit of heat capacity and a measurement unit of entropy, which are generally not considered to be quantities of the same kind.

However, in some cases special measurement unit names are restricted to be used with quantities of specific kind only.

For example, the measurement unit ‘second to the power minus one’ (1/s) is called hertz (Hz) when used for frequencies and becquerel (Bq) when used for activities of radionuclides.

As another example, the joule (J) is used as a unit of energy, but never as a unit of moment of force, i.e. the newton metre (N · m).

**Comment:** — quantities of the same kind have the same quantity dimension, — quantities of different quantity dimensions are always of different kinds, and — quantities having the same quantity dimension are not necessarily of the same kind. ISO 80000-1

**Relations:**

- is\_a math.Mathematical
- is\_a metrology.Quantity
- metrology.hasReferenceUnit only metrology.MeasurementUnit
- disjoint\_union\_of metrology.DerivedQuantity, metrology.BaseQuantity

## Angle

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f3dd74c0\\_f480\\_49e8\\_9764\\_33b78638c235](http://emmo.info/emmo/middle/isq#EMMO_f3dd74c0_f480_49e8_9764_33b78638c235)

**Definition:** Ratio of circular arc length to radius.

**Altlabel:** PlaneAngle

**Dbpediaentry:** <http://dbpedia.org/page/Angle>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00346>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.LengthFractionUnit

## Force

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1f087811\\_06cb\\_42d5\\_90fb\\_25d0e7e068ef](http://emmo.info/emmo/middle/isq#EMMO_1f087811_06cb_42d5_90fb_25d0e7e068ef)

**Elucidation:** Any interaction that, when unopposed, will change the motion of an object.

**Dbpediaentry:** <http://dbpedia.org/page/Force>

**Iupacentry:** <https://doi.org/10.1351/goldbook.F02480>

**Physicaldimension:** T-2 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricConductance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ffb73b1e\\_5786\\_43e4\\_a964\\_cb32ac7affb7](http://emmo.info/emmo/middle/isq#EMMO_ffb73b1e_5786_43e4_a964_cb32ac7affb7)

**Elucidation:** Measure of the ease for electric current to pass through a material.

**Altlabel:** Conductance

**Comment:** Inverse of ‘ElectricalResistance’.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistance\\_and\\_conductance](http://dbpedia.org/page/Electrical_resistance_and_conductance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01925>

**Physicaldimension:** T+3 L-2 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MassNumber

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_dc6c8de0\\_cfc4\\_4c66\\_a7dc\\_8f720e732d54](http://emmo.info/emmo/middle/isq#EMMO_dc6c8de0_cfc4_4c66_a7dc_8f720e732d54)

**Definition:** Number of nucleons in an atomic nucleus.

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.PureNumberQuantity

## SpeedOfLightInVacuum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_99296e55\\_53f7\\_4333\\_9e06\\_760ad175a1b9](http://emmo.info/emmo/middle/isq#EMMO_99296e55_53f7_4333_9e06_760ad175a1b9)

**Elucidation:** The speed of light in vacuum.

**Dbpediaentry:** [http://dbpedia.org/page/Speed\\_of\\_light](http://dbpedia.org/page/Speed_of_light)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05854>

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_SpeedOfLightInVacuum](http://physics.nist.gov/cuu/CODATA-Value_SpeedOfLightInVacuum)

**Relations:**

- is\_a isq.Speed
- is\_a isq.SIExactConstant

## Strain

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_acf636d4\\_9ac2\\_4ce3\\_960a\\_d54338e6cae3](http://emmo.info/emmo/middle/isq#EMMO_acf636d4_9ac2_4ce3_960a_d54338e6cae3)

**Elucidation:** Change of the relative positions of parts of a body, excluding a displacement of the body as a whole.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-57>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Strain>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.LengthFractionUnit

## ElectricalImpedance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_79a02de5\\_b884\\_4eab\\_bc18\\_f67997d597a2](http://emmo.info/emmo/middle/isq#EMMO_79a02de5_b884_4eab_bc18_f67997d597a2)

**Comment:** Measure of the opposition that a circuit presents to a current when a voltage is applied.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_impedance](http://dbpedia.org/page/Electrical_impedance)

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricResistance

## Mass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ed4af7ae\\_63a2\\_497e\\_bb88\\_2309619ea405](http://emmo.info/emmo/middle/isq#EMMO_ed4af7ae_63a2_497e_bb88_2309619ea405)

**Elucidation:** Property of a physical body that express its resistance to acceleration (a change in its state of motion) when a force is applied.

**Dbpediaentry:** <http://dbpedia.org/page/Mass>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03709>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity
- Inverse(properties.hasProperty) only physicalistic.Matter

## AmountConcentration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d5be1faf\\_0c56\\_4f5a\\_9b78\\_581e6dee949f](http://emmo.info/emmo/middle/isq#EMMO_d5be1faf_0c56_4f5a_9b78_581e6dee949f)

**Altlabel:** Concentration

**Altlabel:** MolarConcentration

**Altlabel:** Molarity

**Comment:** The amount of a constituent divided by the volume of the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Molar\\_concentration](http://dbpedia.org/page/Molar_concentration)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00295>

**Physicaldimension:** T0 L-3 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PotentialEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4c151909\\_6f26\\_4ef9\\_b43d\\_7c9e9514883a](http://emmo.info/emmo/middle/isq#EMMO_4c151909_6f26_4ef9_b43d_7c9e9514883a)

**Elucidation:** The energy possessed by a body by virtue of its position or orientation in a potential field.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-48>

**Dbpediaentry:** [http://dbpedia.org/page/Potential\\_energy](http://dbpedia.org/page/Potential_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04778>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/PotentialEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## Pressure

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_50a44256\\_9dc5\\_434b\\_bad4\\_74a4d9a29989](http://emmo.info/emmo/middle/isq#EMMO_50a44256_9dc5_434b_bad4_74a4d9a29989)

**Elucidation:** The force applied perpendicular to the surface of an object per unit area over which that force is distributed.

**Dbpediaentry:** <http://dbpedia.org/page/Pressure>

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04819>

**Physicaldimension:** T-2 L-1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalReactance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_92b2fb85\\_2143\\_4bc7\\_bbca\\_df3e6944bfc1](http://emmo.info/emmo/middle/isq#EMMO_92b2fb85_2143_4bc7_bbca_df3e6944bfc1)

**Comment:** The opposition of a circuit element to a change in current or voltage, due to that element's inductance or capacitance.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_reactance](http://dbpedia.org/page/Electrical_reactance)

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricResistance

## Velocity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0329f1f5\\_8339\\_4ce4\\_8505\\_a264c6d606ba](http://emmo.info/emmo/middle/isq#EMMO_0329f1f5_8339_4ce4_8505_a264c6d606ba)

**Definition:** Vector quantity giving the rate of change of a position vector.

– ISO 80000-3

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-32>

**Iso80000ref:** 3-10.1

**Comment:** The velocity depends on the choice of the reference frame. Proper transformation between frames must be used: Galilean for non-relativistic description, Lorentzian for relativistic description.

– IEC, note 2

**Comment:** The velocity is related to a point described by its position vector. The point may localize a particle, or be attached to any other object such as a body or a wave.

– IEC, note 1

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Speed

## ElectricDipoleMoment

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1a179ce4\\_3724\\_47f8\\_bee5\\_6292e3ac9942](http://emmo.info/emmo/middle/isq#EMMO_1a179ce4_3724_47f8_bee5_6292e3ac9942)

**Elucidation:** An electric dipole, vector quantity of magnitude equal to the product of the positive charge and the distance between the charges and directed from the negative charge to the positive charge.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-35>

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-36>

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_dipole\\_moment](http://dbpedia.org/page/Electric_dipole_moment)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01929>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/ElectricDipoleMoment>

**Physicaldimension:** T+1 L+1 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ReciprocalLength

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ecec2983\\_7c26\\_4f8d\\_a981\\_51ca29668baf](http://emmo.info/emmo/middle/isq#EMMO_ecec2983_7c26_4f8d_a981_51ca29668baf)

**Elucidation:** The inverse of length.

**Dbpediaentry:** [http://dbpedia.org/page/Reciprocal\\_length](http://dbpedia.org/page/Reciprocal_length)

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Reciprocal\\_length](https://en.wikipedia.org/wiki/Reciprocal_length)

**Relations:**

- is\_a isq.ISQDerivedQuantity

## RadiantFlux

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e46f3f24\\_c2ec\\_4552\\_8dd4\\_cfc5c0a89c09](http://emmo.info/emmo/middle/isq#EMMO_e46f3f24_c2ec_4552_8dd4_cfc5c0a89c09)

**Comment:** The radiant energy emitted, reflected, transmitted or received, per unit time.

**Dbpediaentry:** [http://dbpedia.org/page/Radiant\\_flux](http://dbpedia.org/page/Radiant_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05046>

**Physicaldimension:** T-3 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Power

## Momentum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_43776fc9\\_d712\\_4571\\_85f0\\_72183678039a](http://emmo.info/emmo/middle/isq#EMMO_43776fc9_d712_4571_85f0_72183678039a)

**Comment:** Product of mass and velocity.

**Dbpediaentry:** <http://dbpedia.org/page/Momentum>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M04007>

**Physicaldimension:** T-1 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Radioactivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8d3da9ac\\_2265\\_4382\\_bee5\\_db72046722f8](http://emmo.info/emmo/middle/isq#EMMO_8d3da9ac_2265_4382_bee5_db72046722f8)

**Elucidation:** Decays per unit time.

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00114>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AmountOfSubstance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8159c26a\\_494b\\_4fa0\\_9959\\_10888f152298](http://emmo.info/emmo/middle/isq#EMMO_8159c26a_494b_4fa0_9959_10888f152298)

**Elucidation:** The number of elementary entities present.

**Dbpediaentry:** [http://dbpedia.org/page/Amount\\_of\\_substance](http://dbpedia.org/page/Amount_of_substance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00297>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## InternationalSystemOfQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f35cff4d\\_dc09\\_44cf\\_a729\\_22fb79e3bfb2](http://emmo.info/emmo/middle/isq#EMMO_f35cff4d_dc09_44cf_a729_22fb79e3bfb2)

**Elucidation:** Quantities declared under the ISO 80000.

**Seealso:** <https://www.iso.org/obp/ui/#iso:std:iso:80000:-1:ed-1:v1:en:sec:3.1>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/International\\_System\\_of\\_Quantities](https://en.wikipedia.org/wiki/International_System_of_Quantities)

**Relations:**

- is\_a metrology.PhysicalQuantity

## Number branch

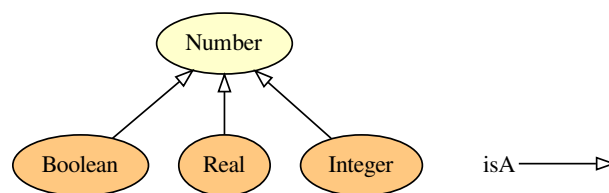


Figure 3.24: Number branch.

## Boolean

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_54dc83cb\\_06e1\\_4739\\_9e45\\_bc09cead7f48](http://emmo.info/emmo/middle/math#EMMO_54dc83cb_06e1_4739_9e45_bc09cead7f48)

**Relations:**

- is\_a math.Number
- math.hasNumericalData only type
- math.hasNumericalData exactly 1 type
- equivalent\_to math.hasNumericalData some type

## Real

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_18d180e4\\_5e3e\\_42f7\\_820c\\_e08951223486](http://emmo.info/emmo/middle/math#EMMO_18d180e4_5e3e_42f7_820c_e08951223486)

**Relations:**

- is\_a math.Number
- math.hasNumericalData only type
- math.hasNumericalData exactly 1 type
- equivalent\_to math.hasNumericalData some type

## Integer

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_f8bd64d5\\_5d3e\\_4ad4\\_a46e\\_c30714fecb7f](http://emmo.info/emmo/middle/math#EMMO_f8bd64d5_5d3e_4ad4_a46e_c30714fecb7f)

**Relations:**

- is\_a math.Number
- math.hasNumericalData only type
- math.hasNumericalData exactly 1 type
- equivalent\_to math.hasNumericalData some type

## Number

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_21f56795\\_ee72\\_4858\\_b571\\_11cfaa59c1a8](http://emmo.info/emmo/middle/math#EMMO_21f56795_ee72_4858_b571_11cfaa59c1a8)

**Elucidation:** A numerical data value.

**Comment:** A number is actually a string (e.g. 1.4, 1e-8) of numerical digits and other symbols. However, in order not to increase complexity of the taxonomy and relations, here we take a number as an “atomic” object (i.e. we do not include digits in the EMMO as alphabet for numbers).

A ‘Number’ individual provide the link between the ontology and the actual data, through the data property hasNumericalValue.

**Comment:** In math usually number and numeral are distinct concepts, the numeral being the symbol or a composition of symbols (e.g. 3.14, 010010, three) and the number is the idea behind it.

More than one numeral stand for the same number.

In the EMMO abstract entities does not exists, and numbers are simply defined by other numerals, so that a number is the class of all the numerals that are equivalent (e.g. 3 and 0011 are numerals that stands for the same number).

Or alternatively, an integer numeral may also stands for a set of a specific cardinality (e.g. 3 stands for a set of three apples). Rational and real numbers are simply a syntactic arrangement of integers (digits, in decimal system).

The fact that you can’t give a name to a number without using a numeral or, in case of positive integers, without referring to a real world objects set with specific cardinality, suggests that the abstract concept of number is not a concept that can be practically used.

For these reasons, the EMMO will consider numerals and numbers as the same concept.

### Relations:

- is\_a math.Numerical
- is\_a math.MathematicalSymbol
- is\_a perceptual.Symbol

## Measurement Unit branch



Figure 3.25: Measurement Unit branch.

## LengthFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cdc962d8\\_f3ea\\_4764\\_a57a\\_c7caa4859179](http://emmo.info/emmo/middle/units-extension#EMMO_cdc962d8_f3ea_4764_a57a_c7caa4859179)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two lengths.

**Example:** Unit for plane angle.

### Relations:



- is\_a units-extension.FractionUnit

## MassFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_18448443\\_dcf1\\_49b8\\_a321\\_cf46e2c393e1](http://emmo.info/emmo/middle/units-extension#EMMO_18448443_dcf1_49b8_a321_cf46e2c393e1)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two masses.

**Example:** Unit for mass fraction.

**Relations:**

- is\_a units-extension.FractionUnit

## ArcMinute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_1e0b665d\\_db6c\\_4752\\_a6d4\\_262d3a8dbb46](http://emmo.info/emmo/middle/units-extension#EMMO_1e0b665d_db6c_4752_a6d4_262d3a8dbb46)

**Definition:** Measure of plane angle defined as 1/60 or a degree.

**Altlabel:** MinuteOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCMIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## ColumnMetre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e9eae5b5\\_620c\\_4dab\\_8f72\\_269ff85d0634](http://emmo.info/emmo/middle/units-extension#EMMO_e9eae5b5_620c_4dab_8f72_269ff85d0634)

**Elucidation:** Measurement unit for electric dipole moment.

**Relations:**

- is\_a siunits.SICoherentDerivedUnit
- metrology.hasPhysicalDimension some isq.MagneticDipoleMomentDimension

## Minute

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_cabb20f0\\_05c7\\_448f\\_9485\\_e129725f15a4](http://emmo.info/emmo/middle/units-extension#EMMO_cabb20f0_05c7_448f_9485_e129725f15a4)

**Definition:** Non-SI time unit defined as 60 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Minute>

**Qudtentry:** <http://qudt.org/vocab/unit/MIN>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “min”

## NewtonMetre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_c10b7090\\_7284\\_4719\\_8e15\\_c743b13ca6ad](http://emmo.info/emmo/middle/units-extension#EMMO_c10b7090_7284_4719_8e15_c743b13ca6ad)

**Elucidation:** SI coherent measurement unit for torque.

**Comment:** Note that the physical dimension is the same as for Joule.

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/newtonMetre>

### Relations:

- is\_a siunits.SICoherentDerivedUnit
- metrology.hasPhysicalDimension some isq.EnergyDimension

## DerivedUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_08b308d4\\_31cd\\_4779\\_a784\\_aa92fc730f39](http://emmo.info/emmo/middle/metrology#EMMO_08b308d4_31cd_4779_a784_aa92fc730f39)

**Elucidation:** Derived units are defined as products of powers of the base units corresponding to the relations defining the derived quantities in terms of the base quantities.

### Relations:

- is\_a metrology.NonPrefixedUnit

## AstronomicalUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_053648ea\\_3c0a\\_468c\\_89cb\\_eb009239323a](http://emmo.info/emmo/middle/units-extension#EMMO_053648ea_3c0a_468c_89cb_eb009239323a)

**Definition:** One astronomical unit is defined as exactly 149597870700 m, which is roughly the distance from earth to sun.

**Dbpediaentry:** [http://dbpedia.org/page/Astronomical\\_unit](http://dbpedia.org/page/Astronomical_unit)

**Qudtentry:** <http://qudt.org/vocab/unit/PARSEC>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Astronomical\\_unit](https://en.wikipedia.org/wiki/Astronomical_unit)

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “au”

## Gram

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f992dc76\\_f9a6\\_45f6\\_8873\\_c8e20d16fbbe](http://emmo.info/emmo/middle/units-extension#EMMO_f992dc76_f9a6_45f6_8873_c8e20d16fbbe)

**Definition:** Gram is defined as one thousandth of the SI unit kilogram.

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02680>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Gram>

### Relations:

- is\_a metrology.UnitSymbol
- is\_a units-extension.CGSUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “g”

## Radian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a121bb1d\\_5225\\_4c78\\_809b\\_0268c3012208](http://emmo.info/emmo/middle/siunits#EMMO_a121bb1d_5225_4c78_809b_0268c3012208)

**Elucidation:** Measure of plane angle.

**Comment:** Dimensionless measurement unit for plane angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05036>

**Qudtentry:** <http://qudt.org/vocab/unit/RAD>

### Relations:

- is\_a units-extension.LengthFractionUnit
- is\_a owl:Nothing
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “rad”
- equivalent\_to siunits.Steradian

## Neper

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b41515a9\\_28d8\\_4d78\\_8165\\_74b2fc72f89e](http://emmo.info/emmo/middle/units-extension#EMMO_b41515a9_28d8_4d78_8165_74b2fc72f89e)

**Definition:** Unit of measurement for quantities of type level or level difference, which are defined as the natural logarithm of the ratio of power- or field-type quantities.

The value of a ratio in nepers is given by  $\ln(x_1/x_2)$  where  $x_1$  and  $x_2$  are the values of interest (amplitudes), and  $\ln$  is the natural logarithm. When the values are quadratic in the amplitude (e.g. power), they are first linearised by taking the square root before the logarithm is taken, or equivalently the result is halved.

Wikipedia

**Dbpediaentry:** <http://dbpedia.org/page/Neper>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N04106>

**Qudtentry:** <http://qudt.org/vocab/unit/NP>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Neper>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “Np”

## CubicMetre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_a055d311\\_9990\\_40a5\\_b2f2\\_288412f5d6a5](http://emmo.info/emmo/middle/units-extension#EMMO_a055d311_9990_40a5_b2f2_288412f5d6a5)

**Elucidation:** SI coherent measurement unit for volume.

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/cubicMetre>

### Relations:

- is\_a siunits.SICoherentDerivedUnit
- metrology.hasPhysicalDimension some isq.VolumeDimension

## Ångström

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_27c530c4\\_dfcd\\_486e\\_b324\\_54ad4448cd26](http://emmo.info/emmo/middle/units-extension#EMMO_27c530c4_dfcd_486e_b324_54ad4448cd26)

**Definition:** Measure of length defined as 1e-10 metres.

**Altlabel:** Angstrom

**Comment:** Ångström is not mentioned in the SI system and deprecated by the International Bureau of Weights and Measures (BIPM).

Despite of that, it is often used in the natural sciences and technology.

**Dbpediaentry:** <http://dbpedia.org/page/%C3%85ngstr%C3%B6m>

**Iupacentry:** <https://doi.org/10.1351/goldbook.N00350>

**Qudtentry:** <http://qudt.org/vocab/unit/ANGSTROM>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Angstrom>

**Relations:**

- is\_a metrology.UnitSymbol
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “Å”

## FractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_c2f5ee66\\_579c\\_44c6\\_a2e9\\_fa2eaa9fa4da](http://emmo.info/emmo/middle/units-extension#EMMO_c2f5ee66_579c_44c6_a2e9_fa2eaa9fa4da)

**Elucidation:** Unit for fractions of quantities of the same kind, to aid the understanding of the quantity being expressed.

**Comment:** Quantities that are ratios of quantities of the same kind (for example length ratios and amount fractions) have the option of being expressed with units (m/m, mol/mol to aid the understanding of the quantity being expressed and also allow the use of SI prefixes, if this is desirable (µm/m, nmol/mol). – SI Brochure

**Relations:**

- is\_a metrology.UnitOne

## Dalton

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_00dd79e0\\_31a6\\_427e\\_9b9c\\_90f3097e4a96](http://emmo.info/emmo/middle/units-extension#EMMO_00dd79e0_31a6_427e_9b9c_90f3097e4a96)

**Definition:** One dalton is defined as one twelfth of the mass of an unbound neutral atom of carbon-12 in its nuclear and electronic ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Unified\\_atomic\\_mass\\_unit](http://dbpedia.org/page/Unified_atomic_mass_unit)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01514>

**Qudtentry:** <http://qudt.org/vocab/unit/Dalton>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “Da”

## SIPrefixedUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_d41ce84b\\_4317\\_41fb\\_a5d1\\_6cd281fca106](http://emmo.info/emmo/middle/siunits#EMMO_d41ce84b_4317_41fb_a5d1_6cd281fca106)

**Elucidation:** A SI base or special unit with a metric prefix.

**Comment:** The presence of the prefix makes this units non-coherent with SI system.

**Relations:**

- is\_a metrology.PrefixedUnit
- is\_a siunits.SINonCoherentUnit

## Bel

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6c7160fc\\_cc64\\_46f0\\_b43b\\_aba65e9952e3](http://emmo.info/emmo/middle/units-extension#EMMO_6c7160fc_cc64_46f0_b43b_aba65e9952e3)

**Definition:** One bel is defined as  $\frac{1}{2} \ln(10)$  **neper**.

**Elucidation:** Unit of measurement for quantities of type level or level difference.

**Comment:** Today decibel (one tenth of a bel) is commonly used instead of bel.

**Comment:** bel is used to express the ratio of one value of a power or field quantity to another, on a logarithmic scale, the logarithmic quantity being called the power level or field level, respectively.

**Qudtentry:** <http://qudt.org/vocab/unit/B>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Decibel>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “B”

## VolumeFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_9fd1e79d\\_41d1\\_44f8\\_8142\\_66dbdf0fc7ad](http://emmo.info/emmo/middle/units-extension#EMMO_9fd1e79d_41d1_44f8_8142_66dbdf0fc7ad)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two volumes.

**Example:** Unit for volume fraction.

### Relations:

- is\_a units-extension.FractionUnit

## BaseUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_db716151\\_6b73\\_45ff\\_910c\\_d182fdcbb4f5](http://emmo.info/emmo/middle/metrology#EMMO_db716151_6b73_45ff_910c_d182fdcbb4f5)

**Elucidation:** A set of units that correspond to the base quantities in a system of units.

### Relations:

- is\_a metrology.UnitSymbol

## SIUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_feb03a8a\\_bbb6\\_4918\\_a891\\_46713ef557f4](http://emmo.info/emmo/middle/siunits#EMMO_feb03a8a_bbb6_4918_a891_46713ef557f4)

**Elucidation:** The set of units provided by the SI referring to the ISQ.

**Comment:** The complete set of SI units includes both the coherent set and the multiples and sub-multiples formed by using the SI prefixes.

**Comment:** The names, symbols and prefixes of SI units are defined by the General Conference on Weights and Measures (CGPM).

[https://en.wikipedia.org/wiki/General\\_Conference\\_on\\_Weights\\_and\\_Measures](https://en.wikipedia.org/wiki/General_Conference_on_Weights_and_Measures)

### Relations:

- is\_a metrology.MeasurementUnit
- disjoint\_union\_of siunits.SICoherentDerivedUnit, siunits.SIBaseUnit, siunits.SINonCoherentDerivedUnit, siunits.SIPrefixedUnit, siunits.SISpecialUnit

## AreaFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6f4d704a\\_a7c6\\_4c07\\_b8a7\\_ea0bab04128f](http://emmo.info/emmo/middle/units-extension#EMMO_6f4d704a_a7c6_4c07_b8a7_ea0bab04128f)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two areas.

**Example:** Unit for solid angle.

**Relations:**

- is\_a units-extension.FractionUnit

## Day

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_28ef05a7\\_ecc1\\_4df6\\_8116\\_c53251fbd4a8](http://emmo.info/emmo/middle/units-extension#EMMO_28ef05a7_ecc1_4df6_8116_c53251fbd4a8)

**Definition:** A measure of time defined as 86 400 seconds.

**Dbpediaentry:** <http://dbpedia.org/page/Day>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01527>

**Qudtentry:** <http://qudt.org/vocab/unit/DAY>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “d”

## NonPrefixedUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_868ae137\\_4d25\\_493e\\_b270\\_21ea3d94849e](http://emmo.info/emmo/middle/metrology#EMMO_868ae137_4d25_493e_b270_21ea3d94849e)

**Elucidation:** A measurement unit symbol that do not have a metric prefix as a direct spatial part.

**Relations:**

- is\_a metrology.MeasurementUnit
- reductionistic.hasSpatialDirectPart only not metrology.MetricPrefix
- equivalent\_to metrology.DerivedUnit or metrology.UnitSymbol

## ElectronVolt

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e29f84db\\_4c1c\\_46ae\\_aa38\\_c4d47536b972](http://emmo.info/emmo/middle/units-extension#EMMO_e29f84db_4c1c_46ae_aa38_c4d47536b972)

**Definition:** The amount of energy gained (or lost) by the charge of a single electron moving across an electric potential difference of one volt.

**Dbpediaentry:** <http://dbpedia.org/page/Electronvolt>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02014>

**Qudtentry:** <http://qudt.org/vocab/unit/EV>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.EnergyDimension
- perceptual.hasSymbolData value “eV”

## Hour

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_21ef2ed6\\_c086\\_4d24\\_8a75\\_980d2bcc9282](http://emmo.info/emmo/middle/units-extension#EMMO_21ef2ed6_c086_4d24_8a75_980d2bcc9282)

**Definition:** Measure of time defined as 3600 seconds.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02866>

**Qudtentry:** <http://qudt.org/vocab/unit/HR>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “h”

## SI Coherent Unit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_707c6032\\_e272\\_4a20\\_98b5\\_d35c4f67be68](http://emmo.info/emmo/middle/siunits#EMMO_707c6032_e272_4a20_98b5_d35c4f67be68)

**Comment:** Derived units are defined as products of powers of the base units. When the numerical factor of this product is one, the derived units are called coherent derived units. The base and coherent derived units of the SI form a coherent set, designated the set of coherent SI units.

### Relations:

- is\_a metrology.NonPrefixedUnit
- is\_a siunits.SIUnit
- disjoint\_union\_of siunits.SI Coherent Derived Unit, siunits.SI Base Unit, siunits.SI Special Unit

## Off System Unit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_591e02fd\\_8d37\\_45a6\\_9d11\\_bb21cef391a0](http://emmo.info/emmo/middle/metrology#EMMO_591e02fd_8d37_45a6_9d11_bb21cef391a0)

**Elucidation:** A unit that does not belong to any system of units.

**Example:** eV barn

### Relations:

- is\_a metrology.MeasurementUnit

## SI Coherent Derived Unit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_1273eb34\\_de48\\_43a9\\_925f\\_104110469dd2](http://emmo.info/emmo/middle/siunits#EMMO_1273eb34_de48_43a9_925f_104110469dd2)

**Elucidation:** A SI derived unit whos numerical factor in front of the product of SI base units is one.

**Example:** m/s kg/m<sup>3</sup>

**Comment:** This class collects all units that are products or powers of SI base or SI special units only.

### Relations:

- is\_a metrology.DerivedUnit
- is\_a siunits.SI Coherent Unit

## Pure Number Unit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_15d62b55\\_38ea\\_4aec\\_b7c4\\_25db1a2e5a01](http://emmo.info/emmo/middle/units-extension#EMMO_15d62b55_38ea_4aec_b7c4_25db1a2e5a01)

**Elucidation:** Unit for dimensionless units that cannot be expressed as a ‘FractionUnit’.

**Example:** Unit of AtomicNumber

### Relations:

- is\_a metrology.UnitOne

## SpeedFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_e7bc8939\\_7ff8\\_4917\\_beb5\\_c42730b390f3](http://emmo.info/emmo/middle/units-extension#EMMO_e7bc8939_7ff8_4917_beb5_c42730b390f3)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two speeds.

**Example:** Unit for refractive index.

**Relations:**

- is\_a units-extension.FractionUnit

## SINonCoherentDerivedUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_60b78cc3\\_6011\\_4134\\_95ab\\_956f56d4bdc1](http://emmo.info/emmo/middle/siunits#EMMO_60b78cc3_6011_4134_95ab_956f56d4bdc1)

**Elucidation:** A derived unit whos numerical factor in front of the product of base units is NOT equal to one.

**Relations:**

- is\_a siunits.SINonCoherentUnit

## Steradian

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_cf3dd6cc\\_c5d6\\_4b3d\\_aef4\\_82f3b7a361af](http://emmo.info/emmo/middle/siunits#EMMO_cf3dd6cc_c5d6_4b3d_aef4_82f3b7a361af)

**Elucidation:** Dimensionless measurement unit for solid angle.

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05971>

**Qudtentry:** <http://qudt.org/vocab/unit/SR>

**Relations:**

- is\_a units-extension.AreaFractionUnit
- is\_a owl:Nothing
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “sr”
- equivalent\_to owl:Nothing

## SpecialUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3ee80521\\_3c23\\_4dd1\\_935d\\_9d522614a3e2](http://emmo.info/emmo/middle/metrology#EMMO_3ee80521_3c23_4dd1_935d_9d522614a3e2)

**Elucidation:** A unit symbol that stands for a derived unit.

**Example:** Pa stands for N/m<sup>2</sup> J stands for N m

**Comment:** Special units are semiotic shortcuts to more complex composed symbolic objects.

**Relations:**

- is\_a metrology.DerivedUnit
- is\_a metrology.UnitSymbol
- is\_a semiotics.Sign
- Inverse(semiotics.hasSign) some metrology.DerivedUnit



## Degree

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b8830065\\_3809\\_41b7\\_be3c\\_e33795567fd9](http://emmo.info/emmo/middle/units-extension#EMMO_b8830065_3809_41b7_be3c_e33795567fd9)

**Definition:** Degree is a measurement of plane angle, defined by representing a full rotation as 360 degrees.

**Dbpediaentry:** [http://dbpedia.org/page/Degree\\_\(angle\)](http://dbpedia.org/page/Degree_(angle))

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01560>

**Qudtentry:** <http://qudt.org/vocab/unit/DEG>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “°”

## SquareMetre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_b0d1c460\\_d06b\\_4c7f\\_8832\\_148bc1c8e7dc](http://emmo.info/emmo/middle/units-extension#EMMO_b0d1c460_d06b_4c7f_8832_148bc1c8e7dc)

**Elucidation:** SI coherent measurement unit for area.

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/squareMetre>

### Relations:

- is\_a siunits.SICoherentDerivedUnit
- metrology.hasPhysicalDimension some isq.AreaDimension

## CGSUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_52e4cb25\\_da39\\_45e2\\_a6db\\_063ec5730499](http://emmo.info/emmo/middle/units-extension#EMMO_52e4cb25_da39_45e2_a6db_063ec5730499)

**Elucidation:** The centimetre–gram–second (CGS) system of units.

**Comment:** CGS is a variant of the metric system.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Centimetre%E2%80%93gram%E2%80%93second\\_system\\_of\\_units](https://en.wikipedia.org/wiki/Centimetre%E2%80%93gram%E2%80%93second_system_of_units)

### Relations:

- is\_a metrology.MeasurementUnit

## AmountFractionUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f76f5a24\\_d703\\_4e8c\\_b368\\_f9a7777cb73a](http://emmo.info/emmo/middle/units-extension#EMMO_f76f5a24_d703_4e8c_b368_f9a7777cb73a)

**Elucidation:** Unit for quantities of dimension one that are the fraction of two amount of substance.

**Example:** Unit for amount fraction.

### Relations:

- is\_a units-extension.FractionUnit

## Litre

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_a155dc93\\_d266\\_487e\\_b5e7\\_2a2c72d5ebf9](http://emmo.info/emmo/middle/units-extension#EMMO_a155dc93_d266_487e_b5e7_2a2c72d5ebf9)

**Definition:** A non-SI unit of volume defined as 1 cubic decimetre (dm<sup>3</sup>),

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03594>

**Qudtentry:** <http://qudt.org/vocab/unit/L>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.VolumeDimension
- perceptual.hasSymbolData value “1”

## MetrePerSecond

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_4a27950a\\_0d31\\_4175\\_bd4e\\_14995aa94702](http://emmo.info/emmo/middle/units-extension#EMMO_4a27950a_0d31_4175_bd4e_14995aa94702)

**Elucidation:** SI coherent measurement unit for speed.

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/metrePerSecond-Time>

**Relations:**

- is\_a siunits.SICoherentDerivedUnit
- metrology.hasPhysicalDimension some isq.VelocityDimension

## UnitOne

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_5ebd5e01\\_0ed3\\_49a2\\_a30d\\_cd05cbe72978](http://emmo.info/emmo/middle/metrology#EMMO_5ebd5e01_0ed3_49a2_a30d_cd05cbe72978)

**Elucidation:** Represents the number 1, used as an explicit unit to say something has no units.

**Example:** Refractive index or volume fraction.

**Example:** Typically used for ratios of two units whos dimensions cancels out.

**Qudtentry:** <http://qudt.org/vocab/unit/UNITLESS>

**Relations:**

- is\_a metrology.BaseUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne

## SINonCoherentUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_8246541a\\_f1f6\\_4d03\\_8bd7\\_fc6b76d17375](http://emmo.info/emmo/middle/siunits#EMMO_8246541a_f1f6_4d03_8bd7_fc6b76d17375)

**Relations:**

- is\_a siunits.SIUnit
- disjoint\_union\_of siunits.SINonCoherentDerivedUnit, siunits.SIPrefixedUnit

## ArcSecond

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6a4547ab\\_3abb\\_430d\\_b81b\\_ce32d47729f5](http://emmo.info/emmo/middle/units-extension#EMMO_6a4547ab_3abb_430d_b81b_ce32d47729f5)

**Definition:** Measure of plane angle defined as 1/3600 or a degree.

**Altlabel:** SecondOfArc

**Qudtentry:** <http://qudt.org/vocab/unit/ARCSEC>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some metrology.DimensionOne
- perceptual.hasSymbolData value “ ”

## UnitSymbol

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_216f448e\\_cdbc\\_4aeb\\_a529\\_7a5fe7fc38bb](http://emmo.info/emmo/middle/metrology#EMMO_216f448e_cdbc_4aeb_a529_7a5fe7fc38bb)

**Elucidation:** A symbol that stands for a single unit.

**Example:** Some examples are “Pa”, “m” and “J”.

**Relations:**

- is\_a metrology.MetrologicalSymbol
- is\_a metrology.NonPrefixedUnit
- equivalent\_to metrology.MeasurementUnit and perceptual.Symbol
- disjoint\_union\_of metrology.SpecialUnit, metrology.BaseUnit

## Tonne

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_f8b92999\\_3cde\\_46e3\\_99d5\\_664da3090a02](http://emmo.info/emmo/middle/units-extension#EMMO_f8b92999_3cde_46e3_99d5_664da3090a02)

**Definition:** A non-SI unit defined as 1000 kg.

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06394>

**Qudtentry:** [http://qudt.org/vocab/unit/TON\\_M](http://qudt.org/vocab/unit/TON_M)

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Tonne>

**Relations:**

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.MassDimension
- perceptual.hasSymbolData value “t”

## MeasurementUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_b081b346\\_7279\\_46ef\\_9a3d\\_2c088fcd79f4](http://emmo.info/emmo/middle/metrology#EMMO_b081b346_7279_46ef_9a3d_2c088fcd79f4)

**Elucidation:** A ‘Quantity’ that stands for the standard reference magnitude of a specific class of measurement processes, defined and adopted by convention or by law.

The numerical quantity value of the ‘MeasurementUnit’ is conventionally 1 and does not appear.

Quantitative measurement results are expressed as a multiple of the ‘MeasurementUnit’.

**Comment:** “Real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the second quantity to the first one as a number” ISO 80000-1

**Comment:** “Unit symbols are mathematical entities and not abbreviations.”

“Symbols for units are treated as mathematical entities. In expressing the value of a quantity as the product of a numerical value and a unit, both the numerical value and the unit may be treated by the ordinary rules of algebra.”

<https://www.bipm.org/utils/common/pdf/si-brochure/SI-Brochure-9-EN.pdf>

**Comment:** While the SI brochure treats ‘MeasurementUnit’ as a ‘PhysicalQuantity’, in the EMMO this is not possible since the latter always has two direct parts, a ‘Numerical’ and a ‘MeasurementUnit’, while the former a single ‘Symbol’.

SI distinguishes between a quantity (an abstract concept) and the quantity value (a number and a reference). The EMMO, following strict nominalism, considers a SI quantity as a SI quantity value, collapsing the two concepts into one: the ‘Quantity’.

So, for the EMMO the symbol “kg” is not a physical quantity but a ‘MeasurementUnit’, while the string “1 kg” is ‘Physical Quantity’.

**Relations:**

- is\_a metrology.ReferenceUnit

- is\_a semiotics.Object
- metrology.hasPhysicalDimension exactly 1 metrology.PhysicalDimension
- disjoint\_union\_of metrology.NonPrefixedUnit, metrology.PrefixedUnit

## Hectare

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_d6eb0176\\_a0d7\\_4b4e\\_8df0\\_50e912be2342](http://emmo.info/emmo/middle/units-extension#EMMO_d6eb0176_a0d7_4b4e_8df0_50e912be2342)

**Definition:** A non-SI metric unit of area defined as the square with 100-metre sides.

**Dbpediaentry:** <http://dbpedia.org/page/Hectare>

**Qudtentry:** <http://qudt.org/vocab/unit/HA>

**Wikipediaentry:** <https://en.wikipedia.org/wiki/Hectare>

### Relations:

- is\_a units-extension.SIAcceptedSpecialUnit
- is\_a metrology.OffSystemUnit
- metrology.hasPhysicalDimension some isq.AreaDimension
- perceptual.hasSymbolData value “ha”

## SIUnitSymbol

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_32129fb5\\_df25\\_48fd\\_a29c\\_18a2f22a2dd5](http://emmo.info/emmo/middle/siunits#EMMO_32129fb5_df25_48fd_a29c_18a2f22a2dd5)

### Relations:

- is\_a metrology.UnitSymbol
- is\_a siunits.SICoherentUnit
- disjoint\_union\_of siunits.SIBaseUnit, siunits.SISpecialUnit

## SIAcceptedSpecialUnit

**IRI:** [http://emmo.info/emmo/middle/units-extension#EMMO\\_6795a4b8\\_ffd0\\_4588\\_a581\\_a9413fe49cac](http://emmo.info/emmo/middle/units-extension#EMMO_6795a4b8_ffd0_4588_a581_a9413fe49cac)

**Elucidation:** Non-SI units mentioned in the SI.

**Comment:** This is a list of units that are not defined as part of the International System of Units (SI), but are otherwise mentioned in the SI brochure, because either the General Conference on Weights and Measures (CGPM) accepts their use as being multiples or submultiples of SI-units, they have important contemporary application worldwide, or are otherwise commonly encountered worldwide.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Non-SI\\_units\\_mentioned\\_in\\_the\\_SI](https://en.wikipedia.org/wiki/Non-SI_units_mentioned_in_the_SI)

### Relations:

- is\_a metrology.SpecialUnit
- is\_a metrology.OffSystemUnit
- disjoint\_union\_of units-extension.Dalton, units-extension.AstronomicalUnit, units-extension.ArcMinute, units-extension.Hour, units-extension.Day, units-extension.ArcSecond, units-extension.Bel, units-extension.Litre, units-extension.Neper, units-extension.Degree, units-extension.Minute, units-extension.Hectare, units-extension.ElectronVolt, units-extension.Tonne

## UTF8 branch



Figure 3.26: UTF8 branch.

## UTF8

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_e13b2173\\_1dec\\_4b97\\_9ac1\\_1dc4b418612a](http://emmo.info/emmo/middle/perceptual#EMMO_e13b2173_1dec_4b97_9ac1_1dc4b418612a)

**Relations:**

- is\_a perceptual.Symbol

## SI Base Unit branch

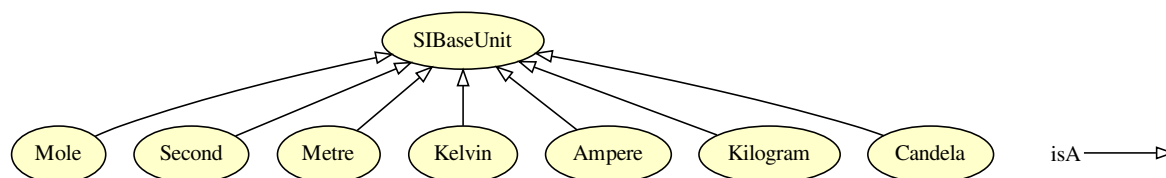


Figure 3.27: SI Base Unit branch.

## Mole

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_df6eeb01\\_1b41\\_4bd8\\_9257\\_a04fbd7cf000](http://emmo.info/emmo/middle/siunits#EMMO_df6eeb01_1b41_4bd8_9257_a04fbd7cf000)

**Definition:** The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly  $6.022\,140\,76 \times 10^{23}$  elementary entities. This number is the fixed numerical value of the Avogadro constant,  $N_A$ , when expressed in the unit  $\text{mol}^{-1}$  and is called the Avogadro number. The amount of substance, symbol  $n$ , of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03980>

**Qudtentry:** <http://qudt.org/vocab/unit/MOL>

**Relations:**

- is\_a siunits.SIBaseUnit
- metrology.hasPhysicalDimension some isq.AmountDimension
- perceptual.hasSymbolData value “mol”

## Second

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_314ba716\\_2d3d\\_4462\\_9a4f\\_d3419ae1df43](http://emmo.info/emmo/middle/siunits#EMMO_314ba716_2d3d_4462_9a4f_d3419ae1df43)

**Definition:** The second, symbol s, is the SI unit of time. It is defined by taking the fixed numerical value of the caesium frequency  $\nu_{\text{Cs}}$ , the unperturbed ground-state hyperfine transition frequency of the caesium 133 atom, to be 9192631770 when expressed in the unit Hz, which is equal to  $\text{s}^{-1}$ .

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05513>

**Qudtentry:** <http://qudt.org/vocab/unit/SEC>

**Relations:**

- is\_a siunits.SIBaseUnit
- metrology.hasPhysicalDimension some isq.TimeDimension
- perceptual.hasSymbolData value “s”

## Metre

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_7db11dbf\\_a643\\_464a\\_9b56\\_07eabcc3e9c5](http://emmo.info/emmo/middle/siunits#EMMO_7db11dbf_a643_464a_9b56_07eabcc3e9c5)

**Definition:** The metre, symbol m, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum  $c$  to be 299792458 when expressed in the unit m s<sup>-1</sup>, where the second is defined in terms of  $\nabla\nu$ Cs.

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03884>

**Qudtentry:** <http://qudt.org/vocab/unit/M>

### Relations:

- is\_a siunits.SIBaseUnit
- metrology.hasPhysicalDimension some isq.LengthDimension
- perceptual.hasSymbolData value “m”

## Kelvin

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_2e5e45fc\\_f52c\\_4294\\_bdc2\\_5ed7a06dfce7](http://emmo.info/emmo/middle/siunits#EMMO_2e5e45fc_f52c_4294_bdc2_5ed7a06dfce7)

**Definition:** The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant  $k$  to be  $1.380649 \times 10^{-23}$  when expressed in the unit J K<sup>-1</sup>, which is equal to kg m<sup>2</sup> s<sup>-2</sup> K<sup>-1</sup>, where the kilogram, metre and second are defined in terms of  $h$ ,  $c$  and  $\nabla\nu$ Cs.

**Iupacentry:** <https://doi.org/10.1351/goldbook.K03374>

**Qudtentry:** <http://qudt.org/vocab/unit/K>

### Relations:

- is\_a siunits.SIBaseUnit
- metrology.hasPhysicalDimension some isq.TemperatureDimension
- perceptual.hasSymbolData value “K”

## Ampere

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_db5dd38d\\_ac79\\_4af6\\_8782\\_fee7e7150ae8](http://emmo.info/emmo/middle/siunits#EMMO_db5dd38d_ac79_4af6_8782_fee7e7150ae8)

**Definition:** The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge  $e$  to be  $1.602176634 \times 10^{-19}$  when expressed in the unit C, which is equal to A s, where the second is defined in terms of  $\nabla\nu$ Cs.

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00300>

**Qudtentry:** <http://qudt.org/vocab/unit/A>

### Relations:

- is\_a siunits.SIBaseUnit
- metrology.hasPhysicalDimension some isq.ElectricCurrentDimension
- perceptual.hasSymbolData value “A”

## SIBaseUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_3a185e6c\\_9e19\\_4776\\_b583\\_19c978156aa0](http://emmo.info/emmo/middle/siunits#EMMO_3a185e6c_9e19_4776_b583_19c978156aa0)

**Elucidation:** The base units in the SI system.

**Seealso:** <https://www.bipm.org/utis/common/pdf/si-brochure/SI-Brochure-9-EN.pdf>

### Relations:

- is\_a metrology.BaseUnit
- is\_a siunits.SIUnitSymbol
- disjoint\_union\_of siunits.Kelvin, siunits.Second, siunits.Metre, siunits.Candela, siunits.Kilogram, siunits.Ampere, siunits.Mole

## Kilogram

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_9bfd6f1e\\_b0ce\\_459c\\_beb7\\_8f1f41708bba](http://emmo.info/emmo/middle/siunits#EMMO_9bfd6f1e_b0ce_459c_beb7_8f1f41708bba)

**Definition:** The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant  $h$  to be  $6.62607015 \times 10^{-34}$  when expressed in the unit J s, which is equal to  $\text{kg m}^2 \text{s}^{-1}$ , where the metre and the second are defined in terms of  $c$  and  $\nabla \nu \text{Cs}$ .

**Iupacentry:** <https://doi.org/10.1351/goldbook.K03391>

**Qudtentry:** <http://qudt.org/vocab/unit/KiloGM>

**Relations:**

- `is_a siunits.SIBaseUnit`
- `metrology.hasPhysicalDimension some isq.MassDimension`
- `perceptual.hasSymbolData value “kg”`

## Candela

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_8d00f093\\_3f45\\_4ea3\\_986c\\_b3545c3c2f4c](http://emmo.info/emmo/middle/siunits#EMMO_8d00f093_3f45_4ea3_986c_b3545c3c2f4c)

**Definition:** The candela, symbol cd, is the SI unit of luminous intensity in a given direction. It is defined by taking the fixed numerical value of the luminous efficacy of monochromatic radiation of frequency  $540 \times 10^{12}$  Hz,  $K_{\text{cd}}$ , to be 683 when expressed in the unit  $\text{lm W}^{-1}$ , which is equal to  $\text{cd sr W}^{-1}$ , or  $\text{cd sr kg}^{-1} \text{m}^{-2} \text{s}^3$ , where the kilogram, metre and second are defined in terms of  $h$ ,  $c$  and  $\nabla \nu \text{Cs}$ .

**Iupacentry:** <https://doi.org/10.1351/goldbook.C00787>

**Qudtentry:** <http://qudt.org/vocab/unit/CD>

**Relations:**

- `is_a siunits.SIBaseUnit`
- `metrology.hasPhysicalDimension some isq.LuminousIntensityDimension`
- `perceptual.hasSymbolData value “cd”`

## SI Special Unit branch

### Pascal

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a80dc6f5\\_b1aa\\_41a7\\_a3a8\\_cd5040da2162](http://emmo.info/emmo/middle/siunits#EMMO_a80dc6f5_b1aa_41a7_a3a8_cd5040da2162)

**Comment:** Measurement unit for pressure.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04442>

**Qudtentry:** <http://qudt.org/vocab/unit/PA>

**Relations:**

- `is_a siunits.SISpecialUnit`
- `metrology.hasPhysicalDimension some isq.PressureDimension`
- `perceptual.hasSymbolData value “Pa”`

### Farad

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a9201b2f\\_e6de\\_442a\\_b3a6\\_d292a5820bc5](http://emmo.info/emmo/middle/siunits#EMMO_a9201b2f_e6de_442a_b3a6_d292a5820bc5)

**Comment:** Measurement unit for electric capacitance.

**Iupacentry:** <https://doi.org/10.1351/goldbook.F02320>

**Qudtentry:** <http://qudt.org/vocab/unit/FARAD>

**Relations:**

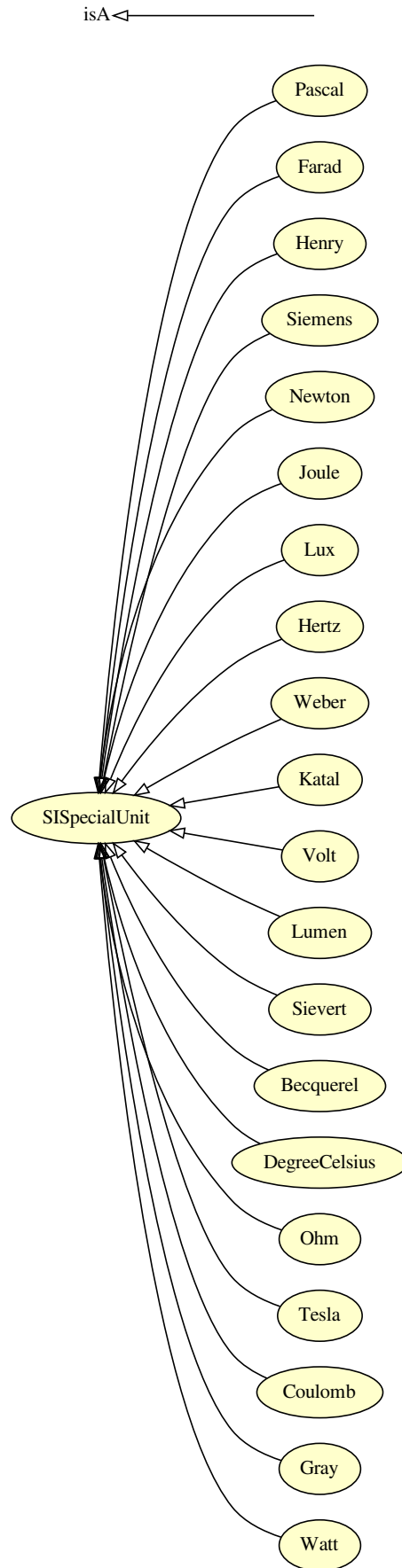


Figure 3.28: SI Special Unit branch.



- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.CapacitanceDimension
- perceptual.hasSymbolData value “F”

## Henry

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_fab003c8\\_f7a6\\_4346\\_9988\\_7161325ed7a3](http://emmo.info/emmo/middle/siunits#EMMO_fab003c8_f7a6_4346_9988_7161325ed7a3)

**Comment:** Measurement unit for electrical inductance.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02782>

**Qudtentry:** <http://qudt.org/vocab/unit/H>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.InductanceDimension
- perceptual.hasSymbolData value “H”

## Siemens

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_f2523820\\_04a6\\_44ab\\_bb67\\_8237dda2b0c2](http://emmo.info/emmo/middle/siunits#EMMO_f2523820_04a6_44ab_bb67_8237dda2b0c2)

**Comment:** Measurement unit for electrical conductance.

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.ElectricConductanceDimension
- perceptual.hasSymbolData value “S”

## Newton

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a979c531\\_f9fa\\_4a6e\\_93c1\\_a2960241ca64](http://emmo.info/emmo/middle/siunits#EMMO_a979c531_f9fa_4a6e_93c1_a2960241ca64)

**Comment:** Measurement unit for force.

**Iupacentry:** <https://doi.org/10.1351/goldbook.N04135>

**Qudtentry:** <http://qudt.org/vocab/unit/N>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.ForceDimension
- perceptual.hasSymbolData value “N”

## Joule

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_8a70dea4\\_d6ab\\_4260\\_b931\\_a3e990982416](http://emmo.info/emmo/middle/siunits#EMMO_8a70dea4_d6ab_4260_b931_a3e990982416)

**Comment:** Measurement unit for energy.

**Iupacentry:** <https://doi.org/10.1351/goldbook.J03363>

**Qudtentry:** <http://qudt.org/vocab/unit/J>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.EnergyDimension
- perceptual.hasSymbolData value “J”

## Lux

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_da1dd4a7\\_c611\\_4ad4\\_bef6\\_7646f28aa598](http://emmo.info/emmo/middle/siunits#EMMO_da1dd4a7_c611_4ad4_bef6_7646f28aa598)

**Comment:** Measurement unit for illuminance.

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03651>

**Qudtentry:** <http://qudt.org/vocab/unit/LUX>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.IlluminanceDimension
- perceptual.hasSymbolData value “lx”

## Hertz

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_e75f580e\\_52bf\\_4dd5\\_af70\\_df409cec08fd](http://emmo.info/emmo/middle/siunits#EMMO_e75f580e_52bf_4dd5_af70_df409cec08fd)

**Comment:** Measurement unit for frequency.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02785>

**Qudtentry:** <http://qudt.org/vocab/unit/HZ>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.FrequencyDimension
- perceptual.hasSymbolData value “Hz”

## Weber

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_d7f11b34\\_a121\\_4519\\_87c0\\_aa754f1c4737](http://emmo.info/emmo/middle/siunits#EMMO_d7f11b34_a121_4519_87c0_aa754f1c4737)

**Comment:** Measurement unit for magnetic flux.

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06666>

**Qudtentry:** <http://qudt.org/vocab/unit/WB>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.MagneticFluxDimension
- perceptual.hasSymbolData value “Wb”

## Katal

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_33b67e69\\_3645\\_4c73\\_b100\\_5ea6759221b4](http://emmo.info/emmo/middle/siunits#EMMO_33b67e69_3645_4c73_b100_5ea6759221b4)

**Comment:** Measurement unit for catalytic activity.

**Iupacentry:** <https://doi.org/10.1351/goldbook.K03372>

**Qudtentry:** <http://qudt.org/vocab/unit/KAT>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.CatalyticActivityDimension
- perceptual.hasSymbolData value “kat”

## Volt

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_e2207e91\\_02b0\\_4a8a\\_b13e\\_61d2a2a839f1](http://emmo.info/emmo/middle/siunits#EMMO_e2207e91_02b0_4a8a_b13e_61d2a2a839f1)

**Comment:** Measurement unit for voltage.

**Iupacentry:** <https://doi.org/10.1351/goldbook.V06634>

**Qudtentry:** <http://qudt.org/vocab/unit/V>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.ElectricPotentialDimension
- perceptual.hasSymbolData value “V”

## Lumen

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_d7b7fd1e\\_645a\\_42cb\\_8f40\\_85f0d034d3ae](http://emmo.info/emmo/middle/siunits#EMMO_d7b7fd1e_645a_42cb_8f40_85f0d034d3ae)

**Comment:** Measurement unit for luminous flux.

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03639>

**Qudtentry:** <http://qudt.org/vocab/unit/LM>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.LuminousIntensityDimension
- perceptual.hasSymbolData value “lm”

## Sievert

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_dc232f53\\_8ed8\\_4ddd\\_9f41\\_cc057985eadb](http://emmo.info/emmo/middle/siunits#EMMO_dc232f53_8ed8_4ddd_9f41_cc057985eadb)

**Comment:** Measurement unit for equivalent dose of ionizing radiation.

Sievert is derived from absorbed dose, but takes into account the biological effectiveness of the radiation, which is dependent on the radiation type and energy.

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05658>

**Qudtentry:** <http://qudt.org/vocab/unit/SV>

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Equivalent\\_dose](https://en.wikipedia.org/wiki/Equivalent_dose)

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.AbsorbedDoseDimension
- perceptual.hasSymbolData value “Sv”

## Becquerel

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_b71e4ba5\\_8f73\\_4199\\_8c96\\_7ea7f94d9e2a](http://emmo.info/emmo/middle/siunits#EMMO_b71e4ba5_8f73_4199_8c96_7ea7f94d9e2a)

**Definition:** Radioactive decays per second.

**Comment:** Unit for radioactive activity.

**Iupacentry:** <https://doi.org/10.1351/goldbook.B00624>

**Qudtentry:** <http://qudt.org/vocab/unit/BQ>

### Relations:

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.FrequencyDimension

- perceptual.hasSymbolData value “Bq”

## DegreeCelsius

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_b20be325\\_8bfd\\_4237\\_bee7\\_201ab0fd9c75](http://emmo.info/emmo/middle/siunits#EMMO_b20be325_8bfd_4237_bee7_201ab0fd9c75)

**Comment:** Measurement unit for Celsius temperature. This unit can only be used for expressing temperature differences.

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01561>

**Qudtentry:** [http://qudt.org/vocab/unit/DEG\\_C](http://qudt.org/vocab/unit/DEG_C)

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.TemperatureDimension
- perceptual.hasSymbolData value “°C”

## Ohm

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_59c10c5c\\_47bd\\_4348\\_ba39\\_38836607dfa1](http://emmo.info/emmo/middle/siunits#EMMO_59c10c5c_47bd_4348_ba39_38836607dfa1)

**Comment:** Measurement unit for resistance.

**Iupacentry:** <https://doi.org/10.1351/goldbook.O04280>

**Qudtentry:** <http://qudt.org/vocab/unit/OHM>

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.ElectricResistanceDimension
- perceptual.hasSymbolData value “Ω”

## Tesla

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_acb50123\\_87a2\\_4753\\_b36c\\_f87114ad4de2](http://emmo.info/emmo/middle/siunits#EMMO_acb50123_87a2_4753_b36c_f87114ad4de2)

**Comment:** Measurement unit for magnetic flux density or induction.

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06283>

**Qudtentry:** <http://qudt.org/vocab/unit/T>

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.MagneticFluxDensityDimension
- perceptual.hasSymbolData value “T”

## Coulomb

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_696ed548\\_9477\\_45ea\\_993c\\_6a8f5271914a](http://emmo.info/emmo/middle/siunits#EMMO_696ed548_9477_45ea_993c_6a8f5271914a)

**Comment:** Measurement unit for electric charge.

**Iupacentry:** <https://doi.org/10.1351/goldbook.C01365>

**Qudtentry:** <http://qudt.org/vocab/unit/C>

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.ElectricChargeDimension
- perceptual.hasSymbolData value “C”

## Gray

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_00199e76\\_69dc\\_45b6\\_a9c6\\_98cc90cdc0f5](http://emmo.info/emmo/middle/siunits#EMMO_00199e76_69dc_45b6_a9c6_98cc90cdc0f5)

**Comment:** Measurement unit for absorbed dose.

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02696>

**Qudtentry:** <http://qudt.org/vocab/unit/GRAY>

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.AbsorbedDoseDimension
- perceptual.hasSymbolData value “Gy”

## Watt

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_080052a1\\_f295\\_44be\\_a60f\\_1326ce13f1ba](http://emmo.info/emmo/middle/siunits#EMMO_080052a1_f295_44be_a60f_1326ce13f1ba)

**Comment:** Measurement unit for power.

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06656>

**Qudtentry:** <http://qudt.org/vocab/unit/W>

**Relations:**

- is\_a siunits.SISpecialUnit
- metrology.hasPhysicalDimension some isq.PowerDimension
- perceptual.hasSymbolData value “W”

## SISpecialUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_e9ffc696\\_5228\\_4ff9\\_8a60\\_0f5e05e9931b](http://emmo.info/emmo/middle/siunits#EMMO_e9ffc696_5228_4ff9_8a60_0f5e05e9931b)

**Elucidation:** The 22 derived units that are given a special name in the SI system that stands for units derived by SI base units.

**Comment:** These units are SI coherent by definition.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/International\\_System\\_of\\_Units#Derived\\_units](https://en.wikipedia.org/wiki/International_System_of_Units#Derived_units)

**Relations:**

- is\_a metrology.SpecialUnit
- is\_a siunits.SIUnitSymbol
- disjoint\_union\_of siunits.Gray, siunits.Watt, siunits.Katal, siunits.Ohm, siunits.Coulomb, siunits.Joule, siunits.Radian, siunits.Pascal, siunits.Farad, siunits.Newton, siunits.Tesla, siunits.DegreeCelsius, siunits.Becquerel, siunits.Steradian, siunits.Lumen, siunits.Weber, siunits.Lux, siunits.Sievert, siunits.Volt, siunits.Hertz, siunits.Siemens, siunits.Henry

## Prefixed Unit branch

### PrefixedUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_c6d4a5e0\\_7e95\\_44df\\_a6db\\_84ee0a8bbc8e](http://emmo.info/emmo/middle/metrology#EMMO_c6d4a5e0_7e95_44df_a6db_84ee0a8bbc8e)

**Elucidation:** A measurement unit that is made of a metric prefix and a unit symbol.

**Relations:**

- is\_a metrology.MeasurementUnit
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart only (metrology.UnitSymbol or metrology.MetricPrefix)
- reductionistic.hasSpatialDirectPart exactly 1 metrology.UnitSymbol

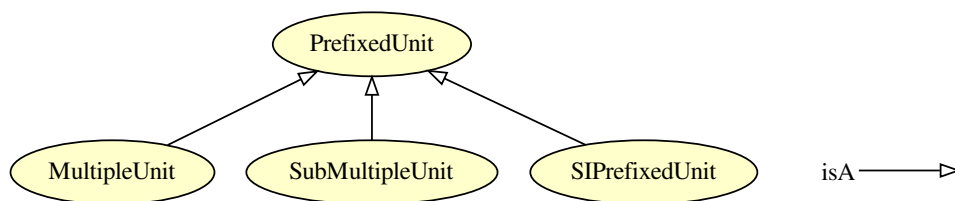


Figure 3.29: Prefixed Unit branch.

- `reductionistic.hasSpatialDirectPart` exactly 1 `metrology.MetricPrefix`
- `disjoint_union_of` `metrology.MultipleUnit`, `metrology.SubMultipleUnit`

## MultipleUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_62f0d847\\_3603\\_45b4\\_bfc4\\_dd4511355ff2](http://emmo.info/emmo/middle/metrology#EMMO_62f0d847_3603_45b4_bfc4_dd4511355ff2)

**Elucidation:** Measurement unit obtained by multiplying a given measurement unit by an integer greater than one.

**Relations:**

- `is_a` `metrology.PrefixedUnit`

## SubMultipleUnit

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_a2f94f33\\_71fa\\_443c\\_a1fb\\_d1685fc537ec](http://emmo.info/emmo/middle/metrology#EMMO_a2f94f33_71fa_443c_a1fb_d1685fc537ec)

**Elucidation:** Measurement unit obtained by dividing a given measurement unit by an integer greater than one.

**Relations:**

- `is_a` `metrology.PrefixedUnit`

## SIPrefixedUnit

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_d41ce84b\\_4317\\_41fb\\_a5d1\\_6cd281fca106](http://emmo.info/emmo/middle/siunits#EMMO_d41ce84b_4317_41fb_a5d1_6cd281fca106)

**Elucidation:** A SI base or special unit with a metric prefix.

**Comment:** The presence of the prefix makes this units non-coherent with SI system.

**Relations:**

- `is_a` `metrology.PrefixedUnit`
- `is_a` `siunits.SINonCoherentUnit`

## Metric Prefix branch

### SIMetricPrefix

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_471cb92b\\_edca\\_4cf9\\_bce8\\_a75084d876b8](http://emmo.info/emmo/middle/siunits#EMMO_471cb92b_edca_4cf9_bce8_a75084d876b8)

**Relations:**

- `is_a` `metrology.MetricPrefix`

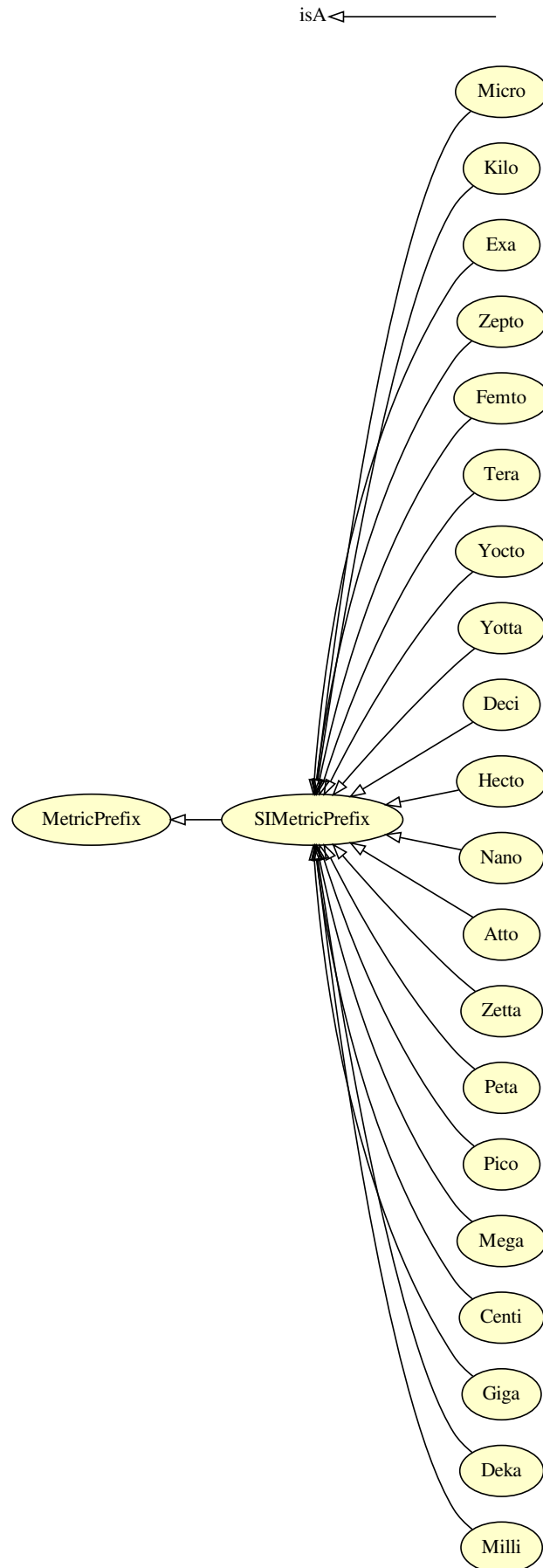


Figure 3.30: Metric Prefix branch.

- disjoint\_union\_of siunits.Pico, siunits.Deci, siunits.Deka, siunits.Hecto, siunits.Femto, siunits.Zepto, siunits.Tera, siunits.Atto, siunits.Peta, siunits.Exa, siunits.Mega, siunits.Kilo, siunits.Micro, siunits.Milli, siunits.Giga, siunits.Centi, siunits.Zetta, siunits.Nano, siunits.Yotta, siunits.Yocto

## Micro

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_9ff3bf8e\\_2168\\_406e\\_8251\\_1d158fc948ae](http://emmo.info/emmo/middle/siunits#EMMO_9ff3bf8e_2168_406e_8251_1d158fc948ae)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-06
- perceptual.hasSymbolData value “μ”

## Kilo

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_74931b1b\\_c133\\_4e59\\_9a75\\_1bf0e1626201](http://emmo.info/emmo/middle/siunits#EMMO_74931b1b_c133_4e59_9a75_1bf0e1626201)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1000.0
- perceptual.hasSymbolData value “k”

## Exa

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_5cf9f86c\\_86f5\\_40c4\\_846d\\_60371f670e0a](http://emmo.info/emmo/middle/siunits#EMMO_5cf9f86c_86f5_40c4_846d_60371f670e0a)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e+18
- perceptual.hasSymbolData value “E”

## Zepto

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_254472c6\\_3dbd\\_4f02\\_bc43\\_571389cd281f](http://emmo.info/emmo/middle/siunits#EMMO_254472c6_3dbd_4f02_bc43_571389cd281f)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-21
- perceptual.hasSymbolData value “z”

## Femto

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_23bfe79a\\_cade\\_48f1\\_9a8c\\_fd96e6bac8ba](http://emmo.info/emmo/middle/siunits#EMMO_23bfe79a_cade_48f1_9a8c_fd96e6bac8ba)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-15
- perceptual.hasSymbolData value “f”

## Tera

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_3a204900\\_2b33\\_47d1\\_b444\\_815cc4c8cffa](http://emmo.info/emmo/middle/siunits#EMMO_3a204900_2b33_47d1_b444_815cc4c8cffa)

### Relations:

- is\_a siunits.SIMetricPrefix



- Inverse(math.hasVariable) only math.hasNumericalData value 1000000000000.0
- perceptual.hasSymbolData value “T”

## Yocto

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_f5769206\\_9257\\_4b08\\_bf7b\\_dad7868c6afc](http://emmo.info/emmo/middle/siunits#EMMO_f5769206_9257_4b08_bf7b_dad7868c6afc)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-24
- perceptual.hasSymbolData value “y”

## Yotta

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_e79c62ff\\_10ad\\_4ec0\\_baba\\_c19ddd4eaa11](http://emmo.info/emmo/middle/siunits#EMMO_e79c62ff_10ad_4ec0_baba_c19ddd4eaa11)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e+24
- perceptual.hasSymbolData value “Y”

## MetricPrefix

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_7d2afa66\\_ae9e\\_4095\\_a9bf\\_421d0be401b6](http://emmo.info/emmo/middle/metrology#EMMO_7d2afa66_ae9e_4095_a9bf_421d0be401b6)

**Elucidation:** Dimensionless multiplicative unit prefix.

**Seealso:** [https://en.wikipedia.org/wiki/Metric\\_prefix](https://en.wikipedia.org/wiki/Metric_prefix)

### Relations:

- is\_a math.MathematicalSymbol
- is\_a math.Constant
- is\_a metrology.MetrologicalSymbol
- is\_a metrology.Metrological
- is\_a perceptual.Symbol

## Deci

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_1181c938\\_c8f0\\_4ad6\\_bc7a\\_2bfdc0903d29](http://emmo.info/emmo/middle/siunits#EMMO_1181c938_c8f0_4ad6_bc7a_2bfdc0903d29)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 0.1
- perceptual.hasSymbolData value “d”

## Hecto

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_21aaefc1\\_3f86\\_4208\\_b7db\\_a755f31f0f8c](http://emmo.info/emmo/middle/siunits#EMMO_21aaefc1_3f86_4208_b7db_a755f31f0f8c)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 100.0
- perceptual.hasSymbolData value “h”

## Nano

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_e1981c25\\_7c55\\_4020\\_aa7a\\_d2e14ced86d4](http://emmo.info/emmo/middle/siunits#EMMO_e1981c25_7c55_4020_aa7a_d2e14ced86d4)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-09
- perceptual.hasSymbolData value “n”

## Atto

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_42955b2d\\_b465\\_4666\\_86cc\\_ea3c2d685753](http://emmo.info/emmo/middle/siunits#EMMO_42955b2d_b465_4666_86cc_ea3c2d685753)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-18
- perceptual.hasSymbolData value “a”

## Zetta

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_daa9ee97\\_4c5f\\_42e5\\_918c\\_44d7523e8958](http://emmo.info/emmo/middle/siunits#EMMO_daa9ee97_4c5f_42e5_918c_44d7523e8958)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e+21
- perceptual.hasSymbolData value “Z”

## Peta

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_43a6b269\\_da31\\_4bb6\\_a537\\_c97df4fff32a](http://emmo.info/emmo/middle/siunits#EMMO_43a6b269_da31_4bb6_a537_c97df4fff32a)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1000000000000000.0
- perceptual.hasSymbolData value “P”

## Pico

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_068c4e58\\_2470\\_4b1c\\_8454\\_010dd4906100](http://emmo.info/emmo/middle/siunits#EMMO_068c4e58_2470_4b1c_8454_010dd4906100)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1e-12
- perceptual.hasSymbolData value “p”

## Mega

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_5eacadc\\_4f0d\\_4a3a\\_afc7\\_1fc0b83cc928](http://emmo.info/emmo/middle/siunits#EMMO_5eacadc_4f0d_4a3a_afc7_1fc0b83cc928)

### Relations:

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1000000.0
- perceptual.hasSymbolData value “M”

## Centi

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_b55cd09a\\_e54d\\_4eb1\\_81dd\\_03c29d1b878e](http://emmo.info/emmo/middle/siunits#EMMO_b55cd09a_e54d_4eb1_81dd_03c29d1b878e)

**Relations:**

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 0.01
- perceptual.hasSymbolData value “c”

## Giga

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a8eb4bbb\\_1bd3\\_4ad4\\_b114\\_2789bcbd2134](http://emmo.info/emmo/middle/siunits#EMMO_a8eb4bbb_1bd3_4ad4_b114_2789bcbd2134)

**Relations:**

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 1000000000.0
- perceptual.hasSymbolData value “G”

## Deka

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_1d8b370b\\_c672\\_4d0c\\_964e\\_eaafcbf2f51f](http://emmo.info/emmo/middle/siunits#EMMO_1d8b370b_c672_4d0c_964e_eaafcbf2f51f)

**Relations:**

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 10.0
- perceptual.hasSymbolData value “da”

## Milli

**IRI:** [http://emmo.info/emmo/middle/siunits#EMMO\\_a3a701ed\\_6f7d\\_4a10\\_9aee\\_dfa1961fc7b7](http://emmo.info/emmo/middle/siunits#EMMO_a3a701ed_6f7d_4a10_9aee_dfa1961fc7b7)

**Relations:**

- is\_a siunits.SIMetricPrefix
- Inverse(math.hasVariable) only math.hasNumericalData value 0.001
- perceptual.hasSymbolData value “m”

## Quantity branch

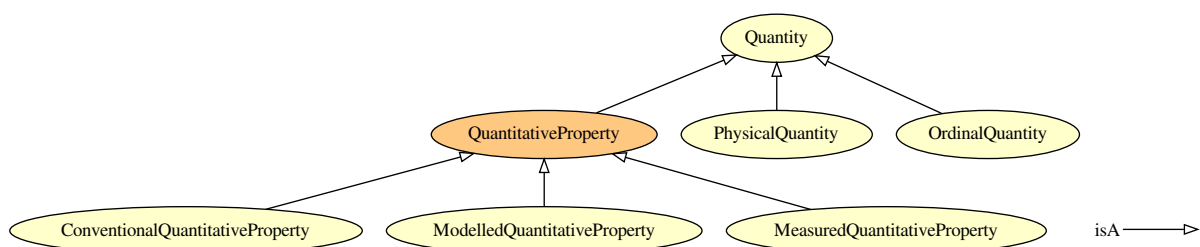


Figure 3.31: Quantity branch.

## ConventionalQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_d8aa8e1f\\_b650\\_416d\\_88a0\\_5118de945456](http://emmo.info/emmo/middle/properties#EMMO_d8aa8e1f_b650_416d_88a0_5118de945456)

**Elucidation:** A quantitative property attributed by agreement to a quantity for a given purpose.

**Example:** The thermal conductivity of a copper sample in my laboratory can be assumed to be the conductivity that appears in the vendor specification. This value has been obtained by measurement of a sample which is not the one I have in my laboratory. This conductivity value is then a conventional quantitative property assigned to my sample through a semiotic process in which no actual measurement is done by my laboratory.

If I don't believe the vendor, then I can measure the actual thermal conductivity. I then perform a measurement process that semiotically assign another value for the conductivity, which is a measured property, since is part of a measurement process.

Then I have two different physical quantities that are properties thanks to two different semiotic processes.

**Comment:** A property that is associated to an object by convention, or assumption.

**Relations:**

- is\_a metrology.QuantitativeProperty

## ModelledQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_d0200cf1\\_e4f4\\_45ae\\_873f\\_b9359daea3cd](http://emmo.info/emmo/middle/properties#EMMO_d0200cf1_e4f4_45ae_873f_b9359daea3cd)

**Relations:**

- is\_a metrology.QuantitativeProperty

## OrdinalQuantity

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_c46f091c\\_0420\\_4c1a\\_af30\\_0a2c8ebcf7d7](http://emmo.info/emmo/middle/metrology#EMMO_c46f091c_0420_4c1a_af30_0a2c8ebcf7d7)

**Elucidation:** "Quantity, defined by a conventional measurement procedure, for which a total ordering relation can be established, according to magnitude, with other quantities of the same kind, but for which no algebraic operations among those quantities exist" International vocabulary of metrology (VIM)

**Example:** Hardness Resilience

**Comment:** "Ordinal quantities, such as Rockwell C hardness, are usually not considered to be part of a system of quantities because they are related to other quantities through empirical relations only." International vocabulary of metrology (VIM)

**Relations:**

- is\_a metrology.Quantity

## QuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_dd4a7f3e\\_ef56\\_466c\\_ac1a\\_d2716b5f87ec](http://emmo.info/emmo/middle/metrology#EMMO_dd4a7f3e_ef56_466c_ac1a_d2716b5f87ec)

**Definition:** "A property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed by means of a number and a reference" ISO 80000-1

"A reference can be a measurement unit, a measurement procedure, a reference material, or a combination of such." International vocabulary of metrology (VIM)

**Elucidation:** A 'Quantity' that can be quantified with respect to a standardized reference physical instance (e.g. the prototype meter bar, the kg prototype) or method (e.g. resilience) through a measurement process.

**Comment:** A quantitative property is always expressed as a quantity (i.e. a number and a reference unit). For the EMMO, a nominalistic ontology, there is no property as abstract object.

A property is a sign that stands for an object according to a specific code shared by some observers.

For quantitative properties, one possible code that is shared between the scientific community (the observers) is the SI system of units.

**Comment:** Subclasses of ‘QuantitativeProperty’ classify objects according to the type semiosis that is used to connect the property to the object (e.g. by measurement, by convention, by modelling).

**Relations:**

- is\_a metrology.Quantity
- is\_a properties.ObjectiveProperty
- equivalent\_to properties.MeasuredQuantitativeProperty or properties.ModelledQuantitativeProperty or properties.ConventionalQuantitativeProperty

## MeasuredQuantitativeProperty

**IRI:** [http://emmo.info/emmo/middle/properties#EMMO\\_873b0ab3\\_88e6\\_4054\\_b901\\_5531e01f14a4](http://emmo.info/emmo/middle/properties#EMMO_873b0ab3_88e6_4054_b901_5531e01f14a4)

**Relations:**

- is\_a metrology.QuantitativeProperty

## Quantity

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_f658c301\\_ce93\\_46cf\\_9639\\_4eace2c5d1d5](http://emmo.info/emmo/middle/metrology#EMMO_f658c301_ce93_46cf_9639_4eace2c5d1d5)

**Elucidation:** A symbolic that has parts a reference unit and a numerical object separated by a space expressing the value of a quantitative property (expressed as the product of the numerical and the unit).

**Example:** 6.8 m 0.9 km 8 K 6 MeV 43.5 HRC(150 kg)

**Comment:** A quantity is not necessarily a property, since it is possible to write “10 kg”, without assigning this quantity to a specific object.

However, a quantitative property is always a quantity.

**Comment:** Referred as Quantity Value in International vocabulary of metrology (VIM)

**Comment:** SI distinguishes between a quantity (an abstract concept) and the quantity value (a number and a reference).

The EMMO, following strict nominalism, denies the existence of abstract objects and then collapses the two concepts of SI quantity and SI quantity value into a single one: the ‘Quantity’.

So, for the EMMO the symbol “kg” is not a physical quantity but simply a ‘Symbolic’ object categorized as a ‘MeasurementUnit’.

While the string “1 kg” is a ‘Physical Quantity’.

**Relations:**

- is\_a metrology.Metrological
- is\_a reductionistic.State
- metrology.hasReferenceUnit exactly 1 metrology.ReferenceUnit
- metrology.hasQuantityValue exactly 1 math.Numerical
- disjoint\_union\_of metrology.PhysicalQuantity, metrology.OrdinalQuantity

## Base Quantity branch

### Time

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d4f7d378\\_5e3b\\_468a\\_baa1\\_a7e98358cda7](http://emmo.info/emmo/middle/isq#EMMO_d4f7d378_5e3b_468a_baa1_a7e98358cda7)

**Definition:** One-dimensional subspace of space-time, which is locally orthogonal to space.

**Elucidation:** The indefinite continued progress of existence and events that occur in apparently irreversible succession from the past through the present to the future.

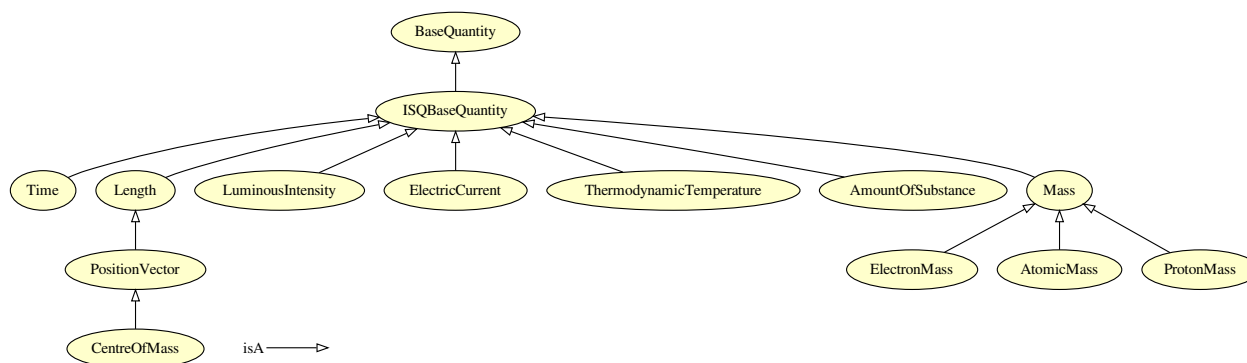


Figure 3.32: Base Quantity branch.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-03>

**Comment:** Time can be seen as the duration of an event or, more operationally, as “what clocks read”.

**Dbpediaentry:** <http://dbpedia.org/page/Time>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06375>

**Physicaldimension:** T+1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## ISQBaseQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1a4c1a97\\_88a7\\_4d8e\\_b2f9\\_2ca58e92dde4](http://emmo.info/emmo/middle/isq#EMMO_1a4c1a97_88a7_4d8e_b2f9_2ca58e92dde4)

**Elucidation:** Base quantities defined in the International System of Quantities (ISQ).

**Wikipediaentry:** [https://en.wikipedia.org/wiki/International\\_System\\_of\\_Quantities](https://en.wikipedia.org/wiki/International_System_of_Quantities)

**Relations:**

- is\_a isq.InternationalSystemOfQuantity
- is\_a metrology.BaseQuantity
- disjoint\_union\_of isq.LuminousIntensity, isq.AmountOfSubstance, isq.ThermodynamicTemperature, isq.ElectricCurrent, isq.Length, isq.Time, isq.Mass

## Length

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cd2cd0de\\_e0cc\\_4ef1\\_b27e\\_2e88db027bac](http://emmo.info/emmo/middle/isq#EMMO_cd2cd0de_e0cc_4ef1_b27e_2e88db027bac)

**Elucidation:** Extend of a spatial dimension.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-19>

**Comment:** Length is a non-negative additive quantity attributed to a one-dimensional object in space.

**Dbpediaentry:** <http://dbpedia.org/page/Length>

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03498>

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## ElectronMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_44fc8c60\\_7a9c\\_49af\\_a046\\_e1878c88862c](http://emmo.info/emmo/middle/isq#EMMO_44fc8c60_7a9c_49af_a046_e1878c88862c)

**Comment:** The rest mass of an electron.

**Dbpediaentry:** [http://dbpedia.org/page/Electron\\_rest\\_mass](http://dbpedia.org/page/Electron_rest_mass)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02008>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectronMass](http://physics.nist.gov/cuu/CODATA-Value_ElectronMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## BaseQuantity

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_acaaa124\\_3dde\\_48b6\\_86e6\\_6ec6f364f408](http://emmo.info/emmo/middle/metrology#EMMO_acaaa124_3dde_48b6_86e6_6ec6f364f408)

**Elucidation:** “Quantity in a conventionally chosen subset of a given system of quantities, where no quantity in the subset can be expressed in terms of the other quantities within that subset” ISO 80000-1

**Relations:**

- is\_a metrology.PhysicalQuantity
- metrology.hasReferenceUnit only metrology.BaseUnit

## PositionVector

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_44da6d75\\_54a4\\_4aa8\\_bd3a\\_156f6e9abb8e](http://emmo.info/emmo/middle/isq#EMMO_44da6d75_54a4_4aa8_bd3a_156f6e9abb8e)

**Definition:** Vector  $\mathbf{r}$  characterizing a point P in a point space with a given origin point O.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-12>

**Altlabel:** Position

**Comment:** In the usual geometrical three-dimensional space, position vectors are quantities of the dimension length.

– IEC

**Comment:** Position vectors are so-called bounded vectors, i.e. their magnitude and direction depend on the particular coordinate system used.

– ISO 80000-3

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Length

## AtomicMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_27367073\\_ed8a\\_481a\\_9b07\\_f836dfe31f7f](http://emmo.info/emmo/middle/isq#EMMO_27367073_ed8a_481a_9b07_f836dfe31f7f)

**Definition:** The mass of an atom in the ground state.

**Comment:** Since the nucleus account for nearly all of the total mass of atoms (with the electrons and nuclear binding energy making minor contributions), the atomic mass measured in Da has nearly the same value as the mass number.

**Comment:** The atomic mass is often expressed as an average of the commonly found isotopes.

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00496>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Atomic\\_mass](https://en.wikipedia.org/wiki/Atomic_mass)

**Relations:**

- is\_a isq.Mass

## LuminousIntensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_50bf79a6\\_a48b\\_424d\\_9d2c\\_813bd631231a](http://emmo.info/emmo/middle/isq#EMMO_50bf79a6_a48b_424d_9d2c_813bd631231a)

**Elucidation:** A measure of the wavelength-weighted power emitted by a light source in a particular direction per unit solid angle. It is based on the luminosity function, which is a standardized model of the sensitivity of the human eye.

**Dbpediaentry:** [http://dbpedia.org/page/Luminous\\_intensity](http://dbpedia.org/page/Luminous_intensity)

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQBaseQuantity

## ElectricCurrent

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_c995ae70\\_3b84\\_4ebb\\_bcf6\\_69e6a281bb88](http://emmo.info/emmo/middle/isq#EMMO_c995ae70_3b84_4ebb_bcf6_69e6a281bb88)

**Elucidation:** A flow of electric charge.

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_current](http://dbpedia.org/page/Electric_current)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01927>

**Physicaldimension:** T0 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## ThermodynamicTemperature

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_affe07e4\\_e9bc\\_4852\\_86c6\\_69e26182a17f](http://emmo.info/emmo/middle/isq#EMMO_affe07e4_e9bc_4852_86c6_69e26182a17f)

**Elucidation:** Thermodynamic temperature is the absolute measure of temperature. It is defined by the third law of thermodynamics in which the theoretically lowest temperature is the null or zero point.

**Dbpediaentry:** [http://dbpedia.org/page/Thermodynamic\\_temperature](http://dbpedia.org/page/Thermodynamic_temperature)

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06321>

**Physicaldimension:** T0 L0 M0 I0 Θ+1 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## CentreOfMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_9d8f708a\\_f291\\_4d72\\_80ec\\_362c6e6bbca6](http://emmo.info/emmo/middle/isq#EMMO_9d8f708a_f291_4d72_80ec_362c6e6bbca6)

**Elucidation:** The unique point where the weighted relative position of the distributed mass of an Item sums to zero. Equivalently, it is the point where if a force is applied to the Item, causes the Item to move in direction of force without rotation.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-12>

**Comment:** In non-relativistic physics, the centre of mass doesn't depend on the chosen reference frame.



**Dbpediaentry:** [http://dbpedia.org/page/Center\\_of\\_mass](http://dbpedia.org/page/Center_of_mass)

**Physicaldimension:** T0 L+1 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Center\\_of\\_mass](https://en.wikipedia.org/wiki/Center_of_mass)

**Relations:**

- is\_a isq.PositionVector

## ProtonMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8d689295\\_7d84\\_421b\\_bc01\\_d5cceb2c2086](http://emmo.info/emmo/middle/isq#EMMO_8d689295_7d84_421b_bc01_d5cceb2c2086)

**Comment:** The rest mass of a proton.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04914>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ProtonMass](http://physics.nist.gov/cuu/CODATA-Value_ProtonMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## AmountOfSubstance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8159c26a\\_494b\\_4fa0\\_9959\\_10888f152298](http://emmo.info/emmo/middle/isq#EMMO_8159c26a_494b_4fa0_9959_10888f152298)

**Elucidation:** The number of elementary entities present.

**Dbpediaentry:** [http://dbpedia.org/page/Amount\\_of\\_substance](http://dbpedia.org/page/Amount_of_substance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00297>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQBaseQuantity

## Mass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ed4af7ae\\_63a2\\_497e\\_bb88\\_2309619ea405](http://emmo.info/emmo/middle/isq#EMMO_ed4af7ae_63a2_497e_bb88_2309619ea405)

**Elucidation:** Property of a physical body that express its resistance to acceleration (a change in its state of motion) when a force is applied.

**Dbpediaentry:** <http://dbpedia.org/page/Mass>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03709>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQBaseQuantity
- Inverse(properties.hasProperty) only physicalistic.Matter

## Derived Quantity branch

### Weight

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04cf0295\\_3e8f\\_4693\\_a87f\\_3130d125cf05](http://emmo.info/emmo/middle/isq#EMMO_04cf0295_3e8f_4693_a87f_3130d125cf05)

**Comment:** Force of gravity acting on a body.

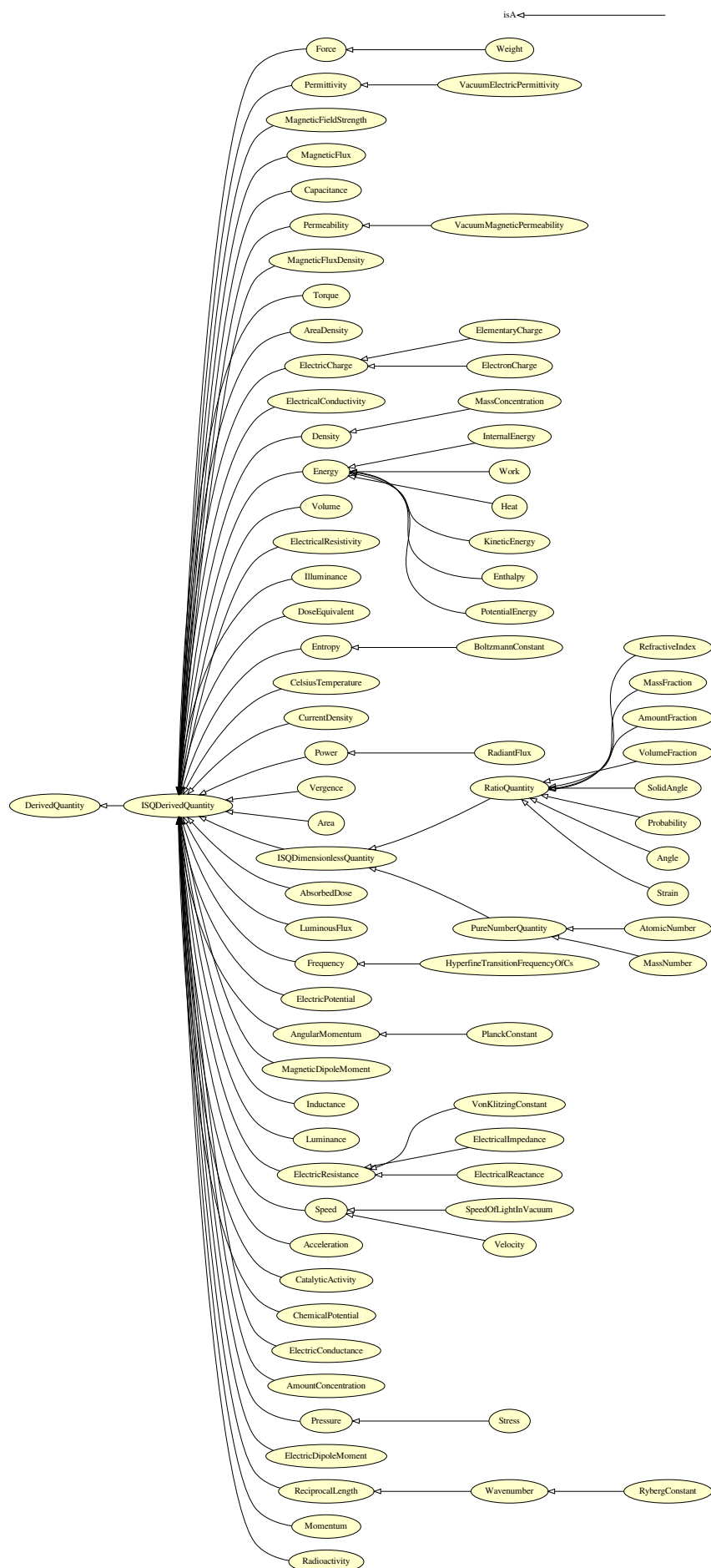


Figure 3.33: Derived Quantity branch.

**Dbpediaentry:** <http://dbpedia.org/page/Weight>

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06668>

**Physicaldimension:** T-2 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Force

## Permittivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0ee5779e\\_d798\\_4ee5\\_9bfe\\_c392d5bea112](http://emmo.info/emmo/middle/isq#EMMO_0ee5779e_d798_4ee5_9bfe_c392d5bea112)

**Comment:** Measure for how the polarization of a material is affected by the application of an external electric field.

**Dbpediaentry:** <http://dbpedia.org/page/Permittivity>

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04507>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Permittivity>

**Physicaldimension:** T+4 L-3 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## BoltzmannConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ffc7735f\\_c177\\_46a4\\_98e9\\_a54440d29209](http://emmo.info/emmo/middle/isq#EMMO_ffc7735f_c177_46a4_98e9_a54440d29209)

**Elucidation:** A physical constant relating energy at the individual particle level with temperature. It is the gas constant R divided by the Avogadro constant.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.B00695>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ-1 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_BoltzmannConstant](http://physics.nist.gov/cuu/CODATA-Value_BoltzmannConstant)

**Relations:**

- is\_a isq.Entropy
- is\_a isq.SIExactConstant

## VacuumMagneticPermeability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_de021e4f\\_918f\\_47ef\\_a67b\\_11120f56b9d7](http://emmo.info/emmo/middle/isq#EMMO_de021e4f_918f_47ef_a67b_11120f56b9d7)

**Comment:** The DBpedia and UIPAC Gold Book definitions ([http://dbpedia.org/page/Vacuum\\_permeability](http://dbpedia.org/page/Vacuum_permeability), <https://doi.org/10.1351/goldbook.P04504>) are outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of magnetic permeability in a classical vacuum.

**Physicaldimension:** T-2 L+1 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_MagneticConstant](http://physics.nist.gov/cuu/CODATA-Value_MagneticConstant)

**Relations:**

- is\_a isq.Permeability
- is\_a metrology.MeasuredConstant

## MagneticFieldStrength

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b4895f75\\_41c8\\_4fd9\\_b6d6\\_4d5f7c99c423](http://emmo.info/emmo/middle/isq#EMMO_b4895f75_41c8_4fd9_b6d6_4d5f7c99c423)

**Comment:** Strength of a magnetic field. Commonly denoted  $H$ .

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_field](http://dbpedia.org/page/Magnetic_field)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03683>

**Physicaldimension:** T0 L-1 M0 I+1  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticFlux

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_3b931698\\_937e\\_49be\\_ab1b\\_36fa52d91181](http://emmo.info/emmo/middle/isq#EMMO_3b931698_937e_49be_ab1b_36fa52d91181)

**Elucidation:** Measure of magnetism, taking account of the strength and the extent of a magnetic field.

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_flux](http://dbpedia.org/page/Magnetic_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03684>

**Physicaldimension:** T-2 L+2 M+1 I-1  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## InternalEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_830b59f7\\_d047\\_438c\\_90cd\\_62845749efcb](http://emmo.info/emmo/middle/isq#EMMO_830b59f7_d047_438c_90cd_62845749efcb)

**Elucidation:** A state quantity equal to the difference between the total energy of a system and the sum of the macroscopic kinetic and potential energies of the system.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-04-20>

**Altlabel:** ThermodynamicEnergy

**Dbpediaentry:** [http://dbpedia.org/page/Internal\\_energy](http://dbpedia.org/page/Internal_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.I03103>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/InternalEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.Energy

## Capacitance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_99dba333\\_0dbd\\_4f75\\_8841\\_8c0f97fd58e2](http://emmo.info/emmo/middle/isq#EMMO_99dba333_0dbd_4f75_8841_8c0f97fd58e2)

**Elucidation:** The derivative of the electric charge of a system with respect to the electric potential.

**Altlabel:** ElectricCapacitance

**Dbpediaentry:** <http://dbpedia.org/page/Capacitance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.C00791>

**Physicaldimension:** T+4 L-2 M-1 I+2  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## RefractiveIndex

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_5eedba4d\\_105b\\_44d8\\_b1bc\\_e33606276ea2](http://emmo.info/emmo/middle/isq#EMMO_5eedba4d_105b_44d8_b1bc_e33606276ea2)

**Comment:** Factor by which the phase velocity of light is reduced in a medium.

**Dbpediaentry:** [http://dbpedia.org/page/Refractive\\_index](http://dbpedia.org/page/Refractive_index)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05240>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.SpeedFractionUnit

## MassFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_7c055d65\\_2929\\_40e1\\_af4f\\_4bf10995ad50](http://emmo.info/emmo/middle/isq#EMMO_7c055d65_2929_40e1_af4f_4bf10995ad50)

**Comment:** Mass of a constituent divided by the total mass of all constituents in the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Mass\\_fraction\\_\(chemistry\)](http://dbpedia.org/page/Mass_fraction_(chemistry))

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03722>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/MassFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.MassFractionUnit

## VonKlitzingConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_eb561764\\_276e\\_413d\\_a8cb\\_3a3154fd9bf8](http://emmo.info/emmo/middle/isq#EMMO_eb561764_276e_413d_a8cb_3a3154fd9bf8)

**Definition:** The von Klitzing constant is defined as Planck constant divided by the square of the elementary charge.

**Comment:** Resistance quantum.

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_VonKlitzingConstant](http://physics.nist.gov/cuu/CODATA-Value_VonKlitzingConstant)

**Relations:**

- is\_a isq.ElectricResistance
- is\_a isq.SIExactConstant

## Permeability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_09663630\\_1b84\\_4202\\_91e6\\_e641104f579e](http://emmo.info/emmo/middle/isq#EMMO_09663630_1b84_4202_91e6_e641104f579e)

**Comment:** Measure for how the magnetization of material is affected by the application of an external magnetic field .

**Dbpediaentry:** [http://dbpedia.org/page/Permeability\\_\(electromagnetism\)](http://dbpedia.org/page/Permeability_(electromagnetism))

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04503>

**Physicaldimension:** T-2 L+1 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticFluxDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_961d1aba\\_f75e\\_4411\\_aaa4\\_457f7516ed6b](http://emmo.info/emmo/middle/isq#EMMO_961d1aba_f75e_4411_aaa4_457f7516ed6b)

**Elucidation:** Strength of the magnetic field.

**Comment:** Often denoted B.

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_field](http://dbpedia.org/page/Magnetic_field)

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03686>

**Physicaldimension:** T-2 L0 M+1 I-1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## RatioQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_faab3f84\\_e475\\_4a46\\_af9c\\_7d249f0b9aef](http://emmo.info/emmo/middle/isq#EMMO_faab3f84_e475_4a46_af9c_7d249f0b9aef)

**Elucidation:** The class of quantities that are the ratio of two quantities with the same physical dimensionality.

**Example:** refractive index, volume fraction, fine structure constant

**Comment:** Quantities defined as ratios  $Q=A/B$  having equal dimensions in numerator and denominator are dimensionless quantities but still have a physical dimension defined as  $\dim(A)/\dim(B)$ .

Johansson, Ingvar (2010). "Metrological thinking needs the notions of parametric quantities, units and dimensions". *Metrologia*. 47 (3): 219–230. doi:10.1088/0026-1394/47/3/012. ISSN 0026-1394.

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Seealso:** <https://iopscience.iop.org/article/10.1088/0026-1394/47/3/012>

**Relations:**

- is\_a isq.ISQDimensionlessQuantity

## Torque

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_aaf9dd7f\\_0474\\_40d0\\_9606\\_02def8515249](http://emmo.info/emmo/middle/isq#EMMO_aaf9dd7f_0474_40d0_9606_02def8515249)

**Elucidation:** The effectiveness of a force to produce rotation about an axis, measured by the product of the force and the perpendicular distance from the line of action of the force to the axis.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-26>

**Comment:** Even though torque has the same physical dimension as energy, it is not of the same kind and can not be measured with energy units like joule or electron volt.

**Dbpediaentry:** <http://dbpedia.org/page/Torque>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06400>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Torque>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Wavenumber

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d859588d\\_44dc\\_4614\\_bc75\\_5fcd0058acc8](http://emmo.info/emmo/middle/isq#EMMO_d859588d_44dc_4614_bc75_5fcd0058acc8)

**Comment:** The number of waves per unit length along the direction of propagation.

**Dbpediaentry:** <http://dbpedia.org/page/Wavenumber>

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06664>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Wavenumber>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ReciprocalLength

## AreaDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_afea89af\\_ef16\\_4bdb\\_99d5\\_f3b2f4c85a6c](http://emmo.info/emmo/middle/isq#EMMO_afea89af_ef16_4bdb_99d5_f3b2f4c85a6c)

**Comment:** Mass per unit area.

**Dbpediaentry:** [http://dbpedia.org/page/Area\\_density](http://dbpedia.org/page/Area_density)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S06167>

**Physicaldimension:** T0 L-2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1604f495\\_328a\\_4f28\\_9962\\_f4cc210739dd](http://emmo.info/emmo/middle/isq#EMMO_1604f495_328a_4f28_9962_f4cc210739dd)

**Elucidation:** The physical property of matter that causes it to experience a force when placed in an electromagnetic field.

**Altlabel:** Charge

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_charge](http://dbpedia.org/page/Electric_charge)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01923>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalConductivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cde4368c\\_1d4d\\_4c94\\_8548\\_604749523c6d](http://emmo.info/emmo/middle/isq#EMMO_cde4368c_1d4d_4c94_8548_604749523c6d)

**Comment:** Measure of a material's ability to conduct an electric current.

Conductivity is equeal to the reciprocal of resistivity.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistivity\\_and\\_conductivity](http://dbpedia.org/page/Electrical_resistivity_and_conductivity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.C01245>

**Physicaldimension:** T+3 L-3 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## DerivedQuantity

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_71f6ab56\\_342c\\_484b\\_bbe0\\_de86b7367cb3](http://emmo.info/emmo/middle/metrology#EMMO_71f6ab56_342c_484b_bbe0_de86b7367cb3)

**Elucidation:** “Quantity, in a system of quantities, defined in terms of the base quantities of that system”.

**Relations:**

- is\_a metrology.PhysicalQuantity

## Density

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_06448f64\\_8db6\\_4304\\_8b2c\\_e785dba82044](http://emmo.info/emmo/middle/isq#EMMO_06448f64_8db6_4304_8b2c_e785dba82044)

**Comment:** Mass per volume.

**Dbpediaentry:** <http://dbpedia.org/page/Density>

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01590>

**Physicaldimension:** T0 L-3 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Energy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_31ec09ba\\_1713\\_42cb\\_83c7\\_b38bf6f9ced2](http://emmo.info/emmo/middle/isq#EMMO_31ec09ba_1713_42cb_83c7_b38bf6f9ced2)

**Elucidation:** A property of objects which can be transferred to other objects or converted into different forms.

**Comment:** Energy is often defined as “ability of a system to perform work”, but it might be misleading since is not necessarily available to do work.

**Dbpediaentry:** <http://dbpedia.org/page/Energy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02101>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Volume

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f1a51559\\_aa3d\\_43a0\\_9327\\_918039f0dfed](http://emmo.info/emmo/middle/isq#EMMO_f1a51559_aa3d_43a0_9327_918039f0dfed)

**Comment:** Extent of an object in space.

**Dbpediaentry:** <http://dbpedia.org/page/Volume>

**Physicaldimension:** T0 L-3 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalResistivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e150fa8d\\_06dc\\_4bb8\\_bf95\\_04e2aea529c1](http://emmo.info/emmo/middle/isq#EMMO_e150fa8d_06dc_4bb8_bf95_04e2aea529c1)

**Comment:** Electric field strength divided by the current density.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistivity\\_and\\_conductivity](http://dbpedia.org/page/Electrical_resistivity_and_conductivity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05316>

**Physicaldimension:** T-3 L+3 M+1 I-2 Θ0 N0 J0



**Relations:**

- is\_a isq.ISQDerivedQuantity

**Illuminance**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_b51fbd00\\_a857\\_4132\\_9711\\_0ef70e7bdd20](http://emmo.info/emmo/middle/isq#EMMO_b51fbd00_a857_4132_9711_0ef70e7bdd20)

**Definition:** The total luminous flux incident on a surface, per unit area.

**Dbpediaentry:** <http://dbpedia.org/page/Illuminance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.I02941>

**Physicaldimension:** T0 L-2 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

**DoseEquivalent**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_3df10765\\_f6ff\\_4c9e\\_be3d\\_10b1809d78bd](http://emmo.info/emmo/middle/isq#EMMO_3df10765_f6ff_4c9e_be3d_10b1809d78bd)

**Elucidation:** A dose quantity used in the International Commission on Radiological Protection (ICRP) system of radiological protection.

**Dbpediaentry:** <http://dbpedia.org/page/Energy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02101>

**Physicaldimension:** T-2 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

**Entropy**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_9bbab0be\\_f9cc\\_4f46\\_9f46\\_0fd271911b79](http://emmo.info/emmo/middle/isq#EMMO_9bbab0be_f9cc_4f46_9f46_0fd271911b79)

**Comment:** Logarithmic measure of the number of available states of a system.

**Comment:** May also be referred to as a measure of order of a system.

**Dbpediaentry:** <http://dbpedia.org/page/Entropy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02149>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ-1 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

**Work**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_624d72ee\\_e676\\_4470\\_9434\\_c22b4190d3d5](http://emmo.info/emmo/middle/isq#EMMO_624d72ee_e676_4470_9434_c22b4190d3d5)

**Definition:** Product of force and displacement.

**Dbpediaentry:** <http://dbpedia.org/page/Heat>

**Dbpediaentry:** [http://dbpedia.org/page/Work\\_\(physics\)](http://dbpedia.org/page/Work_(physics))

**Iupacentry:** <https://doi.org/10.1351/goldbook.W06684>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## CelsiusTemperature

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_66bc9029\\_f473\\_45ff\\_bab9\\_c3509ff37a22](http://emmo.info/emmo/middle/isq#EMMO_66bc9029_f473_45ff_bab9_c3509ff37a22)

**Elucidation:** An objective comparative measure of hot or cold.

Temperature is a relative quantity that can be used to express temperature differences. Unlike ThermodynamicTemperature, it cannot express absolute temperatures.

**Dbpediaentry:** <http://dbpedia.org/page/Temperature>

**Iupacentry:** <https://doi.org/10.1351/goldbook.T06261>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## CurrentDensity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_7c8007b0\\_58a7\\_4486\\_bf1c\\_4772852caca0](http://emmo.info/emmo/middle/isq#EMMO_7c8007b0_58a7_4486_bf1c_4772852caca0)

**Comment:** Electric current divided by the cross-sectional area it is passing through.

**Dbpediaentry:** [http://dbpedia.org/page/Current\\_density](http://dbpedia.org/page/Current_density)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01928>

**Physicaldimension:** T0 L-2 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Power

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_09b9021b\\_f97b\\_43eb\\_b83d\\_0a764b472bc2](http://emmo.info/emmo/middle/isq#EMMO_09b9021b_f97b_43eb_b83d_0a764b472bc2)

**Elucidation:** Rate of transfer of energy per unit time.

**Dbpediaentry:** [http://dbpedia.org/page/Power\\_\(physics\)](http://dbpedia.org/page/Power_(physics))

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04792>

**Physicaldimension:** T-3 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Vergence

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1e7603a7\\_1365\\_49b8\\_b5e5\\_3711c8e6b904](http://emmo.info/emmo/middle/isq#EMMO_1e7603a7_1365_49b8_b5e5_3711c8e6b904)

**Comment:** In geometrical optics, vergence describes the curvature of optical wavefronts.

**Dbpediaentry:** <http://dbpedia.org/page/Vergence>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Area

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_96f39f77\\_44dc\\_491b\\_8fa7\\_30d887fe0890](http://emmo.info/emmo/middle/isq#EMMO_96f39f77_44dc_491b_8fa7_30d887fe0890)

**Comment:** Extent of a surface.

**Dbpediaentry:** <http://dbpedia.org/page/Area>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00429>

**Physicaldimension:** T0 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ISQDimensionlessQuantity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a66427d1\\_9932\\_4363\\_9ec5\\_7d91f2bfda1e](http://emmo.info/emmo/middle/isq#EMMO_a66427d1_9932_4363_9ec5_7d91f2bfda1e)

**Elucidation:** A quantity to which no physical dimension is assigned and with a corresponding unit of measurement in the SI of the unit one.

**Dbpediaentry:** [http://dbpedia.org/page/Dimensionless\\_quantity](http://dbpedia.org/page/Dimensionless_quantity)

**Iupacentry:** <https://doi.org/10.1351/goldbook.D01742>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Dimensionless\\_quantity](https://en.wikipedia.org/wiki/Dimensionless_quantity)

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AmountFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04b3300c\\_98bd\\_42dc\\_a3b5\\_e6c29d69f1ac](http://emmo.info/emmo/middle/isq#EMMO_04b3300c_98bd_42dc_a3b5_e6c29d69f1ac)

**Definition:** The amount of a constituent divided by the total amount of all constituents in a mixture.

**Altlabel:** MoleFraction

**Dbpediaentry:** [http://dbpedia.org/page/Mole\\_fraction](http://dbpedia.org/page/Mole_fraction)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00296>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/AmountOfSubstanceFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.AmountFractionUnit

## VolumeFraction

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a8eb87b5\\_4d10\\_4137\\_a75c\\_e04ee59ca095](http://emmo.info/emmo/middle/isq#EMMO_a8eb87b5_4d10_4137_a75c_e04ee59ca095)

**Elucidation:** Volume of a constituent of a mixture divided by the sum of volumes of all constituents prior to mixing.

**Dbpediaentry:** [http://dbpedia.org/page/Volume\\_fraction](http://dbpedia.org/page/Volume_fraction)

**Iupacentry:** <https://doi.org/10.1351/goldbook.V06643>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/VolumeFraction>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.VolumeFractionUnit

## RybergConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a3c78d6f\\_ae49\\_47c8\\_a634\\_9b6d86b79382](http://emmo.info/emmo/middle/isq#EMMO_a3c78d6f_ae49_47c8_a634_9b6d86b79382)

**Comment:** The Rydberg constant represents the limiting value of the highest wavenumber (the inverse wavelength) of any photon that can be emitted from the hydrogen atom, or, alternatively, the wavenumber of the lowest-energy photon capable of ionizing the hydrogen atom from its ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Rydberg\\_constant](http://dbpedia.org/page/Rydberg_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05430>

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_RybergConstant](http://physics.nist.gov/cuu/CODATA-Value_RybergConstant)

**Relations:**

- is\_a isq.Wavenumber
- is\_a metrology.MeasuredConstant

## SolidAngle

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e7c9f7fd\\_e534\\_4441\\_88fe\\_1fec6cb20f26](http://emmo.info/emmo/middle/isq#EMMO_e7c9f7fd_e534_4441_88fe_1fec6cb20f26)

**Elucidation:** Ratio of area on a sphere to its radius squared.

**Dbpediaentry:** [http://dbpedia.org/page/Solid\\_angle](http://dbpedia.org/page/Solid_angle)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05732>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.AreaFractionUnit

## MassConcentration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_16f2fe60\\_2db7\\_43ca\\_8fee\\_5b3e416bfe87](http://emmo.info/emmo/middle/isq#EMMO_16f2fe60_2db7_43ca_8fee_5b3e416bfe87)

**Comment:** Mass of a constituent divided by the volume of the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Mass\\_concentration\\_\(chemistry\)](http://dbpedia.org/page/Mass_concentration_(chemistry))

**Iupacentry:** <https://doi.org/10.1351/goldbook.M03713>

**Physicaldimension:** T0 L-3 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Density

## AbsorbedDose

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8e5dd473\\_808b\\_4a8a\\_b7cd\\_63068c12ff57](http://emmo.info/emmo/middle/isq#EMMO_8e5dd473_808b_4a8a_b7cd_63068c12ff57)

**Definition:** Energy imparted to matter by ionizing radiation in a suitable small element of volume divided by the mass of that element of volume.

**Dbpediaentry:** [http://dbpedia.org/page/Absorbed\\_dose](http://dbpedia.org/page/Absorbed_dose)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00031>

**Physicaldimension:** T-2 L+2 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

**ISQDerivedQuantity**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_2946d40b\\_24a1\\_47fa\\_8176\\_e3f79bb45064](http://emmo.info/emmo/middle/isq#EMMO_2946d40b_24a1_47fa_8176_e3f79bb45064)

**Elucidation:** Derived quantities defined in the International System of Quantities (ISQ).

**Relations:**

- is\_a isq.InternationalSystemOfQuantity
- is\_a metrology.DerivedQuantity

**PureNumberQuantity**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ba882f34\\_0d71\\_4e4f\\_9d92\\_0c076c633a2c](http://emmo.info/emmo/middle/isq#EMMO_ba882f34_0d71_4e4f_9d92_0c076c633a2c)

**Elucidation:** A pure number, typically the number of something.

**Example:** 1, i,  $\pi$ , the number of protons in the nucleus of an atom

**Comment:** According to the SI brochure counting does not automatically qualify a quantity as an amount of substance.

This quantity is used only to describe the outcome of a counting process, without regard of the type of entities.

“There are also some quantities that cannot be described in terms of the seven base quantities of the SI, but have the nature of a count. Examples are a number of molecules, a number of cellular or biomolecular entities (for example copies of a particular nucleic acid sequence), or degeneracy in quantum mechanics. Counting quantities are also quantities with the associated unit one.”

**Physicaldimension:** T0 L0 M0 I0  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.ISQDimensionlessQuantity

**Heat**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_12d4ba9b\\_2f89\\_4ea3\\_b206\\_cd376f96c875](http://emmo.info/emmo/middle/isq#EMMO_12d4ba9b_2f89_4ea3_b206_cd376f96c875)

**Comment:** Heat is energy in transfer to or from a thermodynamic system, by mechanisms other than thermodynamic work or transfer of matter.

**Iupacentry:** <https://doi.org/10.1351/goldbook.H02752>

**Physicaldimension:** T-2 L+2 M+1 I0  $\Theta$ 0 N0 J0

**Relations:**

- is\_a isq.Energy

**LuminousFlux**

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e2ee1c98\\_497a\\_4f66\\_b4ed\\_5711496a848e](http://emmo.info/emmo/middle/isq#EMMO_e2ee1c98_497a_4f66_b4ed_5711496a848e)

**Elucidation:** Perceived power of light.

**Dbpediaentry:** [http://dbpedia.org/page/Luminous\\_flux](http://dbpedia.org/page/Luminous_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03646>

**Physicaldimension:** T0 L0 M0 I0  $\Theta$ 0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

## VacuumElectricPermittivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_61a32ae9\\_8200\\_473a\\_bd55\\_59a9899996f4](http://emmo.info/emmo/middle/isq#EMMO_61a32ae9_8200_473a_bd55_59a9899996f4)

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Vacuum\\_permittivity](http://dbpedia.org/page/Vacuum_permittivity)) is outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of the absolute dielectric permittivity of classical vacuum.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04508>

**Physicaldimension:** T+4 L-3 M-1 I+2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectricConstant](http://physics.nist.gov/cuu/CODATA-Value_ElectricConstant)

**Relations:**

- is\_a isq.Permittivity
- is\_a metrology.MeasuredConstant

## Frequency

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_852b4ab8\\_fc29\\_4749\\_a8c7\\_b92d4fca7d5a](http://emmo.info/emmo/middle/isq#EMMO_852b4ab8_fc29_4749_a8c7_b92d4fca7d5a)

**Elucidation:** Number of periods per time interval.

**Dbpediaentry:** <http://dbpedia.org/page/Frequency>

**Iupacentry:** <https://doi.org/10.1351/goldbook.FT07383>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricPotential

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4f2d3939\\_91b1\\_4001\\_b8ab\\_7d19074bf845](http://emmo.info/emmo/middle/isq#EMMO_4f2d3939_91b1_4001_b8ab_7d19074bf845)

**Elucidation:** Energy required to move a unit charge through an electric field from a reference point.

**Altlabel:** Voltage

**Dbpediaentry:** <http://dbpedia.org/page/Voltage>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00424>

**Physicaldimension:** T-3 L+2 M+1 I-1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AngularMomentum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_66d01570\\_36dd\\_42fd\\_844d\\_29b81b029cd5](http://emmo.info/emmo/middle/isq#EMMO_66d01570_36dd_42fd_844d_29b81b029cd5)

**Comment:** Measure of the extent and direction an object rotates about a reference point.

**Dbpediaentry:** [http://dbpedia.org/page/Angular\\_momentum](http://dbpedia.org/page/Angular_momentum)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00353>

**Physicaldimension:** T-1 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MagneticDipoleMoment

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_81e767f1\\_59b1\\_4d7a\\_bf69\\_17f322241831](http://emmo.info/emmo/middle/isq#EMMO_81e767f1_59b1_4d7a_bf69_17f322241831)

**Elucidation:** Vector quantity  $\mu$  causing a change to its energy  $\Delta W$  in an external magnetic field of field flux density  $B$ :

$$\Delta W = -\mu \cdot B$$

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-55>

**Iso80000ref:** 10-9.1

**Comment:** For an atom or nucleus, this energy is quantized and can be written as:

$$W = g \mu M B$$

where  $g$  is the appropriate  $g$  factor,  $\mu$  is mostly the Bohr magneton or nuclear magneton,  $M$  is magnetic quantum number, and  $B$  is magnitude of the magnetic flux density.

– ISO 80000

**Dbpediaentry:** [http://dbpedia.org/page/Magnetic\\_moment](http://dbpedia.org/page/Magnetic_moment)

**Iupacentry:** <http://goldbook.iupac.org/terms/view/M03688>

**Physicaldimension:** T<sup>0</sup> L<sup>+2</sup> M<sup>0</sup> I<sup>+1</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Inductance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_04cc9451\\_5306\\_45d0\\_8554\\_22cee4d6e785](http://emmo.info/emmo/middle/isq#EMMO_04cc9451_5306_45d0_8554_22cee4d6e785)

**Elucidation:** A property of an electrical conductor by which a change in current through it induces an electromotive force in both the conductor itself and in any nearby conductors by mutual inductance.

**Altlabel:** ElectricInductance

**Dbpediaentry:** <http://dbpedia.org/page/Inductance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M04076>

**Physicaldimension:** T<sup>-2</sup> L<sup>+2</sup> M<sup>+1</sup> I<sup>-2</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.ISQDerivedQuantity

## HyperfineTransitionFrequencyOfCs

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f96feb3f\\_4438\\_4e43\\_aa44\\_7458c4d87fc2](http://emmo.info/emmo/middle/isq#EMMO_f96feb3f_4438_4e43_aa44_7458c4d87fc2)

**Elucidation:** The frequency standard in the SI system in which the photon absorption by transitions between the two hyperfine ground states of caesium-133 atoms are used to control the output frequency.

**Physicaldimension:** T<sup>-1</sup> L<sup>0</sup> M<sup>0</sup> I<sup>0</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Relations:**

- is\_a isq.Frequency
- is\_a isq.SIExactConstant

## Probability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0a88be81\\_343d\\_4388\\_92c1\\_09228ff95ada](http://emmo.info/emmo/middle/isq#EMMO_0a88be81_343d_4388_92c1_09228ff95ada)

**Elucidation:** Probability is a dimensionless quantity that can attain values between 0 and 1; zero denotes the impossible event and 1 denotes a certain event.

**Comment:** The propability for a certain outcome, is the ratio between the number of events leading to the given outcome and the total number of events.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04855>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only metrology.UnitOne

## ElementaryCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_58a650f0\\_a638\\_4743\\_8439\\_535a325e5c4c](http://emmo.info/emmo/middle/isq#EMMO_58a650f0_a638_4743_8439_535a325e5c4c)

**Elucidation:** The magnitude of the electric charge carried by a single electron.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02032>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElementaryCharge](http://physics.nist.gov/cuu/CODATA-Value_ElementaryCharge)

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## Luminance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_97589322\\_710c\\_4af4\\_9431\\_1e5027f2be42](http://emmo.info/emmo/middle/isq#EMMO_97589322_710c_4af4_9431_1e5027f2be42)

**Comment:** Measured in cd/m<sup>2</sup>. Not to confuse with Illuminance, which is measured in lux (cd sr/m<sup>2</sup>).

**Comment:** a photometric measure of the luminous intensity per unit area of light travelling in a given direction.

**Dbpediaentry:** <http://dbpedia.org/page/Luminance>

**Iupacentry:** <https://doi.org/10.1351/goldbook.L03640>

**Physicaldimension:** T0 L-2 M0 I0 Θ0 N0 J+1

**Relations:**

- is\_a isq.ISQDerivedQuantity

## KineticEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ac540a9d\\_0131\\_43f6\\_a33b\\_17e5cfc432ed](http://emmo.info/emmo/middle/isq#EMMO_ac540a9d_0131_43f6_a33b_17e5cfc432ed)

**Elucidation:** The energy of an object due to its motion.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-49>

**Dbpediaentry:** [http://dbpedia.org/page/Kinetic\\_energy](http://dbpedia.org/page/Kinetic_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.K03402>



**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/KineticEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## ElectricResistance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e88f75d6\\_9a17\\_4cfc\\_bdf7\\_43d7cea5a9a1](http://emmo.info/emmo/middle/isq#EMMO_e88f75d6_9a17_4cfc_bdf7_43d7cea5a9a1)

**Elucidation:** Measure of the difficulty to pass an electric current through a material.

**Altlabel:** Resistance

**Comment:** Inverse of ‘ElectricalConductance’.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistance\\_and\\_conductance](http://dbpedia.org/page/Electrical_resistance_and_conductance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01936>

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectronCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cc01751d\\_dd05\\_429b\\_9d0c\\_1b7a74d1f277](http://emmo.info/emmo/middle/isq#EMMO_cc01751d_dd05_429b_9d0c_1b7a74d1f277)

**Definition:** The charge of an electron.

**Comment:** The negative of ElementaryCharge.

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01982>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## Stress

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d1917609\\_db5e\\_4b8a\\_9b76\\_ef1d6f860a81](http://emmo.info/emmo/middle/isq#EMMO_d1917609_db5e_4b8a_9b76_ef1d6f860a81)

**Comment:** Force per unit oriented surface area .

**Comment:** Measure of the internal forces that neighboring particles of a continuous material exert on each other.

**Dbpediaentry:** [http://dbpedia.org/page/Stress\\_\(mechanics\)](http://dbpedia.org/page/Stress_(mechanics))

**Physicaldimension:** T-2 L-1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Pressure

## Speed

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_81369540\\_1b0e\\_471b\\_9bae\\_6801af22800e](http://emmo.info/emmo/middle/isq#EMMO_81369540_1b0e_471b_9bae_6801af22800e)

**Comment:** Length per unit time.

Speed in the absolute value of the velocity.

**Dbpediaentry:** <http://dbpedia.org/page/Speed>

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05852>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Speed>

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## AtomicNumber

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_07de47e0\\_6bb6\\_45b9\\_b55a\\_4f238efbb105](http://emmo.info/emmo/middle/isq#EMMO_07de47e0_6bb6_45b9_b55a_4f238efbb105)

**Definition:** Number of protons in an atomic nucleus.

**Dbpediaentry:** [http://dbpedia.org/page/Atomic\\_number](http://dbpedia.org/page/Atomic_number)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00499>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.PureNumberQuantity

## Acceleration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e37ac288\\_aa60\\_415a\\_8cb7\\_c375724ac8e1](http://emmo.info/emmo/middle/isq#EMMO_e37ac288_aa60_415a_8cb7_c375724ac8e1)

**Comment:** Derivative of velocity with respect to time.

**Dbpediaentry:** <http://dbpedia.org/page/Acceleration>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00051>

**Physicaldimension:** T-2 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## CatalyticActivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_bd67d149\\_24c2\\_4bc9\\_833a\\_c2bc26f98fd3](http://emmo.info/emmo/middle/isq#EMMO_bd67d149_24c2_4bc9_833a_c2bc26f98fd3)

**Elucidation:** Increase in the rate of reaction of a specified chemical reaction that an enzyme produces in a specific assay system.

**Iupacentry:** <https://doi.org/10.1351/goldbook.C00881>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PlanckConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_76cc4efc\\_231e\\_42b4\\_be83\\_2547681caed6](http://emmo.info/emmo/middle/isq#EMMO_76cc4efc_231e_42b4_be83_2547681caed6)

**Elucidation:** The quantum of action.

**Dbpediaentry:** [http://dbpedia.org/page/Planck\\_constant](http://dbpedia.org/page/Planck_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04685>

**Physicaldimension:** T-1 L+2 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_PlankConstant](http://physics.nist.gov/cuu/CODATA-Value_PlankConstant)

**Relations:**

- is\_a isq.AngularMomentum
- is\_a isq.SIExactConstant

## Enthalpy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4091d5ec\\_a4df\\_42b9\\_a073\\_9a090839279f](http://emmo.info/emmo/middle/isq#EMMO_4091d5ec_a4df_42b9_a073_9a090839279f)

**Comment:** Measurement of energy in a thermodynamic system.

**Dbpediaentry:** <http://dbpedia.org/page/Enthalpy>

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02141>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## ChemicalPotential

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_88fc5d1b\\_d3ab\\_4626\\_b24c\\_915ebe7400ca](http://emmo.info/emmo/middle/isq#EMMO_88fc5d1b_d3ab_4626_b24c_915ebe7400ca)

**Comment:** Energy per unit change in amount of substance.

**Dbpediaentry:** [http://dbpedia.org/page/Chemical\\_potential](http://dbpedia.org/page/Chemical_potential)

**Iupacentry:** <https://doi.org/10.1351/goldbook.C01032>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N-1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Angle

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f3dd74c0\\_f480\\_49e8\\_9764\\_33b78638c235](http://emmo.info/emmo/middle/isq#EMMO_f3dd74c0_f480_49e8_9764_33b78638c235)

**Definition:** Ratio of circular arc length to radius.

**Altlabel:** PlaneAngle

**Dbpediaentry:** <http://dbpedia.org/page/Angle>

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00346>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.LengthFractionUnit

## Force

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1f087811\\_06cb\\_42d5\\_90fb\\_25d0e7e068ef](http://emmo.info/emmo/middle/isq#EMMO_1f087811_06cb_42d5_90fb_25d0e7e068ef)

**Elucidation:** Any interaction that, when unopposed, will change the motion of an object.

**Dbpediaentry:** <http://dbpedia.org/page/Force>

**Iupacentry:** <https://doi.org/10.1351/goldbook.F02480>

**Physicaldimension:** T-2 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricConductance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ffb73b1e\\_5786\\_43e4\\_a964\\_cb32ac7affb7](http://emmo.info/emmo/middle/isq#EMMO_ffb73b1e_5786_43e4_a964_cb32ac7affb7)

**Elucidation:** Measure of the ease for electric current to pass through a material.

**Altlabel:** Conductance

**Comment:** Inverse of ‘ElectricalResistance’.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_resistance\\_and\\_conductance](http://dbpedia.org/page/Electrical_resistance_and_conductance)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01925>

**Physicaldimension:** T+3 L-2 M-1 I+2 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## MassNumber

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_dc6c8de0\\_cfc4\\_4c66\\_a7dc\\_8f720e732d54](http://emmo.info/emmo/middle/isq#EMMO_dc6c8de0_cfc4_4c66_a7dc_8f720e732d54)

**Definition:** Number of nucleons in an atomic nucleus.

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.PureNumberQuantity

## SpeedOfLightInVacuum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_99296e55\\_53f7\\_4333\\_9e06\\_760ad175a1b9](http://emmo.info/emmo/middle/isq#EMMO_99296e55_53f7_4333_9e06_760ad175a1b9)

**Elucidation:** The speed of light in vacuum.

**Dbpediaentry:** [http://dbpedia.org/page/Speed\\_of\\_light](http://dbpedia.org/page/Speed_of_light)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05854>

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_SpeedOfLightInVacuum](http://physics.nist.gov/cuu/CODATA-Value_SpeedOfLightInVacuum)

**Relations:**

- is\_a isq.Speed
- is\_a isq.SIExactConstant

## Strain

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_acf636d4\\_9ac2\\_4ce3\\_960a\\_d54338e6cae3](http://emmo.info/emmo/middle/isq#EMMO_acf636d4_9ac2_4ce3_960a_d54338e6cae3)

**Elucidation:** Change of the relative positions of parts of a body, excluding a displacement of the body as a whole.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-57>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/Strain>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.RatioQuantity
- metrology.hasReferenceUnit only units-extension.LengthFractionUnit

## ElectricalImpedance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_79a02de5\\_b884\\_4eab\\_bc18\\_f67997d597a2](http://emmo.info/emmo/middle/isq#EMMO_79a02de5_b884_4eab_bc18_f67997d597a2)

**Comment:** Measure of the opposition that a circuit presents to a current when a voltage is applied.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_impedance](http://dbpedia.org/page/Electrical_impedance)

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricResistance

## AmountConcentration

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d5be1faf\\_0c56\\_4f5a\\_9b78\\_581e6dee949f](http://emmo.info/emmo/middle/isq#EMMO_d5be1faf_0c56_4f5a_9b78_581e6dee949f)

**Altlabel:** Concentration

**Altlabel:** MolarConcentration

**Altlabel:** Molarity

**Comment:** The amount of a constituent divided by the volume of the mixture.

**Dbpediaentry:** [http://dbpedia.org/page/Molar\\_concentration](http://dbpedia.org/page/Molar_concentration)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00295>

**Physicaldimension:** T0 L-3 M0 I0 Θ0 N+1 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## PotentialEnergy

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_4c151909\\_6f26\\_4ef9\\_b43d\\_7c9e9514883a](http://emmo.info/emmo/middle/isq#EMMO_4c151909_6f26_4ef9_b43d_7c9e9514883a)

**Elucidation:** The energy possessed by a body by virtue of its position or orientation in a potential field.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-03-48>

**Dbpediaentry:** [http://dbpedia.org/page/Potential\\_energy](http://dbpedia.org/page/Potential_energy)

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04778>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/PotentialEnergy>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Energy

## Pressure

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_50a44256\\_9dc5\\_434b\\_bad4\\_74a4d9a29989](http://emmo.info/emmo/middle/isq#EMMO_50a44256_9dc5_434b_bad4_74a4d9a29989)

**Elucidation:** The force applied perpendicular to the surface of an object per unit area over which that force is distributed.

**Dbpediaentry:** <http://dbpedia.org/page/Pressure>

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04819>

**Physicaldimension:** T-2 L-1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ElectricalReactance

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_92b2fb85\\_2143\\_4bc7\\_bbca\\_df3e6944bfc1](http://emmo.info/emmo/middle/isq#EMMO_92b2fb85_2143_4bc7_bbca_df3e6944bfc1)

**Comment:** The opposition of a circuit element to a change in current or voltage, due to that element's inductance or capacitance.

**Dbpediaentry:** [http://dbpedia.org/page/Electrical\\_reactance](http://dbpedia.org/page/Electrical_reactance)

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricResistance

## Velocity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_0329f1f5\\_8339\\_4ce4\\_8505\\_a264c6d606ba](http://emmo.info/emmo/middle/isq#EMMO_0329f1f5_8339_4ce4_8505_a264c6d606ba)

**Definition:** Vector quantity giving the rate of change of a position vector.

– ISO 80000-3

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=113-01-32>

**Iso80000ref:** 3-10.1

**Comment:** The velocity depends on the choice of the reference frame. Proper transformation between frames must be used: Galilean for non-relativistic description, Lorentzian for relativistic description.

– IEC, note 2

**Comment:** The velocity is related to a point described by its position vector. The point may localize a particle, or be attached to any other object such as a body or a wave.

– IEC, note 1

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Speed

## ElectricDipoleMoment

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_1a179ce4\\_3724\\_47f8\\_bee5\\_6292e3ac9942](http://emmo.info/emmo/middle/isq#EMMO_1a179ce4_3724_47f8_bee5_6292e3ac9942)

**Elucidation:** An electric dipole, vector quantity of magnitude equal to the product of the positive charge and the distance between the charges and directed from the negative charge to the positive charge.

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-35>

**Iecentry:** <http://www.electropedia.org/iev/iev.nsf/display?openform&ievref=121-11-36>

**Dbpediaentry:** [http://dbpedia.org/page/Electric\\_dipole\\_moment](http://dbpedia.org/page/Electric_dipole_moment)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01929>

**Ommatch:** <http://www.ontology-of-units-of-measure.org/resource/om-2/ElectricDipoleMoment>

**Physicaldimension:** T+1 L+1 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## ReciprocalLength

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ecec2983\\_7c26\\_4f8d\\_a981\\_51ca29668baf](http://emmo.info/emmo/middle/isq#EMMO_ecec2983_7c26_4f8d_a981_51ca29668baf)

**Elucidation:** The inverse of length.

**Dbpediaentry:** [http://dbpedia.org/page/Reciprocal\\_length](http://dbpedia.org/page/Reciprocal_length)

**Physicaldimension:** T0 L-1 M0 I0 Θ0 N0 J0

**Wikipediaentry:** [https://en.wikipedia.org/wiki/Reciprocal\\_length](https://en.wikipedia.org/wiki/Reciprocal_length)

**Relations:**

- is\_a isq.ISQDerivedQuantity

## RadiantFlux

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_e46f3f24\\_c2ec\\_4552\\_8dd4\\_cfc5c0a89c09](http://emmo.info/emmo/middle/isq#EMMO_e46f3f24_c2ec_4552_8dd4_cfc5c0a89c09)

**Comment:** The radiant energy emitted, reflected, transmitted or received, per unit time.

**Dbpediaentry:** [http://dbpedia.org/page/Radiant\\_flux](http://dbpedia.org/page/Radiant_flux)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05046>

**Physicaldimension:** T-3 L+2 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Power

## Momentum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_43776fc9\\_d712\\_4571\\_85f0\\_72183678039a](http://emmo.info/emmo/middle/isq#EMMO_43776fc9_d712_4571_85f0_72183678039a)

**Comment:** Product of mass and velocity.

**Dbpediaentry:** <http://dbpedia.org/page/Momentum>

**Iupacentry:** <https://doi.org/10.1351/goldbook.M04007>

**Physicaldimension:** T-1 L+1 M+1 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Radioactivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8d3da9ac\\_2265\\_4382\\_bee5\\_db72046722f8](http://emmo.info/emmo/middle/isq#EMMO_8d3da9ac_2265_4382_bee5_db72046722f8)

**Elucidation:** Decays per unit time.

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00114>

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.ISQDerivedQuantity

## Physical Constant branch

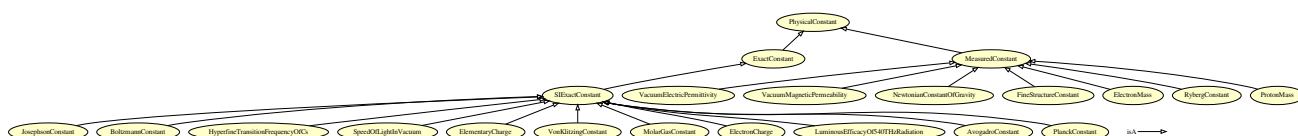


Figure 3.34: Physical Constant branch.

## JosephsonConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ba380bc6\\_2bfd\\_4f11\\_94c7\\_b3cbaafd1631](http://emmo.info/emmo/middle/isq#EMMO_ba380bc6_2bfd_4f11_94c7_b3cbaafd1631)

**Elucidation:** Inverse of the magnetic flux quantum.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Magnetic\\_flux\\_quantum](http://dbpedia.org/page/Magnetic_flux_quantum)) is outdated as May 20, 2019. It is now an exact quantity.

**Physicaldimension:** T+2 L-1 M-1 I+1 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_JosephsonConstant](http://physics.nist.gov/cuu/CODATA-Value_JosephsonConstant)

**Relations:**

- is\_a isq.SIExactConstant

## VacuumElectricPermittivity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_61a32ae9\\_8200\\_473a\\_bd55\\_59a9899996f4](http://emmo.info/emmo/middle/isq#EMMO_61a32ae9_8200_473a_bd55_59a9899996f4)

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Vacuum\\_permittivity](http://dbpedia.org/page/Vacuum_permittivity)) is outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of the absolute dielectric permittivity of classical vacuum.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04508>

**Physicaldimension:** T+4 L-3 M-1 I+2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectricConstant](http://physics.nist.gov/cuu/CODATA-Value_ElectricConstant)

**Relations:**

- is\_a isq.Permittivity
- is\_a metrology.MeasuredConstant



## BoltzmannConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ffc7735f\\_c177\\_46a4\\_98e9\\_a54440d29209](http://emmo.info/emmo/middle/isq#EMMO_ffc7735f_c177_46a4_98e9_a54440d29209)

**Elucidation:** A physical constant relating energy at the individual particle level with temperature. It is the gas constant R divided by the Avogadro constant.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Boltzmann\\_constant](http://dbpedia.org/page/Boltzmann_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.B00695>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ-1 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_BoltzmannConstant](http://physics.nist.gov/cuu/CODATA-Value_BoltzmannConstant)

**Relations:**

- is\_a isq.Entropy
- is\_a isq.SIExactConstant

## VacuumMagneticPermeability

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_de021e4f\\_918f\\_47ef\\_a67b\\_11120f56b9d7](http://emmo.info/emmo/middle/isq#EMMO_de021e4f_918f_47ef_a67b_11120f56b9d7)

**Comment:** The DBpedia and UIPAC Gold Book definitions ([http://dbpedia.org/page/Vacuum\\_permeability](http://dbpedia.org/page/Vacuum_permeability), <https://doi.org/10.1351/goldbook.P04504>) are outdated since May 20, 2019. It is now a measured constant.

**Comment:** The value of magnetic permeability in a classical vacuum.

**Physicaldimension:** T-2 L+1 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_MagneticConstant](http://physics.nist.gov/cuu/CODATA-Value_MagneticConstant)

**Relations:**

- is\_a isq.Permeability
- is\_a metrology.MeasuredConstant

## HyperfineTransitionFrequencyOfCs

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f96feb3f\\_4438\\_4e43\\_aa44\\_7458c4d87fc2](http://emmo.info/emmo/middle/isq#EMMO_f96feb3f_4438_4e43_aa44_7458c4d87fc2)

**Elucidation:** The frequency standard in the SI system in which the photon absorption by transitions between the two hyperfine ground states of caesium-133 atoms are used to control the output frequency.

**Physicaldimension:** T-1 L0 M0 I0 Θ0 N0 J0

**Relations:**

- is\_a isq.Frequency
- is\_a isq.SIExactConstant

## SpeedOfLightInVacuum

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_99296e55\\_53f7\\_4333\\_9e06\\_760ad175a1b9](http://emmo.info/emmo/middle/isq#EMMO_99296e55_53f7_4333_9e06_760ad175a1b9)

**Elucidation:** The speed of light in vacuum.

**Dbpediaentry:** [http://dbpedia.org/page/Speed\\_of\\_light](http://dbpedia.org/page/Speed_of_light)

**Iupacentry:** <https://doi.org/10.1351/goldbook.S05854>

**Physicaldimension:** T-1 L+1 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_SpeedOfLightInVacuum](http://physics.nist.gov/cuu/CODATA-Value_SpeedOfLightInVacuum)

**Relations:**

- is\_a isq.Speed
- is\_a isq.SIExactConstant

## NewtonianConstantOfGravity

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_da831168\\_975a\\_41f8\\_baae\\_279c298569da](http://emmo.info/emmo/middle/isq#EMMO_da831168_975a_41f8_baae_279c298569da)

**Comment:** Physical constant in Newton's law of gravitation and in Einstein's general theory of relativity.

**Dbpediaentry:** [http://dbpedia.org/page/Gravitational\\_constant](http://dbpedia.org/page/Gravitational_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02695>

**Physicaldimension:** T-2 L+3 M-1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_NewtonianConstantOfGravity](http://physics.nist.gov/cuu/CODATA-Value_NewtonianConstantOfGravity)

**Relations:**

- is\_a metrology.MeasuredConstant

## ElementaryCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_58a650f0\\_a638\\_4743\\_8439\\_535a325e5c4c](http://emmo.info/emmo/middle/isq#EMMO_58a650f0_a638_4743_8439_535a325e5c4c)

**Elucidation:** The magnitude of the electric charge carried by a single electron.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Elementary\\_charge](http://dbpedia.org/page/Elementary_charge)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02032>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElementaryCharge](http://physics.nist.gov/cuu/CODATA-Value_ElementaryCharge)

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## VonKlitzingConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_eb561764\\_276e\\_413d\\_a8cb\\_3a3154fd9bf8](http://emmo.info/emmo/middle/isq#EMMO_eb561764_276e_413d_a8cb_3a3154fd9bf8)

**Definition:** The von Klitzing constant is defined as Planck constant divided by the square of the elementary charge.

**Comment:** Resistance quantum.

**Physicaldimension:** T-3 L+2 M+1 I-2 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_VonKlitzingConstant](http://physics.nist.gov/cuu/CODATA-Value_VonKlitzingConstant)

**Relations:**

- is\_a isq.ElectricResistance
- is\_a isq.SIExactConstant

## FineStructureConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_d7d2ca25\\_03e1\\_4099\\_9220\\_c1a58df13ad0](http://emmo.info/emmo/middle/isq#EMMO_d7d2ca25_03e1_4099_9220_c1a58df13ad0)

**Comment:** A fundamental physical constant characterizing the strength of the electromagnetic interaction between elementary charged particles.

**Dbpediaentry:** [http://dbpedia.org/page/Fine-structure\\_constant](http://dbpedia.org/page/Fine-structure_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.F02389>

**Physicaldimension:** T0 L0 M0 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_FineStructureConstant](http://physics.nist.gov/cuu/CODATA-Value_FineStructureConstant)

**Relations:**

- is\_a metrology.MeasuredConstant

## MolarGasConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_ad6c76cf\\_b400\\_423e\\_820f\\_cf0c4e77f455](http://emmo.info/emmo/middle/isq#EMMO_ad6c76cf_b400_423e_820f_cf0c4e77f455)

**Elucidation:** Equivalent to the Boltzmann constant, but expressed in units of energy per temperature increment per mole (rather than energy per temperature increment per particle).

**Dbpediaentry:** [http://dbpedia.org/page/Gas\\_constant](http://dbpedia.org/page/Gas_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.G02579>

**Physicaldimension:** T-2 L+2 M+1 I0 Θ-1 N-1 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_MolarGasConstant](http://physics.nist.gov/cuu/CODATA-Value_MolarGasConstant)

**Relations:**

- is\_a isq.SIExactConstant

## ElectronCharge

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_cc01751d\\_dd05\\_429b\\_9d0c\\_1b7a74d1f277](http://emmo.info/emmo/middle/isq#EMMO_cc01751d_dd05_429b_9d0c_1b7a74d1f277)

**Definition:** The charge of an electron.

**Comment:** The negative of ElementaryCharge.

**Iupacentry:** <https://doi.org/10.1351/goldbook.E01982>

**Physicaldimension:** T+1 L0 M0 I+1 Θ0 N0 J0

**Relations:**

- is\_a isq.ElectricCharge
- is\_a isq.SIExactConstant

## ElectronMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_44fc8c60\\_7a9c\\_49af\\_a046\\_e1878c88862c](http://emmo.info/emmo/middle/isq#EMMO_44fc8c60_7a9c_49af_a046_e1878c88862c)

**Comment:** The rest mass of an electron.

**Dbpediaentry:** [http://dbpedia.org/page/Electron\\_rest\\_mass](http://dbpedia.org/page/Electron_rest_mass)

**Iupacentry:** <https://doi.org/10.1351/goldbook.E02008>

**Physicaldimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ElectronMass](http://physics.nist.gov/cuu/CODATA-Value_ElectronMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## RybergConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_a3c78d6f\\_ae49\\_47c8\\_a634\\_9b6d86b79382](http://emmo.info/emmo/middle/isq#EMMO_a3c78d6f_ae49_47c8_a634_9b6d86b79382)

**Comment:** The Rydberg constant represents the limiting value of the highest wavenumber (the inverse wavelength) of any photon that can be emitted from the hydrogen atom, or, alternatively, the wavenumber of the lowest-energy photon capable of ionizing the hydrogen atom from its ground state.

**Dbpediaentry:** [http://dbpedia.org/page/Rydberg\\_constant](http://dbpedia.org/page/Rydberg_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.R05430>

**Physicaldimension:** T<sup>0</sup> L<sup>-1</sup> M<sup>0</sup> I<sup>0</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>0</sup>

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_RybergConstant](http://physics.nist.gov/cuu/CODATA-Value_RybergConstant)

**Relations:**

- is\_a isq.Wavenumber
- is\_a metrology.MeasuredConstant

## LuminousEfficacyOf540THzRadiation

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_506f7823\\_52bc\\_40cb\\_be07\\_b3b1e10cce13](http://emmo.info/emmo/middle/isq#EMMO_506f7823_52bc_40cb_be07_b3b1e10cce13)

**Elucidation:** The luminous efficacy of monochromatic radiation of frequency  $540 \times 10^{12}$  Hz, K cd , is a technical constant that gives an exact numerical relationship between the purely physical characteristics of the radiant power stimulating the human eye (W) and its photobiological response defined by the luminous flux due to the spectral responsivity of a standard observer (lm) at a frequency of  $540 \times 10^{12}$  hertz.

**Comment:** Defines the Candela unit in the SI system.

**Physicaldimension:** T<sup>+3</sup> L<sup>-1</sup> M<sup>-1</sup> I<sup>0</sup> Θ<sup>0</sup> N<sup>0</sup> J<sup>+1</sup>

**Relations:**

- is\_a isq.SIExactConstant

## AvogadroConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_176cae33\\_b83e\\_4cd2\\_a6bc\\_281f42f0ccc8](http://emmo.info/emmo/middle/isq#EMMO_176cae33_b83e_4cd2_a6bc_281f42f0ccc8)

**Elucidation:** The number of constituent particles, usually atoms or molecules, that are contained in the amount of substance given by one mole.

**Comment:** The DBpedia definition ([http://dbpedia.org/page/Avogadro\\_constant](http://dbpedia.org/page/Avogadro_constant)) is outdated as May 20, 2019. It is now an exact quantity.

**Dbpediaentry:** [http://dbpedia.org/page/Avogadro\\_constant](http://dbpedia.org/page/Avogadro_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.A00543>

**Physicaldimension:** T<sup>0</sup> L<sup>0</sup> M<sup>0</sup> I<sup>0</sup> Θ<sup>0</sup> N<sup>-1</sup> J<sup>0</sup>

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_AvogadroConstant](http://physics.nist.gov/cuu/CODATA-Value_AvogadroConstant)

**Relations:**

- is\_a isq.SIExactConstant

## MeasuredConstant

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_3f15d200\\_c97b\\_42c8\\_8ac0\\_d81d150361e2](http://emmo.info/emmo/middle/metrology#EMMO_3f15d200_c97b_42c8_8ac0_d81d150361e2)

**Elucidation:** For a given unit system, measured constants are physical constants that are not used to define the unit system. Hence, these constants have to be measured and will therefore be associated with an uncertainty.

**Relations:**

- is\_a metrology.PhysicalConstant

## SIExactConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_f2ca6dd0\\_0e5f\\_4392\\_a92d\\_cafdae6cfc95](http://emmo.info/emmo/middle/isq#EMMO_f2ca6dd0_0e5f_4392_a92d_cafdae6cfc95)

**Elucidation:** Physical constant that by definition (after the latest revision of the SI system that was enforced May 2019) has a known exact numerical value when expressed in SI units.

**Relations:**

- is\_a metrology.ExactConstant

## ExactConstant

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_89762966\\_8076\\_4f7c\\_b745\\_f718d653e8e2](http://emmo.info/emmo/middle/metrology#EMMO_89762966_8076_4f7c_b745_f718d653e8e2)

**Comment:** Physical constant used to define a unit system. Hence, when expressed in that unit system they have an exact value with no associated uncertainty.

**Relations:**

- is\_a metrology.PhysicalConstant

## ProtonMass

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_8d689295\\_7d84\\_421b\\_bc01\\_d5cceb2c2086](http://emmo.info/emmo/middle/isq#EMMO_8d689295_7d84_421b_bc01_d5cceb2c2086)

**Comment:** The rest mass of a proton.

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04914>

**Physicdimension:** T0 L0 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_ProtonMass](http://physics.nist.gov/cuu/CODATA-Value_ProtonMass)

**Relations:**

- is\_a isq.Mass
- is\_a metrology.MeasuredConstant

## PhysicalConstant

**IRI:** [http://emmo.info/emmo/middle/metrology#EMMO\\_b953f2b1\\_c8d1\\_4dd9\\_b630\\_d3ef6580c2bb](http://emmo.info/emmo/middle/metrology#EMMO_b953f2b1_c8d1_4dd9_b630_d3ef6580c2bb)

**Comment:** Physical constants are categorised into “exact” and measured constants.

With “exact” constants, we refer to physical constants that have an exact numerical value after the revision of the SI system that was enforced May 2019.

**Wikipediaentry:** [https://en.wikipedia.org/wiki/List\\_of\\_physical\\_constants](https://en.wikipedia.org/wiki/List_of_physical_constants)

**Relations:**

- is\_a metrology.PhysicalQuantity
- disjoint\_union\_of metrology.MeasuredConstant, metrology.ExactConstant

## PlanckConstant

**IRI:** [http://emmo.info/emmo/middle/isq#EMMO\\_76cc4efc\\_231e\\_42b4\\_be83\\_2547681caed6](http://emmo.info/emmo/middle/isq#EMMO_76cc4efc_231e_42b4_be83_2547681caed6)

**Elucidation:** The quantum of action.

**Dbpediaentry:** [http://dbpedia.org/page/Planck\\_constant](http://dbpedia.org/page/Planck_constant)

**Iupacentry:** <https://doi.org/10.1351/goldbook.P04685>

**Physicaldimension:** T-1 L+2 M+1 I0 Θ0 N0 J0

**Qudtentry:** [http://physics.nist.gov/cuu/CODATA-Value\\_PlankConstant](http://physics.nist.gov/cuu/CODATA-Value_PlankConstant)

**Relations:**

- is\_a isq.AngularMomentum
- is\_a isq.SIExactConstant

## Reductionistic branch

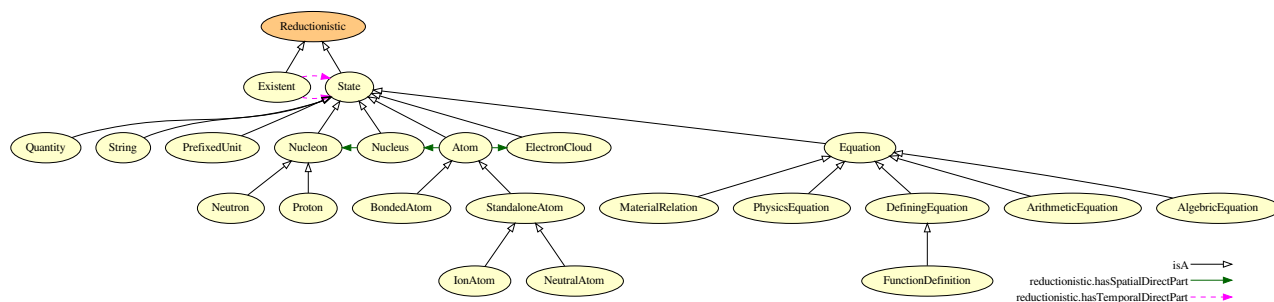


Figure 3.35: Reductionistic branch.

## Existent

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_52211e5e\\_d767\\_4812\\_845e\\_eb6b402c476a](http://emmo.info/emmo/middle/reductionistic#EMMO_52211e5e_d767_4812_845e_eb6b402c476a)

**Elucidation:** A ‘Physical’ which is a tessellation of ‘State’ temporal direct parts.

**Comment:** ‘Existent’ is the EMMO class to be used for representing real world physical objects under a reductionistic perspective (i.e. objects come from the composition of sub-part objects, both in time and space).

‘Existent’ class collects all individuals that stand for physical objects that can be structured in well defined temporal sub-parts called states, through the temporal direct parthood relation.

This class provides a first granularity hierarchy in time, and a way to axiomatize tessellation principles for a specific whole with a non-transitivity relation (direct parthood) that helps to retain the granularity levels.

e.g. a car, a supersaturated gas with nucleating nanoparticles, an atom that becomes ionized and then recombines with an electron.

**Comment:** An ‘Existent’ individual stands for a real world object for which the ontologist wants to provide univocal tessellation in time.

By definition, the tiles are represented by ‘State’-s individual.

Tiles are related to the ‘Existent’ through temporal direct parthood, enforcing non-transitivity and inverse-functionality.

**Comment:** Being hasTemporalDirectPart a proper parthood relation, there cannot be ‘Existent’ made of a single ‘State’.

Moreover, due to inverse functionality, a ‘State’ can be part of only one ‘Existent’, preventing overlapping between ‘Existent’-s.

**Comment:** ex-sistere (latin): to stay (to persist through time) outside others of the same type (to be distinct from the rest).

**Relations:**

- is\_a reductionistic.Reductionistic
- reductionistic.hasTemporalDirectPart some reductionistic.State
- reductionistic.hasTemporalDirectPart only reductionistic.State

## BondedAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_8303a247\\_f9d9\\_4616\\_bdcd\\_f5cbd7b298e3](http://emmo.info/emmo/middle/materials#EMMO_8303a247_f9d9_4616_bdcd_f5cbd7b298e3)

**Elucidation:** An bonded atom that shares at least one electron to the atom-based entity of which is part of.

**Comment:** A real bond between atoms is always something hybrid between covalent, metallic and ionic.

In general, metallic and ionic bonds have atoms sharing electrons.

**Comment:** The bond types that are covered by this definition are the strong electronic bonds: covalent, metallic and ionic.

**Comment:** This class can be used to represent molecules as simplified quantum systems, in which outer molecule shared electrons are un-entangled with the inner shells of the atoms composing the molecule.

### Relations:

- is\_a materials.Atom

## Neutron

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_df808271\\_df91\\_4f27\\_ba59\\_fa423c51896c](http://emmo.info/emmo/middle/materials#EMMO_df808271_df91_4f27_ba59_fa423c51896c)

### Relations:

- is\_a materials.Nucleon

## Proton

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_8f87e700\\_99a8\\_4427\\_8ffb\\_e493de05c217](http://emmo.info/emmo/middle/materials#EMMO_8f87e700_99a8_4427_8ffb_e493de05c217)

### Relations:

- is\_a materials.Nucleon
- properties.hasProperty some isq.ElementaryCharge
- properties.hasProperty some isq.ProtonMass

## String

**IRI:** [http://emmo.info/emmo/middle/perceptual#EMMO\\_50ea1ec5\\_f157\\_41b0\\_b46b\\_a9032f17ca10](http://emmo.info/emmo/middle/perceptual#EMMO_50ea1ec5_f157_41b0_b46b_a9032f17ca10)

**Elucidation:** A physical made of more than one symbol sequentially arranged.

**Example:** The word “cat” considered as a collection of ‘symbol’-s respecting the rules of english language.

In this example the ‘symbolic’ entity “cat” is not related to the real cat, but it is only a word (like it would be to an italian person that ignores the meaning of this english word).

If an ‘interpreter’ skilled in english language is involved in a ‘semiotic’ process with this word, that “cat” became also a ‘sign’ i.e. it became for the ‘interpreter’ a representation for a real cat.

**Comment:** A string is made of concatenated symbols whose arrangement is one-dimensional. Each symbol can have only one previous and one next neighborhood (bidirectional list).

**Comment:** A string is not requested to respect any syntactic rule: it’s simply directly made of symbols.

### Relations:

- is\_a perceptual.SymbolicComposition
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart some perceptual.Symbol
- reductionistic.hasSpatialDirectPart only perceptual.Symbol

## State

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_36c79456\\_e29c\\_400d\\_8bd3\\_0eedddb82652](http://emmo.info/emmo/middle/reductionistic#EMMO_36c79456_e29c_400d_8bd3_0eedddb82652)

**Elucidation:** A ‘Physical’ which is a tessellation of spatial direct parts.

**Example:** e.g. the existent in my glass is declared at  $t = t\_start$  as made of two direct parts: the ice and the water. It will continue to exist as state as long as the ice is completely melted at  $t = t\_end$ . The new state will be completely made of water. Between  $t\_start$  and  $t\_end$  there is an exchange of molecules between the ice and the water, but this does not affect the existence of the two states.

If we partition the existent in my glass as ice surrounded by several molecules (we do not use the object water as direct part) then the appearance of a molecule coming from the ice will cause a state to end and another state to begin.

**Comment:** Direct partitions declaration is a choice of the ontologist that chooses the classes to be used as direct parts, according to its own world view.

A ‘State’ can always be directly partitioned in ‘Elementary’-s and ‘Void’ or ‘Physical’.

e.g. the water in my glass can be seen as a single object without declaring direct parts, or as made of H<sub>2</sub>O molecules direct parts.

**Comment:** The definition of ‘State’ implies that its spatial direct parts (i.e. ‘physicals’) are not gained or lost during its temporal extension (they exist from the left to the right side of the time interval), so that the cardinality of spatial direct parts in a ‘State’ is constant.

This does not mean that there cannot be a change in the internal structure of the ‘State’ direct parts. It means only that this change must not affect the existence of the direct part itself.

There is no change in granularity or cardinality of direct parts of a ‘State’.

The use of spatial direct parthood in ‘State’ definition means that a ‘State’ cannot overlap in space another ‘State’.

**Comment:** The usefulness of ‘State’ is that it makes it possible to describe the evolution in time of an ‘Existent’ in terms of series of ‘State’-s that can take into account the disappearance or appearance of parts within a ‘Physical’.

A ‘State’ is a recognizable granularity level of matter, in the sense that its direct parts do not appear or disappear within its lifetime as it can be for a generic ‘Existent’.

**Comment:** There is no change in granularity or cardinality of parts within a state.

The use of spatial direct parthood in state definition means that a state cannot overlap in space another state that is direct part of the same whole.

### Relations:

- `is_a reductionistic.Reductionistic`
- `reductionistic.hasSpatialDirectPart some physical.Physical`

## Nucleon

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_50781fd9\\_a9e4\\_46ad\\_b7be\\_4500371d188d](http://emmo.info/emmo/middle/materials#EMMO_50781fd9_a9e4_46ad_b7be_4500371d188d)

### Relations:

- `is_a materials.Subatomic`
- `is_a reductionistic.State`
- `reductionistic.hasSpatialDirectPart some physicalistic.Quark`
- `disjoint_union_of materials.Proton, materials.Neutron`

## Reductionistic

**IRI:** [http://emmo.info/emmo/middle/reductionistic#EMMO\\_15db234d\\_ecaf\\_4715\\_9838\\_4b4ec424fb13](http://emmo.info/emmo/middle/reductionistic#EMMO_15db234d_ecaf_4715_9838_4b4ec424fb13)



**Elucidation:** A class devoted to categorize ‘Physical’-s according to their granularity relations, first in terms of time evolution (Existent) and then in terms of their composition (State), up to the spatial a-tomistic element (Elementary).

**Comment:** Direct parthood is the relation used to build the class hierarchy (and the granularity hierarchy) for this perspective.

**Relations:**

- is\_a top.Perspective
- equivalent\_to reductionistic.State or reductionistic.Existent

## MaterialRelation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_e5438930\\_04e7\\_4d42\\_ade5\\_3700d4a52ab7](http://emmo.info/emmo/middle/models#EMMO_e5438930_04e7_4d42_ade5_3700d4a52ab7)

**Elucidation:** An ‘equation’ that stands for a physical assumption specific to a material, and provides an expression for a ‘physics\_quantity’ (the dependent variable) as function of other variables, physics\_quantity or data (independent variables).

**Example:** The Lennard-Jones potential.

A force field.

An Hamiltonian.

**Comment:** A material\_relation can e.g. return a predefined number, return a database query, be an equation that depends on other physics\_quantities.

**Relations:**

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity

## PhysicsEquation

**IRI:** [http://emmo.info/emmo/middle/models#EMMO\\_27c5d8c6\\_8af7\\_4d63\\_beb1\\_ec37cd8b3fa3](http://emmo.info/emmo/middle/models#EMMO_27c5d8c6_8af7_4d63_beb1_ec37cd8b3fa3)

**Elucidation:** An ‘equation’ that stands for a ‘physical\_law’ by mathematically defining the relations between physics\_quantities.

**Example:** The Newton’s equation of motion.

The Schrödinger equation.

The Navier-Stokes equation.

**Relations:**

- is\_a math.Equation
- is\_a models.MathematicalModel
- reductionistic.hasSpatialDirectPart some metrology.PhysicalQuantity
- Inverse(models.hasModel) some models.PhysicalPhenomenon

## FunctionDefinition

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_4bc29b0f\\_8fcc\\_4026\\_a291\\_f9774a66d9b8](http://emmo.info/emmo/middle/math#EMMO_4bc29b0f_8fcc_4026_a291_f9774a66d9b8)

**Elucidation:** A function defined using functional notation.

**Example:**  $y = f(x)$

**Relations:**

- is\_a math.DefiningEquation

## IonAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_db03061b\\_db31\\_4132\\_a47a\\_6a634846578b](http://emmo.info/emmo/middle/materials#EMMO_db03061b_db31_4132_a47a_6a634846578b)

**Elucidation:** A standalone atom with an unbalanced number of electrons with respect to its atomic number.

**Comment:** The ion\_atom is the basic part of a pure ionic bonded compound i.e. without electron sharing,

**Relations:**

- is\_a materials.StandaloneAtom

## NeutralAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4588526f\\_8553\\_4f4d\\_aa73\\_a483e88d599b](http://emmo.info/emmo/middle/materials#EMMO_4588526f_8553_4f4d_aa73_a483e88d599b)

**Elucidation:** A standalone atom that has no net charge.

**Relations:**

- is\_a materials.StandaloneAtom

## DefiningEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_29afdf54\\_90ae\\_4c98\\_8845\\_fa9ea3f143a8](http://emmo.info/emmo/middle/math#EMMO_29afdf54_90ae_4c98_8845_fa9ea3f143a8)

**Elucidation:** An equation that define a new variable in terms of other mathematical entities.

**Example:** The definition of velocity as  $v = dx/dt$ .

The definition of density as mass/volume.

$y = f(x)$

**Relations:**

- is\_a math.Equation

## StandaloneAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_2fd3f574\\_5e93\\_47fe\\_afca\\_ed80b0a21ab4](http://emmo.info/emmo/middle/materials#EMMO_2fd3f574_5e93_47fe_afca_ed80b0a21ab4)

**Elucidation:** An atom that does not share electrons with other atoms.

**Comment:** A standalone atom can be bonded with other atoms by intermolecular forces (i.e. dipole–dipole, London dispersion force, hydrogen bonding), since this bonds does not involve electron sharing.

**Relations:**

- is\_a materials.Atom
- disjoint\_union\_of materials.NeutralAtom, materials.IonAtom

## ElectronCloud

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_1067b97a\\_84f8\\_4d22\\_8ace\\_b842b8ce355c](http://emmo.info/emmo/middle/materials#EMMO_1067b97a_84f8_4d22_8ace_b842b8ce355c)

**Elucidation:** A ‘spacetime’ that stands for a quantum system made of electrons.

**Relations:**

- is\_a materials.Subatomic
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart some physicalistic.Electron

## Nucleus

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_f835f4d4\\_c665\\_403d\\_ab25\\_dca5cc74be52](http://emmo.info/emmo/middle/materials#EMMO_f835f4d4_c665_403d_ab25_dca5cc74be52)

### Relations:

- is\_a materials.Subatomic
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart some materials.Nucleon

## Equation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_e56ee3eb\\_7609\\_4ae1\\_8bed\\_51974f0960a6](http://emmo.info/emmo/middle/math#EMMO_e56ee3eb_7609_4ae1_8bed_51974f0960a6)

**Elucidation:** The class of ‘mathematical’-s that stand for a statement of equality between two mathematical expressions.

**Example:**  $2+3 = 5$   $x^2 + 3x = 5x$   $dv/dt = a \sin(x) = y$

**Comment:** An equation with variables can always be represented as:

$f(v_0, v_1, \dots, v_n) = g(v_0, v_1, \dots, v_n)$

where f is the left hand and g the right hand side expressions and  $v_0, v_1, \dots, v_n$  are the variables.

### Relations:

- is\_a math.MathematicalFormula
- is\_a reductionistic.State
- is\_a math.Mathematical
- reductionistic.hasSpatialDirectPart some math.Expression

## Atom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_eb77076b\\_a104\\_42ac\\_a065\\_798b2d2809ad](http://emmo.info/emmo/middle/materials#EMMO_eb77076b_a104_42ac_a065_798b2d2809ad)

**Elucidation:** A standalone atom has direct part one ‘nucleus’ and one ‘electron\_cloud’.

An O ‘atom’ within an O<sub>2</sub> ‘molecule’ is an ‘e-bonded\_atom’.

In this material branch, H atom is a particular case, with respect to higher atomic number atoms, since as soon as it shares its electron it has no nucleus entangled electron cloud.

We cannot say that H<sub>2</sub> molecule has direct part two H atoms, but has direct part two H nucleus.

**Comment:** An ‘atom’ is a ‘nucleus’ surrounded by an ‘electron\_cloud’, i.e. a quantum system made of one or more bounded electrons.

### Relations:

- is\_a physicalistic.Matter
- is\_a reductionistic.State
- properties.hasProperty some isq.AtomicNumber
- properties.hasProperty some isq.AtomicMass
- properties.hasProperty some isq.MagneticDipoleMoment
- reductionistic.hasSpatialDirectPart some materials.ElectronCloud
- reductionistic.hasSpatialDirectPart some materials.Nucleus

## ArithmeticEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_a6138ba7\\_e365\\_4f2d\\_b6b4\\_fe5a5918d403](http://emmo.info/emmo/middle/math#EMMO_a6138ba7_e365_4f2d_b6b4_fe5a5918d403)

**Example:**  $1 + 1 = 2$

### Relations:

- is\_a math.Equation

## AlgebraicEquation

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_98d65021\\_4574\\_4890\\_b2fb\\_46430841077f](http://emmo.info/emmo/middle/math#EMMO_98d65021_4574_4890_b2fb_46430841077f)

**Example:**  $2 * a - b = c$

**Comment:** An 'equation' that has parts two 'polynomial'-s

**Relations:**

- is\_a math.Equation
- reductionistic.hasSpatialDirectPart some math.AlgebraicExpression

## Expression branch

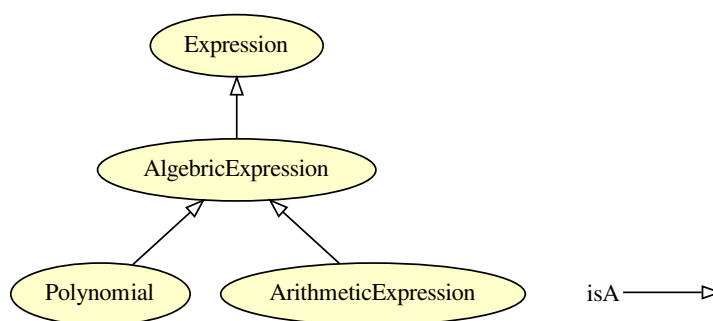


Figure 3.36: Expression branch.

## Expression

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_f9bc8b52\\_85e9\\_4b53\\_b969\\_dd7724d5b8e4](http://emmo.info/emmo/middle/math#EMMO_f9bc8b52_85e9_4b53_b969_dd7724d5b8e4)

**Elucidation:** A well-formed finite combination of mathematical symbols according to some specific rules.

**Relations:**

- is\_a math.Mathematical
- is\_a perceptual.SymbolicComposition

## AlgebraicExpression

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_1aed91a3\\_d00c\\_48af\\_8f43\\_a0c958b2512a](http://emmo.info/emmo/middle/math#EMMO_1aed91a3_d00c_48af_8f43_a0c958b2512a)

**Example:**  $2x+3$

**Comment:** An expression that has parts only integer constants, variables, and the algebraic operations (addition, subtraction, multiplication, division and exponentiation by an exponent that is a rational number)

**Relations:**

- is\_a math.Expression

## Polynomial

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_91447ec0\\_fb55\\_49f2\\_85a5\\_3172dff6482c](http://emmo.info/emmo/middle/math#EMMO_91447ec0_fb55_49f2_85a5_3172dff6482c)

**Example:**  $2 * x^2 + x + 3$

**Relations:**

- is\_a math.AlgebraicExpression

**ArithmeticExpression**

**IRI:** [http://emmo.info/emmo/middle/math#EMMO\\_89083bab\\_f69c\\_4d06\\_bf6d\\_62973b56cdc7](http://emmo.info/emmo/middle/math#EMMO_89083bab_f69c_4d06_bf6d_62973b56cdc7)

**Example:** 2+2

**Relations:**

- is\_a math.AlgebraicExpression
- is\_a not reductionistic.hasSpatialDirectPart some math.Variable

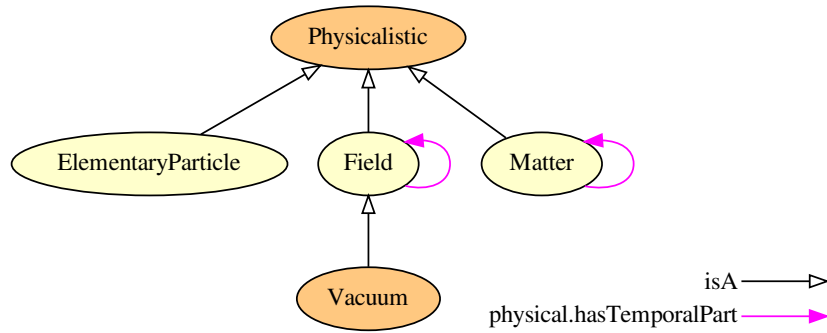
**Physicalistic branch**

Figure 3.37: Physicalistic branch.

**Vacuum**

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_3c218fbe\\_60c9\\_4597\\_8bcf\\_41eb1773af1f](http://emmo.info/emmo/middle/physicalistic#EMMO_3c218fbe_60c9_4597_8bcf_41eb1773af1f)

**Elucidation:** A ‘Physical’ with no ‘Massive’ parts.

**Relations:**

- is\_a physicalistic.Field
- equivalent\_to physicalistic.Field and not physicalistic.Matter

**Field**

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_70dac51e\\_bddd\\_48c2\\_8a98\\_7d8395e91fc2](http://emmo.info/emmo/middle/physicalistic#EMMO_70dac51e_bddd_48c2_8a98_7d8395e91fc2)

**Elucidation:** A ‘Physical’ with ‘Massless’ parts that are mediators of interactions.

**Comment:** The concepts of matter and field for classical physics, upon which we can categorize physical entities, are replaced in quantum physics by the more general concepts of quantum field.

Here the class ‘Field’ refers to the quantum field of massless bosonic particles (i.e. photons, gluons), while the class ‘Matter’ refers to the quantum field of massive fermionic or bosonic particles (e.g. quarks, electrons).

**Relations:**

- is\_a physicalistic.Physicalistic
- is\_a physical.Physical

- mereotopology.hasPart some physicalistic.Massless
- physical.hasTemporalPart only physicalistic.Field

## Physicalistic

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_98ada9d8\\_f1c8\\_4f13\\_99b5\\_d890f5354152](http://emmo.info/emmo/middle/physicalistic#EMMO_98ada9d8_f1c8_4f13_99b5_d890f5354152)

**Elucidation:** The perspective for which physical objects are categorized only by concepts coming from applied physical sciences.

### Relations:

- is\_a top.Perspective
- equivalent\_to physicalistic.Matter or physicalistic.Field

## Elementary Particle branch

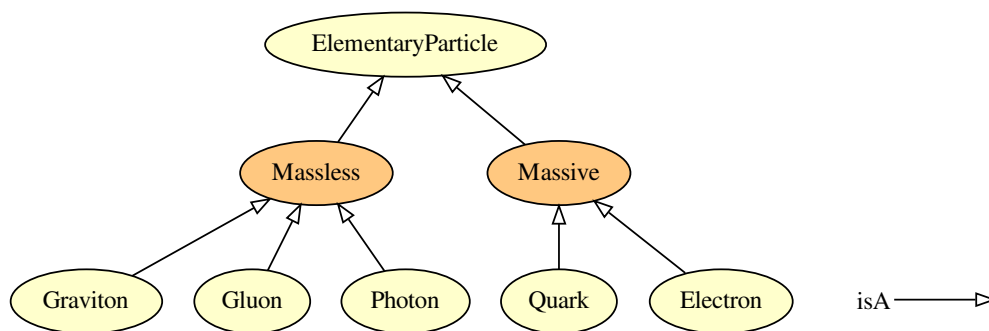


Figure 3.38: Elementary Particle branch.

## Massive

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_385b8f6e\\_43ac\\_4596\\_ad76\\_ac322c68b7ca](http://emmo.info/emmo/middle/physicalistic#EMMO_385b8f6e_43ac_4596_ad76_ac322c68b7ca)

**Elucidation:** The union of classes of elementary particles that possess mass.

### Relations:

- is\_a physicalistic.ElementaryParticle
- equivalent\_to physicalistic.Quark or physicalistic.Electron

## Quark

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_72d53756\\_7fb1\\_46ed\\_980f\\_83f47efbe105](http://emmo.info/emmo/middle/physicalistic#EMMO_72d53756_7fb1_46ed_980f_83f47efbe105)

**Elucidation:** The class of individuals that stand for quarks elementary particles.

### Relations:

- is\_a physicalistic.Massive
- is\_a physical.Elementary

## Graviton

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_eb3c61f0\\_3983\\_4346\\_a0c6\\_e7f6b90a67a8](http://emmo.info/emmo/middle/physicalistic#EMMO_eb3c61f0_3983_4346_a0c6_e7f6b90a67a8)

**Elucidation:** The class of individuals that stand for gravitons elementary particles.

**Comment:** While this particle is only supposed to exist, the EMMO approach to classical and quantum systems represents fields as made of particles.

For this reason graviton is an useful concept to homogenize the approach between different fields.

**Relations:**

- is\_a physicalistic.Massless
- is\_a physical.Elementary

## ElementaryParticle

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_c26a0340\\_d619\\_4928\\_b1a1\\_1a04e88bb89d](http://emmo.info/emmo/middle/physicalistic#EMMO_c26a0340_d619_4928_b1a1_1a04e88bb89d)

**Elucidation:** The union of all classes categorizing elementary particles according to the Standard Model.

**Comment:** Only a subset of elementary particles from the Standard Model are here included for the sake of simplicity.

**Relations:**

- is\_a physicalistic.Physicalistic
- is\_a physical.Elementary
- disjoint\_union\_of physicalistic.Photon, physicalistic.Quark, physicalistic.Gluon, physicalistic.Electron, physicalistic.Graviton

## Gluon

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_7db59e56\\_f68b\\_48b7\\_ae99\\_891c35ae5c3b](http://emmo.info/emmo/middle/physicalistic#EMMO_7db59e56_f68b_48b7_ae99_891c35ae5c3b)

**Elucidation:** The class of individuals that stand for gluons elementary particles.

**Relations:**

- is\_a physicalistic.Massless
- is\_a physical.Elementary

## Photon

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_25f8b804\\_9a0b\\_4387\\_a3e7\\_b35bce5365ee](http://emmo.info/emmo/middle/physicalistic#EMMO_25f8b804_9a0b_4387_a3e7_b35bce5365ee)

**Elucidation:** The class of individuals that stand for photons elementary particles.

**Relations:**

- is\_a physicalistic.Massless
- is\_a physical.Elementary

## Electron

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_8043d3c6\\_a4c1\\_4089\\_ba34\\_9744e28e5b3d](http://emmo.info/emmo/middle/physicalistic#EMMO_8043d3c6_a4c1_4089_ba34_9744e28e5b3d)

**Elucidation:** The class of individuals that stand for electrons elementary particles.

**Relations:**

- is\_a physicalistic.Massive
- is\_a physicalistic.Matter
- is\_a physical.Elementary
- properties.hasProperty some isq.ElectronMass

- `properties.hasProperty some isq.ElectronCharge`

## Massless

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_e5488299\\_8dab\\_4ebb\\_900a\\_26d2abed8396](http://emmo.info/emmo/middle/physicalistic#EMMO_e5488299_8dab_4ebb_900a_26d2abed8396)

**Elucidation:** The union of classes of elementary particles that do not possess mass.

### Relations:

- `is_a physicalistic.ElementaryParticle`
- `equivalent_to physicalistic.Photon` or `physicalistic.Gluon` or `physicalistic.Graviton`

## Subatomic branch

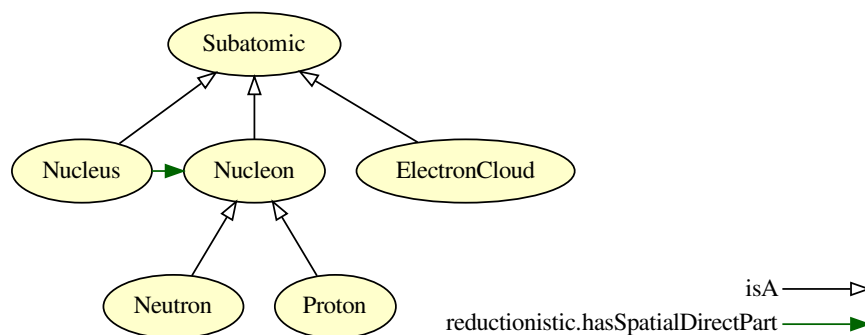


Figure 3.39: Subatomic branch.

## Nucleus

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_f835f4d4\\_c665\\_403d\\_ab25\\_dca5cc74be52](http://emmo.info/emmo/middle/materials#EMMO_f835f4d4_c665_403d_ab25_dca5cc74be52)

### Relations:

- `is_a materials.Subatomic`
- `is_a reductionistic.State`
- `reductionistic.hasSpatialDirectPart some materials.Nucleon`

## Subatomic

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_7d66bde4\\_b68d\\_41cc\\_b5fc\\_6fd98c5e2ff0](http://emmo.info/emmo/middle/materials#EMMO_7d66bde4_b68d_41cc_b5fc_6fd98c5e2ff0)

### Relations:

- `is_a physicalistic.Matter`

## Nucleon

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_50781fd9\\_a9e4\\_46ad\\_b7be\\_4500371d188d](http://emmo.info/emmo/middle/materials#EMMO_50781fd9_a9e4_46ad_b7be_4500371d188d)

### Relations:

- `is_a materials.Subatomic`
- `is_a reductionistic.State`



- reductionistic.hasSpatialDirectPart some physicalistic.Quark
- disjoint\_union\_of materials.Proton, materials.Neutron

## Neutron

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_df808271\\_df91\\_4f27\\_ba59\\_fa423c51896c](http://emmo.info/emmo/middle/materials#EMMO_df808271_df91_4f27_ba59_fa423c51896c)

**Relations:**

- is\_a materials.Nucleon

## Proton

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_8f87e700\\_99a8\\_4427\\_8ffb\\_e493de05c217](http://emmo.info/emmo/middle/materials#EMMO_8f87e700_99a8_4427_8ffb_e493de05c217)

**Relations:**

- is\_a materials.Nucleon
- properties.hasProperty some isq.ElementaryCharge
- properties.hasProperty some isq.ProtonMass

## ElectronCloud

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_1067b97a\\_84f8\\_4d22\\_8ace\\_b842b8ce355c](http://emmo.info/emmo/middle/materials#EMMO_1067b97a_84f8_4d22_8ace_b842b8ce355c)

**Elucidation:** A ‘spacetime’ that stands for a quantum system made of electrons.

**Relations:**

- is\_a materials.Subatomic
- is\_a reductionistic.State
- reductionistic.hasSpatialDirectPart some physicalistic.Electron

## Matter branch

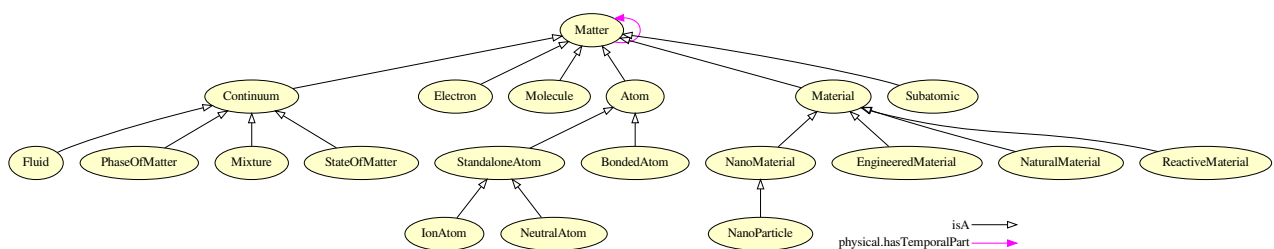


Figure 3.40: Matter branch.

## IonAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_db03061b\\_db31\\_4132\\_a47a\\_6a634846578b](http://emmo.info/emmo/middle/materials#EMMO_db03061b_db31_4132_a47a_6a634846578b)

**Elucidation:** A standalone atom with an unbalanced number of electrons with respect to its atomic number.

**Comment:** The ion\_atom is the basic part of a pure ionic bonded compound i.e. without electron sharing,

**Relations:**

- is\_a materials.StandaloneAtom

## Molecule

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_3397f270\\_dfc1\\_4500\\_8f6f\\_4d0d85ac5f71](http://emmo.info/emmo/middle/materials#EMMO_3397f270_dfc1_4500_8f6f_4d0d85ac5f71)

**Elucidation:** An atom\_based state defined by an exact number of e-bonded atomic species and an electron cloud made of the shared electrons.

**Example:** H2O, C6H12O6, CH4

**Comment:** An entity is called essential if removing one direct part will lead to a change in entity class.

An entity is called redundant if removing one direct part will not lead to a change in entity class.

**Comment:** This definition states that this object is a non-periodic set of atoms or a set with a finite periodicity.

Removing an atom from the state will result in another type of atom\_based state.

e.g. you cannot remove H from H2O without changing the molecule type (essential). However, you can remove a C from a nanotube (redundant). C60 fullerene is a molecule, since it has a finite periodicity and is made of a well defined number of atoms (essential). A C nanotube is not a molecule, since it has an infinite periodicity (redundant).

**Relations:**

- is\_a physicalistic.Matter

## BondedAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_8303a247\\_f9d9\\_4616\\_bdcd\\_f5cbd7b298e3](http://emmo.info/emmo/middle/materials#EMMO_8303a247_f9d9_4616_bdcd_f5cbd7b298e3)

**Elucidation:** An bonded atom that shares at least one electron to the atom-based entity of which is part of.

**Comment:** A real bond between atoms is always something hybrid between covalent, metallic and ionic.

In general, metallic and ionic bonds have atoms sharing electrons.

**Comment:** The bond types that are covered by this definition are the strong electronic bonds: covalent, metallic and ionic.

**Comment:** This class can be used to represent molecules as simplified quantum systems, in which outer molecule shared electrons are un-entangled with the inner shells of the atoms composing the molecule.

**Relations:**

- is\_a materials.Atom

## NaturalMaterial

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_75fe4fd1\\_0f7e\\_429b\\_b91d\\_59d248561bae](http://emmo.info/emmo/middle/materials#EMMO_75fe4fd1_0f7e_429b_b91d_59d248561bae)

**Elucidation:** A Material occurring in nature, without the need of human intervention.

**Relations:**

- is\_a physicalistic.Material

## ReactiveMaterial

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_68390bfb\\_e307\\_479d\\_8f78\\_d66d8773cb1d](http://emmo.info/emmo/middle/materials#EMMO_68390bfb_e307_479d_8f78_d66d8773cb1d)

**Elucidation:** A material that undergoes chemical changes.

**Relations:**

- is\_a physicalistic.Material

## EngineeredMaterial

**IRI:** [http://emmo.info/emmo/middle/manufacturing#EMMO\\_ec7464a9\\_d99d\\_45f8\\_965b\\_4e9230ea8356](http://emmo.info/emmo/middle/manufacturing#EMMO_ec7464a9_d99d_45f8_965b_4e9230ea8356)

**Comment:** A material that is synthesized within a manufacturing process.

**Relations:**

- is\_a manufacturing.Engineered
- is\_a physicalistic.Material
- Inverse(holistic.hasProperParticipant) some manufacturing.ContinuousManufacturing

## Matter

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_5b222df\\_4da6\\_442f\\_8244\\_96e9e45887d1](http://emmo.info/emmo/middle/physicalistic#EMMO_5b222df_4da6_442f_8244_96e9e45887d1)

**Elucidation:** A 'Physical' that possesses some 'Massive' parts.

**Relations:**

- is\_a physicalistic.Physicalistic
- is\_a semiotics.Object
- is\_a physical.Physical
- properties.hasProperty some isq.CentreOfMass
- properties.hasProperty some isq.Mass
- properties.hasProperty some isq.Volume
- mereotopology.hasPart some physicalistic.Massive
- physical.hasTemporalPart only physicalistic.Matter

## NeutralAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4588526f\\_8553\\_4f4d\\_aa73\\_a483e88d599b](http://emmo.info/emmo/middle/materials#EMMO_4588526f_8553_4f4d_aa73_a483e88d599b)

**Elucidation:** A standalone atom that has no net charge.

**Relations:**

- is\_a materials.StandaloneAtom

## Continuum

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_8b0923ab\\_b500\\_477b\\_9ce9\\_8b3a3e4dc4f2](http://emmo.info/emmo/middle/materials#EMMO_8b0923ab_b500_477b_9ce9_8b3a3e4dc4f2)

**Elucidation:** A state that is a collection of sufficiently large number of other parts such that: - it is the bearer of qualities that can exist only by the fact that it is a sum of parts - the smallest partition  $dV$  of the state volume in which we are interested in, contains enough parts to be statistically consistent:  $n \left[ \frac{\#}{m^3} \right] \times dV \left[ m^3 \right] \gg 1$

**Comment:** A continuum is made of a sufficient number of parts that it continues to exist as continuum individual even after the loss of one of them i.e. a continuum is a redundant.

**Comment:** A continuum is not necessarily small (i.e. composed by the minimum amount of states to fulfill the definition).

A single continuum individual can be the whole fluid in a pipe.

**Comment:** A continuum is the bearer of properties that are generated by the interactions of parts such as viscosity and thermal or electrical conductivity.

**Relations:**

- is\_a physicalistic.Matter

## StandaloneAtom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_2fd3f574\\_5e93\\_47fe\\_afca\\_ed80b0a21ab4](http://emmo.info/emmo/middle/materials#EMMO_2fd3f574_5e93_47fe_afca_ed80b0a21ab4)

**Elucidation:** An atom that does not share electrons with other atoms.

**Comment:** A standalone atom can be bonded with other atoms by intermolecular forces (i.e. dipole–dipole, London dispersion force, hydrogen bonding), since this bonds does not involve electron sharing.

**Relations:**

- is\_a materials.Atom
- disjoint\_union\_of materials.NeutralAtom, materials.IonAtom

## Material

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_4207e895\\_8b83\\_4318\\_996a\\_72cfb32acd94](http://emmo.info/emmo/middle/physicalistic#EMMO_4207e895_8b83_4318_996a_72cfb32acd94)

**Elucidation:** A matter individual that stands for a real world object representing an amount of a physical substance (or mixture of substances) in different states of matter or phases.

**Comment:** A instance of a material (e.g. nitrogen) can represent different states of matter. The fact that the individual also belongs to other classes (e.g. Gas) would reveal the actual form in which the material is found.

**Comment:** Material usually means some definite kind, quality, or quantity of matter, especially as intended for use.

**Relations:**

- is\_a physicalistic.Matter

## NanoParticle

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_10dd1eed\\_da7d\\_45a3\\_860c\\_477ca9e152aa](http://emmo.info/emmo/middle/materials#EMMO_10dd1eed_da7d_45a3_860c_477ca9e152aa)

**Elucidation:** Nanomaterials are Materials possessing all external dimension measuring 1-100nm

**Relations:**

- is\_a materials.NanoMaterial

## Atom

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_eb77076b\\_a104\\_42ac\\_a065\\_798b2d2809ad](http://emmo.info/emmo/middle/materials#EMMO_eb77076b_a104_42ac_a065_798b2d2809ad)

**Elucidation:** A standalone atom has direct part one ‘nucleus’ and one ‘electron\_cloud’.

An O ‘atom’ within an O<sub>2</sub> ‘molecule’ is an ‘e-bonded\_atom’.

In this material branch, H atom is a particular case, with respect to higher atomic number atoms, since as soon as it shares its electron it has no nucleus entangled electron cloud.

We cannot say that H<sub>2</sub> molecule has direct part two H atoms, but has direct part two H nucleus.

**Comment:** An ‘atom’ is a ‘nucleus’ surrounded by an ‘electron\_cloud’, i.e. a quantum system made of one or more bounded electrons.

**Relations:**

- is\_a physicalistic.Matter
- is\_a reductionistic.State
- properties.hasProperty some isq.AtomicNumber
- properties.hasProperty some isq.AtomicMass
- properties.hasProperty some isq.MagneticDipoleMoment
- reductionistic.hasSpatialDirectPart some materials.ElectronCloud
- reductionistic.hasSpatialDirectPart some materials.Nucleus

## NanoMaterial

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5d659e25\\_a508\\_43ed\\_903c\\_3707c7c7cd4b](http://emmo.info/emmo/middle/materials#EMMO_5d659e25_a508_43ed_903c_3707c7c7cd4b)

**Elucidation:** Nanomaterials are Materials possessing, at minimum, one external dimension measuring 1-100nm

**Relations:**

- is\_a physicalistic.Material

## PhaseOfMatter

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_668fbd5b\\_6f1b\\_405c\\_9c6b\\_d6067bd0595a](http://emmo.info/emmo/middle/materials#EMMO_668fbd5b_6f1b_405c_9c6b_d6067bd0595a)

**Elucidation:** A matter object throughout which all physical properties of a material are essentially uniform.

**Comment:** In the physical sciences, a phase is a region of space (a thermodynamic system), throughout which all physical properties of a material are essentially uniform. Examples of physical properties include density, index of refraction, magnetization and chemical composition. A simple description is that a phase is a region of material that is chemically uniform, physically distinct, and (often) mechanically separable. In a system consisting of ice and water in a glass jar, the ice cubes are one phase, the water is a second phase, and the humid air is a third phase over the ice and water. The glass of the jar is another separate phase.

The term phase is sometimes used as a synonym for state of matter, but there can be several immiscible phases of the same state of matter. Also, the term phase is sometimes used to refer to a set of equilibrium states demarcated in terms of state variables such as pressure and temperature by a phase boundary on a phase diagram. Because phase boundaries relate to changes in the organization of matter, such as a change from liquid to solid or a more subtle change from one crystal structure to another, this latter usage is similar to the use of “phase” as a synonym for state of matter. However, the state of matter and phase diagram usages are not commensurate with the formal definition given above and the intended meaning must be determined in part from the context in which the term is used.

[[https://en.wikipedia.org/wiki/Phase\\_\(matter\)](https://en.wikipedia.org/wiki/Phase_(matter))]

**Relations:**

- is\_a materials.Continuum
- is\_a physicalistic.Matter

## Electron

**IRI:** [http://emmo.info/emmo/middle/physicalistic#EMMO\\_8043d3c6\\_a4c1\\_4089\\_ba34\\_9744e28e5b3d](http://emmo.info/emmo/middle/physicalistic#EMMO_8043d3c6_a4c1_4089_ba34_9744e28e5b3d)

**Elucidation:** The class of individuals that stand for electrons elementary particles.

**Relations:**

- is\_a physicalistic.Massive
- is\_a physicalistic.Matter
- is\_a physical.Elementary
- properties.hasProperty some isq.ElectronMass
- properties.hasProperty some isq.ElectronCharge

## Fluid branch

### Dust

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e4281979\\_2b07\\_4a43\\_a772\\_4903fb3696fe](http://emmo.info/emmo/middle/materials#EMMO_e4281979_2b07_4a43_a772_4903fb3696fe)

**Elucidation:** A suspension of fine particles in the atmosphere.

**Relations:**

- is\_a materials.GasSolidSuspension

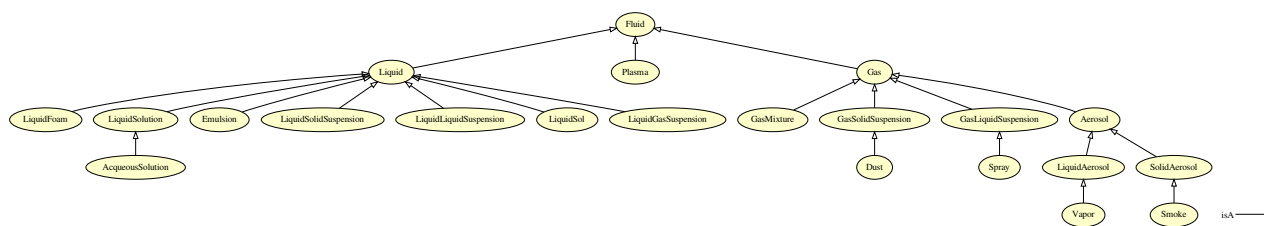


Figure 3.41: Fluid branch.

## LiquidFoam

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d69d2e95\\_b22f\\_499a\\_a552\\_17fde0d778fc](http://emmo.info/emmo/middle/materials#EMMO_d69d2e95_b22f_499a_a552_17fde0d778fc)

**Elucidation:** A foam of trapped gas in a liquid.

**Relations:**

- is\_a materials.Foam
- is\_a materials.Liquid

## SolidAerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_96c8d72f\\_b436\\_44e2\\_9f7f\\_085c24094292](http://emmo.info/emmo/middle/materials#EMMO_96c8d72f_b436_44e2_9f7f_085c24094292)

**Elucidation:** An aerosol composed of fine solid particles in air or another gas.

**Relations:**

- is\_a materials.Aerosol

## GasLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e0edfb9e\\_9a96\\_4fae\\_b942\\_831ffe27b84a](http://emmo.info/emmo/middle/materials#EMMO_e0edfb9e_9a96_4fae_b942_831ffe27b84a)

**Elucidation:** A coarse dispersion of liquid in a gas continuum phase.

**Example:** Rain, spray.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## Plasma

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4c21fb86\\_fdcf\\_444e\\_b498\\_86fe656295af](http://emmo.info/emmo/middle/materials#EMMO_4c21fb86_fdcf_444e_b498_86fe656295af)

**Elucidation:** A fluid in which a gas is ionized to a level where its electrical conductivity allows long-range electric and magnetic fields to dominate its behaviour.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## AcqueousSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5cb107ba\\_7daa\\_46dd\\_8f9f\\_da22a6eac676](http://emmo.info/emmo/middle/materials#EMMO_5cb107ba_7daa_46dd_8f9f_da22a6eac676)

**Elucidation:** A liquid solution in which the solvent is water.

**Relations:**

- is\_a materials.LiquidSolution

## Vapor

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4d604a13\\_d1f6\\_42fd\\_818f\\_d3138d5e308c](http://emmo.info/emmo/middle/materials#EMMO_4d604a13_d1f6_42fd_818f_d3138d5e308c)

**Elucidation:** A liquid aerosol composed of water droplets in air or another gas.

**Relations:**

- is\_a materials.LiquidAerosol

## Gas

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_04f2a2d5\\_e799\\_4692\\_a654\\_420e76f5acc1](http://emmo.info/emmo/middle/materials#EMMO_04f2a2d5_e799_4692_a654_420e76f5acc1)

**Elucidation:** Gas is a compressible fluid, a state of matter that has no fixed shape and no fixed volume.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## LiquidLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_47fe2379\\_be21\\_48d1\\_9ede\\_402f0faf494b](http://emmo.info/emmo/middle/materials#EMMO_47fe2379_be21_48d1_9ede_402f0faf494b)

**Elucidation:** A coarse dispersion of liquid in a liquid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## Liquid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_7509da43\\_56b1\\_4d7f\\_887a\\_65d1663df4ba](http://emmo.info/emmo/middle/materials#EMMO_7509da43_56b1_4d7f_887a_65d1663df4ba)

**Elucidation:** A liquid is a nearly incompressible fluid that conforms to the shape of its container but retains a (nearly) constant volume independent of pressure.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## LiquidAerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_94010cbc\\_c2a6\\_4cb9\\_b29a\\_83aa99d2ff70](http://emmo.info/emmo/middle/materials#EMMO_94010cbc_c2a6_4cb9_b29a_83aa99d2ff70)

**Elucidation:** An aerosol composed of liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Aerosol

## LiquidSol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4354ac74\\_7425\\_43ab\\_92e4\\_6dc19d1afee9](http://emmo.info/emmo/middle/materials#EMMO_4354ac74_7425_43ab_92e4_6dc19d1afee9)

**Elucidation:** A type of sol in the form of one solid dispersed in liquid.

**Relations:**

- is\_a materials.Sol
- is\_a materials.Liquid

## Aerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_560d833a\\_6184\\_410c\\_859a\\_05d982712fd7](http://emmo.info/emmo/middle/materials#EMMO_560d833a_6184_410c_859a_05d982712fd7)

**Elucidation:** A colloid composed of fine solid particles or liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Colloid

## Fluid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_87ac88ff\\_8379\\_4f5a\\_8c7b\\_424a8fff1ee8](http://emmo.info/emmo/middle/materials#EMMO_87ac88ff_8379_4f5a_8c7b_424a8fff1ee8)

**Elucidation:** A continuum that has no fixed shape and yields easily to external pressure.

**Example:** Gas, liquid, plasma,

**Relations:**

- is\_a materials.Continuum

## LiquidGasSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_42185fe7\\_122c\\_4e0c\\_a3cd\\_659d3e21c389](http://emmo.info/emmo/middle/materials#EMMO_42185fe7_122c_4e0c_a3cd_659d3e21c389)

**Elucidation:** A coarse dispersion of gas in a liquid continuum phase.

**Example:** Sparkling water

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## LiquidSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4b3e2374\\_52a1\\_4420\\_8e3f\\_3ae6b9bf7dff](http://emmo.info/emmo/middle/materials#EMMO_4b3e2374_52a1_4420_8e3f_3ae6b9bf7dff)

**Elucidation:** A liquid solution made of two or more component substances.

**Relations:**

- is\_a materials.Solution
- is\_a materials.Liquid

## Emulsion

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_40e18c93\\_a1b5\\_49ff\\_b06a\\_d9d932d1fb65](http://emmo.info/emmo/middle/materials#EMMO_40e18c93_a1b5_49ff_b06a_d9d932d1fb65)

**Elucidation:** An emulsion is a mixture of two or more liquids that are normally immiscible (a liquid-liquid heterogeneous mixture).

**Example:** Mayonnaise, milk.

**Relations:**

- is\_a materials.Colloid
- is\_a materials.Liquid



## LiquidSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e9e02156\\_651f\\_41c8\\_9efb\\_d5da0d4ce5e2](http://emmo.info/emmo/middle/materials#EMMO_e9e02156_651f_41c8_9efb_d5da0d4ce5e2)

**Elucidation:** A coarse dispersion of solids in a liquid continuum phase.

**Example:** Mud

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## GasMixture

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5be9c137\\_325a\\_43d8\\_b7cd\\_ea93e7721c2d](http://emmo.info/emmo/middle/materials#EMMO_5be9c137_325a_43d8_b7cd_ea93e7721c2d)

**Elucidation:** A gaseous solution made of more than one component type.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Solution

## GasSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d4f37e32\\_16ae\\_4cc6\\_b4cd\\_fd896b2449c4](http://emmo.info/emmo/middle/materials#EMMO_d4f37e32_16ae_4cc6_b4cd_fd896b2449c4)

**Elucidation:** A coarse dispersion of solid in a gas continuum phase.

**Example:** Dust, sand storm.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## Smoke

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5a2af26d\\_99de\\_4e5e\\_b1cd\\_514be71420c3](http://emmo.info/emmo/middle/materials#EMMO_5a2af26d_99de_4e5e_b1cd_514be71420c3)

**Elucidation:** Smoke is a solid aerosol made of particles emitted when a material undergoes combustion or pyrolysis.

**Relations:**

- is\_a materials.SolidAerosol

## Spray

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_498aad49\\_f8d4\\_40a4\\_a9eb\\_efd563a0115f](http://emmo.info/emmo/middle/materials#EMMO_498aad49_f8d4_40a4_a9eb_efd563a0115f)

**Elucidation:** A suspension of liquid droplets dispersed in a gas through an atomization process.

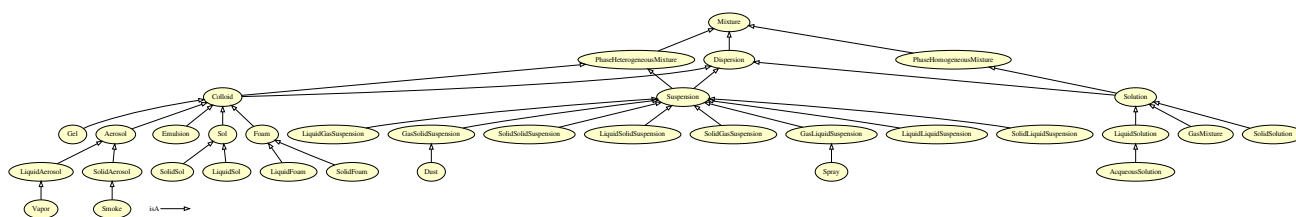
**Relations:**

- is\_a materials.GasLiquidSuspension

## Mixture branch

### Dust

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e4281979\\_2b07\\_4a43\\_a772\\_4903fb3696fe](http://emmo.info/emmo/middle/materials#EMMO_e4281979_2b07_4a43_a772_4903fb3696fe)



**Elucidation:** A suspension of fine particles in the atmosphere.

- is\_a materials.GasSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_9bed5d66\\_805a\\_4b3a\\_9153\\_beaf67143848](http://emmo.info/emmo/middle/materials#EMMO_9bed5d66_805a_4b3a_9153_beaf67143848)

**Relations:**

- is\_a materials.Foam
- is\_a materials.Solid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_96c8d72f\\_b436\\_44e2\\_9f7f\\_085c24094292](http://emmo.info/emmo/middle/materials#EMMO_96c8d72f_b436_44e2_9f7f_085c24094292)

- is a materials.Aerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_0e030040\\_98a7\\_49b2\\_a871\\_dced1f3a6131](http://emmo.info/emmo/middle/materials#EMMO_0e030040_98a7_49b2_a871_dced1f3a6131)

For example, immiscible liquid phases (e.g. oil and water) constitute a mixture whose phases are clearly separated but share the same state of matter.

**Relations:**

- is\_a materials.Mixture
- mereotopology.hasProperPart some materials.PhaseOfMatter

## PhaseHomogeneousMixture

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_0e6378df\\_1ce8\\_4321\\_b00c\\_ee9beea60a67](http://emmo.info/emmo/middle/materials#EMMO_0e6378df_1ce8_4321_b00c_ee9beea60a67)

**Relations:**

- is\_a materials.Mixture

## GasLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e0edfb9e\\_9a96\\_4fae\\_b942\\_831ffe27b84a](http://emmo.info/emmo/middle/materials#EMMO_e0edfb9e_9a96_4fae_b942_831ffe27b84a)

**Elucidation:** A coarse dispersion of liquid in a gas continuum phase.

**Example:** Rain, spray.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## AcqueousSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5cb107ba\\_7daa\\_46dd\\_8f9f\\_da22a6eac676](http://emmo.info/emmo/middle/materials#EMMO_5cb107ba_7daa_46dd_8f9f_da22a6eac676)

**Elucidation:** A liquid solution in which the solvent is water.

**Relations:**

- is\_a materials.LiquidSolution

## LiquidLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_47fe2379\\_be21\\_48d1\\_9ede\\_402f0faf494b](http://emmo.info/emmo/middle/materials#EMMO_47fe2379_be21_48d1_9ede_402f0faf494b)

**Elucidation:** A coarse dispersion of liquid in a liquid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## SolidLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_33e0ac8b\\_a318\\_4285\\_b1de\\_e95347784632](http://emmo.info/emmo/middle/materials#EMMO_33e0ac8b_a318_4285_b1de_e95347784632)

**Elucidation:** A coarse dispersion of liquid in a solid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## LiquidAerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_94010cbc\\_c2a6\\_4cb9\\_b29a\\_83aa99d2ff70](http://emmo.info/emmo/middle/materials#EMMO_94010cbc_c2a6_4cb9_b29a_83aa99d2ff70)

**Elucidation:** An aerosol composed of liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Aerosol

## LiquidGasSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_42185fe7\\_122c\\_4e0c\\_a3cd\\_659d3e21c389](http://emmo.info/emmo/middle/materials#EMMO_42185fe7_122c_4e0c_a3cd_659d3e21c389)

**Elucidation:** A coarse dispersion of gas in a liquid continuum phase.

**Example:** Sparkling water

**Relations:**

- is\_a materials.Suspension

- is\_a materials.Liquid

## LiquidSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4b3e2374\\_52a1\\_4420\\_8e3f\\_3ae6b9bf7dff](http://emmo.info/emmo/middle/materials#EMMO_4b3e2374_52a1_4420_8e3f_3ae6b9bf7dff)

**Elucidation:** A liquid solution made of two or more component substances.

**Relations:**

- is\_a materials.Solution
- is\_a materials.Liquid

## Sol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_31557fae\\_b039\\_491c\\_bebb\\_0ccb8711d5a6](http://emmo.info/emmo/middle/materials#EMMO_31557fae_b039_491c_bebb_0ccb8711d5a6)

**Elucidation:** A colloid in which small particles (1 nm to 100 nm) are suspended in a continuum phase.

**Relations:**

- is\_a materials.Colloid

## GasMixture

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5be9c137\\_325a\\_43d8\\_b7cd\\_ea93e7721c2d](http://emmo.info/emmo/middle/materials#EMMO_5be9c137_325a_43d8_b7cd_ea93e7721c2d)

**Elucidation:** A gaseous solution made of more than one component type.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Solution

## GasSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d4f37e32\\_16ae\\_4cc6\\_b4cd\\_fd896b2449c4](http://emmo.info/emmo/middle/materials#EMMO_d4f37e32_16ae_4cc6_b4cd_fd896b2449c4)

**Elucidation:** A coarse dispersion of solid in a gas continuum phase.

**Example:** Dust, sand storm.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## Smoke

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5a2af26d\\_99de\\_4e5e\\_b1cd\\_514be71420c3](http://emmo.info/emmo/middle/materials#EMMO_5a2af26d_99de_4e5e_b1cd_514be71420c3)

**Elucidation:** Smoke is a solid aerosol made of particles emitted when a material undergoes combustion or pyrolysis.

**Relations:**

- is\_a materials.SolidAerosol

## Spray

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_498aad49\\_f8d4\\_40a4\\_a9eb\\_efd563a0115f](http://emmo.info/emmo/middle/materials#EMMO_498aad49_f8d4_40a4_a9eb_efd563a0115f)

**Elucidation:** A suspension of liquid droplets dispersed in a gas through an atomization process.

**Relations:**

- is\_a materials.GasLiquidSuspension

## LiquidFoam

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d69d2e95\\_b22f\\_499a\\_a552\\_17fde0d778fc](http://emmo.info/emmo/middle/materials#EMMO_d69d2e95_b22f_499a_a552_17fde0d778fc)

**Elucidation:** A foam of trapped gas in a liquid.

**Relations:**

- is\_a materials.Foam
- is\_a materials.Liquid

## Suspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4a464c8d\\_8895\\_44a8\\_a628\\_aed13509f1bd](http://emmo.info/emmo/middle/materials#EMMO_4a464c8d_8895_44a8_a628_aed13509f1bd)

**Elucidation:** An heterogeneous mixture that contains coarsly dispersed particles (no Tyndall effect), that generally tend to separate in time to the dispersion medium phase.

**Comment:** Suspensions show no significant effect on light.

**Relations:**

- is\_a materials.Dispersion
- is\_a materials.PhaseHeterogeneousMixture
- is\_a materials.StateOfMatter
- disjoint\_union\_of materials.SolidSolidSuspension, materials.SolidLiquidSuspension, materials.LiquidGasSuspension, materials.LiquidLiquidSuspension, materials.SolidGasSuspension, materials.GasSolidSuspension, materials.GasLiquidSuspension, materials.LiquidSolidSuspension

## Mixture

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_ec2c8ac8\\_98c5\\_4c74\\_b85b\\_ff8e8ca6655c](http://emmo.info/emmo/middle/materials#EMMO_ec2c8ac8_98c5_4c74_b85b_ff8e8ca6655c)

**Elucidation:** A Mixture is a material made up of two or more different substances which are physically (not chemically) combined.

**Relations:**

- is\_a materials.Continuum

## Foam

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_1f5e3e7e\\_72c9\\_40d4\\_91dd\\_ae432d7b7018](http://emmo.info/emmo/middle/materials#EMMO_1f5e3e7e_72c9_40d4_91dd_ae432d7b7018)

**Elucidation:** A colloid formed by trapping pockets of gas in a liquid or solid.

**Relations:**

- is\_a materials.Colloid

## Solution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_2031516a\\_2be7\\_48e8\\_9af7\\_7e1270e308fe](http://emmo.info/emmo/middle/materials#EMMO_2031516a_2be7_48e8_9af7_7e1270e308fe)

**Elucidation:** A solution is a homogeneous mixture composed of two or more substances.

**Comment:** Solutions are characterized by the occurrence of Rayleigh scattering on light,

**Relations:**

- is\_a materials.Dispersion
- is\_a materials.PhaseHomogeneousMixture

## Dispersion

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_0b15f4ae\\_092e\\_4487\\_9100\\_3c44176c545c](http://emmo.info/emmo/middle/materials#EMMO_0b15f4ae_092e_4487_9100_3c44176c545c)

**Elucidation:** A material in which distributed particles of one phase are dispersed in a different continuous phase.

**Relations:**

- is\_a materials.Mixture
- disjoint\_union\_of materials.Solution, materials.Suspension, materials.Colloid

## SolidSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5e77f00d\\_5c0a\\_44e7\\_baf1\\_2c2a4cb5b3ae](http://emmo.info/emmo/middle/materials#EMMO_5e77f00d_5c0a_44e7_baf1_2c2a4cb5b3ae)

**Elucidation:** A solid solution made of two or more component substances.

**Relations:**

- is\_a materials.Solution
- is\_a materials.Solid

## Vapor

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4d604a13\\_d1f6\\_42fd\\_818f\\_d3138d5e308c](http://emmo.info/emmo/middle/materials#EMMO_4d604a13_d1f6_42fd_818f_d3138d5e308c)

**Elucidation:** A liquid aerosol composed of water droplets in air or another gas.

**Relations:**

- is\_a materials.LiquidAerosol

## Gel

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_3995e22d\\_5720\\_4dcf\\_ba3b\\_d0ce03f514c6](http://emmo.info/emmo/middle/materials#EMMO_3995e22d_5720_4dcf_ba3b_d0ce03f514c6)

**Elucidation:** A soft, solid or solid-like colloid consisting of two or more components, one of which is a liquid, present in substantial quantity.

**Relations:**

- is\_a materials.Colloid
- is\_a materials.Solid

## LiquidSol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4354ac74\\_7425\\_43ab\\_92e4\\_6dc19d1afee9](http://emmo.info/emmo/middle/materials#EMMO_4354ac74_7425_43ab_92e4_6dc19d1afee9)

**Elucidation:** A type of sol in the form of one solid dispersed in liquid.

**Relations:**

- is\_a materials.Sol
- is\_a materials.Liquid

## Aerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_560d833a\\_6184\\_410c\\_859a\\_05d982712fd7](http://emmo.info/emmo/middle/materials#EMMO_560d833a_6184_410c_859a_05d982712fd7)

**Elucidation:** A colloid composed of fine solid particles or liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Colloid

## SolidSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_2dd512a1\\_5187\\_47cc\\_b0b8\\_141214e22b59](http://emmo.info/emmo/middle/materials#EMMO_2dd512a1_5187_47cc_b0b8_141214e22b59)

**Elucidation:** A coarse dispersion of solid in a solid continuum phase.

**Example:** Granite, sand, dried concrete.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## Emulsion

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_40e18c93\\_a1b5\\_49ff\\_b06a\\_d9d932d1fb65](http://emmo.info/emmo/middle/materials#EMMO_40e18c93_a1b5_49ff_b06a_d9d932d1fb65)

**Elucidation:** An emulsion is a mixture of two or more liquids that are normally immiscible (a liquid-liquid heterogeneous mixture).

**Example:** Mayonnaise, milk.

**Relations:**

- is\_a materials.Colloid
- is\_a materials.Liquid

## LiquidSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e9e02156\\_651f\\_41c8\\_9efb\\_d5da0d4ce5e2](http://emmo.info/emmo/middle/materials#EMMO_e9e02156_651f_41c8_9efb_d5da0d4ce5e2)

**Elucidation:** A coarse dispersion of solids in a liquid continuum phase.

**Example:** Mud

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## SolidSol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5add9885\\_dc98\\_4fa5\\_8482\\_fdf9ba5e3889](http://emmo.info/emmo/middle/materials#EMMO_5add9885_dc98_4fa5_8482_fdf9ba5e3889)

**Elucidation:** A type of sol in the form of one solid dispersed in another continuous solid.

**Relations:**

- is\_a materials.Sol
- is\_a materials.Solid

## SolidGasSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_c457b6b9\\_5e73\\_4853\\_ae08\\_d776c12b8058](http://emmo.info/emmo/middle/materials#EMMO_c457b6b9_5e73_4853_ae08_d776c12b8058)

**Elucidation:** A coarse dispersion of gas in a solid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## Colloid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_6c487fb3\\_03d1\\_4e56\\_91ed\\_c2e16dcbef60](http://emmo.info/emmo/middle/materials#EMMO_6c487fb3_03d1_4e56_91ed_c2e16dcbef60)

**Elucidation:** A mixture in which one substance of microscopically dispersed insoluble or soluble particles (from 1 nm to 1  $\mu\text{m}$ ) is suspended throughout another substance and that does not settle, or would take a very long time to settle appreciably.

**Comment:** Colloids are characterized by the occurring of the Tyndall effect on light.

**Relations:**

- is\_a materials.Dispersion
- is\_a materials.PhaseHeterogeneousMixture

## State Of Matter branch

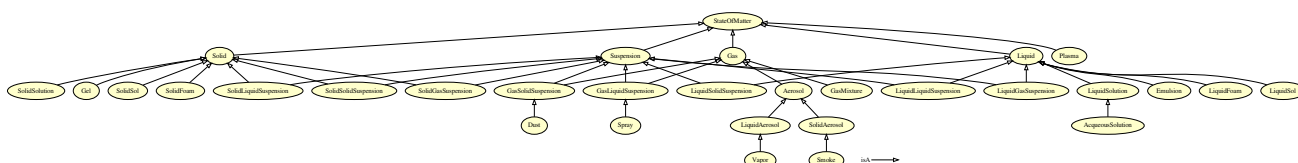


Figure 3.43: State Of Matter branch.

## Dust

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e4281979\\_2b07\\_4a43\\_a772\\_4903fb3696fe](http://emmo.info/emmo/middle/materials#EMMO_e4281979_2b07_4a43_a772_4903fb3696fe)

**Elucidation:** A suspension of fine particles in the atmosphere.

**Relations:**

- is\_a materials.GasSolidSuspension

## LiquidFoam

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d69d2e95\\_b22f\\_499a\\_a552\\_17fde0d778fc](http://emmo.info/emmo/middle/materials#EMMO_d69d2e95_b22f_499a_a552_17fde0d778fc)

**Elucidation:** A foam of trapped gas in a liquid.

**Relations:**

- is\_a materials.Foam
- is\_a materials.Liquid



## SolidAerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_96c8d72f\\_b436\\_44e2\\_9f7f\\_085c24094292](http://emmo.info/emmo/middle/materials#EMMO_96c8d72f_b436_44e2_9f7f_085c24094292)

**Elucidation:** An aerosol composed of fine solid particles in air or another gas.

**Relations:**

- is\_a materials.Aerosol

## Suspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4a464c8d\\_8895\\_44a8\\_a628\\_aed13509f1bd](http://emmo.info/emmo/middle/materials#EMMO_4a464c8d_8895_44a8_a628_aed13509f1bd)

**Elucidation:** An heterogeneous mixture that contains coarsly dispersed particles (no Tyndall effect), that generally tend to separate in time to the dispersion medium phase.

**Comment:** Suspensions show no significant effect on light.

**Relations:**

- is\_a materials.Dispersion
- is\_a materials.PhaseHeterogeneousMixture
- is\_a materials.StateOfMatter
- disjoint\_union\_of materials.SolidSolidSuspension, materials.SolidLiquidSuspension, materials.LiquidGasSuspension, materials.LiquidLiquidSuspension, materials.SolidGasSuspension, materials.GasSolidSuspension, materials.GasLiquidSuspension, materials.LiquidSolidSuspension

## SolidFoam

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_9bed5d66\\_805a\\_4b3a\\_9153\\_beaf67143848](http://emmo.info/emmo/middle/materials#EMMO_9bed5d66_805a_4b3a_9153_beaf67143848)

**Elucidation:** A foam of trapped gas in a solid.

**Example:** Aerogel

**Relations:**

- is\_a materials.Foam
- is\_a materials.Solid

## Solid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_a2b006f2\\_bbfd\\_4dba\\_bcaa\\_3fca20cd6be1](http://emmo.info/emmo/middle/materials#EMMO_a2b006f2_bbfd_4dba_bcaa_3fca20cd6be1)

**Elucidation:** A continuum characterized by structural rigidity and resistance to changes of shape or volume, that retains its shape and density when not confined.

**Relations:**

- is\_a materials.StateOfMatter
- is\_a materials.Continuum

## GasLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e0edfb9e\\_9a96\\_4fae\\_b942\\_831ffe27b84a](http://emmo.info/emmo/middle/materials#EMMO_e0edfb9e_9a96_4fae_b942_831ffe27b84a)

**Elucidation:** A coarse dispersion of liquid in a gas continuum phase.

**Example:** Rain, spray.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## SolidSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5e77f00d\\_5c0a\\_44e7\\_baf1\\_2c2a4cb5b3ae](http://emmo.info/emmo/middle/materials#EMMO_5e77f00d_5c0a_44e7_baf1_2c2a4cb5b3ae)

**Elucidation:** A solid solution made of two or more component substances.

**Relations:**

- is\_a materials.Solution
- is\_a materials.Solid

## AcqueousSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5cb107ba\\_7daa\\_46dd\\_8f9f\\_da22a6eac676](http://emmo.info/emmo/middle/materials#EMMO_5cb107ba_7daa_46dd_8f9f_da22a6eac676)

**Elucidation:** A liquid solution in which the solvent is water.

**Relations:**

- is\_a materials.LiquidSolution

## Vapor

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4d604a13\\_d1f6\\_42fd\\_818f\\_d3138d5e308c](http://emmo.info/emmo/middle/materials#EMMO_4d604a13_d1f6_42fd_818f_d3138d5e308c)

**Elucidation:** A liquid aerosol composed of water droplets in air or another gas.

**Relations:**

- is\_a materials.LiquidAerosol

## Gas

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_04f2a2d5\\_e799\\_4692\\_a654\\_420e76f5acc1](http://emmo.info/emmo/middle/materials#EMMO_04f2a2d5_e799_4692_a654_420e76f5acc1)

**Elucidation:** Gas is a compressible fluid, a state of matter that has no fixed shape and no fixed volume.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## Gel

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_3995e22d\\_5720\\_4dcf\\_ba3b\\_d0ce03f514c6](http://emmo.info/emmo/middle/materials#EMMO_3995e22d_5720_4dcf_ba3b_d0ce03f514c6)

**Elucidation:** A soft, solid or solid-like colloid consisting of two or more components, one of which is a liquid, present in substantial quantity.

**Relations:**

- is\_a materials.Colloid
- is\_a materials.Solid

## LiquidLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_47fe2379\\_be21\\_48d1\\_9ede\\_402f0faf494b](http://emmo.info/emmo/middle/materials#EMMO_47fe2379_be21_48d1_9ede_402f0faf494b)

**Elucidation:** A coarse dispersion of liquid in a liquid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## Liquid

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_7509da43\\_56b1\\_4d7f\\_887a\\_65d1663df4ba](http://emmo.info/emmo/middle/materials#EMMO_7509da43_56b1_4d7f_887a_65d1663df4ba)

**Elucidation:** A liquid is a nearly incompressible fluid that conforms to the shape of its container but retains a (nearly) constant volume independent of pressure.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## LiquidAerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_94010cbc\\_c2a6\\_4cb9\\_b29a\\_83aa99d2ff70](http://emmo.info/emmo/middle/materials#EMMO_94010cbc_c2a6_4cb9_b29a_83aa99d2ff70)

**Elucidation:** An aerosol composed of liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Aerosol

## StateOfMatter

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_b9695e87\\_8261\\_412e\\_83cd\\_a86459426a28](http://emmo.info/emmo/middle/materials#EMMO_b9695e87_8261_412e_83cd_a86459426a28)

**Elucidation:** A superclass made as the disjoint union of all the form under which matter can exist.

**Comment:** In physics, a state of matter is one of the distinct forms in which matter can exist. Four states of matter are observable in everyday life: solid, liquid, gas, and plasma.

[https://en.wikipedia.org/wiki/State\\_of\\_matter](https://en.wikipedia.org/wiki/State_of_matter)

**Relations:**

- is\_a materials.Continuum
- is\_a physicalistic.Matter
- disjoint\_union\_of materials.Gas, materials.Plasma, materials.Liquid, materials.Solid

## SolidLiquidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_33e0ac8b\\_a318\\_4285\\_b1de\\_e95347784632](http://emmo.info/emmo/middle/materials#EMMO_33e0ac8b_a318_4285_b1de_e95347784632)

**Elucidation:** A coarse dispersion of liquid in a solid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## LiquidSol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4354ac74\\_7425\\_43ab\\_92e4\\_6dc19d1afee9](http://emmo.info/emmo/middle/materials#EMMO_4354ac74_7425_43ab_92e4_6dc19d1afee9)

**Elucidation:** A type of sol in the form of one solid dispersed in liquid.

**Relations:**

- is\_a materials.Sol
- is\_a materials.Liquid

## Aerosol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_560d833a\\_6184\\_410c\\_859a\\_05d982712fd7](http://emmo.info/emmo/middle/materials#EMMO_560d833a_6184_410c_859a_05d982712fd7)

**Elucidation:** A colloid composed of fine solid particles or liquid droplets in air or another gas.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Colloid

## LiquidGasSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_42185fe7\\_122c\\_4e0c\\_a3cd\\_659d3e21c389](http://emmo.info/emmo/middle/materials#EMMO_42185fe7_122c_4e0c_a3cd_659d3e21c389)

**Elucidation:** A coarse dispersion of gas in a liquid continuum phase.

**Example:** Sparkling water

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## SolidSol

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5add9885\\_dc98\\_4fa5\\_8482\\_fdf9ba5e3889](http://emmo.info/emmo/middle/materials#EMMO_5add9885_dc98_4fa5_8482_fdf9ba5e3889)

**Elucidation:** A type of sol in the form of one solid dispersed in another continuous solid.

**Relations:**

- is\_a materials.Sol
- is\_a materials.Solid

## LiquidSolution

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4b3e2374\\_52a1\\_4420\\_8e3f\\_3ae6b9bf7dff](http://emmo.info/emmo/middle/materials#EMMO_4b3e2374_52a1_4420_8e3f_3ae6b9bf7dff)

**Elucidation:** A liquid solution made of two or more component substances.

**Relations:**

- is\_a materials.Solution
- is\_a materials.Liquid

## Emulsion

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_40e18c93\\_a1b5\\_49ff\\_b06a\\_d9d932d1fb65](http://emmo.info/emmo/middle/materials#EMMO_40e18c93_a1b5_49ff_b06a_d9d932d1fb65)

**Elucidation:** An emulsion is a mixture of two or more liquids that are normally immiscible (a liquid-liquid heterogeneous mixture).

**Example:** Mayonnaise, milk.

**Relations:**

- is\_a materials.Colloid
- is\_a materials.Liquid

## LiquidSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_e9e02156\\_651f\\_41c8\\_9efb\\_d5da0d4ce5e2](http://emmo.info/emmo/middle/materials#EMMO_e9e02156_651f_41c8_9efb_d5da0d4ce5e2)

**Elucidation:** A coarse dispersion of solids in a liquid continuum phase.

**Example:** Mud

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Liquid

## Plasma

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_4c21fb86\\_fdcf\\_444e\\_b498\\_86fe656295af](http://emmo.info/emmo/middle/materials#EMMO_4c21fb86_fdcf_444e_b498_86fe656295af)

**Elucidation:** A fluid in which a gas is ionized to a level where its electrical conductivity allows long-range electric and magnetic fields to dominate its behaviour.

**Relations:**

- is\_a materials.Fluid
- is\_a materials.StateOfMatter

## GasMixture

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5be9c137\\_325a\\_43d8\\_b7cd\\_ea93e7721c2d](http://emmo.info/emmo/middle/materials#EMMO_5be9c137_325a_43d8_b7cd_ea93e7721c2d)

**Elucidation:** A gaseous solution made of more than one component type.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Solution

## GasSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_d4f37e32\\_16ae\\_4cc6\\_b4cd\\_fd896b2449c4](http://emmo.info/emmo/middle/materials#EMMO_d4f37e32_16ae_4cc6_b4cd_fd896b2449c4)

**Elucidation:** A coarse dispersion of solid in a gas continuum phase.

**Example:** Dust, sand storm.

**Relations:**

- is\_a materials.Gas
- is\_a materials.Suspension

## SolidSolidSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_2dd512a1\\_5187\\_47cc\\_b0b8\\_141214e22b59](http://emmo.info/emmo/middle/materials#EMMO_2dd512a1_5187_47cc_b0b8_141214e22b59)

**Elucidation:** A coarse dispersion of solid in a solid continuum phase.

**Example:** Granite, sand, dried concrete.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## SolidGasSuspension

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_c457b6b9\\_5e73\\_4853\\_ae08\\_d776c12b8058](http://emmo.info/emmo/middle/materials#EMMO_c457b6b9_5e73_4853_ae08_d776c12b8058)

**Elucidation:** A coarse dispersion of gas in a solid continuum phase.

**Relations:**

- is\_a materials.Suspension
- is\_a materials.Solid

## Smoke

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_5a2af26d\\_99de\\_4e5e\\_b1cd\\_514be71420c3](http://emmo.info/emmo/middle/materials#EMMO_5a2af26d_99de_4e5e_b1cd_514be71420c3)

**Elucidation:** Smoke is a solid aerosol made of particles emitted when a material undergoes combustion or pyrolysis.

**Relations:**

- is\_a materials.SolidAerosol

## Spray

**IRI:** [http://emmo.info/emmo/middle/materials#EMMO\\_498aad49\\_f8d4\\_40a4\\_a9eb\\_efd563a0115f](http://emmo.info/emmo/middle/materials#EMMO_498aad49_f8d4_40a4_a9eb_efd563a0115f)

**Elucidation:** A suspension of liquid droplets dispersed in a gas through an atomization process.

**Relations:**

- is\_a materials.GasLiquidSuspension

## Chapter 4

# Individuals

### Universe

**IRI:** [http://emmo.info/emmo/top/mereotopology#EMMO\\_08cb807c\\_e626\\_447b\\_863f\\_e2835540e918](http://emmo.info/emmo/top/mereotopology#EMMO_08cb807c_e626_447b_863f_e2835540e918)

### Relations:

- is\_a physical.Physical

## Chapter 5

# Appendix

The complete taxonomy of EMMO relations

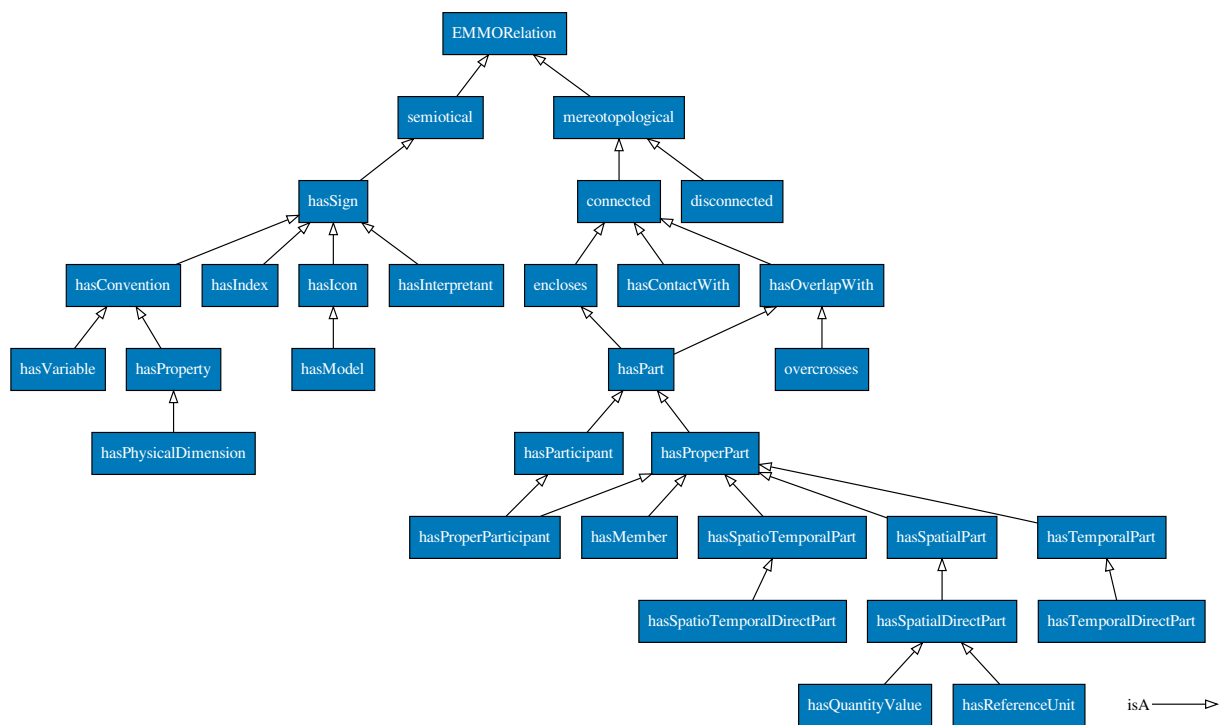


Figure 5.1: The complete taxonomy of EMMO relations.

The taxonomy of EMMO classes



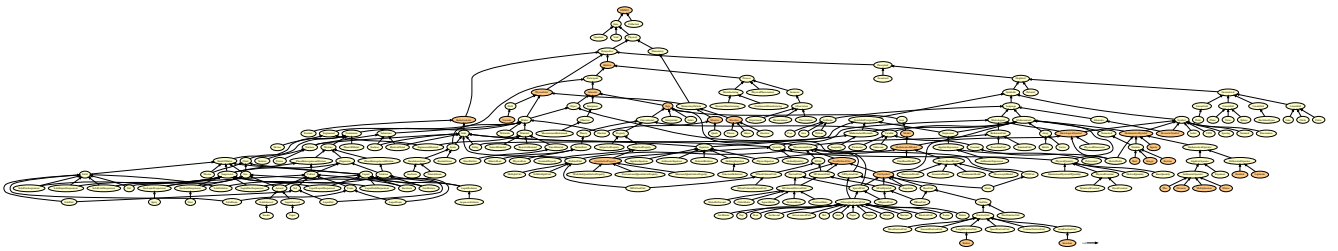


Figure 5.2: The almost complete taxonomy of EMMO classes. Only physical quantities and constants are left out.