Week 5: Leibniz and Cavendish

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Southern University of Science and Technology

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Early Modern Western Philosophy (17th-18th Centuries)

近代西方哲学（十七–十八世纪）

Week 5: Leibniz and Cavendish

Weekly Quiz

A Quiz from the Last Week

Quiz 4: (P1) ω; (P2) $\alpha \supset \neg\omega$; therefore, $\neg\alpha$. What is this rule of inference called?

1. Existential Generalisation
2. Universal Instantiation
3. Modus Ponens
4. Modus Tollens

This is not related to your final grade, but intended to observe your understanding of the last class.

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1. Existential Generalisation
2. Universal Instantiation
3. Modus Ponens
4. **Modus Tollens ('mode that denies [by denying]': check Spinoza's arguments against teleology)**

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Descartes on Matter and Motion

1 Weekly Quiz

2 Descartes on Matter and Motion

3 Leibniz on Matter and Motion

4 Cavendish on Matter and Motion
- Argument against the Transfer of Motion
- Argument for the Origination of Motion
- Argument for Self-Motion

5 Assignments for the Next Lecture

Matter in the *Meditations*

[N]ow it is possible for me to achieve full and certain knowledge [...] concerning the whole of that corporeal nature which is **the subject-matter of pure mathematics.**

– Meditation 5, CSM II 49

There are, however, many other things which I may appear to have been taught by nature, but which in reality I acquired not from nature but from a habit of making ill-considered judgements. [...] Cases in point are the belief that any space in which nothing is occurring to stimulate my senses must be empty; or that the heat in a body is something exactly resembling the idea of heat which is in me; or that when a body is white or green, the selfsame whiteness or greenness which I perceive through my senses is present in the body. [...] For the proper purpose of the sensory perceptions given me by nature is simply to inform the mind of what is beneficial or harmful for the composite of which the mind is a part; and to this extent they are sufficiently clear and distinct. But I misuse them by treating them as reliable touchstones for immediate judgements about the essential nature of the bodies located outside us; yet this is an area where they provide only very obscure information.

– Meditation 6, CSM II 56

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Reading Questions

According to Descartes

- How do we learn the nature of matter?
- How is matter related to space?
- How is motion related to matter?
- What happens when two material objects collide?
- How does Descartes try to justify his **laws of physics**? What is his methodology?

N.B. *Principles of Philosophy* (*Principia philosophiæ*) 1644/47:
Philosophical Writings aka CSM I (1985) – abridged;
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Matter in the *Principles*

[T]here exists something extended in length, breadth and depth and possessing all the properties which we clearly perceive to belong to an extended thing. And it is this extended thing that we call 'body' or 'matter'.

– *Principles* §2.1, CSM I 223

[S]ensory perceptions are related exclusively to this combination of the human body and mind. They normally tell us of the benefit or harm that external bodies may do to this combination, and do not, except occasionally and accidentally, show us what external bodies are like in themselves. If we bear this in mind we will easily lay aside the preconceived opinions acquired from the senses, and in this connection make use of the intellect alone, carefully attending to the ideas implanted in it by nature.

– *Principles* §2.3, CSM I 224

If we do this, we shall perceive that the nature of matter, or body considered in general, consists not in its being something which is hard or heavy or coloured, or which affects the senses in any way, but simply in its being something which is extended in length, breadth and depth.

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Matter and Space

How is matter related to space?

It is easy for us to recognize that the extension constituting the nature of a body is exactly the same as that constituting the nature of a space.

– *Principles* §2.11, CSM I 227

The matter existing in the entire universe is thus one and the same, and it is always **recognized as matter simply in virtue of its being extended.** All the properties which we clearly perceive in it are reducible to its divisibility and consequent mobility in respect of its parts, and its resulting capacity to be affected in all the ways which we perceive as being derivable from the movement of the parts.

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The Nature of Motion

How is motion related to matter?

[M]otion is the transfer of one piece of matter, or one body, from the vicinity of the other bodies which are in immediate contact with it, and which are regarded as being at rest, to the vicinity of other bodies. [...] I say 'the transfer' as opposed to the force or action which brings about the transfer, to show that motion is always in the moving body as opposed to the body which brings about the movement. The two are not normally distinguished with sufficient care; and I want to make it clear that the motion of something that moves is, like the lack of motion in a thing which is at rest, a mere mode of that thing and not itself a subsistent thing, just as shape is a mere mode of the thing which has shape.

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Descartes's Laws of Motion (Nature)

0. **[Conservation Principle]** God is the primary cause of motion; and he always preserves the same quantity of motion in the universe.
1. **[Inertia]** each and everything, in so far as it can, always continues in the same state; and thus what is once in motion always continues to move.
2. **[Rectilinear motion]** all motion is in itself rectilinear; and hence any body moving in a circle always tends to move away from the centre of the circle which it describes.
3. **[Impact/transfer of motions]** if a body collides with another body that is stronger than itself, it loses none of its motion; but if it collides with a weaker body, it loses a quantity of motion equal to that which it imparts to the other body.

– *Principles* §§2.36–40; cf. *The World* ch. 7 (CSM I)

'[T]he whole of philosophy is like a tree. **The roots are metaphysics, the trunk is physics**, and the branches emerging from the trunk are all the other sciences, which may be reduced to three principal ones, namely medicine, mechanics and morals.' (Preface to *Principles*, CSM I 186)

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– *Principles* §2.40, CSM I 242

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– *Principles* §2.40, CSM I 242

The first part of this law is proved by the fact that there is a difference between motion considered in itself [...] and its determination in a certain direction; for the determination of the direction can be altered, while the motion remains constant. [...] Now if one body collides with a second, hard body [...] there is an obvious reason why its motion should not remain fixed in the same direction ...but there is no reason why its motion should be stopped or diminished, [...] since one motion is not the opposite of another motion. Hence it follows that the motion in question ought not to diminish at all.

– *Principles* §2.41, CSM I 242

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The second part of the law is proved from the immutability of the workings of God. [...] For the whole of space is filled with bodies, and the motion of every single body is rectilinear in tendency; hence it is clear that when he created the world in the beginning God did not only impart various motions to different parts of the world, but also produced all the reciprocal impulses and transfers of motion between the parts. Thus, since God preserves the world by the selfsame action and in accordance with the selfsame laws as when he created it, the motion which he preserves is not something permanently fixed in given pieces of matter, but something which is mutually transferred when collisions occur. The very fact that creation is in a continual state of change is thus evidence of the immutability of God.

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Key Points

- Descartes holds that, in collisions, the very same motion is sometimes transferred from one body to another. Quantity of motion (speed multiplied by quantity of matter) is conserved.
- Descartes derives the fundamental laws of his physics 'from the armchair' by consideration of the natures of matter, motion, and God.

Leibniz on Matter and Motion

Descartes's Law is Empirically False

Our new philosophers commonly make use of the famous rule that God always conserves the same quantity of motion in the world. [...] I have since recognized what is wrong with it. **Descartes and many other able mathematicians have believed that the quantity of motion, that is, the speed multiplied by the size of the moving body, coincides exactly with the moving force.** [...] Now, it is extremely reasonable that the same force is always conserved in the universe. [...] But to show the difference between [force and quantity of motion], I assume that a body falling from a certain height acquires the force to rise up that height. [...] For example, a pendulum would rise again exactly to the height from which it descended, if the resistance of the air and some other small obstacles did not diminish its acquired force a little.

I assume also that as much force is required to elevate A, a body of one pound, to CD, a height of four fathoms, as to elevate B, a body of four pounds, to EF, a height of one fathom. [...] Galileo demonstrated that the speed acquired by the fall CD is twice the speed acquired by the fall EF, even though the one height is four times the other. [...] Therefore the quantity of motion of body (A) at point D is half of the quantity of motion of body (B) at point F; yet their forces are equal.

– *Discourse on Metaphysics* §17 (figure 1 from the AG edition)

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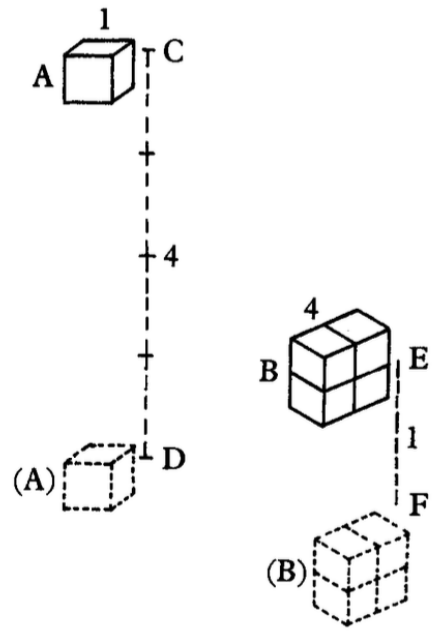

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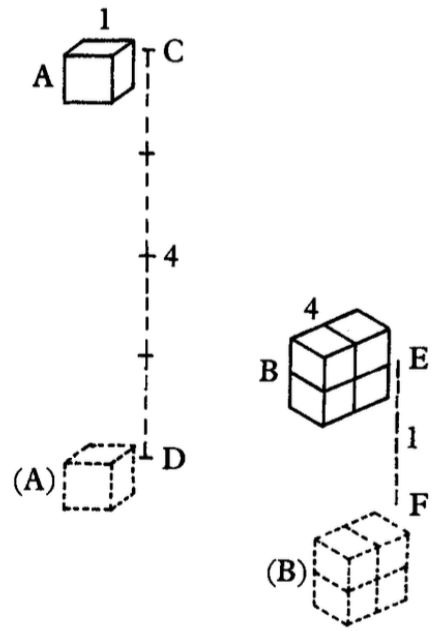

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Speed is proportional to the square root of distance: $\sqrt{4} = \sqrt{1}x2$

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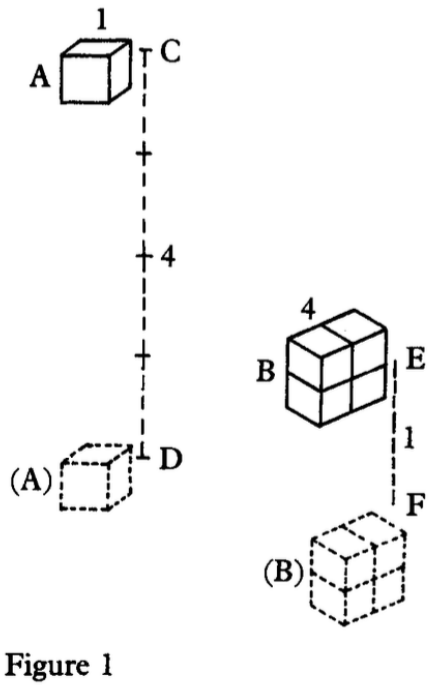

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$P_A \propto 1\sqrt{4}$
$P_B \propto 4\sqrt{1}$
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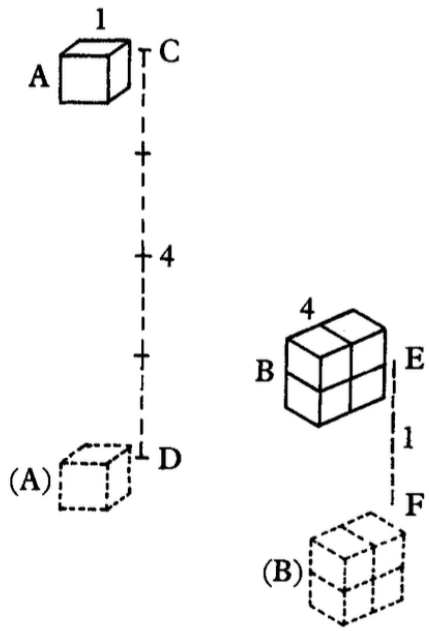

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The Laws are *not* Geometrically Demonstrable

I discovered at the same time that the laws of motion actually existing in Nature, and confirmed by experiments, are not in reality absolutely demonstrable, as a geometrical proposition would be; but neither is it necessary that they be so. They do not spring entirely from the principle of necessity, but rather from the principle of perfection and order; they are an effect of the choice and the wisdom of God. I can demonstrate these laws in divers ways, but must always assume something that is not of an absolutely geometrical necessity. Thus these admirable laws are wonderful evidence of an intelligent and free being, as opposed to the system of absolute and brute necessity, advocated by Strato or **Spinoza**.

– *Theodicy* §345

If Mechanical Rules Depended Only on Geometry without Metaphysics, the Phenomena Would Be Entirely Different.

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The Laws are *not* Geometrically Demonstrable

I discovered at the same time that the laws of motion actually existing in Nature, and confirmed by experiments, are not in reality absolutely demonstrable, as a geometrical proposition would be; but neither is it necessary that they be so. They do not spring entirely from the principle of necessity, but rather from the principle of perfection and order; they are an effect of the choice and the wisdom of God. I can demonstrate these laws in divers ways, but must always assume something that is not of an absolutely geometrical necessity. Thus these admirable laws are wonderful evidence of an intelligent and free being, as opposed to the system of absolute and brute necessity, advocated by Strato or **Spinoza**.

– *Theodicy* §345

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Matter is *not* Just Extension

> [A]nyone who will meditate about the nature of substance, as I have explained it above, will find that the nature of body does not consist merely in extension, that is, in size, shape, and motion, but that we must necessarily recognize in body something related to souls, something we commonly call substantial form, even though it makes no change in the phenomena. [...] It is even possible to demonstrate that the notions of size, shape, and motion are not as distinct as is imagined and that they contain something imaginary and relative to our perception, as do (though to a greater extent) color, heat, and other similar qualities, qualities about which one can doubt whether they are truly found in the nature of things outside ourselves.That is why qualities of this kind cannot constitute any substance. And if there were no other principle of identity in body other than the one just mentioned, a body could not subsist for more than a moment.
>
> – *Discourse on Metaphysics* §12

The Nature of Substance

the nature of an individual substance or of a complete being is to have a notion so complete that it is sufficient to contain and to allow us to deduce from it all the predicates of the subject to which this notion is attributed. (*Discourse on Metaphysics* §8)

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Contrast with Descartes's Laws of Motion

[M]otion is the transfer of one piece of matter, or one body, from the vicinity of the other bodies which are in immediate contact with it, and which are regarded as being at rest, to the vicinity of other bodies.

– *Principles* §2.25, CSM I 233

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Discourse on Metaphysics

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What is Force in Leibniz?

[F]orce must be calculated from the quantity of the effect it can produce, for example, by the height to which a heavy body of a certain size and kind can be raised.

– *Discourse on Metaphysics* §17

[F]orce is something different from size, shape, and motion, and one can therefore judge that not everything conceived in body consists solely in extension and its modifications, as our moderns have persuaded themselves.

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[I]n corporeal things there is something over and above extension, in fact, something prior to extension, namely that force of nature implanted everywhere by the Creator, [...] endowed with *conatus* or *nisus*. [... T]here is nothing real in motion but a momentary something which consists in a force striving toward change. Whatever there is in corporeal nature over and above the object of geometry or extension reduces to this.

– 'Specimen dynamicum', 1695 (Ariew-Garber ed. p. 118)

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What is this concept called in physics textbooks today?

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Further Philosophical Questions

- What are the proper roles of *a priori* and empirical (i.e. *a posteriori*) considerations in physics?
- What is the nature of matter?
- How can one body set another in motion?

– See also Boudri, *What was Mechanical about Mechanics* (2002, ch. 3 'Leibniz: Force as the Essence of Substance'); Fazio, 'Leibniz on Force, Cause and Subject of Motion' (2021), etc.

Cavendish on Matter and Motion

Margaret Cavendish, Duchess of Newcastle (c.1623–73)

Biographical Overview

> 'The present Duchess of Newcastle, by her own genius, rather than any timely instruction, over-tops many grave gownmen.'
>
> – Cavendish's contemporary, Bathsua Makin (c.1600–75), *An Essay to Revive the Antient Education of Gentlewomen* (London, 1673, p. 10)

Project Vox (female canons)

Margaret Cavendish, Duchess of Newcastle (c.1623–73)

Biographical Overview

- **1623** – Born in Essex, self-educated.
- **1643** – Becomes maid of honour to Queen Henrietta Maria (wife of Charles I).
- **1644** – Goes with the queen from Oxford into exile in France (and Antwerp/Holland).
- **1645** – Marries William Cavendish, Marquess of Newcastle. They remain in exile in Paris until the Restoration (1660).
- **1655** – *Philosophical and Physical Opinions*
- **1664** – *Philosophical Letters*
- **1666** – *Observations upon Experimental Philosophy*
- **1667** – First woman invited to a meeting of the Royal Society
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The 'Newcastle' Circle
French philosophers including **Descartes, Mersenne, and Gassendi**, as well as English in exile such as **Hobbes** and Kenelm Digby, attend meetings at their home in Paris.

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Cavendish against Descartes

Reading questions

- According to Cavendish, what is wrong with Descartes's view about **the transfer of motion**?
- According to Cavendish, what is the source of motion?

Cavendish against Descartes

I [...] do not assent to [Descartes's] opinion when he defines *Motion to be onely a Mode of a thing, and not the thing or body it selfe*; for in my opinion there can be no abstraction made of motion from body, neither really, nor in the manner of our conceptions, for how can I conceive that which is not, nor cannot be in nature, that is, to conceive motion without body? Wherefore Motion is but one thing with body, without any separation or abstraction soever. Neither doth it agree with my reason, that *one body can give or transferr motion into another body* [...] For how can motion, being no substance, quit one body and pass into another?

– *Philosophical Letters*, letter 1.30

Objections to Descartes

- Motion is the essence or nature of body, not merely a mode.
- Even if motion were a mode of body, it would not be possible for the same motion to be transferred from one body to another.

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Argument against the Transfer of Motion

> [M]otion being material and inseparable from matter, cannot be imparted without matter; and if not, then the body that receives motion would increase in bulk, and the other that loses motion would decrease, by reason of the addition and diminution of the parts of matter, which must of necessity increase and lessen the bulk of the body: the contrary whereof is sufficiently known.
>
> – *Observations*, ch. 1.17 (pp. 74–75)

Argument

1. Motion is inseparable from matter.
2. If motion is inseparable from matter, then motion cannot be transferred without transferring matter.
3. Therefore, motion cannot be transferred without transferring matter. [Modus Ponens: the first conclusion]
4. When two bodies collide, no matter is transferred. [The contrary.]
5. Therefore, when two bodies collide, no motion is transferred.

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Cavendish's Argument for the Origination of Motion

Question

If the *same* motion cannot be transferred from one body to another, what accounts for changes in bodies' states of motion?

Argument

1. The motion of a body must originate [i.e. be occasioned] from somewhere, either *outside* or *inside* that body.
2. The motion of a body cannot originate from outside that body.

C Therefore, the motion of a body originates from inside that body.

Cavendish's Argument for the Origination of Motion

> [F]or example, A Watch-maker doth not give the watch its motion, but he is onely the occasion, that the watch moves after that manner, for the motion of the watch is the watches own motion, inherent in those parts ever since that matter was, and if the watch ceases to move after such a manner or way, that manner or way of motion is never the less in those parts of matter, the watch is made of, and if several other figures should be made of that matter, the power of moving in the said manner or mode, would yet still remain in all those parts of matter as long as they are body, and have motion in them. Wherefore one body may occasion another body to move so or so, but not give it any motion, but every body (though occasioned by another, to move in such a way) moves by its own natural motion; for self-motion is the very nature of animate matter.
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But to return to motion, my opinion is, That all matter is partly animate, and partly inanimate, and all matter is moving and moved [...] the animate moves of it self, and the inanimate moves by the help of the animate, and thus the animate is moving and the inanimate moved; not that the animate matter communicates its own motion to the inanimate; for this is impossible, by reason it cannot part with its own nature, nor alter the nature of inanimate matter, but each retains its own nature [...] Wherefore every creature being composed of this commixture of animate and inanimate matter, has also selfe-motion, that is life and knowledge, sense and reason, so that no part hath need to give or receive motion from another part; although it may be an occasion of such a manner of motion to another part, and cause it to move thus or thus.

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1. The motion of a body must originate [i.e. be occasioned] from somewhere, either *outside* or *inside* that body.
2. The motion of a body cannot originate from outside that body.

C Therefore, the motion of a body originates from inside that body.

Cavendish's Argument for the Origination of Motion

But to return to motion, my opinion is, That all matter is partly animate, and partly inanimate, and all matter is moving and moved [...] the animate moves of it self, and the inanimate moves by the help of the animate, and thus the animate is moving and the inanimate moved; not that the animate matter communicates its own motion to the inanimate; for this is impossible, by reason **it cannot part with its own nature, nor alter the nature of inanimate matter, but each retains its own nature** [...] Wherefore every creature being composed of this commixture of animate and inanimate matter, has also selfe-motion, that is life and knowledge, sense and reason, so that **no part hath need to give or receive motion from another part**; although it may be an occasion of such a manner of motion to another part, and cause it to move thus or thus.

– *Philosophical Letters*, letter 1.30

Argument

1. The motion of a body must originate [i.e. be occasioned] from somewhere, either *outside* or *inside* that body.
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Cavendish's Argument for the Origination of Motion

Disjunctive Syllogism [*modus tollendo ponens*]:
a valid mode of 'affirming by denying'

$$\frac{\varphi \vee \psi \qquad \neg\psi}{\varphi}$$

Argument

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Cavendish's Argument for Self-Motion

Question

If the *same* motion cannot be transferred from one body to another, what accounts for changes in bodies' states of motion?

Argument

1. If there is providence in nature, then nature has wisdom.
2. If nature has wisdom, nature has sense and reason.
3. If nature has sense and reason, then nature has self-motion.
4. If nature has self-motion, then all the parts of nature have self-motion.
5. But there is providence in nature. [Affirming the antecedent of P1]

C. Therefore, all the parts of nature have self-motion. [MP]

Cavendish's Argument for Self-Motion

> [I]f there be any providence in nature, then certainly nature has knowledge and wisdom; and if she hath knowledge and wisdom, then she has sense and reason; and if sense and reason, then she has self-motion; and if nature has self-motion, then none of her parts can be called inanimate or soulless: for motion is the life and soul of nature, and all of her parts, and if the body be animate, the parts must be so too, there being no part of the animate body of nature that can be dead, or without motion; [...] besides, it is not probable, that one part moving another should produce all things so orderly and wisely as they are in nature.
>
> – *Observations*, ch. 1.16 (pp. 72–73)

Argument

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Assignments for the Next Lecture

1 Weekly Quiz

2 Descartes on Matter and Motion

3 Leibniz on Matter and Motion

4 Cavendish on Matter and Motion

- Argument against the Transfer of Motion
- Argument for the Origination of Motion
- Argument for Self-Motion

5 Assignments for the Next Lecture

Next Week 6: Cavendish and Malebranche

- Assignment 1: Read Cavendish's *Observations upon Experimental Philosophy*, Part I, chs. 25, 35 (pp. 95ff, 137ff); Part II, chs. 6-7 (pp. 204–10); Malebranche's *Search after Truth*, pp. 448–450.
- Assignment 2: Read the 'Argument Advice' and 'Essay Questions' in PDF. And ask me or your assigned TA for anything unclear in the documents and slides.

- Keep active in the **WeCom**/企业微信 group for this course, and pay attention to the **Blackboard** (SS149, Spring 2024), in which you can find all the basic info and `recommended references`.
- **Office hours** of the instructor (Center for Social Sciences, C111) and TAs (their offices) are Mondays 2-4pm, or any working time of appointment, by WeCom direct message or email.