



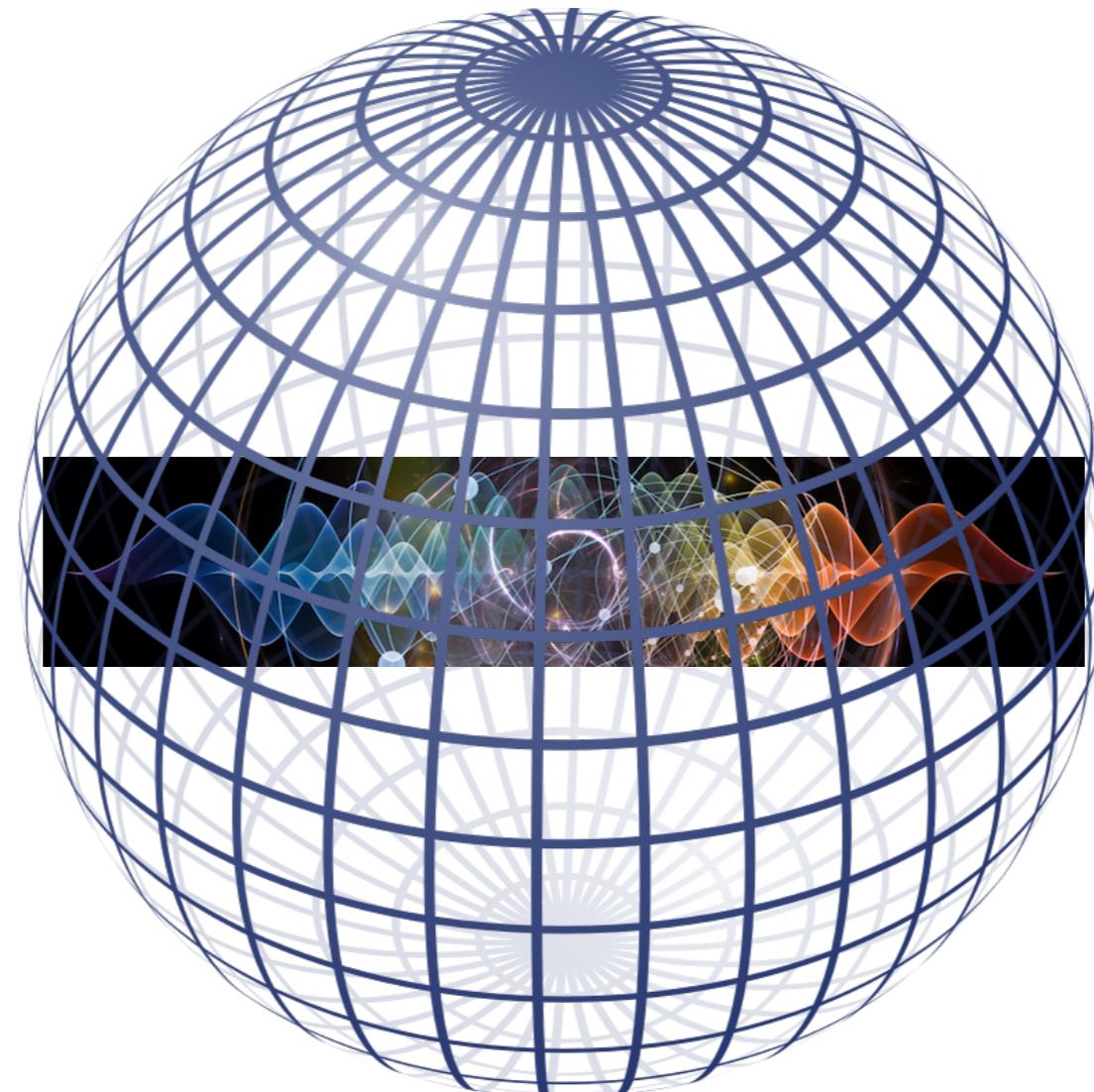
Theoretical Physics

A combination of Mathematics, Physics, and Philosophy

$$a^2 + b^2 + c^2 = d^2$$

$$E = mc^2$$

$$e^{i\theta} = \cos(\theta) + i \sin(\theta)$$



Hosted by Dr. Pierros Ntelis and IBS
Speakers: Prof. Thierry Martin and Dr. Aiofe Bharucha

Dr. Pierros Ntelis

2008-2013, Bachelor of Applied Mathematics and Physics
at National Technical University of Athens, Greece

2013-2014, Master in Astrophysics & Cosmology
at University of Paris, France

2014-2017, PhD in Fundamental Physics & Cosmology
at University of Paris, France

2018-2020, PostDoc in Observational Cosmology
at Aix-University, CPPM, France

Since 2022, Teacher of Math and Physics at IBS

Specialised in

- Astrophysics
- Cosmology
- Teaching Math and Physics



Dr. Bharucha Aoife

2002-2006 Bachelor/Master: University of Oxford, UK

2006-2010 PhD: Institute of Particle Physics Phenomenology
Durham University, UK

2010-2014 Postdocs: Hamburg University
Technical University Munich Allemagne

2015-Present Chargé de recherche,
Centre Physique Théorique, Marseille

Specialised in

- particle physics,
- interactions between quarks (flavour physics)
- dark matter.



Prof. Thierry Martin

Born 26/10/1962

Bachelor at Ecole Polytechnique Fédérale de Lausanne

Master and PhD of physics at University of California Los Angeles

Postdoc 1: IBM T. J. Watson Research Center, New York

Postdoc 2: Los Alamos National Laboratory

Postdoc 3: Institut Laue Langevin, Grenoble

since 1996: Professeur des Universités (2ème classe,
1ère classe, puis classe exceptionnelle)

Specialised in

- theoretical condensed matter physics,
- mesoscopic physics/quantum nanophysics
- electronic transport in nanostructures





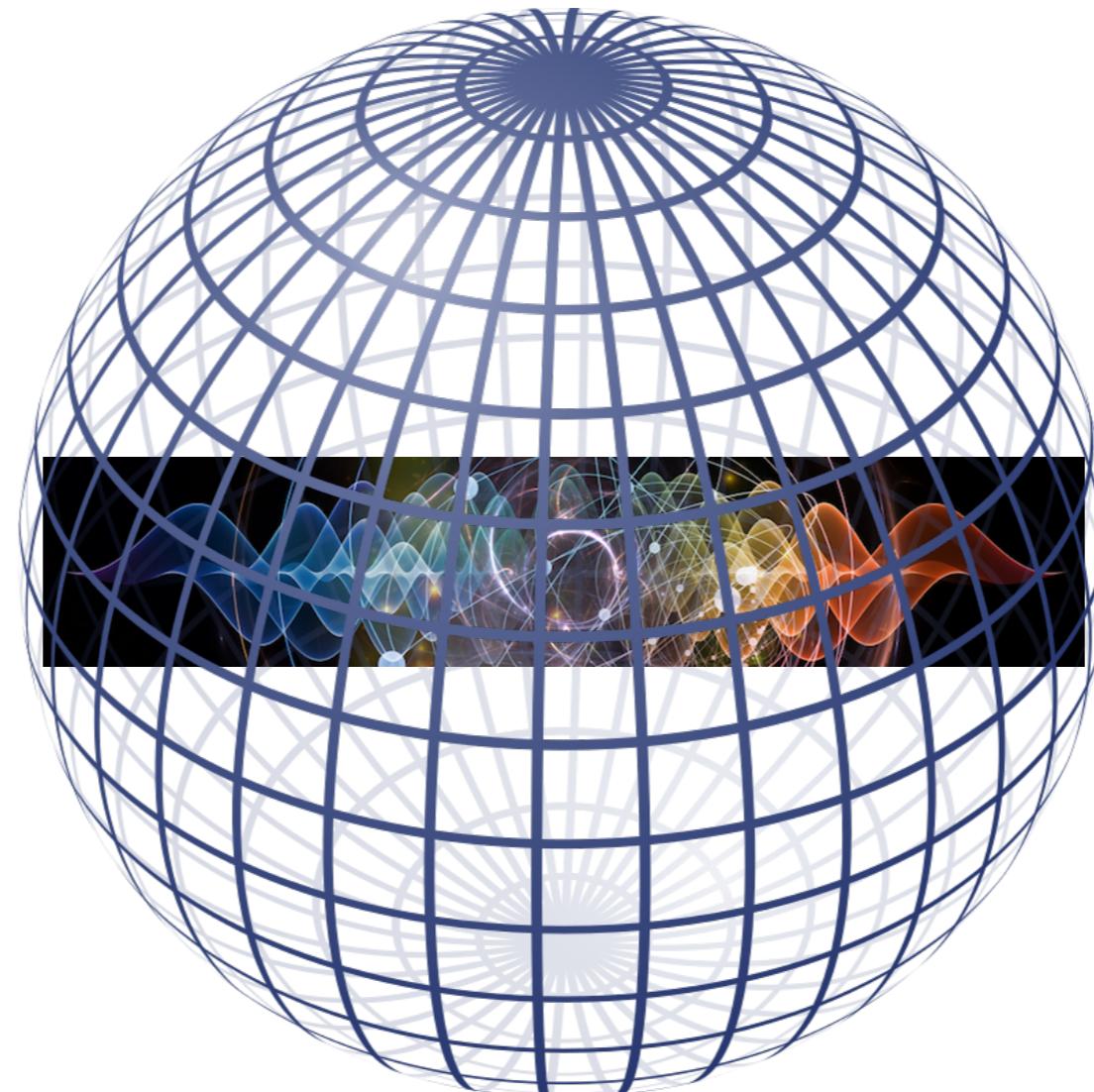
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Philosophy originates from the greek word, **φιλοσοφία**
Which is a compound word, composed by
The word **φιλο-**, **friendly**, and word, **-σοφία**, **wisdom**.
Ergo, philosophy means being friends with wisdom

Look at :

- **Theory of Knowledge (TOK)**
- **Global perspectives (GP) courses**

Officially, modern Philosophy is the study of general and fundamental questions:

abstraction, existence, reason, knowledge, values, mind, and language.

Such questions are often posed as problems to be studied or resolved.



Mathematics

Mathematics (μαθηματικά) originates from the greek word, μάθημα, which means learning.

Axioms . / $1 \in \mathbb{N}, \pi \simeq 3.14 \in \mathbb{Q}', e^\pi \in \mathbb{R}, e^{i\pi} \in \mathbb{C}$ Numbers

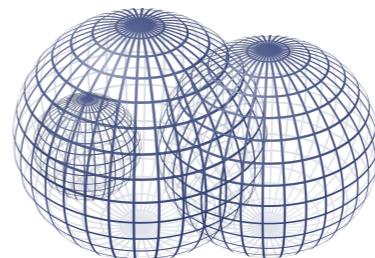
Functions $f(x) : \mathbb{R} \rightarrow \mathbb{R}^+$ $(a \pm b)^2 = a^2 \pm 2ab + b^2$ Algebra

$f'(x) = \frac{\partial f}{\partial x}$



Geometry

$f''(x) = \frac{\partial^2 f}{\partial x^2}$



Sets

Derivatives $\dots = \dots$

$f^{(n)}(x) = \frac{\partial^n f}{\partial x^n}$ $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ Limits

Integrals $F(x) = \int_0^x f(s)ds$ $P(x; \mu, \sigma) \propto e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$ Probabilities

Statistics $\lim_{s \rightarrow +\infty} \int_{-s}^{+s} dx P(x) = 1$ $a^2 + b^2 + c^2 = d^2$ Theorems

with proofs !

Physics

Physics (φυσική) originates from the greek word, φύση, and it means the study of nature.

Newton 2nd Law of motion

$$F = ma$$

$$\frac{\partial p}{\partial t} = m \frac{\partial^2 x}{\partial t^2}$$

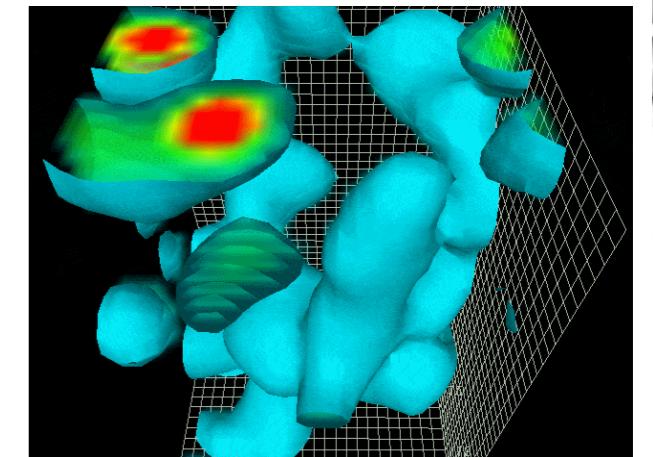


Cosmology is the study of the smallest to largest objects



Electric force

$$F_{12} = k_e \frac{q_1 Q_2}{r_{12}^2}$$



Quantum mechanics (Special Relativity)

Energy is a manifestation of **matter**

$$E = mc^2$$

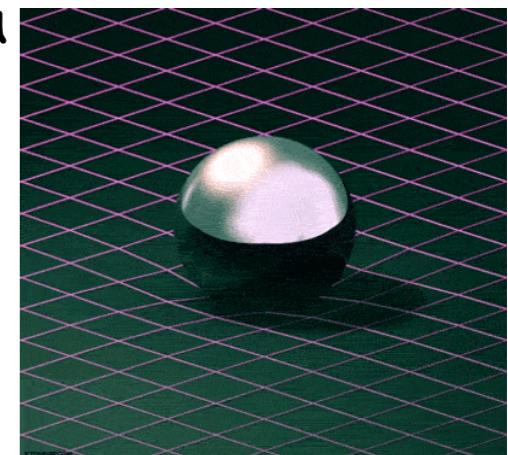
Small world

Gravity (General Relativity)

Geometry is a manifestation of **Energy**

$$G_{\mu\nu} \simeq E_{\mu\nu}$$

Large world



Physics; Cosmology

Functor of actions (S_{FA}) for high school students

Functor (F) is the generalisation concept of functionals

Functionals is the generalisation concept of functions

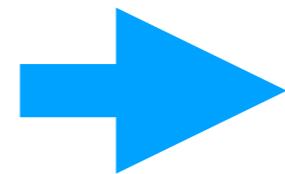
Action (S) in physics is a quantity which is the product of energy with time.

Action is a quantity which tell us the amount of possible ways a particle can travel from one point to another within a certain region

Functor of actions predict the possible existence of the **actionic fluctuations and field-particles** which are analogues of the **energetic fluctuations and field-particles**, in nature.

$$S_{FA} \supset \int_{\Omega_S} dS' \supset S = \int dx \mathcal{L}$$

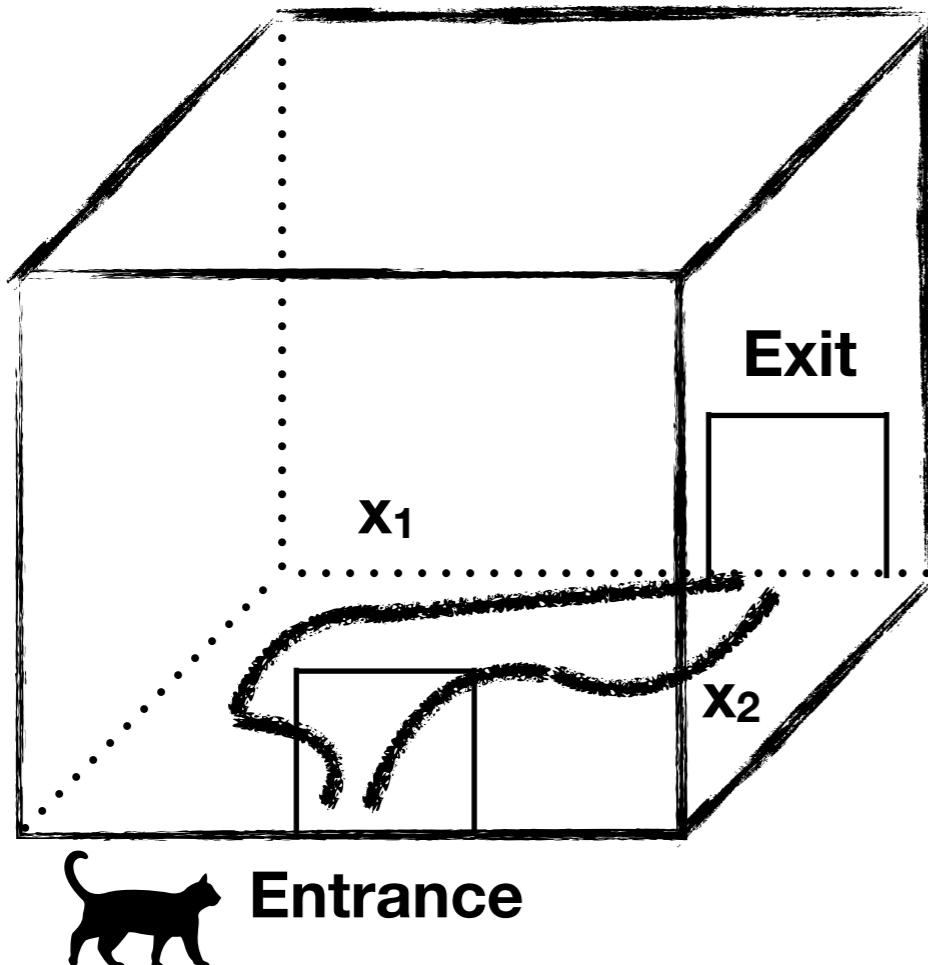
Actionic field interpretation
Action answers to the question :



There is actually an actionic field
everywhere

What is the number of all possible routes
a cat can use to pass through each room ?

$$N = 2$$

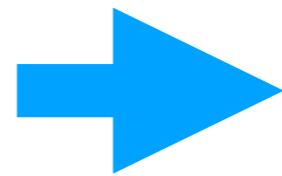


x_1 is possible for both rooms, x_2 is not possible for the 2nd room

space, x



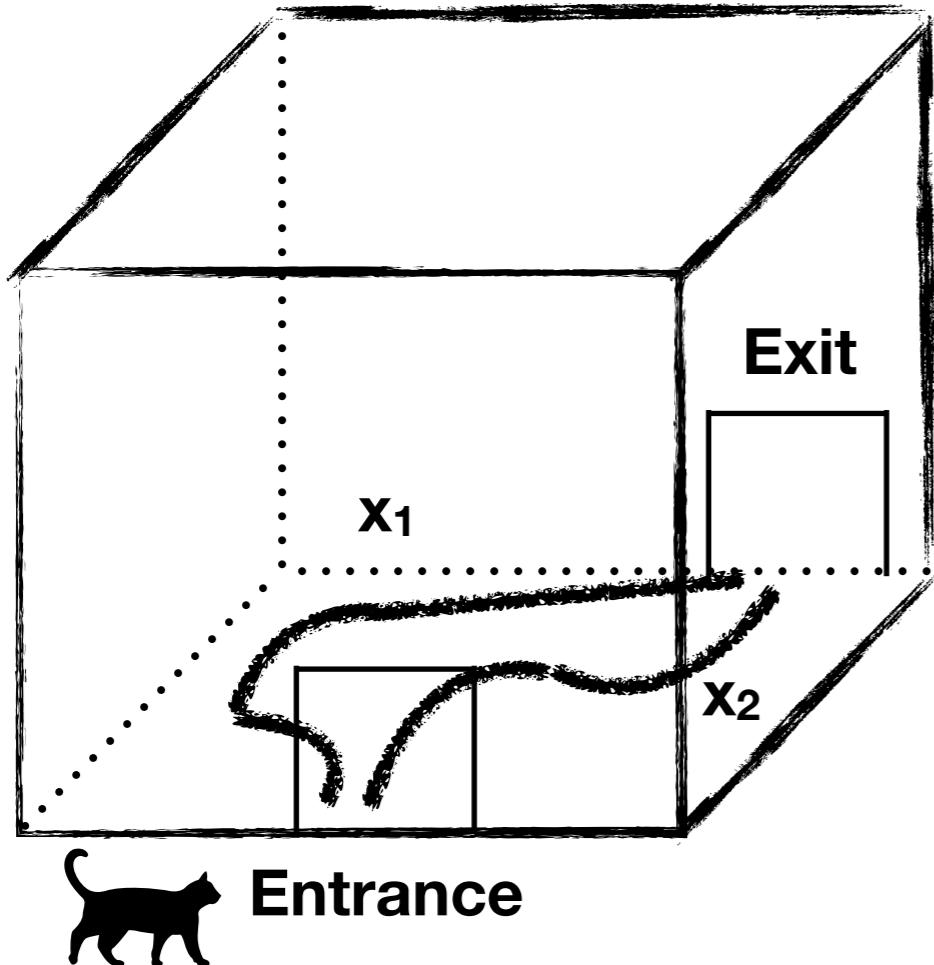
Actionic field interpretation
Action answers to the question :



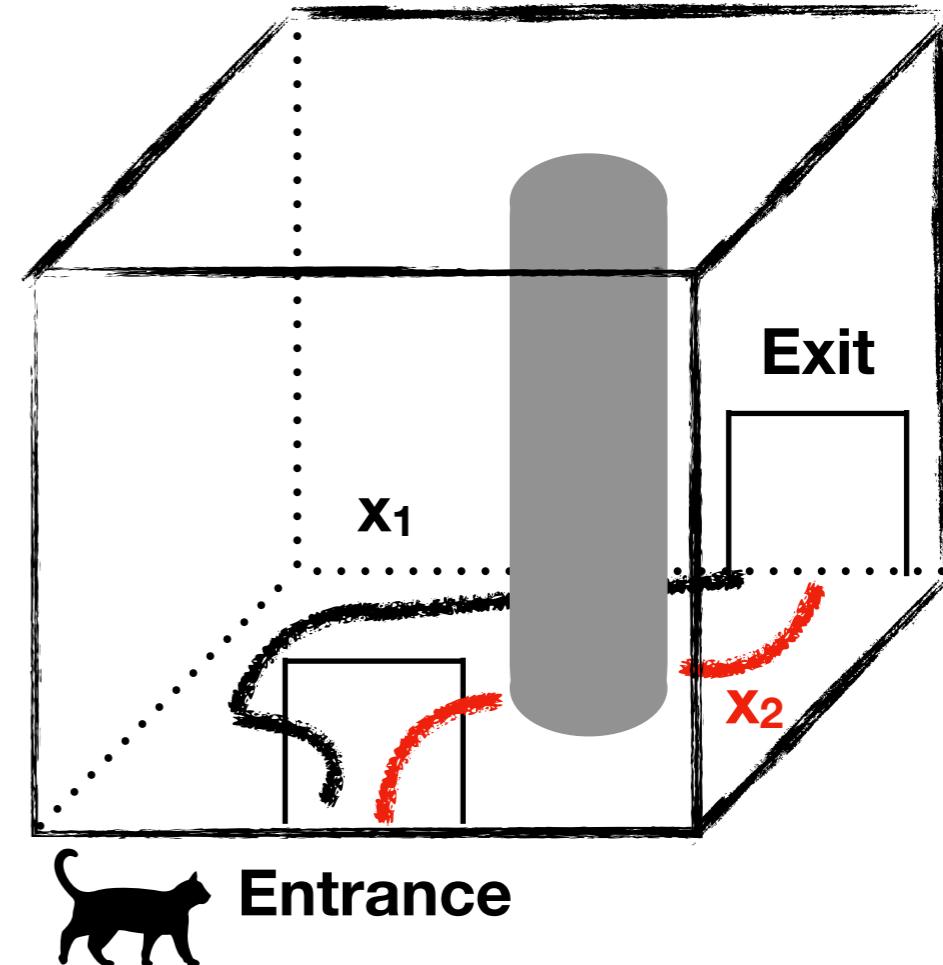
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$N-n$
 $2-1$



x_1 is possible for both rooms, x_2 is not possible for the 2nd room

space, x

Thank you for your attention!

