UNIVERSITY OF LIVERPOOL

The Laws of Physics

Philosophy for physicists
Lecture VI

13/04/2026

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Philosophy of Physics

- Simplification of the Laws of Nature
- Physics as a paradigm of all science

- Understanding the rules
  disregarding the strategy
  ⇒ fundamental rules
  - fundamental
  - derived

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Minimal Primitivism (MinP)

Eddy Keming Chen – Laws of Physics

- True and fundamental
- Not production of the future from the past, but rather bounds, restrictions

  - Requirements
  - Descriptions
  - Constraints

- What is their ontology? (Or just in our mind?)

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- Modality
- Causality
- Counterfactuals
- Time
- Induction
- Determinism

Where do the Laws of Physics exist?

- Metaphysical issues

⇒ Our goal is to formalise

Conceptual complexity ⇔ enormous service to clarity

- fixed question to filter (*ontology* & *nomology*)

Existence outside space and time?

How do we know the Laws of Physics?

- Epistemological issue

  - Induction?
  - In the case of empiric equivalence, how do we choose?

    Simplicity, universality, exactness

    ⇒ Philosophical topics

Ensemble of the Laws of Physics

- Nomological issue

  - How do we select the laws?

  We refuse the existence of an invisible Elf moving the planets… why?

  - Ockham’s razor
  - Simplicity
  - Exactness
  - Objectivity

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Humean - Non-Humean

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Do the laws of Physics govern the physical world of simply describe it?

Existence (?) and constraints

Dynamic production

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Minimal Primitivims

Bounding the possibilities of the natural/physical objects

Existence (?) and constraints

Dynamic production

Minimal Primitivims

Bounding the possibilities of the natural/physical objects

- No need to establish causal relationships
- No need of of presuming the concept of time
- … bit too vague

Physical theory

1. Ontology
   - What exists…

2. Nomology
   - How what exists behave…

⇒ Fundamental Ontology

… Quantum Mechanics

Fundamental Ontology of Newtonian gravity

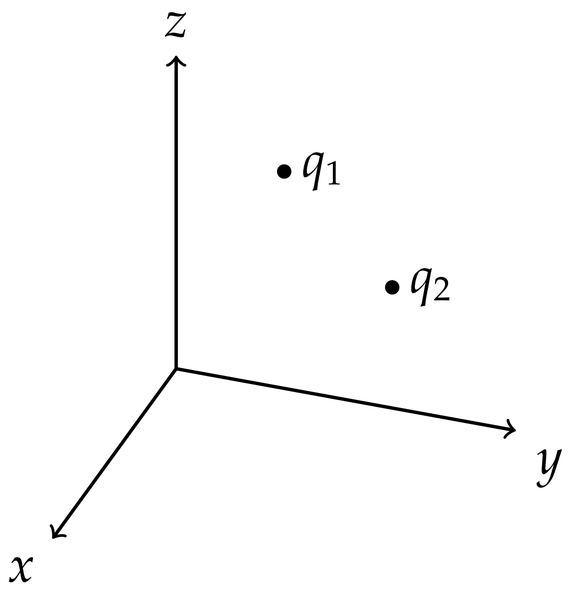
- Fundamental ontology: *N* particles

- Fundamental properties: masses (m_1, m_2, …, m_N), trajectories in the physical space ($q_1(t)$, $q_2(t)$, …, $q_N(t)$)

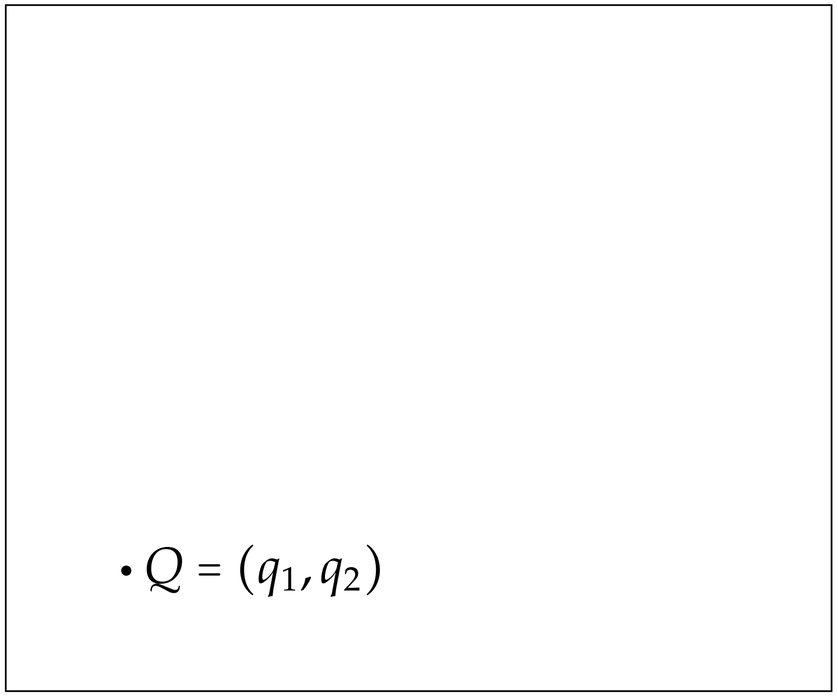
- Space-Time: 3D Euclidean space, $\mathbb{R}^3$

Configuration of a two-particle universe

- State of the fundamental ontology



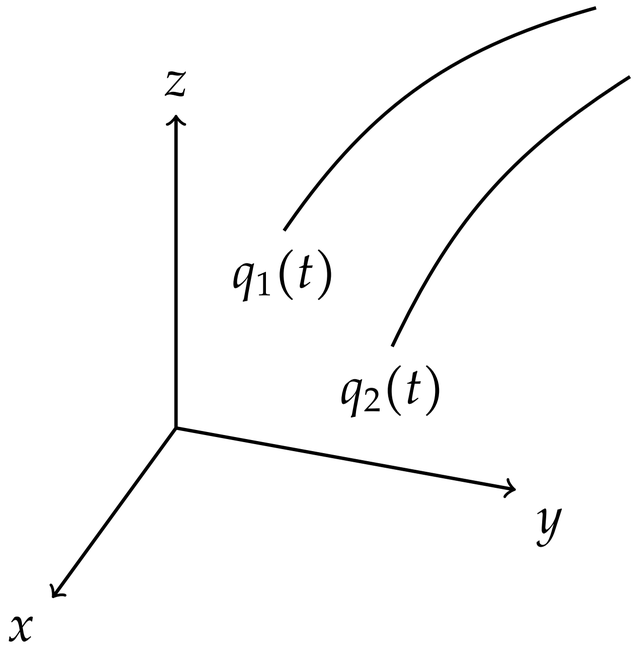
(a) Physical space $\mathbb{R}^3$



(b) State space $\mathbb{R}^6$

Physical history of a two-particle universe

- N curves in physical space: positions of the N particles at different t
- *Does not presuppose a direction of time*



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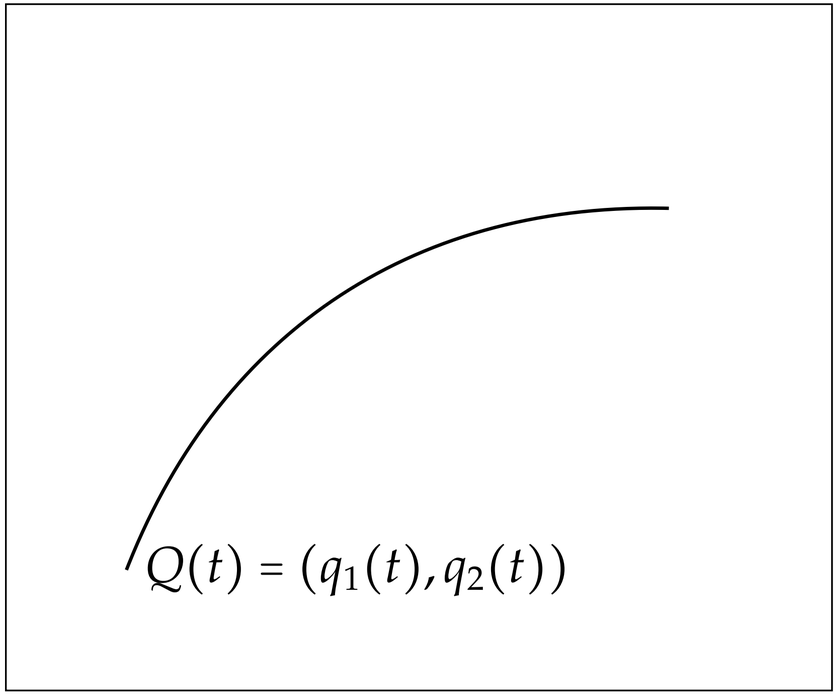

(b) State space $\mathbb{R}^6$

Direction of time?

Fundamental Nomology of Newtonian gravity

- The fundamental laws of the theory

  - Dynamical law: $F_i(t) = m_i \frac{d^2 q_i(t)}{dt^2}$

  - Force law: $F_i(t) = \sum_{j \neq i}^{N} \frac{G m_i m_j}{|q_i(t) - q_j(t)|^2}$

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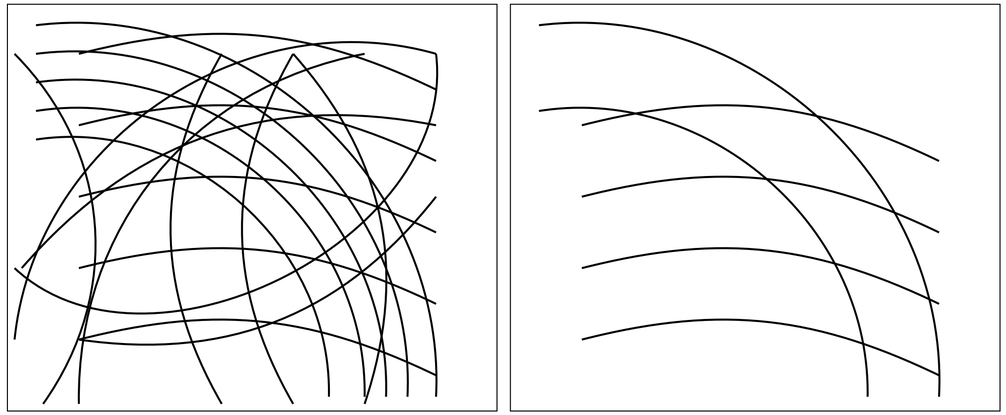
What physical histories are permitted



(a) Arbitrary histories in state space (b) Nomologically possible histories

Little vocabulary

- A possible world ω:

  a spacetime and a distribution of material contents

- The actual world α:

  actual spacetime and the actual distribution of material contents

- Ω^T:

  set of possible worlds that satisfy the fundamental laws specified in theory *T*

- Ω_α:

  the set of possible worlds that satisfy the actual fundamental laws of α, i.e. the set of all nomologically possible worlds

Possibility vs. Necessity

- Nomological Possibility:

  permitted in some nomologically possible world

- Nomological Necessity:

  has to occur in every possible world

When a theory is more complex all this is not just a verbal/linguistic complication

⇒ Clarity in our concepts: a set of fixed questions to filter the ontology and the nomology

End of the VI session

THANK YOU!

—> Next session addressing the *Counterfactuals* and *Causation*