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La possibilité physique

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Physical possibility

In the metaphysical literature, physical possibility is often understood as nomological possibility.

Typical definition of nomically possible:

[A] proposition is nomically possible if and only if it is metaphysically compossible with what, in those circumstances, are the laws of nature (their conjunction is metaphysically possible).

Williamson 2016

Bottom-up approach

From a scientific perspective

Experimental possibilities: systems and behaviors that could be empirically produced.

Theoretical possibilities: systems and behaviors that are compatible with our best theoretical frameworks.

The notion of system

System: a remarkably difficult notion

- System as a collection of entities forming a whole.
- System as a connected portion of spacetime.
- System as an entity for which what happen on its frontiers is known.
- System as the subject of dynamics.

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The Lagrangian formalism

Advantages

(1) It is more attuned with the lessons of relativity than than, for example the Hamiltonian formalism, since it does not depend on the (3+1) dimensional baggage of conjugate momenta and constraints. In other words, it is not plagued by the problem of time.

(2) This formalism provides an elegant transition between classical and quantum systems.

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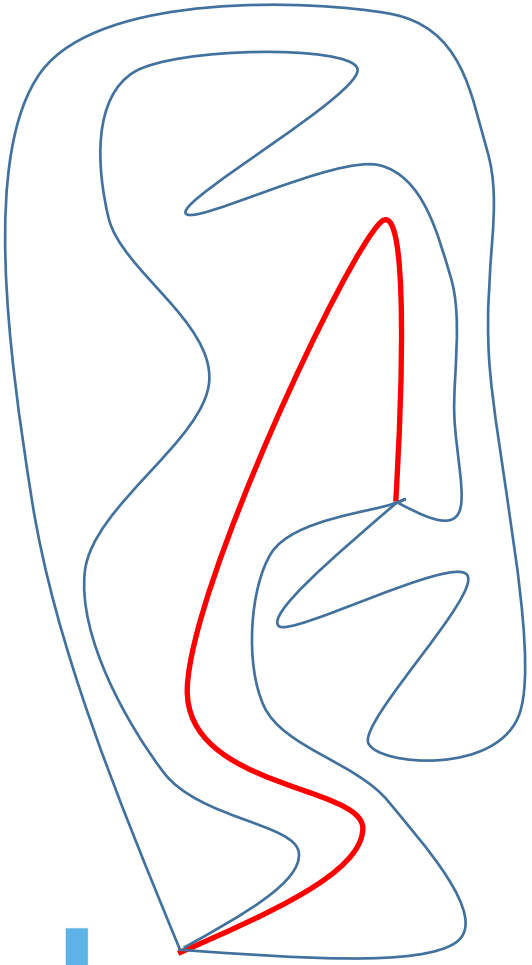
Lagrangian approach in classical physics



Kinematical possibilities: the set of possible histories of the system

Dynamical possibilities: genuine physically possible histories of the system according to the laws

Change: the absence of changelessness

(invariance of the histories under a time translation group of the underlying spacetime)

More details in Belot 2007

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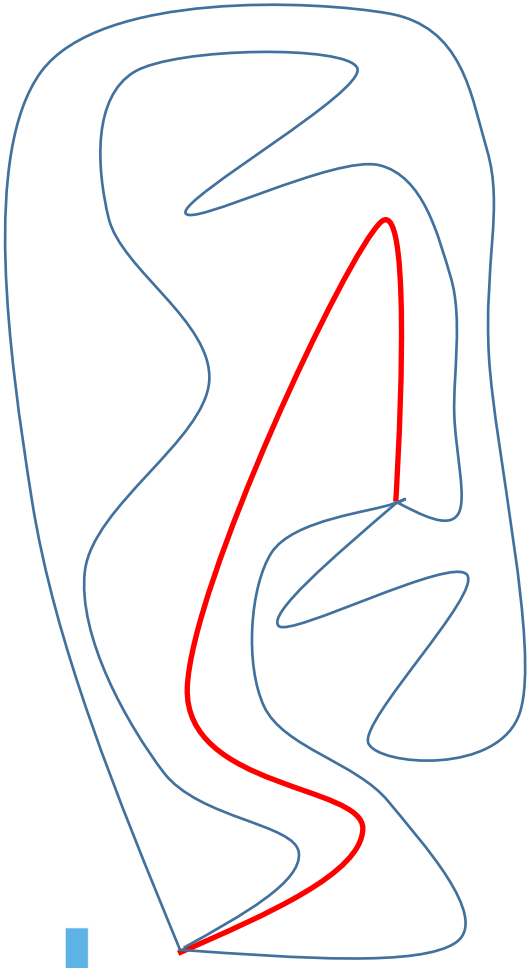
Relation between K and D possibilities



In order to identify a D possibility among the compatible K possibilities, we will have to “consider different laws of motion, even for a given problem”. Butterfield 2003

The set of K possibilities are the different histories generated if the same system could be governed by different laws.

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Hamilton principle

$$\delta S[\varphi] = \delta \int L[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

On the condensed notation, see Guay 2008

A D possibility is an extremum of the action functional S, where the laws are encoded in the Lagrangian density function *L*.

- There could be more than one extremum (more than one actual possibility governed by the same laws).
- The space of K possibilities is structured. For example, there is a functional S that could be used to compute a distance between histories.

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A possible worry

$$\delta S[\varphi] = \delta \int L[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

Is the actual history genuinely dependant of possible nomological possibilities?

No!

Each computation of *S* only invokes the intrinsic properties of a single history. Possible histories are to be understood as variation of the actual world.

More in Butterfield 2003

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The quantum case

$$\langle out|in\rangle = \int e^{iS[\varphi]}\mu[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

- On the left, we have a transition amplitude (a quantum property of the actual world).
- On the right, we have an integral over the action associated to each K possibilities (classical possible histories).
- μ is a volume density for the K possibilities space.

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Questions

$$\langle out|in\rangle = \int e^{iS[\varphi]}\mu[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

- How should we interpret this mathematical dependency between a modal quantum property and classical possibilities?
  - No problem after all.
  - K possibilities can be eliminated.
  - Pragmatic considerations.

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Questions

$$\langle out|in\rangle = \int e^{iS[\varphi]}\mu[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

No problem after all

1) Classical histories are variations of the actual quantum world.

Or,

2) Classical histories are non physical, impossible worlds.

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Questions

$$\langle out|in\rangle = \int e^{iS[\varphi]}\mu[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

Elimination of K possibilities

We do not know how to do this.

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Questions

$$\langle out|in\rangle = \int e^{iS[\varphi]}\mu[\varphi][d\varphi], \quad [d\varphi] := \prod_i d\varphi^i$$

Pragmatic considerations

- Because of cognitive limitations, we cannot do otherwise.
- For pragmatic reasons, we formulated QM in terms of classical physics.

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References

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