

LMU The ontology of physics
5 November 14



Laws of nature: Humeanism vs. modal realism

Michael Esfeld
LMU-MCMP &
Université de Lausanne

Overview



1) primitive ontology:

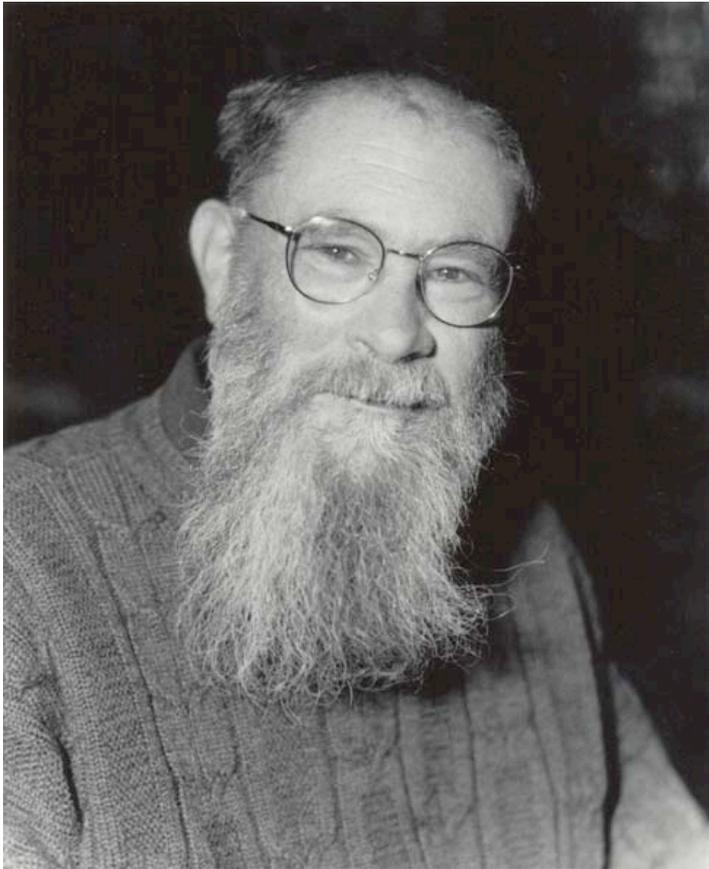
- **fundamental: composing everything else, but not composed of anything**
- **primitive stuff: *res extensa*, no properties**
- ➔ **what there simply is, no modality**

2) properties: dynamics, laws

- **Humeanism: no addition to being, no modality**
- **modal realism: dispositions / powers**
- ➔ **not primitive vs. derivative, not local vs. universal: factual vs. modal**

David Lewis (1986)

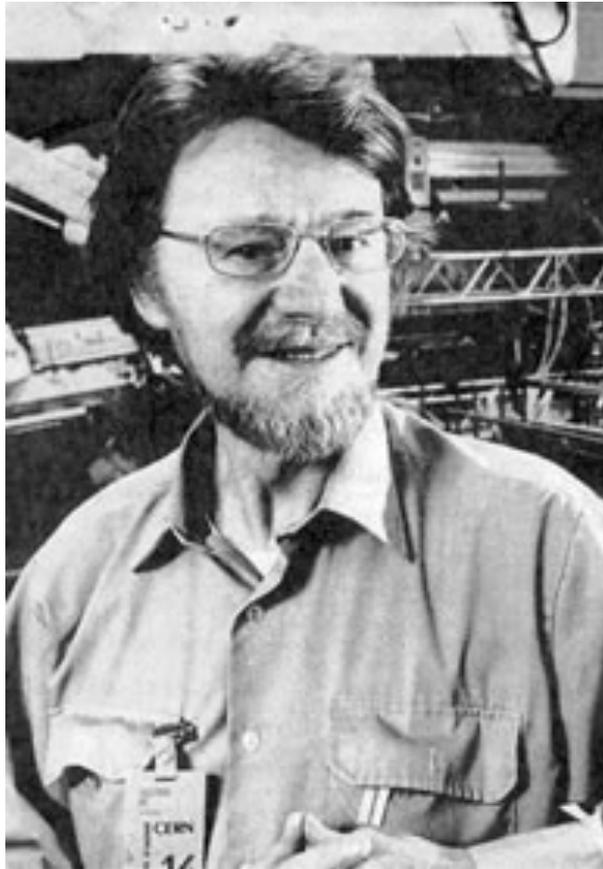
Humean metaphysics



“It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. ...
We have geometry: a system of external relations of spatio-temporal distance between points. ... And at those points we have local qualities ... For short: we have an arrangement of qualities. And that is all. ... All else supervenes on that.”

John Bell (1975)

“The theory of local beables”



“One of the apparent non-localities of quantum mechanics is the instantaneous, over all space, ‘collapse of the wave function’ on ‘measurement’. **But this does not bother us if we do not grant beable status to the wave function.** We can regard it simply as a convenient but inessential mathematical device for formulating correlations between experimental procedures and experimental results, i.e., between one set of beables and another.”

Humeanism

- distribution of matter throughout space-time: **complete history of initial configuration of matter points**
- that distribution manifests certain patterns
- **Humean best system:** the laws of nature are the axioms of the system that achieves the best balance between being simple and being informative in describing the distribution of matter throughout space-time
- **→ What the laws of nature are is fixed only “at the end of the world”.** The laws do not determine the temporal development of matter. That development determines the laws.

Humeanism: classical mechanics

- variables such as mass and charge figure in the laws
- mass and charge attributed to particles on the basis of patterns in the motion of the particles throughout space-time
- propositions that ascribe mass and charge to particles true, but truth-maker not properties that particles possess; truth-maker distribution of particle positions throughout space-time
- → mass and charge predicates, not properties
- inertial system, acceleration: defined through patterns in the history of the spatial relations among the matter points
- → Everything else apart from initial configuration of matter points and its temporal development comes in one package from the patterns that this temporal development happens to manifest.

Humeanism: quantum mechanics

- wave-function, representing quantum state, figures in the laws
- attributed to configuration of stuff (Bohmian particles, GRW flashes, GRW matter density) on the basis of patterns in the distribution of the stuff in space-time
- propositions that ascribe quantum state to particles / flashes / matter density true, but truth-maker not state that particles / flashes / matter density possess; truth-maker distribution of positions of stuff throughout space-time
- → quantum state predicate, not property
- → non-locality, EPR: quantum state true *description* that correlates matter points independently of spatial distance, but no relations of entanglement instantiated in space-time over and above spatio-temporal relations among matter points
- → quantum state no addition to being

Humeanism vs. modal realism

- **Humeanism:** no explanations in fundamental physics
- → brute fact that regularities on which we rely in science and everyday life always turn out to be well-confirmed
- **modal realism:** given an initial configuration of matter points, there is something about this configuration that puts a constraint on how it can develop in time; that something expressed in the laws of nature
- → laws express / reveal modal connections, thereby explanatory
- **more ambitious ontology:** primitive ontology & something modal that constrains development of primitive ontology
- **danger of surplus commitments:** commitment to modal realities that are there but that do not manifest themselves (differences that do not make a difference)

Modal realism: classical mechanics

- dynamical variables that figure in the laws represent properties of particles whose essence it is to induce a certain temporal development of the particles: **mass and charge as powers of the particles that manifest themselves in the temporal development of the particles**
- laws express these properties
- intrinsic properties: powers that the particles have taken individually
- powers, rather than dispositions, because no external stimulus

Modal realism: quantum mechanics

- universal wave-function at t represents property of whole configuration of primitive ontology (Bohmian particles, GRW flashes, GRW matter density) whose essence it is to induce a certain temporal development of the configuration
- **that essence expressed in dynamical law**
- quantum state = dynamical state of configuration of matter points, puts a constraint on the development of the matter points
- quantum state = holistic property: power of configuration of matter points as a whole (powerful structure that relates all the matter points)
- In the same way as matter points taken individually can have powers (mass, charge), so the whole configuration of matter points can have a collective power.
- **→ EPR-correlations explained without action at a distance (no interaction between primitive stuff since no intrinsic properties)**

Conclusion



- Humeanism fall back option, always available
- Plausibility of modal realism depends on its being spelled out in a simple and elegant manner: **as on Humeanism all dynamical variables & geometry come in one package**, so on modal realism wrt QM (BM, GRW), quantum state qua power of (initial) configuration of matter as represented by the universal wave-function has to incorporate everything that determines / puts a constraint on the temporal development of the configuration of matter
- → one holistic power that yields all the dynamics
- **no problem of surplus commitments**: that power automatically manifest in the temporal development of the configuration of matter