

Finding ordinary objects in some quantum worlds

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“Physics meets Metaphysics on the Banks of the Raritan”
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Assumptions

- Extreme scientific essentialism is false for ‘person’, ‘chair’, ‘planet’, etc. (dispensable).
- Facts about consciousness, goodness, etc. aren’t going require positing any distinctive extra fundamental structure.

Hypothesis H

The most obvious, flat-footed way of basing an account of the fundamental structure of the world on QM:

- Model it on what QM says about “closed quantum systems”; ignore the stuff about measurement and collapse, which *prima facie* looks non-fundamental.
- Don’t postulate any extra structure beyond what’s needed for this.

My questions

Could there be ordinary objects [chairs / trees / people / people sitting on chairs / people seeing trees / ...] if H were true?

- If so, what would they be like?
- Is what we know of ourselves and the ordinary objects with which we interact (prior to doing modern physics) consistent with H?

What I won't be doing

- Assessing the a priori likelihood of our evidence, given H, or comparing H with competitors.
- Presenting a way of understanding the full apparatus of quantum theory (e.g. claims about “probability”) on which it is consistent with H.
- Considering how much of this carries over to speculations about fundamental structure based on more realistic physics.

Sharpening the hypothesis

The fundamental structure of the world can be exhaustively represented by a trio of functions

$$m: P \rightarrow \mathbb{R}$$

$$V: Q \rightarrow \mathbb{R}$$

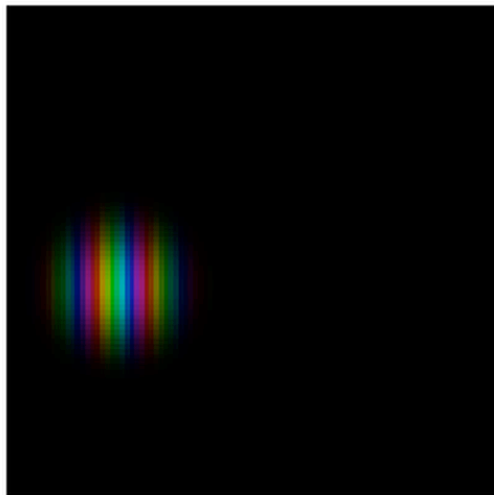
$$\psi: \mathbb{R} \times Q \rightarrow \mathbb{C}$$

where P is a set of *particles* and Q is the set of functions from P to \mathbb{R}^3 .

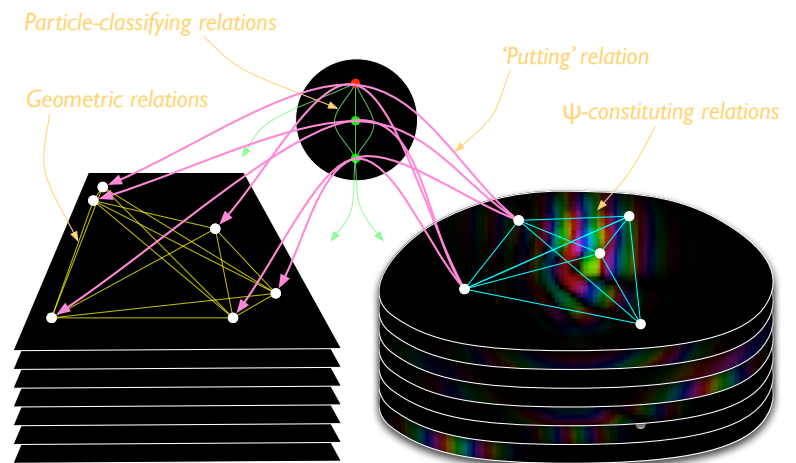
These functions satisfy Schrödinger's equation:

$$i \frac{\partial}{\partial t} \psi = - \frac{\nabla \cdot \nabla \psi}{2} + V \psi$$

Relative to the standard geometry on Q (which is determined by m).

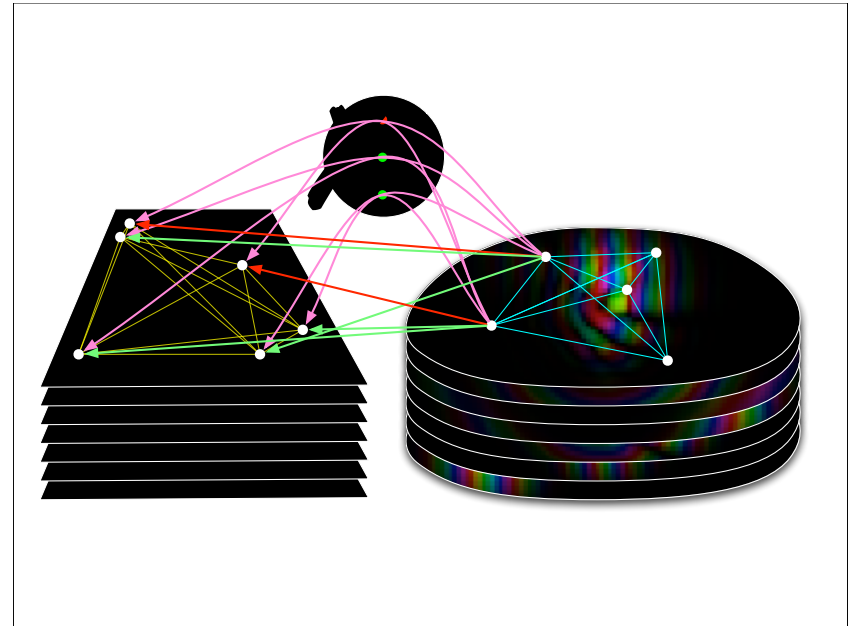


What Schrödinger would have said



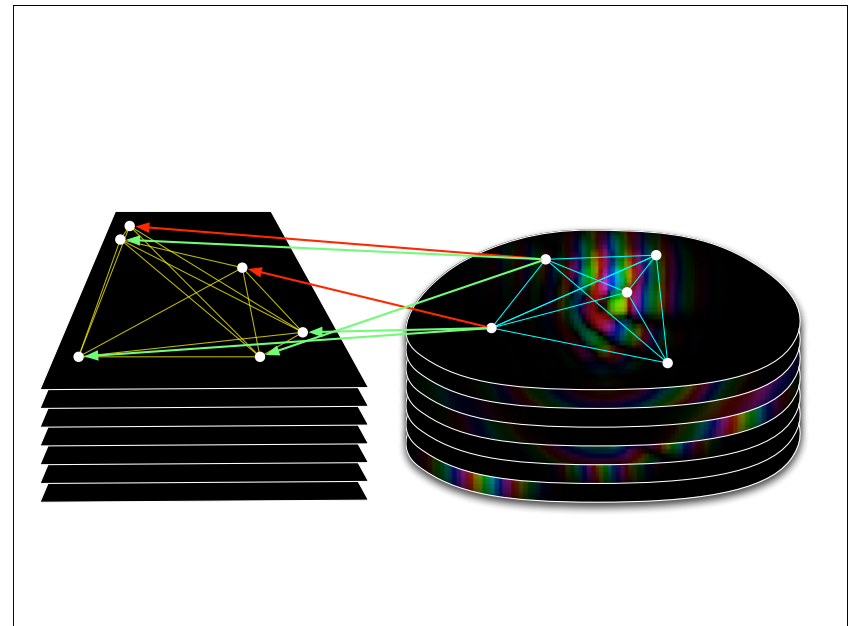
Variations

- Get rid of particles; replace the ternary “putting” relation with binary relations: “puts-an-electron-at”, “puts-a-proton-at”, etc.



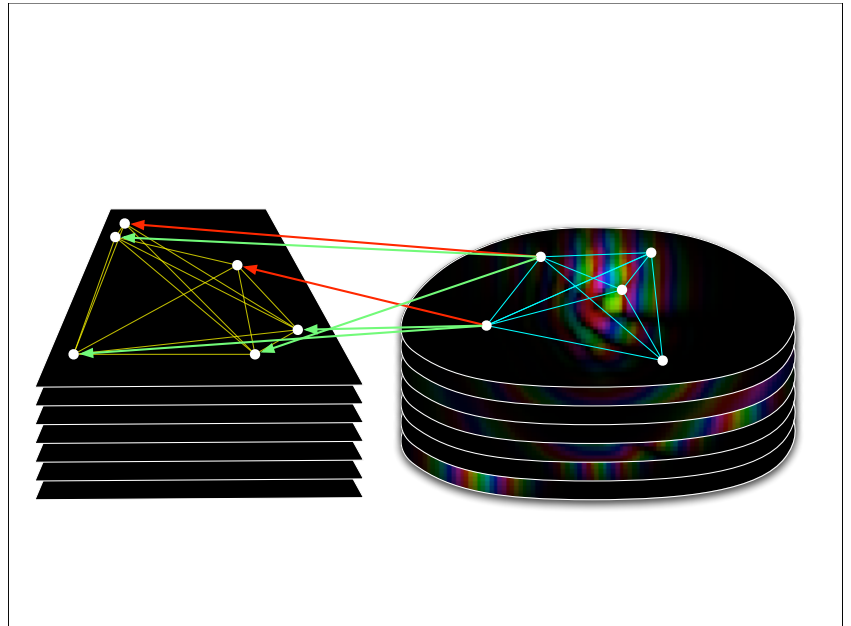
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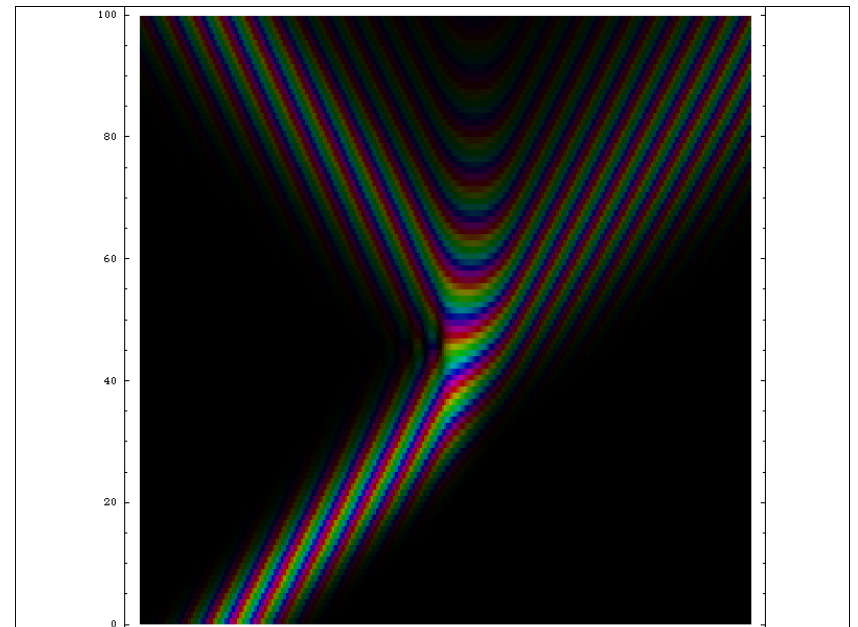
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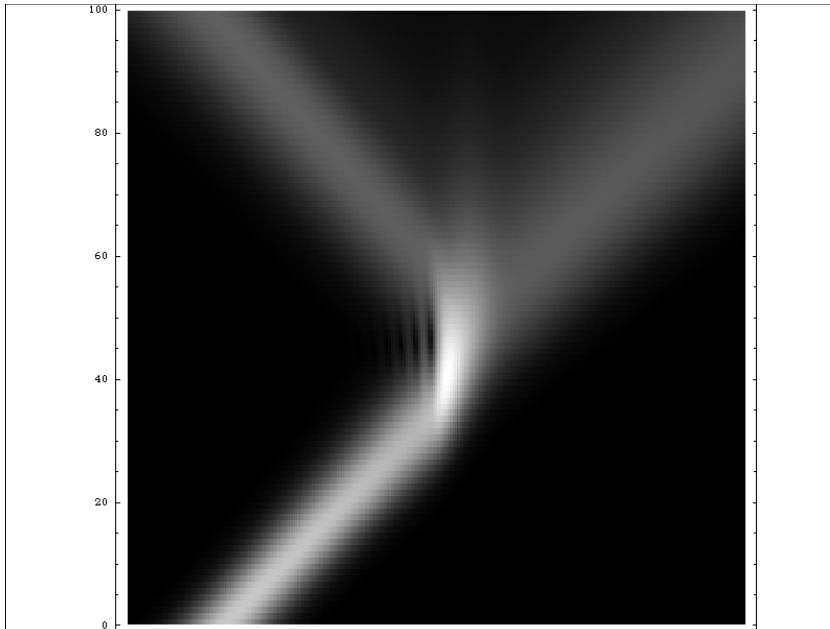
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- Have the fundamental objects be the “puttings” (“point-slices”); construct the old fundamental objects as equivalence classes.
- Make spacetime and configuration spacetime gunky.
- Construe “putting” as parthood: c-points as mereological sums of spacetime points.
- Get rid of spacetime too? (Albert)



Schrödinger worlds are messy

At any reasonably complex Schrödinger world, the wavefunction can't stay neatly “clumped” for long—most of the time, it's be widely scattered.





Schrödinger:

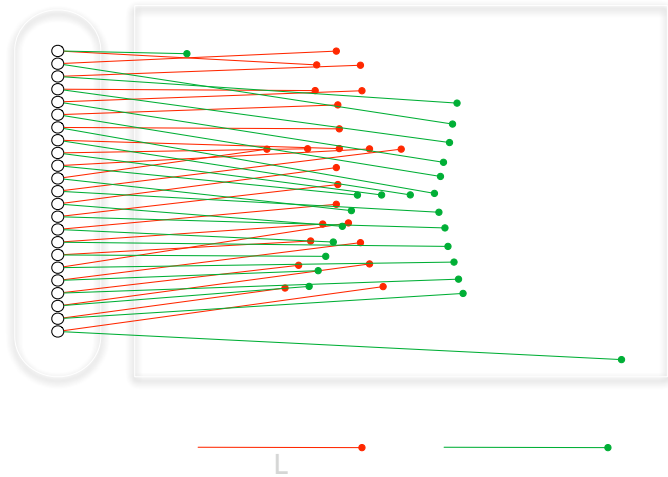
‘He thinks that if the laws of nature took *this* form for, let me say, a quarter of an hour, we should find our surroundings rapidly turning into a quagmire, or sort of featureless jelly or plasma, all contours becoming blurred, we ourselves probably becoming jelly fish.’

A canonical argument

1. At almost any time in any reasonably complicated Schrödinger world, the complete fundamental truth about any quantum system isn't such as could ground the attribution to the system of even an approximate shape, size, location, velocity, etc.
2. Ordinary objects must have approximate shapes, sizes, etc. to exist.
3. Ordinary objects ~~in Schrödinger worlds~~ must be quantum systems if they are anything at all.
4. So at almost any time in a Schrödinger world, there are no ordinary objects.

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- 3* Each ordinary object at a Schrödinger world is constituted at each time by a quantum system, with which it must share at least its categorical, temporally localised properties like shape and size.
4. So at almost any time in a Schrödinger world, there are no ordinary objects.

A world with two “location” relations



1. There are ordinary objects at the L - L^* world, which [determinately] have ordinary shapes, sizes, etc.
2. Aggregates of particles at the L - L^* world don't [determinately] have ordinary shapes, sizes, etc.
3. So either the ordinary objects are not constituted by aggregates of particles, or constitution doesn't require sharing properties like shape and size.

If we want to know the shape or size of an ordinary object at the L - L^* world, it's not enough to know the list of its constituent particles. We also need to know whether it's an 'L-object' or an ' L^* -object'.

The constitution of ordinary objects at Schrödinger worlds

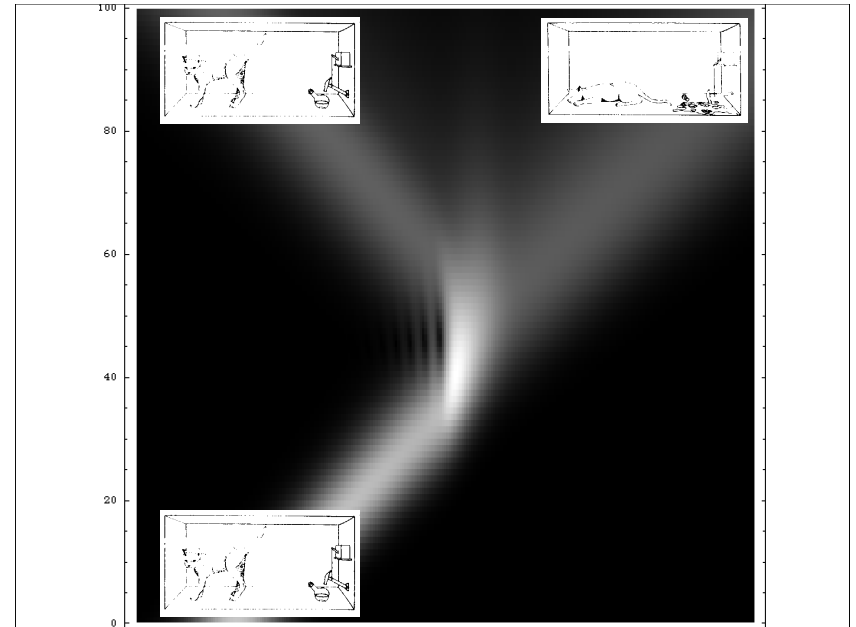
To specify the structure of a given ordinary object in a way that is adequate to determine its categorical properties, it is not enough to specify a set of particles, or a partial function from times to sets of particles. What is enough, then?

Proposal: a partial function from c -points to sets of particles.

Thick objects or thin objects?

Are ordinary objects thin—“occupying” only one c-point per time? Or are they thick, occupying many c-points per time?

- If we say that ordinary objects are thick, we will have to say that they are constantly *splitting*—undergoing fission—as the wavefunction gets more and more scattered.



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- If we say that ordinary objects are thick, we will have to say that they are constantly *splitting*—undergoing fission—as the wavefunction gets more and more scattered.
- This would be drastically at odds with our ordinary beliefs about the future.

Theories of fission

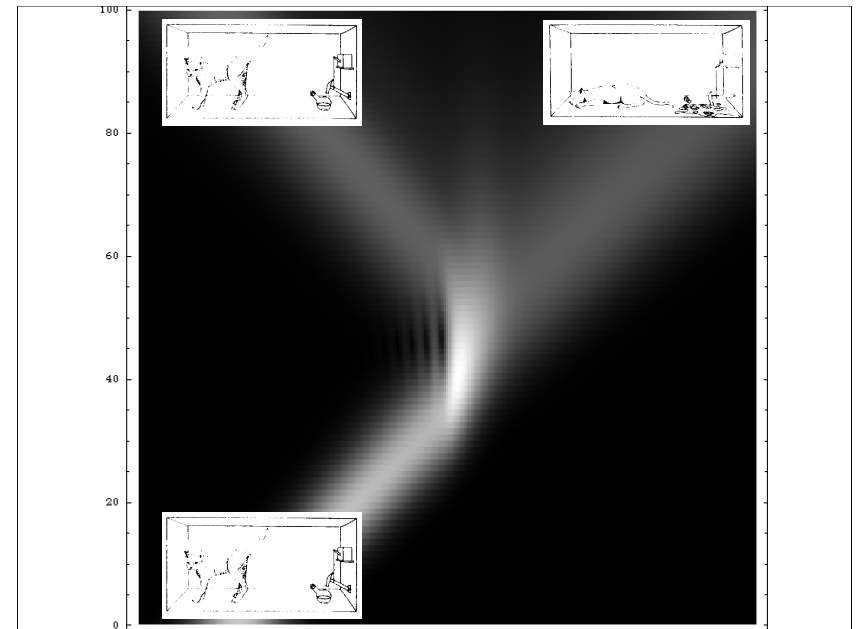
1. The amoeba goes one way or the other; it's indefinite which (Williamson).
2. The amoeba goes both ways.
3. The amoeba ceases to exist and two new amoebae come into existence (Parfit).
4. There were two amoebae all along (Lewis).

Claim: no matter which of these is right, once one knows the fates of one's fission products, there is no further *subject matter for uncertainty or ignorance* about the future.

Thin objects?

Would it help to suppose that ordinary objects are thin?

- Only if there were some non-arbitrary principle for answering the question which points of configuration space an ordinary object will occupy in the future, given the point it occupies now.

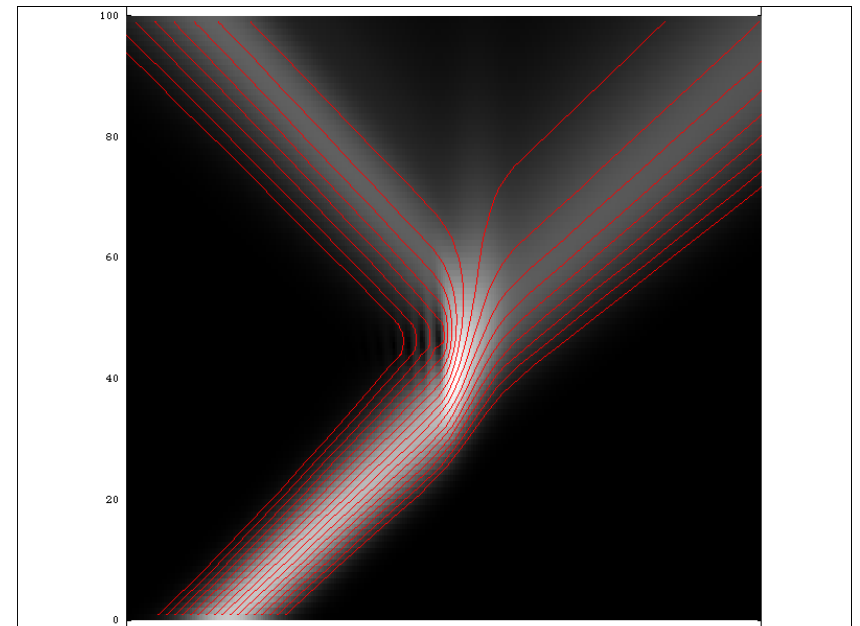


Bohm to the rescue!

We don't need to *add* any new fundamental structure to get a natural division of configuration spacetime into threads. Such a division is implicit in the fundamental structure we already have.

- It's specified by the 'Guiding Equation' of Bohmian Mechanics, which, given a wavefunction, spits out a vector field on configuration space at each time.

$$\vec{v}_\psi(t, \mathbf{q}) = \text{Im} \frac{\nabla \psi(t, \cdot)}{\psi(t, \cdot)}(\mathbf{q})$$



What makes the guiding equation uniquely natural:?

- Intrinsic naturalness: many other equations that might look simpler turn out to make sense only relative to an arbitrary choice of co-ordinates.
- Natural fit with Schrödinger's equation: evolving a region in accordance with the guiding equation preserves $|\psi|^2$...

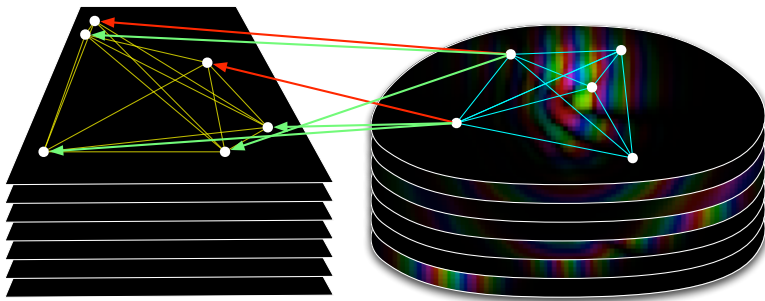
A step-by-step argument

World 1: spacetime + configuration spacetime + many families of Bohmian particles.

World 2: like World 1 except that the “particles” are equivalence classes of particle-timeslices, related by a primitive “genidentity” relation.

World 3: configuration spacetime is no longer fundamental; let the particle-timeslices themselves bear the wavefunction relations

World 4: eliminate the primitive genidentity relation.



A more abstract argument

Some sentences are “somewhat analytic”: an interpretation on which they are true at some given world is better than one on which they are false at that world.

Sentences like “if people exist, they often persist through appreciable stretches of time without undergoing fission” are somewhat analytic.

Other things are equal.

So an interpretation on which “ordinary objects live on Bohmian threads” is true at Schrödinger worlds is better than one on which “ordinary objects constantly undergo fission” is.

Causation within and across threads

If it's to make sense to think of objects as confined to a thread, the causal relations between objects from the same thread had better be very different in character, and more extensive, than causal relations between objects from different threads.

- Strategy for defending this: claim that if given ordinary objects had been different in some ordinary way—e.g. if Princip hadn't shot the Archduke—the world would have been *merely haecceitistically* different: different fundamental objects would have played the same qualitative roles.

