Department of Philosophy Lakatos Award 2013 lectures

Developing the Scientific Image: The Quantum Darkroom

Professor Laura Ruetsche

Professor of Philosophy,
University of Michigan

The Emergent Multiverse

Dr David Wallace

Tutorial Fellow, Balliol College and CUF Lecturer,
University of Oxford

Suggested hashtag for Twitter users: **#LSELakatos**

LSE events

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Quantum Theory and the Many-Worlds Interpretation

David Wallace (Balliol College, Oxford)

LSE, October 2014

Interpreting superpositions

$|\text{live cat}\rangle$ - represents system with a living cat in

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$a|\text{live cat}\rangle + b|\text{dead cat}\rangle$ - represents ?????????????

Probabilities and amplitudes

Born rule:

When superpositions are *measured*, the mod-squared amplitude of a term in the superposition is the probability that the measurement outcome corresponds to that term

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Probability interpretation:

Superpositions represent systems in an *unknown but definite* state

Problems for probabilistic interpretation

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- *Interference*

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- *Interference*
- Kochen-Specker Theorem
- Gleason's Theorem
- Pusey-Barrett-Rudolph theorem

The Measurement Problem

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- *Macroscopic quantum states* cannot be interpreted physically because of Schrodinger cat states

- *Actual physical practice* shifts inchoately between these interpretations

Change the philosophy?

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- Operationalism?

Change the philosophy?

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- Complementarity?

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- Operationalism?
- Complementarity?
- Quantum logic?

Change the physics?

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- Collapse of the wavefunction

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- Hidden variables?

Change the physics?

- Collapse of the wavefunction?
- Hidden variables?
- Retrocausation?

The paradox of electromagnetism

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A(x,y,z,t)- represents a pulse of radio waves going from Earth to Moon

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a A(x,y,z,t) + b B(x,y,z,t) – represents ?????????

The Emergent Multiverse?

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- *Physics* (decoherence) tells us that the quantum state, at large scales, has the *structure* of a branching multiverse with the branches obeying quasiclassical dynamics

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- *Philosophy* tells us (should tell us!) that higher-order ontology is a matter of autonomous higher-order structure and dynamics

Two Problems of Probability

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(1) What, if anything, is the categorical basis for probabilities?

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(1) What, if anything, is the categorical basis for probabilities?

(2) Why does that categorical basis play the probability role?

Lewis: Principal Principle?

Papineau: Inferential & Decision-Theoretic Links

The “what” problem

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- Frequentism?

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- Frequentism?
- Best-systems analysis?
- Bare postulate?
- **Everett: probabilities are mod-squared amplitudes in regimes where decoherence guarantees they obey the probability calculus**

The “Why” problem

“[I]s there any way that any Humean magnitude could fill the chance-role? Is there any way that an unHumean magnitude could? What I fear is that the answer is “no” both times! Yet how can I reject the very idea of chance, when I know full well that each tritium atom has a certain chance of decaying at any moment?”

(Lewis)

The “Why” problem, Everett-style

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- Probability from locality

  (Zurek, Carroll/Sebens)

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- Probability from decision theory

  (Deutsch, Greaves, Myrvold, DW)

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  The Everettian Epistemic Theorem (EM 218-223)

  (roughly) “An agent who obeys normal decision-theoretic axioms, and who considers Everettian QM as a live epistemic probability, will treat mod-squared amplitudes in that theory as probabilities”

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