

Title: Quantum Bayesian: Pros and Cons

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Abstract: The Quantum Bayesianism of Caves, Fuchs and Schack presents a distinctive starting point from which to attack the problem of axiomatising - or re-constructing - quantum theory. However, many have had the doubt that this starting point is itself already too radical. In this talk I will briefly introduce the position (it will be familiar to most, no doubt) and describe what I take to be its philosophical standpoint. More importantly, I shall seek to defend it from some bad objections, before going on to level some more substantive challenges. The background paper is: 0804.2047 on the arXiv.

# Quantum Bayesianism: Pros and Cons

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# Summary:

- Explaining the position
- What's good about quantum Bayesianism
- Some weak objections
- Some more substantive concerns:
  - What's the ontology?
  - What of explanation?
  - The means/ends objection.



# In a nutshell:

- *A quantum state represents an agent's degrees of belief about what the outcome of measurements will be and nothing more.*
  - These are purely subjective judgements, not matters of fact
- *Similarly, quantum operations and POVM elements are subjective too.*
- *But why should we think like this?*

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  - Diachronic: update degrees of belief on evidence, standardly by Bayes' thm.

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- What does the fact that *this* (QM) is our fundamental theory tell us (perforce indirectly) about the world at the basic level?

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- **Hard: a foundational project: find the axioms**

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- *Anything* can be treated quantum mechanically (assigned a state by some agent);
- What can't not be?
- Claim: A shift from a non-quantum to a quantum treatment of an object is not associated with any ontological shift.

- **Claim: It's permissible to assign non-classical superpositions to objects which one believes (or knows) there to be classical level facts about.**



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- New kinds of technical questions.



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- This is just instrumentalism! (e.g. Hagar)
- This is empirically refutable! (e.g. Hemmo)

# Real Concerns: (1) Ontology

- What ontological picture goes with a quantum Bayesian world unspeakable at the micro-level?
- Fuchs: pragmatism and an open future:
  - “The quantum world...[is] a world in continual creation” (Fuchs 2005)



- **The crucial point:**

- What happens (singular event) when a system and measuring device interact is not (not even probabilistically) determined by anything.

- **Fuchs:**

- “Something new really does come into the world when two bits of it [system and apparatus] are united. We capture the idea that something new really arises by saying that physical law cannot go there—that the individual outcome of a quantum measurement is random and lawless.” (4.9.01)
- “There is no such thing as THE universe in any completed and waiting-to-be-discovered sense...the universe as a whole is still under construction...Nothing is completed...even the “very laws” of physics. The idea is that they too are building up in precisely the way—and ever in the same danger of falling down as—individual organic species.” (24.6.02)

“My point of departure, unlike [William] James’s, [is] not abstract philosophy. It [is] simply trying to make sense of quantum mechanics, where the most reasonable and simplest conclusion one can draw from the Kochen-Specker results and Bell inequality violations is...“unperformed measurements have no outcomes”. The measurement provokes the truth-value into existence; it doesn’t exist beforehand.” (27.6.02)



- But one doesn't need to be a possibilist or pragmatist to make sense of the central idea:
- More conservatively:-
  - Eternalism: facts (timeless) pertaining to particular times
  - The facts at one time (e.g. about a measurement outcome occurring ) neither determine nor are determined by the facts pertaining to any other time

- The picture we are left with:
- A four-dimensional pattern of events, where the events at one time neither determine nor imply probabilities for events at any earlier or later time;
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- An *unruly* pattern; too unruly to parse out any laws or even weaker forms of generalisation.
- But how should we think of this roiling mess?
  - Proposal: A Cartwrightian picture of powers and dispositions.

## (2) Troubles with Explanation

- **Some central examples of explanation**
  - **Explanations of why macro objects have the physical properties they do in virtue of the behaviour of their constituents.**
    - **E.g. Solidity; conductivity.**



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- **QB ends:**
  - **Finding out how the world is;**
  - **Dealing with what the world brings.**
- **Means: performing experiments and updating on results.**
- **Why is this a good thing to do??**



# Summary:

- **Q Bayesianism is an interesting interpretive project**
  - **Combines realism about physics with anti-realism about (much of) QM;**
  - **Dissolves problems over measurement etc. and manages shifting split.**
- **Doesn't fall to some common objections;**
- **Intelligible ontology can be found;**
- **But problems remain over explanation and subjective probabilities.**

## (2) Troubles with Explanation

- **Some central examples of explanation**
  - **Explanations of why macro objects have the physical properties they do in virtue of the behaviour of their constituents.**
    - **E.g. Solidity; conductivity.**
- **But how, if quantum mechanics does not provide a story about the properties of micro-objects and laws governing how they behave can such explanations function?**