Review of "Epistemic-Pragmatist Interpretations of Quantum Mechanics: A Comparative Assessment", by Ali Barzegar and Daniele Oriti (*Foundations of Physics* 54:66, pp. 1–34, 2024)

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In the foundations of quantum mechanics (QM), one important distinction is that drawn by Harrigan and Spekkens (2010), between 'ψ-ontic' and 'ψ-epistemic' approaches. Here, recall, is how they put the distinction:

> We call a hidden variable model ψ-*ontic* if every complete physical state or *ontic state* in the theory is consistent with only one pure quantum state; we call it ψ-*epistemic* if there exist ontic states that are consistent with more than one pure quantum state. (Harrigan and Spekkens 2010, p. 126)

Famously, ψ-epistemic approaches are at risk of falling prey to the no-go theorem of Pusey et al. (2012) (the 'PBR theorem'). That being said, there are other approaches to QM which might be described (if only loosely) as 'epistemic', which (at least *prima facie*) reject the ontological models framework in which the PBR theorem is situated, and (*prima facie*, *ipso facto*) manage to evade it. These approaches include many of the 'epistemic-pragmatist' approaches which are the subject of the article under review here.[1]

According to Barzegar & Oriti, these epistemic-pragmatist approaches are—broadly and of course with differences in emphasis and presentation—committed to the following 'common core' of views:

1. An 'epistemic' (as opposed to ontic) view of quantum states. (p. 4)

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[1]See p. 5 of the article under review for discussion of the rejection of the ontological models framework by (many of) these 'epistemic-pragmatist' approaches.

2. A metaphysics of participatory realism. (p. 6)

3. An epistemology of perspectival objectivity. (p. 6)

I have already discussed (1). The idea of (2) is that these approaches place central weight upon the *relations* between embodied observers and measurement processes on the one hand, and the rest of the world on the other. The idea of (3) is that all the approaches under consideration "share the rejection of a strong form of objectivity that is context-independent and in which intersubjectivity is complete."[2]

Which approaches fall under this 'empiricist–pragmatist' heading? Barzegar & Oriti present the following list (in this order):

A. Bohr's view

B. The Bub–Pitowski interpretation

C. The Janas–Cuffaro–Janssen interpretation

D. Mueller's interpretation

E. Relational quantum mechanics (RQM)

F. The Brukber–Zeilinger interpretation

G. QBism

H. Healey's pragmatist interpretation[3]

[2]In the context of (3), the authors write that:

> The strategy to secure some form of objectivity and avoid radical relativism is by relying on this existence of isomorphisms between perspectives, when there are no invariant elements across different perspectives. These isomorphisms guarantee a form of weaker objectivity, while invariant elements would be our best candidates for what we could regard as objectively real in the strongest, traditional sense. (p. 8)

Considering these 'isomorphisms' suggests the Kleinian approach to geometry—see Read (2022) and Wallace (2019). But the Kleinian approach identifies as invariants those structures which are preserved by the isomorphisms under consideration, and so it is not obvious why this notion of objectivity is 'weaker'.

[3]One version of quantum pragmatism, distinct from that of Healey but which Barzegar & Oriti do not mention, which in fact offers something akin to a Bohrian account, is the 'inferentialist' approach due to Menon (2024). According to this position, the quantum state is representational when and only when it would be apt to describe the physical system under consideration as having undergone decoherence (which, of course, is akin to a 'classical measuring context'). One advantage of Menon's approach over that of Healey might

One of the central merits of the article under review here is to bring all of these approaches together under a single roof, and to compare them in a systematic and tolerably clear way. As such, the article should prove to be a valuable resource going forwards for research into the foundations of QM.

I won't quibble too much about whether all of (A)–(H) fall under (1)–(3) (i.e., satisfy what Barzegar & Oriti call the 'common core' of epistemic-pragmatist approaches to QM), especially when the authors hedge appropriately by writing: "we do not claim beforehand that all the different interpretations are committed to the core elements of this framework to the same extent and degree" (p. 8). That being said, there are a few relatively minor points on this front which I do want to make with respect to QBism and RQM in particular.

I'll begin with QBism. Barzegar & Oriti claim that, according to all epistemic-pragmatist approaches, "the quantum state is a complete characterization of the physical system" (p. 3). But this doesn't seem to accurately capture the guiding idea of QBism, which is that the quantum state is purely subjective (and state collapse is just Bayesian updating), and so does *not* exhaustively characterise the physical system under consideration! Moreover, on the basis of (2), Barzegar & Oriti aver that epistemic-pragmatist approaches are all such that "we should move from an object-based ontology to a relation-based one"—but it's not clear why this is so in the case of QBism, given that (to repeat) on this view the quantum state is not in any straightforward way related to the fundamental ontology of the world (which is broadly ineffable and perhaps—following the analysis by Timpson (2008)—dispositional/modal). And finally, regarding QBism and (3): when Barzegar & Oriti say that, given (3), "[t]here is no perspective-independent fact. In other words, facts (about physical systems) are irreducibly relative", it's in fact not obvious that a QBist need accept this—the true physical state of the world might be *non*-perspectival; it's just that the quantum state is perspectival insofar as it is purely subjective.[4]

I'll now move on to RQM. In the context of (3), Barzegar & Oriti note that Adlam and Rovelli (2023) invoke what they call 'cross-perspective links' in order to secure cross-perspective consistency; they claim, moreover, that this principle establishes "an invariant element of RQM" and hence "a

be argued to be that, while it seems that Healey cannot avail himself of something like the Deutsch–Wallace theorem in order to underwrite the objectivity of quantum probabilities (which isn't to suggest that he would in fact *want* to do this), Menon—by regarding the quantum state as representation when decoherence has occurred—can do this.

[4]Aside: in the article, I would like to have read a little more about how (B), (C), (D) and (F) relate to QBism.

stronger form of objectivity" than is strictly required by (3), i.e. 'perspectival objectivity' (p. 14). The first point which I want to make here is simply that, in fact, 'cross-perspective links' comes in different strengths. Here is Rovelli:

> There are two ways to interpret this postulate. It can be interpreted strongly, as an absolute statement about a relation between perspectives. Alternatively, it can be interpreted weakly, as a statement about what can be ascertained by a (possibly further) observer. (Rovelli 2025, §3.3)

What I want to flag here is that Barzegar & Oriti seem to have in mind the strong reading of this principle, but in fact it's the weaker version which seems more straightforwardly in line with 'perspectival objectivity'.[5] Moving on now to (1), I likewise want to flag that although Barzegar & Oriti don't say anything incorrect on this front, the literature on RQM is in fact rather unclear about whether the quantum state is to be regarded as (merely) epistemic. Although articles such as Rovelli (2025) suggest that quantum states in RQM are mere 'tools', such a claim can be read in many ways. One such way would be epistemic, and that the quantum state is not representational. Another would be that the quantum state represents categorical properties of systems, but only relational such properties; yet another would be that the quantum state doesn't even represent categorical properties of systems, but perhaps only dispositional/modal ones.[6] These readings aren't equivalent, so one has to be cautious in adopting a purely 'epistemic' reading of the (relativised) quantum state in RQM (the claims of its proponents notwithstanding).

There's one further point regarding RQM which is worth making here. Later in their article, Barzegar & Oriti consider the status of probabilities in this approach, writing that: "If probabilities in RQM are interpreted in an objective manner as propensities or dispositions then it means that the quantum state cannot be regarded as epistemic in RQM" (p. 25). Quite so—but, as I have stressed above, proponents of RQM needn't be implicated in regarding the quantum state as (merely) epistemic. As Barzegar & Oriti then say, "[t]his deduction would bring RQM, in fact, outside the epistemic-pragmatist camp as we characterised it"—again just so, which is why there's at least some ground to question whether it should have been included in this

[5] For more on the differences between Adlam's preferred 'absolutist' reading of RQM and Rovelli's preferred 'relativist' reading of RQM, see Faglia (2025).

[6] Cf. comments by Timpson (2008) on QBism and non-categorical representation, also mentioned above.

categorisation in the first place. (To repeat, it was clearly not unreasonable to include RQM in this categorisation on the basis of comments made by its proponents—what I want to flag is only that there are various possible interpretations of RQM, some of which would seem to implicate it in a denial of (1) and hence place it outside of the 'common core' of epistemic-pragmatist approaches.)

One important more general claim which arises out of this paper is that there is a case of underdetermination of theory by evidence when it comes to all of these epistemic-pragmatist approaches to QM, in analogy with the (apparent) underdetermination between the 'standard' realist approaches to QM, namely dynamical collapse theories (such as the GRW theory), Bohmian mechanics, and the Everett interpretation. But I think this claim can be resisted in two ways. First: is it really true that there is indeed a case of underdetermination in the case of those 'standard' approaches? Recently, Wallace (2023) has argued that there is no genuine underdetermination here, for only the Everett interpretation is reconcilable with relativistic quantum field theory, which is the mainstay of contemporary theoretical physics. But even setting this aside, there is another issue: there is a case to be made that the claim that these epistemic-pragmatist approaches exhibit a case of theoretical underdetermination is premature, because most of such approaches are still in early stages of development, with their conceptual/mathematical/ontological aspects remaining unclear in various ways, etc. Perhaps in the future an uncontroversial case of theoretical underdetermination will arise for some subset of these approaches, but we are not quite there yet.[7,8]

In the conclusion of their article, Barzegar & Oriti write that "[a]ll these core commitments [of epistemic-pragmatist approaches] point to new, radical, and in our opinion extremely interesting philosophical perspectives that deserve, and in fact require, further analysis" (p. 31). I fully concur with these verdicts: these topics offer some of the most exciting and as-yet un-

[7] On p. 28, the authors write that

> we feel that disentangling the mathematics of the theory from its physical or mathematical content is more dangerous than useful, increasing the interpretation [*sic*] underdetermination [...].

There are perhaps interesting connections to explore here with the 'math-first structural realism' recently espoused by Wallace (2022).

[8] There is also the following point (for which my thanks to Emily Adlam). Some of these epistemic-pragmatist approaches seem to differ mostly in how they conceptually motivate the relativisation (supposedly) present in QM. But perhaps some of these conceptual motivations are compatible after all—in which case, there will not be underdetermination.

tapped areas for exploration in the foundations of QM. As such, this article will offer a helpful guide for future explorations into these areas.

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