Relationalism versus realism: a dilemma for relational quantum mechanics

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Abstract

Are absolute representations of reality—i.e., representations of reality from no particular point view—possible? Moore (1997) has offered abstract arguments for the following answer to this question: 'yes, *invariably*'. But there are questions regarding whether (and how) this conclusion can be compatible with modern physics, where absolute representations often seem hard to come by. These questions were taken up by Jacobs and Read (2025) in the context of classical spacetime physics; here, we turn our attention to quantum mechanics. In particular, when the arguments of Moore (1997) are brought into contact with the 'relational quantum mechanics' of Rovelli (1996) and collaborators, one finds that the latter is unstable: either it is not relational view, or it is not a realist view.

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1 Introduction

Does physics provide absolute representations of reality? This question has recurred many times over the course of the history of physics, from debates about the conventionality of geometry to discussions of symmetries and invariance.[1] But one particularly salient area of physics is, of course, quantum mechanics. Insofar as quantum states purport to describe the world,[2] one can ask whether they describe the world in absolute or relative terms. By which we mean: is a quantum state a neutral representation of reality, or does it always adopt the perspective of some particular observer?

The interpretation of quantum mechanics known as 'relational quantum mechanics' (RQM), promulgated by Rovelli (1996), plumps for the latter. The quantum state is a description only of the variables of one system *relative to those of another*. If RQM is correct, then there is no 'view from nowhere' in quantum mechanics. It is important to note that we are concerned here with *descriptions* of reality—namely, the quantum states—and not with reality itself. Accordingly, we will from the outset make the basic realist assumption that there is one objective and mind-independent world by which true representations are made true. The matter at stake is whether an *absolute* representation of this reality exists. We will use Moore's framework in his *Points of View* (Moore 1997) to elucidate the notion of an absolute representation.

Our aim in this article is to critique RQM, which indeed is one of the main non-absolute interpretations of quantum mechanics. We will discuss three major versions of RQM: Rovelli's original version, which we (following Faglia (2025)) call RRQM; Adlam and Rovelli's modified version in which 'cross-perspective links' are added, which we (again following Faglia) call ARQM; and Adlam's most recent 'dynamical interpretation' (Adlam 2025), which we call DRQM. We'll find that each of these interpretations faces a dilemma: either it must reject the basic realist assumption that true representations are made true by one and the same reality, or it is pressured to accept that quantum states are not relative but absolute. In brief: if RQM is *truly* relational, then it is not a realist interpretation in the above sense.

[1] See, respectively, Dürr and Read (2024) and Saunders (2002).

[2] *Contra* pragmatist views of quantum theory propounded by, for example, Healey (2023a).

2 Realism and Reality

Before moving on to RQM in earnest, it'll be helpful to provide a clearer characterisation of realism, and a more precise distinction between absolute and perspectival representations. These are our objectives for this and the next section, respectively.

We first distinguish between *metaphysical realism* and *scientific realism*. The former is the thesis that there exists a mind-independent world. The latter is the thesis that our scientific theories aim to describe this world and are at least to some extent successful in achieving this aim. These theses resemble closely what Rovelli (2018, p. 9) calls 'weak realism' and 'strong realism'. Weak realism, says Rovelli, "is the assumption that there is a world outside our mind," while strong realism has it that "it is in principle possible to list all the features of the world, all the values of all variables describing it at some fundamental level, at each moment of continuous time, as is the case in classical mechanics."[3] Since metaphysical realism is held in common between us and advocates of RQM, we will not discuss it further here.

The scientific realist adds that quantum mechanics represents this world. We will in fact hold the scientific realist to the more specific claim that quantum mechanics is able to represent *nomically contingent features* of the world: features that are not fixed by the laws, such as the particular value of a quantity. Put differently, it should represent initial conditions (in addition, of course, to laws of nature). Although this specificity condition strengthens scientific realism, it is straightforwardly satisfied by realist interpretations of theories such as classical mechanics and general relativity. For example, one can take particular solutions to the Einstein field equations to represent particular possibilities. We believe that an interpretation of a theory for which this specificity condition does not hold is not sufficiently successful in its aim to describe our world to count as truly realist.

The representational machinery of quantum mechanics consists of such devices as Hilbert spaces, self-adjoint operators, and quantum states (i.e. 'the wavefunction'). The former two represent broad features of the theory, in particular its kinematical structure and observables. To take those as the only representational devices of quantum mechanics falls short of our definition of scientific realism: it does not meet the specificity condition. The quantum state, on the other hand, seems able to describe actual systems and their features.[4] Applied to quantum mechanics, then, and absent any other aspect of the formalism of quantum mechanics that could represent specific features of our world, scientific realism entails that quantum states represent reality.

[3] Of course, this is stronger than scientific realism as we ourselves have presented it.

[4] At least their occurrent features, and perhaps their modal features as well, if one follows the lead of Wilson (2020).

We endorse scientific realism. But it is not always clear whether advocates of RQM are realists in this sense.[5] On the one hand, advocates of RQM often talk about what the quantum state is supposed to represent: Rovelli (2025) states explicitly that "RQM is realist about quantum states in the weak sense that they represent something physically real." In the same vein, Adlam and Rovelli (2023, p. 2) open their paper with the claim that "[RQM] is an interpretation of quantum mechanics based on the idea that quantum states describe not an absolute property of a system but rather a relationship between systems." Adlam (2025, p. 15) confirms that the quantum state "describes concrete dynamical facts." On the other hand, RQM's advocates are also wont to deny—often within the same paper—the quantum state any representational significance. Di Biagio and Rovelli (2021, pp. 7–8), for instance, declare that the quantum state "is what a physicist uses to calculate probabilities for relative facts between physical systems to happen." Adlam (2025, p. 14) similarly writes that "there is no fact of the matter about the 'true' interaction state" and that it is "simply a convenient tool for extracting locally meaningful consequences for various possible interactions out of the complex global dynamics of quantum mechanics."

We can only read the latter kind of statements as confessions to scientific anti-realism about quantum mechanics: there *is* a mind-independent reality, but quantum mechanics does not describe (much of) it.[6] If RQM is, after all, intended as a scientifically anti-realist interpretation of RQM, then of course the question of whether it provides absolute representations does not even arise. But it seems to us that there is ample scope to read (the aspirations of) RQM in a scientific realist way, and it is this interpretation of the theory to which we confine ourselves in what follows.

3 Absolute Representations

We'll now clarify what we mean by an absolute representation. To start with, a representation is a vehicle which is true or false by virtue of its content. We will follow Moore (1997), who defines an absolute representation as one that can be 'integrated by simple addition' with any other representation. To *integrate* two representations means to provide a third representation whose content is the product of theirs, that is, which is true just in case they are both true. To integrate two representations *by simple addition* is

[5] Cf. Read (2025).

[6] There are affinities here with points made by Timpson (2008) about QBism (on which see Healey (2023b) for a summary). That approach to quantum theory is not anti-realist *tout court*—its proponents still affirm that there exists some mind-independent reality—but it *is* anti-realist about the quantum state. As we see it, the situation is similar in the case of RQM.

to integrate them in such a way that the result is a conjunction of two representations of the same type as theirs. The simplest example of integration by simple addition is logical conjunction: the sentence 'it is round and it is blue' integrates the sentences 'it is round' and 'it is blue'. For an example of a representation that is not absolute, consider the sentences 'it rains today' and 'it doesn't rain today'. We may suppose that the first sentence is truthfully uttered on Monday and the second is truthfully uttered on Tuesday. Yet, because these sentences adopt a temporal perspective, it is *not* possible to integrate them by simple addition: the conjunction 'it rains today and it is doesn't rain today' is false on either day.

Moore (1997) argues that an absolute representation of all of reality is possible. We won't recap his argument here, but see Jacobs and Read (2025) for a thorough discussion of its structure. For our purposes, we require only one of Moore's premises, namely that *there exists a set C of possible representations that are integrable by simple addition such that for any pair of true representations r_1 and r_2, there exists an $R \in C$ part of which reveals how r_1 and r_2 are made true by reality.* Moore's justification for this premise consists of two steps. First, he writes that "it means nothing to say that each of them [r_1 and r_2] is made true by reality unless it is possible, in principle, to produce a representation that reveals how" (Moore 1997, p. 69). Second, he assumes that true representations are made true by "the same reality in every case" (*ibid.*). This means that "not only must it be possible to provide an account of the kind just described for any possible true representation, but the part of this account that is used for the indirect endorsement of the representation must be combinable with every other such part into a single conception of reality—call it C." Crucially, at this stage in the argument it is not yet claimed that C is an *absolute* conception of reality.[7] Moore claims only that it is a *unified* conception of reality: one that accounts for all of reality from at most one perspective.

We concur with Moore's assumptions that (i) for every pair of representations r_1 and r_2, if r_1 and r_2 are made true by reality then it is possible to produce a representation R that reveals how, and (ii) if every true representation is made true by the same reality then there exists at least one perspective p such that for every pair of representations r_1 and r_2, the R that reveals how is from p. We believe that these are basic realist tenets that any scientific realist should accept. Informally, they amount to the idea that it is possible from one perspective to make sense of what reality looks like from another perspective. If this were not possible, it would not make sense to speak of *the* reality or *the* world.

[7]The terminology 'absolute conception' is due to Williams (1978, 1985), from whom Moore (1997) draws inspiration. We will understand a 'conception' of reality as a set of representations that jointly represents all of reality.

In fact, our assumptions are relatively weak. They are compatible with the possibility of an absolute conception of reality, but also with a more perspectival metaphysics such as the fragmentalism about tense due to Fine (2005) or the fragmentalism about special relativity due to Lipman (2020). For it is possible to offer a unified representation of reality from within one frame of reference (cf. the 'Lorentzian pedagogy' of Bell (1976)) and, by means of the Lorentz transformations (plus various further assumptions tied up with the Lorentzian pedagogy), to reveal from one frame of reference how representations in another frame of reference are made true by this reality. We will see below that the kind of perspectivalism apparently entailed by RQM is more radical than this, because in RQM it becomes impossible to translate between perspectives in a systematic way.[8]

To make our points here completely clear, an analogy might prove helpful. The situation in which we contend that RQM finds itself is akin to the way in which gravitational stress-energy pseudotensors in GR fail to be geometric objects because they do not have well-behaved transformation rules.[9] Indeed, in the literature on geometric objects in physics, it's often taken to be a necessary condition for an object's representing something real that there be well-defined transformation rules between its perspectival representations (see Read (2022) for a philosophical overview). This is true for tensors such as the Minkowski metric (which underwrites our claim that a fragmentalist approach to special relativity *à la* Lipman (2020) is compatible with absolutism), but seems to fail for the case of pseudotensors, undermining (the thought goes) any claim to the effect that the latter in fact represent anything at all.[10] What we'll show in this article is that either RQM finds itself in the latter situation (the situation analogous to the case of pseudotensors)—in which case the view is questionably realist at all—or it finds itself in the former case (the situation analogous to fragmentalism in special relativity)—in which case it seems to be pushed into a view which is questionably relationalist.

[8]To be clear, we don't claim that fragmentalism is invariably compatible with our basic realist tenets—only that certain versions of fragmentalism, e.g. Lipman's application of the position to special relativity, are so compatible (in that case because the Lorentz transformations afford one the ability to transform between perspectives). Other versions of fragmentalism where the analogues of such transformations are unavailable will not so obviously be compatible with our basic realist tenets.

[9]See Jacobs and Read (2025) for discussion; cf. Duerr (2019), Pitts (2010), and Read (2018, 2022).

[10]Jacobs and Read (2025) offer a way of giving an absolute representation of the physical content of pseudotensors after all; we won't go into the details of their proposal here.

4 Relative RQM

We are now in a position to critique the first version of RQM: Rovelli's RRQM. As Faglia (2025) states, the first 'R' here can stand both for 'Rovelli'—since this is the version of the theory expounded by him—and for 'relative'—since it holds that quantum events are always relative to another system. This is one of RRQM's core ideas: see Rovelli (1996). By a 'quantum event', we mean the instantiation of a particular value v of a quantity Q by a system S relative to an observer O. RRQM thus postulates that such events only take place *relative to a third system,* R. Insofar as quantum states describe the values of a quantity instantiated by a system, they only describe this relative to (or 'from the perspective of') another system. For example, the spin state $|\uparrow\rangle_S$ of a particle S implicitly adopts the perspective of an external observer.[11]

To illustrate these ideas, consider a standard Wigner's friend set-up. Alice measures the spin of a particle in a superposition state. After the measurement, the particle will have a definite spin state relative to Alice—let's say it's up. Meanwhile, Alice does not interact with Bob. By the unitary evolution of quantum mechanics, Bob will conclude that after the measurement Alice is in a superposition state of having measured up and having measured down. This is Alice's state relative to Bob.

The puzzle arises when we ask what happens to this state when Bob measures Alice's result. It would seem that Bob should find that Alice's outcome was indeed spin up. The state of the particle relative to Alice would then match the state of the particle relative to Alice relative to Bob. But RRQM allows for the possibility that from Bob's perspective, Alice has measured spin down, while from Alice's own perspective the measurement outcome is spin up. This follows directly from the core idea that "different observers can give different accounts of the same set of events" (Rovelli 1996). Dieks (2025), whom we interpret as an advocate of RRQM,[12] calls this feature 'radical perspectivalism', by which he means that "the relativization of facts with respect to observers persists even if these observers make causal contact and interrogate each other about their results."

In case all this seems somewhat abstract, consider the case in which Bob simply *asks* Alice what the result of her measurement was. By radical perspectivalism, it is possible that within Alice's own perspective she has observed her measurement device display 'spin-up', yet within Bob's perspective Alice says to him that she has observed the device display 'spin-down'. This is not a miscommunication or an hallucination: Bob is equally correct as Alice. Moreover, neither Alice nor Bob would ever discover this dis-

[11] In this and the next section we assume that quantum states represent occurrent features of a system; in §6 we will address the proposal that quantum states instead represent *modal* features.

[12] Dieks (2025) writes that his view only differs from RQM "on a minor point" (fn. 5).

crepancy empirically, because within their respective perspectives all observations perfectly cohere with each other. For example, if Bob were to subsequently measure the state of the particle himself, he would find that it's spin-down. In some sense Alice and Bob live in different, parallel worlds.

But in fact RRQM is even more radical than this. For we have implicitly supposed that it makes sense to compare the quantum state from the perspective of Alice to that from the perspective of Bob. This is explicitly ruled out by another of RRQM's postulates, however: "we can [only] make statements about the state of the S–O system, provided that we interpret these statements as relative to a third physical system P" (Rovelli (1996); see also Di Biagio and Rovelli (2021)). This is what makes RRQM a *relativist* interpretation. It follows that there is no unique state of the particle relative to Alice: there is only the state of the particle relative to Alice *relative to Alice*, and the state of the particle relative to Alice *relative to Bob*, and so forth. It does not end there: Riedel (2024) shows that this relativity 'iterates', such that in order to compare the state of the particle relative to Alice relative to Alice to the state of the particle relative to Alice relative to Bob, one has to consider the state of the particle relative to Alice relative to Alice/Bob *relative to a further system—ad infinitum*.

We see two ways to understand this aspect of RRQM, both of which conflict with Moore's above-articulated injunction that there exist a unified (if not an absolute, i.e. perspective-free) conception of reality. Firstly, it is possible that there are *no* facts from a finite number of perspectives. In that case it does not even make sense to speak of the state of the particle relative to Alice. We find it difficult to see how there are facts at all on this view. But even if infinitely perspectival facts are conceivable, they cannot provide a unified representation of reality. To see this, consider any two such facts: because there is no stable perspective from which to evaluate them, there is no procedure by which to integrate them either directly (that is, to take their conjunction) or indirectly (that is, to provide a third perspective that incorporates both of them). They are thus not made true by one reality. Secondly, and more plausibly, there *are* facts from a finite number of perspectives, but it is impossible to absolutely compare those facts from any further perspective. We believe this is the view that Rovelli has in mind. Since Alice's and Bob's perspective are now simply incomparable, it is clearly impossible to reveal how true representations from one perspective are made true by reality from the perspective of the other. Bob's quantum state does not explain Alice's. Neither is it possible to reveal from a third perspective—say, Chidi's—how the state of the particle from Alice's perspective and the state of the particle from Bob's perspective are both made true by reality. For the state of the particle relative to Alice relative to Chidi is just not the same as the state of the particle relative to Alice. Chidi has a new window onto reality different from both Alice's and Bob's. Moreover, the same dialectic recurs at the next level. For one can also compare the state of the particle relative to Alice and Bob, respectively, from the perspective of a fourth observer, Djamila, such that yet another perspective is necessary to reveal how the potentially distinct accounts of Chidi and Djamila are both made true by the same reality. Therefore, it is impossible in RRQM to provide a unified representation of reality from one perspective.[13]

On the assumption that Moore's premise is correct, then, RRQM as advocated by Rovelli (1996, 2025) and Dieks (2022, 2025) must reject the principle that true representations from different perspectives are made true by the same reality in every case. This goes much further than the initial idea that quantum states describe the state of one system relative to that of another. That idea, after all, is compatible with the existence of a unified reality behind those relative states, in the same way that the coordinate-independent Minkowski metric underlies coordinate-variant attributions of length and duration. There is no analogue of a Lorentz transformation that takes one from the particle's state relative to Alice to the particle's state relative to Bob. This precludes the possibility of a unified conception of reality from any one perspective. RRQM therefore falls prey to the first horn of our dilemma: it entails that there is no one reality by which our representations are made true. We emphasise that we have not assumed the possibility of an absolute representation of quantum reality—advocates of RQM might well reject such an assumption out of hand—but only the possibility of a unified representation of quantum reality, which follows from our basic realist tenets. RRQM conflicts even with this weaker premise.

5 Absolute RQM

Adlam and Rovelli (2023) also object to radical perspectivalism, although for the less lofty reason that it leads to a kind of solipsism that seems to make intersubjective science impossible (see Adlam (2022)). This leads them to propose a revised version of RQM with a new postulate intended to rule out radical perspectivalism: ARQM. As Faglia (2025) states, the 'A' can stand both for 'Adlam' and for 'absolute'. We believe that this version of RQM falls prey to the second horn of our dilemma: it requires absolute quantum states anyway.

[13] Perhaps one could construct a unified conception of reality that simply consists of a description of the world from each perspective? Dieks (2022, p. 17) indeed suggests that "the totality of reality is formed by the entire collection of all fragments." But we concur with Moore (1997, p. 66) that "the question is not whether there can be representations that are from all points of view at once. It is easy to think of the absolute as somehow encompassing the perspectival. But if this thought amounts to anything, it certainly does not amount to the absurd idea that being from no point of view is the same as, or even equivalent to, being from every point of view."

Recall that in Wigner's friend type scenarios, it's possible that the state of a system relative to Alice does not match the state of the selfsame system relative to Alice relative to Bob. If Bob were to ask Alice what she measured, her answer might not reflect her own measurement result. In order to rule out such possibilities, Adlam and Rovelli (2023, §4) postulate a principle called 'cross-perspective links' (CPL):

> **Cross-perspective links:** In a scenario where some observer Alice measures a variable V of a system S, then provided that Alice does not undergo any interactions which destroy the information about V stored in Alice's physical variables, if Bob subsequently measures the physical variable representing Alice's information about the variable V, then Bob's measurement result will match Alice's measurement result.

We understand CPL as an absolute fact about the relation between perspectives. It is a principle which is not itself evaluated from within any perspective. This differs from Rovelli's own independent interpretation of CPL—adumbrated in Rovelli (2024, 2025)—whereby the facts ('links') postulated by the principle themselves obtain only within some particular perspective. As Rovelli (2024, p. 5) admits, understood this way CPL is "not a modification of the perspectivalism of RQM." Since this invites the same objections as those levelled at RRQM above, we won't consider here any further Rovelli's weaker interpretation of CPL.

The principle of CPL counters the threat of solipsism for RQM insofar as it ensures that the perspectives of different observers always align. It also enables ARQM to evade the first horn of our dilemma, since it makes possible a representation of all of reality from one perspective. For example, it is possible to describe the world—*inclusive of Alice's perspective on the world*—from Bob's perspective, since by CPL the values of variables relative to Alice relative to Bob will equal those relative to Alice herself.[14] There is a sense in which perspectives are 'recursively embeddable'. Of course, this is still a *perspectival* conception of reality. We nevertheless submit that perspectivalism must ultimately yield to absolutism: the best explanation of CPL requires absolute states. This is the second horn of our dilemma.

We are not the first to notice that ARQM seems to push RQM away from relativism: the point has also been made by Calosi and Riedel (2024) and Lewis (2024). However, whereas other commentators are mainly interested in the ontology of RQM, we are concerned with its representations. It is true that the ontology of ARQM, as

[14] Note, however, that this is only true after Bob and Alice have both measured those variables; otherwise, it's possible that a variable is definite relative to Alice but indeterminate relative to Bob. In those cases our objection to RRQM also applies to ARQM.

Adlam and Rovelli (2023) concede, contains absolute quantum events. These absolute events consist of the instantiation of a value of a variable of one system relative to another system.[15] Thus, quantum states in ARQM consist of relations between systems, just like in RRQM, but it is an absolute fact whether such a relation obtains, unlike in RRQM. But at the level of representations, Adlam and Rovelli (2023) maintain that quantum states "remain purely relational". The quantum state always describes one system from the perspective of another. We'll now show that there are reasons to believe that absolute states in fact underlie those relational states.

In order to do this, we have to take a step back and introduce the notion of a 'cosmic conspiracy' (Jacobs 2024; Jacobs and March 2025). This refers to an axiom or theorem the truth of which is unlikely/unexplained unless the theory is mistaken about its fundamental ontology. For example, Maudlin (2007) has argued that the triangle inequality (the distance between a and b added to the distance between b and c is not smaller than the distance between a and c) is a cosmic conspiracy if it is an axiom or theorem of a relationist theory, which says that distances are fundamental quantities. There is no reason to expect that distances satisfy the inequality unless they are not fundamental but depend on path lengths. Martens (2019) likewise argues that the transitivity of mass ratios (for any particles i, j and k, the mass ratio between i and j times the mass ratio between j and k is equal to the mass ratio between i and k) is a cosmic conspiracy unless mass relations depend on intrinsic masses. We contend that CPL is similar to the triangle inequality and the transitivity of mass relations in this respect.

To make this more precise, we appropriate and adopt the principle that fundamentality entails modal freedom (FEMF): "[the set of fundamental properties and relations] is modally free iff any pattern of instantiation of the properties or relations in [this set] is possible" (Wang 2016, p. 451). This principle is of course closely related to 'Hume's dictum', which states that there are no necessary connections between distinct existents. Indeed, following Caulton (2024) one can leverage Hume's dictum as a guide to the fundamental ontology of a theory: a quantity is fundamental in a theory only if the theory's state space contains a state for any possible assignment of values of that quantity. Applied to the example of distance, this means that if distance is a fundamental quantity, then for any pair of points and any value of distance there exists a state in which those particles bear that distance to each other—even if this assignment of distances does not satisfy the triangle inequality. But since distances in the actual world always satisfy this inequality, any empirically adequate theory would have to include

[15] Although our interpretation of ARQM here is consistent with the way Riedel (2024) and Faglia (2025) understand ARQM, it is perhaps also possible to read Adlam and Rovelli (2023) such that the instantiation of values in quantum events are *not* relative to a second system. We discuss such a view, which we dub 'dynamical RQM', in the next section.

the triangle inequality as an axiom or theorem.

This, in itself, is not necessarily a problem for relationism about distance. The laws of nature function in any case to rule out some metaphysical possibilities as physically impossible. The problem for relationism is that the triangle inequality is automatically satisfied if distances are not fundamental but depend on path lengths. For suppose that the distance between two points is simply defined as the length of the shortest path between those points. Since a path from a to b conjoined to a path from a to c itself constitutes a path from a to c, the length of the *shortest* path from a to c can never exceed the length of the shortest path from a to b added to the length of the shortest path from b to c. Therefore, the observed truth of the triangle inequality makes it seem *just as if* distances are not fundamental, but depend on path lengths. It seems a cosmic conspiracy that the laws of nature would just happen to pick out those assignments of distances to pairs of points as physical that are embeddable into assignments of lengths to paths. Given the empirical evidence, it is much more plausible that the latter are more fundamental than the former. The same is the case for the transitivity of mass ratios. For suppose that the mass ratio between two particles is simply defined as the ratio of their intrinsic masses: $r_{ij} = m_i/m_j$. Then $r_{ij} \cdot r_{jk} := m_i/m_j \cdot m_j/m_k = m_i/m_k =: r_{ik}$. Therefore, the observed truth of the transitivity of mass ratios makes it seem *just as if* mass ratios are not fundamental, but depend on intrinsic masses. The pattern here is as follows: (i) the relational quantities of a theory are modally free; however, (ii) they are empirically constrained to satisfy certain rules; and (iii) those rules are automatically satisfied if the theory's relational quantities depend on some absolute quantities.

We claim now that the same objection holds for ARQM. The fundamental states of RQM (whether CPL is postulated or not) are relational: they describe the instantiation of the value of a variable of one system relative to another system. These instantiations are the quantum events. They are relational in that the value of one system is always instantiated relative to another system. By Hume's dictum, quantum events are modally free; that is, if it is possible for quantity Q of system S to take on value v relative to system S', and it is possible for Q of R to take on value w relative to R', then it is possible for both quantum events to take place.[16] Thus, (i) quantum events are modally free. RRQM's radical perspectivalism embraces this fact, since it entails that even patterns of quantum events that fail link up perspectives are physically possible. It is possible, for instance, that Q of S takes on v relative to S' but v' relative to S''. Adlam and Rovelli

[16] At this point, one might wonder whether this isn't already falsified by the Heisenberg uncertainty relations, which after all state that some possible values for position and momentum are not compossible. We take this to establish that position and momentum are not in fact distinct quantities in quantum mechanics, but rather are quantities which ontologically depend on each other. This is itself an interesting point worthy of further investigation—but it is one which we won't pursue further here.

(2023), however, believe that this is incompatible with the intersubjectivity of science. They postulate CPL in order to rule out such patterns. CPL ensures that if Q of S takes on v relative to S', then Q of S will also take on v relative to S'' as soon as S and S'' interact. It follows that (ii) quantum events are empirically constrained to satisfy the cross-perspective links.

Finally, note that (iii) CPL is satisfied automatically if relational quantum events are in fact determined by non-relational quantum events; that is, events that consist of the instantiation of the value of a variable of a system, relative to no other system. This is easiest to see in a simple collapse scenario, although as we show below our explanation does not rely on a collapse postulate. Suppose that Alice measures the spin of a particle as 'up'. The joint state of Bob, Alice and the particle then collapses as follows:

$$|\text{`ready'}\rangle_B \, |\text{`ready'}\rangle_A \, (|{\uparrow}\rangle_S + |{\downarrow}\rangle_S) \rightarrow |\text{`ready'}\rangle_B \, |\text{`up'}\rangle_A \, |{\uparrow}\rangle_S \, . \tag{1}$$

Unlike the relational quantum states of ARQM, (1) is an absolute quantum state that describes the Bob-Alice-particle system from no perspective. In particular, $|{\uparrow}\rangle_S$ is the absolute state of the particle. It is not relativised to any other system. If we want to know the state of the particle relative to Alice, we simply check her measurement result: 'up'. It immediately follows from the unitary dynamics that once Bob measures the particle's state, he will also obtain 'up'. Thus, the alignment between the state of the particle relative to Alice and its state relative to Bob (and even the state of Alice relative to Bob) is explained by the fact that the particle just *is* in its up-state. Notice that the radically perspectival scenarios countenanced by Rovelli (2025) and Dieks (2025) are not explicable in this way, since in such scenarios the state of the particle relative to Alice is distinct from its state relative to Bob even after Bob's measurement. The imposition of CPL thus makes it seem *as if* relative states in fact depend on absolute states, since it rules out exactly those situations in which relative states are *not* reducible to absolute states. Just as the truth of the triangle inequality supports absolutism over relationism about distance, then, the truth of CPL supports absolute quantum mechanics over relational quantum mechanics.

We emphasise that none of this relies in any way on the collapse postulate. On a many worlds interpretation without collapse, for example, the post-Alice's measurement state is

$$|\text{`ready'}\rangle_B \left( |\text{`up'}\rangle_A \, |{\uparrow}\rangle_S + |\text{`down'}\rangle_A \, |{\downarrow}\rangle_S \right) . \tag{2}$$

Again, (2) is understood as an absolute quantum state. Due to entanglement, the particle by itself does not have a (pure) state, but the absolute state of the Bob-Alice-particle system nevertheless determines what Alice and Bob will measure in each branch. Again, the unitary dynamics entail that Bob's outcome will match Alice's within each branch.

Although we will not elaborate on this here, one could tell similar stories for hidden variable interpretations, dynamical collapse theories, and so forth.[17]

In response to this, the advocate of ARQM could admit that there are absolute facts about non-relational values—*contra* our initial take on ARQM's ontology[18]—but insist that those facts are just not represented by a quantum state nor by any other element of the quantum formalism—so that RQM's central claim that quantum states are relativised remains satisfied. But this strikes us as unduly restrictive. If it is after all an absolute and non-relational fact that particle S is in a spin up state, for example, then why couldn't one use the quantum state $|\uparrow\rangle_S$ to represent that fact? Indeed, absolute interpretations of quantum mechanics such as the Everett interpretation routinely represent absolute facts in exactly this way. We see no reason to think that the absolute facts countenanced by this modification of ARQM are so radically different from the absolute facts countenanced by absolute interpretations of quantum mechanics as to require an entirely novel formalism. (Although one reason may be that the quantum state never represents any occurrent facts at all but only dynamical facts; on which see our discussion of dynamical RQM in the next section.)

Although ARQM's relative quantum states enable a unified representation of reality, then, the very possibility of this representation makes it likely that there are absolute quantum states at a more fundamental level. Put differently: absolute quantum mechanics provides the best (perhaps even the only!) explanation for the posited cross-perspective links. We conclude that absolute interpretations of quantum mechanics provide a more perspicuous representation of the theory's commitments than relational interpretations; representations which, moreover, are after all perfectly compatible with an absolute representation of reality.

6 Dynamical RQM

Adlam (2025) has recently offered a distinctive take on ARQM, on which the relationism of quantum mechanics is 'dynamical' in a sense to be defined shortly. We call this interpretation *dynamical* RQM, or DRQM for short. (In this case, the terminology is our own, rather than due to Faglia (2025).) Although Adlam (p.c.) intends this as an explication of ARQM as it exists already, we find her account sufficiently novel to warrant its own label. Looked at one way, DRQM leaves even more space for absolutism than ARQM, which allows it to avoid cosmic conspiracies. Looked at another way,

[17] We conjecture that conditional on CPL, a set of relative quantum states determines a unique Everettian state, but we will not try to prove this here; cf. Faglia (2025, fn. 24).

[18] Cf. fn. 15.

however, DRQM moves further away from absolutism, to the extent that it falls back into the first horn of non-realism.

Adlam's interpretation turns on the distinction between *occurrent* and *interaction* states (Adlam 2025, p. 5). The occurrent state of a system is a representation of its current intrinsic state. The interaction state of a system, meanwhile, is a representation of how a system would behave under certain interactions with other systems. Typically, the quantum state of a system is taken to be an occurent state. RQM as normally understood says that *those* states are always relative to some other system. Adlam's DRQM, on the other hand, takes quantum states to be interaction states. DRQM says the interaction state of a system is always relativised to another system, but its occurrent state is not. Although occurrent facts are thus absolute, DRQM does not describe such facts: "the quantum formalism cannot be used to directly characterize the distribution of absolute facts as a whole" (Adlam 2025, p. 16).

If DRQM is correct, then the value of Q for S at a particular time is *not* held relative to another system S'. It is an absolute fact about S that it has a certain value for Q whenever it does have such a value. This means that DRQM does not have to postulate a cosmic conspiracy in order for the occurrent states to behave well.[19] Moreover, insofar as the interaction states are at least sometimes explained by the occurrent state—an issue to which we return below—the latter can account for the consistency of the former. If Alice has measured spin up, for example, then the fact that Bob's interaction state for the particle after *he* measures its state is also a spin up state is accounted for by the fact that the particle occurrently *is* in a spin up state.

Nevertheless, DRQM is relational insofar as the quantum state represents modal facts about what would happen in an interaction between a systems S and an observer O *from the perspective of* O. If Alice assigns the state $|\uparrow\rangle_S$ to a particle, then this is a description of what would happen were *she* to interact with S. We can thus ask the same question as we asked of RRQM: is it possible to reveal how any two such relative states are made true by reality from one perspective? This is what realism demands, but it is fairly easy to show that this is not possible. For there is no quantum state (nor any other element of the quantum formalism) that describes, from a third perspective S'', what would happen in an interaction between S and S' (i.e. Alice or Bob), since a quantum state of some system relative to S'' can only describe what would happen if that system were to interact with S''. It may seem as if the quantum state of S and S' relative to S'' describes the interaction between S and S', but this is a mistake: "the

[19] There is another interpretation of DRQM, consistent with Adlam (2025), on which values are still held relative to another system. If that is the case, our objection to CPL in the context of ARQM still applies.

quantum description of S and S' relative to S'' is merely an interaction state describing the dynamics that would take effect if S'' were to interact with S and/or S'" (Adlam 2022, p. 16). Notice that this problem is particular to the dynamical interpretation of RQM. If quantum states are occurrent states, then the occurrent state of S and S' relative to S'' also encodes the occurrent state of S relative to S' (conditional on CPL). But interaction states are not recursively embeddable in this way, because an interaction between S'' and S and/or S' need not constitute an interaction between S and S' (and vice versa).

Just as with RRQM, then, DRQM's perspectivalism is too radical for realism: it is not possible to systematically transform representations from one perspective to another. Each perspective is an island unto itself.

Now, DRQM might seem to have a response available: if interaction states supervene on occurrent states, then the latter could provide a unified—indeed, an absolute—representation of reality that includes the former. But this response is a poisoned chalice, for it requires (i) that occurrent states are representable by quantum states, and (ii) that the occurrent states are sufficiently 'rich' to derive the interaction states. Since the occurrent states are absolute, (ii) would mean that DRQM's relationism is merely effective—contrary to the spirit of RQM.

Let us comment on these points in turn. *Ad* (i): it is insufficient to say only that the interaction facts are determined by the occurrent facts, since this does not yet enable a unified *representation* of these facts. If the occurrent facts enable a representation that reveals how interaction states from different perspectives are made true by reality, then it must be possible to represent the occurrent facts by quantum states (or by some other means available within the quantum formalism). But Adlam (2025, p. 16) is very clear that this is not possible in DRQM: "The quantum formalism cannot be used to directly characterize the distribution of absolute facts as a whole, because that would require us to ascribe quantum states in a non-relativized way, which does not make sense if we believe that quantum mechanics is inherently relational." *Ad* (ii): it is not clear whether the absolute occurrent facts are sufficient as a supervenience base for the interaction facts. Adlam purposefully leaves it open what exactly the absolute facts are in DRQM, although they must at the very least include measurement outcomes. But let us suppose that there are sufficiently many absolute facts, and that they are sufficiently detailed, that one could in principle derive the interaction states from them. If, moreover, these facts are represented by a quantum state (as required by (i)), then the relationality of DRQM is merely effective—in exactly the sense of Adlam (2025, p. 3) that "there may be emergent relational quantum descriptions, but there also exists an underlying 'absolute' quantum state which is not relativized to anything." The occurrent quantum state that underlies the relative interaction states is, after all, absolute. This is exactly the situation in Everettian quantum mechanics: there is an absolute quantum state from which it is possible to derive the quantum states relative to particular systems (in particular branches). We think it is abundantly clear, however, that such an interpretation of quantum mechanics is not *relational*. Therefore, DRQM's only option to provide a unified representation of reality is to drop its relationism. Hence our main claim: RQM, if truly realist, is not relational.

7 Conclusion

We believe that physics should provide true representations *of* reality, that such representations are made true *by* reality, and that this is the *same* reality in every case. From this, it follows that a unified conception of reality is possible.

In principle, however, this is compatible with the absence of an *absolute* conception of reality, that is, a representation of reality from no perspective. The advocates of RQM believe that their approach to quantum mechanics provides exactly such a realist yet perspectival picture of the world. We have shown that this is nevertheless inconsistent with our realist credo. If RQM is thoroughly perspectival, then it cannot explain how true representations are made true by the same reality in every case. This is the case for RRQM and DRQM. If, on the other hand, RQM's perspectivalism is moderated by cross-perspective links, then it is natural to explain these links in terms of absolute states at the fundamental level. This is the case for ARQM.

Put a different way, realism (as we've understood it in this article) requires that all representations are made true by a single world (we might just say 'by reality'), but realism does not (necessarily) require absolute representations of this world. It might seem as if RQM preserves realism in this sense, and merely rejects absolute representations. But what we've sought to show in this article is that RQM either cannot in fact preserve realism, or has to posit implausible 'cosmic conspiracies' which are best underwritten by an absolutist approach to quantum mechanics. Of course, it is open to the proponent of RQM to reject what we have understood in this article by 'realism'. In that case, we hope to have made clear what exactly it is that RQM rejects, and the direction in which RQM is thereby pushed.

Acknowledgements

We are sincerely grateful to Emily Adlam, Paolo Faglia, Timotheus Riedel, and Chris Timpson for detailed and probing feedback on previous drafts of this article. We also thank Eleanor March for helpful discussions.

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