Why does quantum mechanics not scale up?

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Abstract

Quantum mechanics (QM) has the problem of lacking a coherent conceptual foundation, even if its quantitative algorithms are functionally adequate. This paper appraises the conceptual logic beneath quantum mechanics, using as the point of reference a novel alternative conceptual framework called the cordus conjecture. If the cordus conjecture is correct then the comparison suggests that quantum mechanics is conceptually fallacious in several areas: (1) Particles need not be zero-dimensional points after all. (2) Bell's theorem is refuted as being not universally applicable, and the principle of locality also fails. (3) The wavefunction is a mathematical approximation of a deeper reality, and superposition is not a physical state. (4) Superposition confounds positional and causal (temporal) variability, and this causes the weirdness of the QM interpretations. (5) Cordus identifies the factors that cause decoherence and (6) explains why quantum mechanics does not scale up to macroscopic objects. (7) It is fallacious to consider fields and particles as independent phenomena. Instead they are closely coupled in the cordus, and this explains the measurement context. Several core principles of QM are thereby refuted. The paradox of Schrödinger's Cat is explained as an artefact of these flawed premises. The paper also explains why the mathematical machinery of quantum mechanics is a reasonable approximation to reality, even if the concepts are not. The mathematics works, at least within a certain scale-range where: (a) things look like particles and the proposed cordus structure is not evident (i.e. not too small) and (b) where body-coherence is attainable (i.e. not too large). Outside of that range quantum mechanics seems neither conceptually nor mathematically relevant. The same analysis predicts QM is unlikely to scale down to the next deeper level of physics. The implications are that QM is profoundly deficient in its conceptual foundations, and is only an approximation of a deeper and more logically consistent mechanics.

Keywords: quantum scale invariance, myth, fallacy, paradox

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1 Introduction

Quantum mechanics (QM) is the dominant theory for fundamental physics. Nonetheless it lacks a coherent conceptual foundation, even if its quantitative algorithms seem functional. Many of its commonly held explanations and principles are of dubious validity [1]. Its several descriptive explanations ('interpretations') all have elements of incongruity when compared to reality. Feynman stated that 'We absolutely must leave room for doubt', and though he did not necessarily

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mean that of quantum mechanics in particular, there have been ongoing concern about the lack of conceptual coherence and questions about the veracity of the explanations derived from QM.

Many of the original paradoxes of quantum mechanics, such as wave-particle duality and the scaling problem, have never been resolved. Thus while theoretical physics has advanced by quantifying more phenomena, it has not yet revealed a coherent picture for physics. It has left behind unfinished conceptual business, and it is those voids that interest us. Since the deficiencies in QM are conceptual rather than mathematical, there is value in focussing on the former. Working in this area necessitates a conceptual design methodology. It is not countenanced as much in physics as in engineering, from whence the methodology used here is borrowed. Conceptual design is a risky venture, both in terms of the subjectivity of the process and the uncertainty of success, but also has the potential for surprising insights.

The purpose here is to appraise the premises beneath QM and see why it has the conceptual issues that it does, such as its inability to scale up to the macroscopic level. To do this requires a point of reference of some sort, preferably outside of QM. While there are several interpretations of QM, there are not many viable alternative theories that are external to it, so we first had to create one. We used concept-design [2] to create a novel alternative conceptual framework. This is *ab initio*: from first principles in a conceptual sense. This involved synthesising a satisfactory solution with the desired properties to give an adequate fit to observed quantum reality of the double-slit device, and then purposefully extending the design to describe other phenomena. This subjective design-cognition is very different to the mathematical modelling used conventionally in physics, and we acknowledge it may seem foreign. Nonetheless it creates a concept which is entirely independent of QM conceptually, yet explains the same basic fundamentals, and is therefore a suitable mechanism for a contrast. The synthesised design is called the cordus conjecture and its detailed assumptions are described elsewhere [3, 4]. Its validity is unknown, but it does have a high degree of logical consistency, and it provides opportunity for evaluating QM in ways not previously possible, because new ideas suggest new comparisons.

2 Cordus conjecture

The cordus conjecture [5] is that all 'particles', e.g. photons and electrons, have a specific internal structure of a *cordus,* comprising two *reactive ends*, with a *fibri*l joining them. The reactive ends are a small finite *span* apart, and energised (typically in turn) at a frequency, at which time they behave like a particle. When energised they emit a transient force pulse along a line called a *hyperfine fibril (hyff),* and this makes up the field. See Figure 1 for application to the photon.

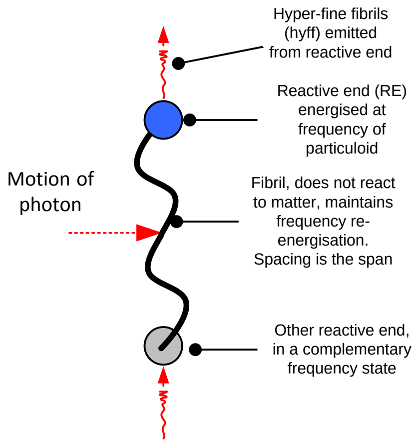

Figure 1: Cordus model of the photon. It is proposed that the photon probably only has a single radial hyff at each reactive end, whereas the electron has three, but the fundamental structural concept is similar.

How does the cordus idea help?

The cordus particuloid oscillates its appearance between its two reactive ends, so it looks like a single 'particle' when it collapses to one of its two modes. This explains why particles seem to be in two places as once: these are the two modes of the cordus reactive ends. However it should be noted that in this variant of the cordus conjecture only one reactive end is energised at any one time, not both simultaneously. The probabilities of a particle being in one particular location, rather than the other, arise simply as the cutting points on the frequency. Stop the experiment with the photon in a different part of its frequency cycle and it may appear in the other position. Cordus particuloids look like point particles at a large scale. A cordus is not the same as a 'dipole', which is a separation of negative and positive charges.

Thus in this conceptual model the cordus is the deeper structure: the 'particle' nature appears in turn at the two reactive ends, as does the 'wave' nature in the hyff. The cordus is neither a wave nor a particle but behaves as either depending on the measuring method. If the experiment is arranged to detect a particle, then the cordus simply collapses to one of its two modes, and a particle will be detected. Likewise wave-detecting apparatus will not collapse the cordus but instead detect the hyff and a wave will be detected. The measurement method unavoidably changes how the cordus behaves, so wave and particle duality are only measuring artefacts, not the reality in this model.

The cordus idea is a conjecture and unproven, but offers a logically consistent conceptual explanation across many phenomena: it explains wave-particle duality in the double-slit device [3], and derives the basic optical laws for reflection and refraction from scratch, among other outcomes [4]. [2]

3 Conceptual grounds

Quantum mechanics and the cordus conjecture both describe phenomena at the particle level, but from such radically different conceptual perspectives that the comparison provides a high degree of contrast. The comparative analysis identifies the following conceptual discrepancies in QM. The fact that it is possible to present a coherent counter-point to QM shows that there is the potential to falsify QM, and therefore warrants the term ‘fallacious’ in the sense of being mistaken ideas.

The conceptual premises underpinning quantum mechanics have been questioned before. Specifically, Nikolic suggested that fundamental randomness, virtual particles, and the belief that there is no reality beyond what is measured, are all myths [1]. Nonetheless, in many cases he could only point out that the other options, e.g. hidden-variable solutions, were actually not prohibited in QM, but he could not distinguish further between the various options.

The cordus position is more radical, and raises further and deeper issues.

3.1 The fallacy that particles are points

The QM concept of 'particle' is generally of zero-dimensional points, of no physical size at all, and no internal structure. QM accepts that the atom is not really indivisible, and assumes that particles may comprise still smaller particles, but does not explain how those particles are held in assembly.

From the contrasting perspective the particle, e.g. photon or electron, is neither a point nor a sphere in the first place, but rather a cordus with two reactive ends and emitting hyff, the zone of influence of which extend beyond its geometric modes. The particuloid only *appears* to behave as a point particle when viewed from a coarser level. From this perspective the QM wave-function is an approximate descriptor of the average behaviour of the particuloid. The probabilistic nature of QM thus arises because there are deeper degrees of freedom in the structure of the photon (internal variables) that are not under experimental control nor represented in the wavefunction.

Thus from the contrasting perspective it is a fallacy to assume that particles have to be points. The cordus conjecture demonstrates a coherent solution without using points, so points have to be considered

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[2] The cordus conjecture offers a logically consistent explanation to frequency of 'particles', Zeno effect, entanglement, Aharonov-Bohm effect, Pauli exclusion principle, entropy, superfluidity including quantum vortices, superconductivity including Meissner effect, Casimir effect, tunnelling, among other effects. More speculative explanations are given for quantisation and unification of electrostatic, magnetism and gravitation force, spacetime, finite speed of light in vacuum, quark colour and charge, mass excess, parity violation, and the internal structure of the proton.

an optional concept, if not rejected outright. Thus all physical interpretations, including superposition, that are based on the point paradigm are questionable. This means that cordus also challenges the entrenched paradigm that conceives of a particle as a sedate, stable, solid, in-one-place, well-defined sphere (of mass or charge), as if it were a planet. It is not even remotely meaningful, from the cordus perspective, to perceive the atom as hard little balls orbiting around a nucleus made of compacted other balls, as shown in the popular symbol for the atom. [3]

3.2 The fallacy of Bell's theorem and locality

The principle of locality is that the behaviour of an object is only affected by its immediate surroundings, not by distant objects or events elsewhere. Thus a 'particle' is only affected by the values of the fields (electromagnetic, gravitational, etc.) at the infinitesimally small location of the point. Hence also *local realism*: that the properties of an object pre-exist before the object is observed. Entanglement appears to require the principle of locality to be violated: twin particles may be linked, such that changing the state of one instantly changes the other, even if they are separated by macroscopic distances. The mechanisms are incompletely understood in conventional physics, but the effect seems real. Bell's theorem sets these against each other by implying that only one perspective can be correct: either superluminal effects or local realism does not exist. The many actual experimental results are generally interpreted as supporting non-locality behaviour in quantum mechanics. A common interpretation is to accept Bell's theorem and conclude that no viable hidden-variable solution of any kind can exist.

The contrasting perspective is that the fundamental reality need not be points, and therefore that a principle of Wider locality [6] applies: a cordus particuloid is affected by the cumulative effect of the fields in its local surroundings, these being the space to which its hyff have access. Further, hyff have access to spaces that the reactive ends do not. Thus cordus also explains the Aharonov-Bohm effect [7]. The cordus explanation for entanglement is that the fibrils of two cordi become synchronised through mutual hyff interactions, called *complementary frequency state synchronisation (*CoFS) such that changes to the one affect the other even when the span of the fibril is stretched. The fibrils still retain their ability to

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[3] **What is the diameter of a particle?**
The conventional premise is that a particle is a stable aggregate of one or more semi-permanently existing sub-particles, hence that it is meaningful to ask questions like 'what is the diameter of the particle, e.g. proton?' From a cordus perspective this is an invalid question: it is not meaningful to talk about the diameter of say a proton, as if it had a hard surface. Existing methods of attempting to measure the 'diameter' of the proton involve measuring its interaction with electrons, either in bonding situations or impact-scattering. From a cordus perspective these experiments are measuring the average interaction geometry of the electron and proton, not a physical diameter. It is natural to call this the 'diameter' of the proton, but that really is only an interpretation based on the premise, which cordus refutes, that a particle *should be* a sphere of charge. Cordus further suggests that the measurement is dependent on the probing particle, since its span is inversely related to its energy and mass. This is consistent with the observation that the diameter of the proton is measured to be smaller when the muon is used as the probing particle. Thus cordus predicts that a proton has no solid diameter but instead will have many 'diameters' depending on the nature of the probe.

communicate practically instantly [6]. Changing one reactive end at one site therefore changes the other, and that change can be immediately observed at the other site.[4]

The cordus model demonstrates that there is no problem with having all of superluminal effects, hidden variables, and some degree of wider locality. From this perspective Bell's theorem is a fallacy that uses circular reasoning: it makes the implicit prior premise that particles *are* points, applies locality to the phenomenon of entanglement, concludes that particles are points, and hence infers that there are no internal structures (hidden variables) to particles. Bell's theorem is a self-sustaining belief-system, not a logical necessity. It is only an obstacle to hidden-variable solutions, if one has the prior belief that the solution *must* be limited to only zero-dimensional particle designs [1].

3.3 The fallacy of superposition being the reality

Superposition from the QM perspective is that a particle occupies *all* possible quantum states *simultaneously*, and only collapses to one when the variable is measured. According to most interpretations of QM it is only probability that drives this, there is no underlying variable.

From the contrasting perspective, superposition and the wavefunction are simply approximations to the deeper mechanics of the cordus particuloid physically oscillating between its two mode positions. The cordus particuloid (e.g. photon cordus) collapses to one of these ends when it is grounded.

The probabilistic nature only emerges because the observer inserts indeterminacy by selecting, even inadvertently, the moment to make the measurement, and therefore the frequency state of the cordus and ultimately the reactive end at which it will be found. Thus it is possible to refute the Copenhagen interpretation that the probability is the reality: from the cordus perspective superposition is not a physical state but simply a misinterpretation of the mathematics, and the measured probability is only an artefact of the observation process. It is not God that plays dice – the observer does, by selecting the method and moment at which to make the observation. [5]

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[4] **Cordus Complementary frequency state synchronisation (CoFS) and coherence**
This principle from the cordus conjecture explains is important in several explanations and briefly elaborated below. Since a photon has two reactive ends, and these are not energised all the time, it is possible for a second photon to occupy the same space, or to co-exist nearby. This requires that the frequency states be complementary, i.e. the reactive-end a1 of photon a is in the opposite state to b1 of photon b, and physically near each other, mutually affecting each other through the hyff to provide synchronisation. Likewise a2 and b2 at the opposite end. With entanglement the photon spans are stretched so that the reactive ends are far apart. It only looks like there is a whole photon at each location, when actually there are two photons sharing the space such that only one is visible at the location at any particular time. The bonds between any cordus particles are hyff and carry forces that synchronise the cordus frequency and phase of particuloids.

[5] Superposition: To put it another way, the root cause of the problem with superposition is deficiency in its statistical formulation. Quantum mechanics was originally built with a statistical methodology that approached the problem as a cross-sectional statistical design (single point in time). Therefore the mathematical representations that QM developed are

3.4 The fallacy of causal variability

From the contrasting perspective, superposition confounds two different effects: *positional* and *causal variability*.

Positional variability is ambiguity about where the particle (cordus particuloid) actually 'is' at any one moment. For QM this corresponds to the un-collapsed wavefunction, and the interpretation is that the particle is simultaneously in two places at once. For the cordus interpretation the positional variability instead corresponds to the statistical modes of the two reactive ends. Only one end is actually reactive and in the place at any one time, it is just that if the measurement frequency is not high enough then it *appears* that the particuloid is simultaneously in both positions.

Causal variability is multiple consequences in *time*, i.e. divergent system states. Consider a subatomic event that has two possible outcome, e.g. a photon that could take path A or B. Once either of these states occurs, then there are say two more outcomes: A1 or A2 for the A path of the tree, and B1 or B2 for the B branch. Thus *after time* the system state has diverged into *various temporal outcomes,* hence 'causal variability'. Quantum mechanics routinely assumes that causal variability necessarily occurs with positional variability.[6]

The cordus perspective identifies that QM fails to differentiate these logically separate phenomena. Thus the fallacious premise of quantum mechanics is the assumption that causal variability necessarily occurs with positional variability. This is an almost universally held premise of QM, and is an example of the expediency of current methodologies of physics that ignore the deficiencies in the conceptual foundations so long as the

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only applicable to average particle behaviour, at one point in time, because that is all that a cross-sectional design is valid for. Quantum mechanics is outside its base of validity for its statistical methodology when it tries to provide physical interpretations for longitudinal effects (multiple consecutive points in time). An average is fundamentally an unreliable predictor of longitudinal future outcomes when the population is bimodal. This criticism stands regardless of the validity of the cordus conjecture.

[6] **In what ways does quantum theory misuse Causal variability?**
The QM thinking goes something like this: 'the particle is in two places at once, but the choice of which has not yet been made. There are subsequent events <notice the insertion of a time and causality premise here> the outcome of which will depend on which location the particle chooses. Therefore those subsequent events are also in superposition, i.e. exist simultaneously'. An example of this QM logic is: *'The quantum world … is 'both/and': a magnetic atom, say, has no trouble at all pointing both directions at once. The same is true for other properties such as energy, location or speed; generally speaking, they can take on a range of values simultaneously, so that all you can say is that this value has that probability. When that is the case, physicists say that a quantum object is in a 'superposition' of states.'8. Ball, P., Physics: Quantum all the way. Nature News, 2008.* ***453****(30 April 2008): p. 22-25.*
QM commonly extrapolates this further to whole bodies: 'Therefore the object or person <notice the insertion of a premise of body-coherence here> in question will simultaneously be in several states, i.e. in different futures.' From there it is a very short logical step to the idea of a separate universe, one for every causal outcome of every superposition states, hence the 'many worlds' theory. The combinatorial branching on that tree of universes must be enormous if every superposition of every quark for all time, is to be accommodated. It is currently one of the favourite contenders for a qualitative description of how QM works, but from a logical perspective it creates more problems, and is hardly parsimonious or even physically measureable.

mathematical approaches seem to give adequate results. This fallacy is an integral part of all interpretations of QM, which are thereby also refuted. Thus the contrasting perspective deflates the many-worlds/multiverse theories, and shows that the weirdness in quantum mechanics arises not from inadequate human comprehension, but from deep conceptual flaws in QM itself.

Thus from the cordus perspective, a particuloid that oscillates between two reactive ends (modes) does not have dual futures: it only has one even if it is unclear at the time, and the driving mechanisms are fundamentally deterministic even if at too high a frequency to detect. The confounding of these two types of variability drives the paradox of Schrödinger's Cat, as will be shown.

3.5 The fallacy of easy coherence

From the QM perspective coherence is the ability for particles to interfere. This includes constructive and destructive interference of photons or waves (hence fringes), and dependencies ('correlation') between two different particles. The dependency may exist to a greater or lesser extent, i.e. involving more variables between the particles. There is also the matter of how strongly the dependency is preserved over time. The concept of coherence also includes the idea that only one wave or particle is involved: that its properties at one instant of time can be linked those at a different location or time ('self-coherence'). Examples of QM coherence at the large-scale include the laser, electrical superconductivity, and superfluidity. Nonetheless, even within QM there are differences of opinion about the interpretation of coherent states [9].

The QM expectation is that all objects, subatomic as well as macroscopic, *should* follow quantum theory and exhibit superposition, but the reality is that only particles and some microscopic objects show the behaviour. The latter are inanimate objects that have been cooled to close to absolute zero temperature (referred to as their 'ground state') [10, 11]. There is much hope that superposition and quantum behaviour will be attainable in larger and warmer objects [12], as QM suggests should happen. It is not clear where the boundary is between the quantum world of particles and the macroscopic world that we perceive, and quantum mechanics itself cannot identify why there should be a boundary, nor where it would be.

The contrasting interpretation is different, and offers answers to all those questions. First, note that coherence, from the cordus perspective, is when all the cordus particuloids, which may be photons, electrons, protons, atoms, etc., have synchronised frequencies and phases thereof (see CoFS above). This particular state, where all the particuloids in the body of matter are synchronised, is termed 'body coherence'. For photons in light beams, where the bonds are weak if they exist at all, the coherence may be mainly temporal and coincidental. In superfluidity and superconductivity the coherence is substantial [13]. However these are special states of purity and temperature, and macroscopic objects at our level of existence generally do not show this degree of coherence.

The cordus conjecture can also predict what extent of coherence should be visible, and why. First, note that the critical factors for body-coherence are predicted to be temperature, homogeneity of composition, internal thermodynamic processes, internal mechanics, and gross size. It comes down to a sufficiently stiff structure: one where the bonds between atoms are consistent, firm enough to sustain the synchronicity, and there are minimal phonons. Coherence becomes difficult to sustain when one part of the body goes in a different direction, e.g. internal motion, or living physiology.

Single cordus particuloids, such as electrons, are self-coherent under any conditions. Entangled particuloids, such as electrons sharing orbits, are also coherent. Entanglement is thus a simple form of coherence between two particuloids, see the CoFS principle above. Cordus predicts that sufficiently small bodies, typically atoms and molecules, should be able to diffract, form fringes through gaps, and pass through the double-slit experiment with the usual outcomes, providing they are in body-coherence – though that will be increasingly difficult to achieve as the bodies become larger and warmer. Indeed, largish molecules have shown some of these behaviours [14].

Microscopic sized bodies, including viruses but excluding cells functioning at the time, should be capable of body coherence at *low temperature*, and thus exhibit bimodal positional variability (i.e. what QM would interpret as superposition). Indeed, resonance has been observed for small engineered objects [10, 11]. It has also been proposed for viruses [15], and cordus suggests that is feasible.

Large macroscopic bodies of *homogeneous composition*, e.g. liquid helium, *cooled to near zero* should be able to be placed into coherence as a type of supersolid, and should be able to diffract and form fringes through sufficiently large gaps or at edges, though the effects will be miniscule. Large macroscopic bodies are predicted to be unable to form fringes through the double-slit device, because the whole object needs to be able to go through a slit at each of its positional extremes, and this will effectively delete the medulla and convert the experiment to a gap.

However, getting a large macroscopic body of *inhomogeneous composition and ambient temperature* into body-coherence is likely to be next to practically impossible, especially for something like a motor car with moving parts. Or a cat. Cordus predicts that practically every object at ambient temperature and visible with the naked eye is not going to form matter waves or fringes, nor display superposition (neither positional nor causal) [13].

If cordus is correct, then coherence is a special state, and QM is in error by assuming that it readily applies. Coherence is therefore not practical for realistic every-day bodies, living creatures, or the universe at large: there is too much temperature (phonons), diversity of atomic composition, and internal mechanics/thermodynamics to create the CoFS state. QM assumes that decoherence arises because the body interacts with the external environment in some unspecified way. Cordus identifies the factors and qualitatively describes their interaction. Thus it explains why small objects are more easily coherent, even at high temperatures, whereas large objects are not. The dominant disruptive mechanism is thus the response of the body to phonons. The fallacy in QM is to assume that coherence automatically applies to all bodies. Identifying this fallacy, and understanding why it arises, is important in the following explanation of why quantum mechanics does not scale up.[7]

3.6 The fallacy of scale invariance

We now come to the central puzzle of QM: why the effects it predicts are only visible at sub-microscopic scale. Why does QM not scale up properly? If it is valid at subatomic scale, what is preventing it from working at macroscopic scales? This is not something that QM has itself been able to explain.

For example, particles seem to be able to appear in more than one place, and the act of observing them *does* seem to influence their location. Yet macroscopic bodies show no such tendency. This is a particularly serious issue for theories of cosmology, which have to take a position on this.[8]

The general premise in physics is that quantum mechanics is the reality, and the classical world that we perceive emerges from that [8], but how this happens is unknown. It is generally believed that the macroscopic body loses coherence (hence ‘decoherence‘) in some way because of some interaction with the rest of the environment, but the detailed mechanisms are still uncertain.

Not only are the mechanisms unknown, but so too is where the transition lies. Current efforts have managed to place microscopic engineered objects into ‘superposition’ at low temperatures [10, 11] (cordus would consider this positional variability instead), and there is much interest in trying to extend this as far as possible towards macroscopic objects.

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[7] Why has QM persisted in the false belief of easy coherence for macroscopic bodies, despite all the empirical evidence to the contrary? Is it because it needs to be true for the integrity of the QM paradigm? QM consists of a set of interlocked premises (wavefunction, superposition, coherence, interference) that make up its conceptual model. If QM is to be a theory of everything, then it needs to scale up to macroscopic bodies, and all the above premises are needed for that. Of those four, coherence is the weakest and most in need of being true if the belief system as a whole is to be sustained. Quantum mechanics is an adequate descriptor of much of subatomic reality, but clearly and obviously is not the complete reality because it does not explain all things in physics. To believe that QM is the reality necessarily requires personal belief to bridge the residual ambiguities and sustain the cognitive congruence of the mental-model..

[8] The various forms of conventional cosmology accept the QM perspective, but are then faced with the implication that the universe as a whole is constantly in a state of superposition ('multiverse'), and thus leads to philosophical dilemmas about how and who the observer might be that collapses the wavefunction to give the world that we see. If these collapses do occur, they are not physically apparent to us, not for objects that we can hold with our hands, nor for the universe at large.

The contrasting cordus interpretation has an explanation: quantum mechanics does not scale up, because macroscopic bodies are impractical to place into body coherence, in turn because internal entropy prevents formation of the CoFS state.

The deeper question is why entropy arises at all, given that atomic interactions are reversible. This is not easily answerable with QM, but again cordus offers an explanation. An atom that has surplus energy, say from an incoming photon, can dispense it in five main forms: electron orbital change (including bonding), electron ejection, photon ejection, electron flow (displacement of free electrons or plasmons), and phonon propagation (vibrational strain between the electrons making up the inter-atomic bonds, hence conduction). These mechanisms, especially phonons, distribute the energy to further atoms in the bulk, diluting it in the process. Through any of these mechanisms a remote atom might receive energy and then in turn emit a photon. Even if that photon was sent straight back to the original atom, there would still be less energy in the feedback loop because of the phonon dilution in the intervening bulk, the time required for the photon flight, and the expansion of space in the intervening period. The geometric and micro-structural complexity of the matter accessible to the photons and phonons introduces so many dilution paths that it is extremely unlikely that the energy fragments will spontaneously recombine using the thermionic effect to recreate the original photon. Thus the individual mechanisms are all reversible (elastic), but the system as a whole is not, hence entropy and thermodynamic irreversibility.

The scaling problem of QM is thus explained as entropy causing an inability to sustain body-coherence. So the particuloids in the body are unable to move in synchrony but instead have different frequencies and phases, and thus have to find locations for their reactive ends by negotiating with their neighbouring particuloids, through the hyff. The fallacy in QM is the assumption that its principles and mathematical formulations are universally true and therefore invariant with scale. It fails to adequately conceptualise entropy. Thus quantum mechanics becomes irrelevant at macroscopic scales. It is only useful for the narrow range of scales where (1) things look like particles (i.e. not too small), and (2) where body-coherence is attainable (i.e. small, cold, inanimate, not too large).

Thus the cordus conjecture is able to offer an explanation as to why quantum mechanics *does not* scale up to the macroscopic objects at ambient conditions, nor the universe in general. Cordus explains *how* the decoherence arises. It also answers the question as to where the boundary lies between the quantum and classical worlds, and predicts what should, and should not, be achievable in quantum behaviour.

3.7 The fallacy that fields and particles are independent

Quantum mechanics includes concepts of both fields and particles, but has no coherent unified model of causality for these. There is ongoing debate as to which is the more fundamental [1]. The case has been made that even quantum field theory, which nominally is about fields, is actually a theory of particles [1], and therefore that particles are the more fundamental entity. Indeed, as that author points out, it is only particles that are observed in the collisions of high-energy physics. Yet quantum mechanics has the internal inconsistency of elsewhere taking the wave interpretation: that particles '*always* behave as waves' [1]. [1].

In contrast the cordus model shows it is possible to conceive of a tight dependence between fields and particles. The energy shuttles between the internal structures (fibril, reactive ends, hyff) and what happens to one affects the other [16]. Thus the process of measurement, whether of field or particle, fundamentally *changes* the internal energy distribution of the cordus and thereby influences the outcome that will be observed. There is a *measurement interlock*: whatever happens to the field affects the particle, and the inverse. Hence the measured reality is contextual: it depends on the intrusiveness of the observation itself. Different observation processes applied to the same underlying reality will therefore yield different measurements. Specifically, if we apply an *intrusive* observation like putting a screen in the path of a photon, then we force the cordus to collapse to one of its reactive ends, and therefore the measurement shows a ‘particle’. Alternatively, if we put an antenna near a *passing* photon, then we interact dynamically with its hyff, perhaps delaying or speeding up the hyff emission process, and therefore our measurement shows a ‘wave’ has passed by.

Therefore the debate as to which is more fundamental, fields or particles, is sterile, as both are equally important. They can communicate with each other through the internal structures. Cordus also refutes the QM premise that there is no reality beyond that which is measured. Instead cordus suggests that the measured outcome is an artefact of the chosen observation process, and the way that dynamically interacts with the internal structures of the cordus.

5 Discussion

Using a contrasting perspective we have shown that it is possible to refute the core premises of QM. Thus: (1) it is unnecessarily limiting for physics to conceive of particles as points; (2) Bell's theorem is refuted; (3) QM fundamentally mis-conceptualises superposition; (4) QM confounds positional and causal (temporal) variability; (5) QM is in error in thinking that coherence is easy to achieve; (6) QM is wrong in expecting its principles to be scale invariant; and (7) it is a mistake to consider fields and particles as independent phenomena.

Unlocking Schrödinger's Cat

Understanding these fallacies allows several quantum paradoxes to be resolved, including wave-particle duality [3], and Schrödinger's Cat.

Schrödinger's Cat is a thought-experiment in superposition: the basic idea is that a cat is placed in a box with a radioactive sample rigged up so that decay emits a particle which breaks a vial of poison that kills the cat. If the box is closed and no-one can see inside, in what state is the poison and the cat? This is an extension of the idea in quantum theory that a physical system can be in multiple configurations (dead vs. alive), and therefore from the quantum perspective is simultaneously in all those configurations until the act of observation forces it to one particular configuration, i.e. collapses the waveform. Alternatively that each of the other non-selected configurations does continue, but in another parallel universe. Yet there is nothing in our usual experience that suggest that reality behaves this way. Unlooked-at cats do not really seem to be in an indeterminate state of life and death. Why not? Is quantum mechanics wrong? Or are our cognitive constructs of reality wrong?

The paradox becomes trivial to unlock, by noting that it invokes superposition, causal variability, easy coherence, and scale invariance: all of which have been refuted. Thus from the cordus perspective there need be no dilemma about the state of the cat before opening the box, in the sense that it is not simultaneously alive and dead but instead simply still alive or already dead. A simple act of passive observation does not change the system's state.[9] Thus cordus asserts that the presence of the passive Observer does nothing, and this voids the existential Observer dilemmas, and the many-worlds theory. Something as large and internally dynamic (nerve impulses, flowing blood, etc.) as a cat cannot have that CoFS body-coherence in the first place: initially imposing the coherence would deprive it of life. Only small, cold, inanimate things of relatively homogeneous composition can be put into body coherence.

But if Schrödinger's Cat dilemma collapses because of lack of coherence of the cat, then what about replacing the cat with an electron: something that can generally be thought of as in 'quantum superposition'? Will the dilemma still be sustained then? Is the electron simultaneously blasted and not-blasted by the radioactive decay? QM states that the electron occupies all possible quantum states simultaneously, so the electron should be in normal and high energy states simultaneously, and only collapse to one when measured. The answer, according to the cordus conjecture, is no: those are the fallacies of superposition and causal variability at work. Not-observing the electron makes no difference either.

The fact that no-one has yet implemented the experiment is circumstantial evidence supporting the cordus perspective that superposition is merely a mathematical approximation for handling positional uncertainty, not a real

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[9] Passive observation is inconsequential, whereas passing observation (interrogation of the hyff) can have consequences, the Zeno effect being an example. The most intrusive form of measurement is 'intrusive' as the term suggests, and this forces the cordus to collapse at one of its reactive ends.

physical effect, nor a temporal one, and macroscopic physical bodies cannot be assumed to be in body coherence.

Schrödinger‘s Cat is a wildly unrealistic concept, and is an artefact of flawed premises. It is not physically realisable, nor does it prove quantum mechanics is correct. That it is even considered a paradox shows how difficult it is for the limitations of quantum theory to be comprehended from within the QM paradigm.

Is there an objective reality?

What is the fundamental reality of matter, light, forces, and time? Quantum mechanics is ambiguous about objective reality [1, 17], so it is difficult to assign physical meaning to its mathematics. By contrast the cordus conjecture *does* provide an objective reality. It describes internal sub-structures (fibril, reactive ends, hyff) for the photon and matter particuloid, and it provides a basic set of causal relationships for their interaction: a type of descriptive mechanics. The cordus conjecture also shows how these internal structures manifest as external variables, including the flexibility to appear as wave or particle depending on how the Observer makes the intervention. Cordus suggests that quantum mechanics is profoundly and very fundamentally wrong about reality.

Limitations

The cordus conjecture was used for the de-biasing conceptual perspective. We are not saying that cordus is necessarily valid, only that it can conceptually explain many effects and is a useful contrast. It uses a single logically-consistent conceptual foundation, which is something that even quantum mechanics has not yet achieved. The unknown validity of cordus is not a limitation for the present study. Falsification of the cordus conjecture might invalidate the criticism of superposition (#3 above), but the point about particles (#1) still stands, as does the criticism of Bell's theorem (#2) and the confounded variability (#4). Even if the precise explanation of the difficulty of obtaining coherence in macroscopic objects (#5) should fail, there is every reason to believe that QM still has a problem in this regard. Likewise, until QM itself can give a coherent physical (as opposed to metaphysical) explanation of why it does not appear to scale up (#6), then that criticism also stands. Even if cordus is incorrect about the tight dependence between field and particle (#7), QM will still need to solve this problem sometime. It is inescapable that there are serious failings in the fundamental constructs of quantum mechanics.

Where quantum mechanics goes wrong

From the cordus perspective, the classical world does *not* emerge from the quantum world, *nor* is quantum mechanics the reality. Rather there is a deeper mechanics from which both emerge. Quantum mechanics only approximates some of the deeper behaviour, and even then only for a limited range of geometric scales. Classical physics emerges directly from the deeper mechanics when many pieces of matter are aggregated and the inter-particuloid behaviour (e.g. phonons, entropy) dominates the intra-particuloid behaviour (e.g. CoFS).[10] In this sense QM is a conceptual dead-end. Its conceptual foundations are only adequate on which to build a pretty-good set of quantitative algorithms, but the mathematics does not describe the reality, only the approximation of the reality. Thus all the attempts to derive a physical interpretation from the mathematics of QM are fraught, hence their weirdness.

What quantum mechanics has done is take some flawed conceptual foundations, derive some beautiful and dazzling mathematics, ignore the foundations, and then in a recursive way infer physical interpretations from the mathematics. Those interpretations of QM have generally been incongruous with reality, but physics has tended to insist that reality must really be weird, or our human perception inadequate. The obvious alternative conclusion has been ignored: there has been a failure to logically trace the chain of reasoning back to the conceptual foundations to check whether they are sound.

Current quantum theory has become an interlocked belief system, with a reliance on mathematical modelling, and sustained by confirmation bias.[11] It no-longer needs, and therefore is disconnected from, its conceptual foundation. Hence there is little or no interest in orthodox quantum theory to rethink conceptual physics: it is considered irrelevant, and new ideas are contemptuously treated as ‘fringe’ and automatically marginalised.

The present work, based on the cordus conjecture as a contrast, suggests that the whole of quantum mechanics is built on deeply flawed conceptual foundations. Simply by being able to conceive of an alternative conceptual model, and one with arguably greater explanatory power and descriptive coherence than quantum mechanics itself, we have shown that there is a reasonable possibility that quantum mechanics might yet be overthrown. Whether or not cordus is the solution, the larger point is that design cognition, a methodology foreign to physics, has been demonstrated to have the potential to crack the interlocked belief system of QM and expose its premises. One may or may not agree that cordus is correct in identifying all these fallacies in QM, but cordus has arguably got further

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[10] To put this another way, the presence of the hyff from other matter messes up the overall hyff environment, and makes the complementary frequency synchronised (CoFS) states more complex and eventually unattainable, thereby causing decoherence. The yet more radical interpretations of cordus surmise that the hyff environment at large makes up the transmission fabric for the electro-magneto-gravitational field 18. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus in extremis: Part 4.2 Fabric of the universe*. 2011.http://vixra.org/abs/1104.0028

[11] Quantum mechanics originated with the idea that electrons can only take up certain steps in energy, hence quanta. However with time QM has come to mean more: that reality for particles is fundamentally probabilistic; and that the wavefunction is the complete reality (Copenhagen interpretation). QM is now a set of mathematics and beliefs about reality, that include probabilistic origins, wave-particle duality, wavefunction mathematics, and the uncertainty principle. QM offers a solution, of sorts, for wave-particle duality: first by positing that particles are wave-packets, second by assuming that particles can be in multiple places at once (through superposition or virtual twins), third by assuming that the state of a particle can only be known as a probability, and fourth that the actual position of the particle is only determined when it is observed, hence collapsing the wave-function. From the mainstream QM perspective the strangeness of wave-particle duality is the natural reality and any perception of weirdness is only an artefact of our inadequate human cognition: ‘the "paradox" is only a conflict between reality and your feeling of what reality "ought to be" ‘(Feynman, Lectures, 1964). Thus has physics insulated itself from the conceptual dissonance of its subject. It is because the quantitative machinery of QM generally works so well, that mathematical modelling has become the dominant methodology and conceptual aetiology has become marginalised.

than QM in *explaining* the paradoxes of particle behaviour even if QM is more advanced in its mathematical *modelling*. However it will be difficult to reconceptualise QM, whereas mathematical algorithms can readily be added to cordus: much of the quantum machinery can probably be repurposed as a starting point, though we do not attempt that here as our interest is in first developing the concept and improving its validity. The cordus conjecture is a class of solutions, and even if the particular design variant ('working model') used here is invalidated, cordus has other variants to offer.

Implications

The cordus conjecture shows that it is feasible to construct a serious conceptual challenge to quantum mechanics. The contrast used here has refuted much of the conceptual foundation of quantum mechanics. If so, why does QM work at all? The answer is that the mathematical machinery of QM is a sufficiently good approximation for small particles within a certain scale-range where components of matter approximate point particles, *and* coherence can be obtained. Thus the QM machine works adequately for many things that practical physicists need to compute, while being profoundly and very fundamentally wrong in the conceptual sense. Hence it does *not* show good agreement with reality regarding very small objects (e.g. wave-particle duality) or macroscopic bodies (scaling problems), and its qualitative descriptions are incongruent (inconsistent with reality).

This is a serious criticism, and we look forward to a spirited explanation from orthodox physics as to why the above fallacies should not apply to QM. We encourage critique of the cordus conjecture itself, and better interpretations from QM. Quantum mechanics urgently needs to address its own conceptual deficiencies, and do so in ways that do not require non-physical belief systems.

If the criticism holds and the fallacies cannot be refuted, then it means that quantum mechanics is conceptually deficient at its most fundamental level. If the fundamental concepts lack logical consistency, then how can the mathematical derivations have coherence? One would have to then question whether it really is worthwhile attempting to construct an all-inclusive theory of physics on such a weak conceptual framework.

6 Conclusions

The purpose of this paper was to critically appraise the conceptual foundations of quantum mechanics, using a contrasting perspective. If one wishes to objectively and creatively critique so established a theory as QM, one must seek a conceptual position well outside it. Unfortunately there is a dearth of viable alternative theories, but the new cordus conjecture provides such a vantage. Therefore, while we acknowledge the subjectivity of the analysis, we do not apologise for it, because there really seems to be no other way to appraise quantum mechanics without being dominated by its way of thinking.

If the cordus conjecture is correct then the comparison suggests that quantum mechanics is conceptually fallacious in several areas. (1) Particles need not be zero-dimensional points after all, and this immediately erodes several other premises of QM. (2) Bell's theorem is refuted as being not universally applicable, and the principle of locality also fails. (3) The wavefunction is a mathematical approximation of a deeper reality, and superposition is not a physical state but simply a misinterpretation of the mathematics and an artefact of the observation process. Only one end is actually reactive and in the place at any one time, it is just that if the measurement frequency is not high enough then it *appears* that the particuloid is simultaneously in both positions. (4) The QM concept of superposition is identified as a confounded concept that mixes positional and causal (temporal) variability, and this is found to be the cause of much of the weirdness of the QM interpretations of reality. (5) QM is mistaken in assuming that coherence of a physical object is automatic and easy to obtain, and cordus identifies the factors that cause decoherence and qualitatively describes their interaction. (6) Cordus explains why quantum mechanics does not scale *up* to macroscopic objects, and why it does not represent finer structures either. (7) It is fallacious to consider fields and particles as independent phenomena. Instead they are closely coupled in the cordus, and this explains the measurement context.

These assertions refute some of the core principles of QM, and so the implications are that the foundations of quantum mechanics lack conceptual integrity. This is likely to apply to all interpretations and derivatives of quantum mechanics, because they all use the same flawed premises, to greater or lesser degree.

The mathematical machinery of quantum mechanics is a reasonable approximation to reality, even if the concepts are not, and the comparison with cordus shows why. Thus the mathematics works, at least within a certain scale-range where: (1) things look like particles and the proposed cordus structure is not evident (i.e. not too small) and (2) where body-coherence is attainable (i.e. not too large). Outside of that range quantum mechanics seems neither conceptually nor mathematically relevant. The same analysis predicts QM is unlikely to scale *down* to the next deeper level of physics. The implications are that QM itself is profoundly deficient in its conceptual foundations, and is only an approximation of a deeper and more logically consistent mechanics.

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