Cordus matter: Part 3.1 Wider Locality

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Abstract
The dominant paradigm in conventional physics is that of a 'particle', which this paper suggests is a badly flawed premise. The cordus particuloid is a more coherent concept in that it offers explanations of phenomena that are otherwise puzzling, and does so with one conceptual consistent framework across a wide variety of phenomena. This paper shows how entanglement is readily explained as a natural consequence of the cordus. It also introduces the principle of complementary frequency state synchronisation (CoFS) as the deeper principle beneath the Pauli exclusion principle, and coherence. It is suggested that Bell's Theorem is only applicable to 1D point particles, and is thus generally irrelevant. Specifically, Bell's Theorem is not an obstacle to models of hidden variables. Furthermore, it is suggested that the principle of locality is not viable in its present form, and a principle of wider locality is proposed.

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1 Introduction

Classical mechanics, with its equations for force and motion, are adequate for the macroscopic bodies in the environment around our human existence. However, at sub-microscopic scale the behaviour of sub-atomic particles of matter can be unexpected: entanglement, superfluidity, and superconductivity, are some examples. Explanations of these effects have had to rely on adaptations of quantum mechanics (QM) as classical theories are at a loss.

QM does a good job of providing mathematical descriptions of the effects, and the fact that it can do so is usually taken as circumstantial evidence that QM must be correct. Unlike other areas, such as wave-particle duality, there is no major competing interpretation to QM in the area of sub-atomic particles. All the same, QM is not particularly effective at providing a qualitative *description* of the effects, and this makes it complex and difficult to understand at an intuitive level, and consequently people generally, though perhaps not physicists specifically, perceive QM as strange. Maybe the effects really are intrinsically complex, and the mathematical formulations are the reality: the simplest possible way to express the underlying mechanisms of causality.

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However, there is always the possibility that there might be another way, different to QM and perhaps even simpler, of *understanding* the effects. The purpose of this paper is to explore that possibility, and it does so by extending the cordus concept (ref. 'Cordus Conjecture').

Background: photon cordus

The concept of a cordus is that a photon consists not of a point but of two reactive ends (RE) connected together with a fibril. The REs emit directional force lines called hyff, which are detectable externally as a polarised electrostatic field. The companion paper (ref. 'Cordus conjecture'), describes the background to this idea, applies it to path dilemmas in the double-slit device and Mach-Zehnder interferometer, and uses it to explain fringes. It is shown that the Cordus conjecture is conceptually able to resolve wave-particle duality for the photon. Another paper (ref. 'Cordus optics') shows that the idea is applicable to conventional optical effects, such as refraction. That paper also further develops the concept of frequency and the dynamic internal states of the photon. We recommend that at least the first bracket of papers (ref. 'Cordus conjecture'), be read before this one, as the fundamental concept and cognitive point of difference are developed there. Also, the frequency model from 'Cordus Optics' (part 2.1) is necessary foundational material.

The present paper conjecturally builds on those ideas, and applies them to entanglement, the electron, and matter generally. The paper consists of several parts, of which this is the first and addresses entanglement and locality. Part two describes a cordus model for the electron, its orbitals, matter more generally, and part three explains entropy. In part four are covered several special states of matter – superposition, coherence, superfluidity, and superconductivity – and these are re-interpreted in a cordus context, with surprising results. The final part five of this bracket contrasts Cordus with QM, and reconceptualises the issues with Schrodinger's Cat.

Method

The approach taken is a continuation of that described in the companion paper 'Cordus conjecture', and not detailed here. Briefly, it involves reverse-engineering the system: it uses logic, conjecture and intuition to build on the existing cordus model, thereby postulating a set of mechanisms that can plausibly explain the known system-behaviour. Specifically, the objective is to postulate electron structure and behaviour sufficient to explain several matter effects. It is like trying to work out the contents of a black box by observing its outputs in different situations, and synthesising a working-model that is sufficient to explain as many of the situations as possible.

Results

This is a design way of thinking, being very different to the conventional mathematical analytical approaches, and the outcome is likewise more qualitative than quantitative. Thus we term the results a *conceptual solution*. Being conceptual means that the broad principles are described, within which a whole class of solutions are possible. Where possible we

single out the most promising of these specific solutions and term it the *working model.* Along the way we note the underlying assumptions as a series of *lemmas.* These we do not attempt to prove: they are simply to make the premises explicit so that they can be evaluated later. The lemmas make up the central strand through the papers. Where relevant for continuity, references are made to lemmas in the other papers.

The results follow, starting with some basic preliminary premises on the particle behaviour of photons, then moving on to electrons, followed by application to matter more generally.

2 Entanglement

Einstein called entanglement 'spooky action at a distance' and it continues to sit uneasily within physics since a qualitative explanation is lacking even though the reality is accepted. It is contrary to relativity, and to the *principle of locality*. Nor can entanglement satisfactorily be explained with existing hidden-variable theories. However it is consistent with quantum mechanics.

The principle of locality is that an object is only affected by its immediate surrounding. Entanglement appears to require the principle 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.

The effect can be addressed by the Cordus Conjecture with the addition of a further set of assumptions.

Lemma M.1 Photon-photon interaction

This lemma sets out the assumptions for the interaction of the photon with other photons.

M.1.1 Photons in flight apparently do not interact much with each other. There is no known evidence of them merging with each other in flight. However nothing in the Cordus logic requires them to be incapable of merging. If they don't merge, the constraint could simply be that they cannot generally get sufficiently close to each other, and aligned, and synchronised for long enough to achieve the union. Nonetheless it is proposed that some interaction is possible of the passing type.

M.1.2 Photons do not generally interfere with other photons in the sense of destructively (constructively) creating fringes.

M.1.3 Photons can be initially created identical in certain key regards (e.g. frequency).

M.1.4 Cordi from different photons may lock onto each other and become synchronised through the hyff. The hyff provide the means for coupling into/out of the fibril (hence also *passing* observation, see 'Cordus Conjecture').

M.1.5 continued below

There are two candidate Cordus interpretations for entanglement. The first is that some entanglement devices might not be doing much more than splitting the photon (Cordus Conjecture L.1.1): that what appear to be two particles are only two reactive ends of the same cordus.

The second, and the current working model, is that the fibrils of two cordi become synchronised through mutual hyff interactions, called *complementary frequency state synchronisation* (see below), such that changes to the one affect the other.

3 Complementary frequency state synchronisation (CoFS)

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. Similarly for *a2* and *b2*. By *complementary frequency states* we mean that the hyff of one photon are phased to feed into that of the other that is co-located. This concept originates in the frequency model (ref. 'Cordus optics').

Applying this to entanglement, means that 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 either location at any particular time. The photons are subsequently split (Cordus Conjecture L.1.3) so that the reactive ends are far apart. What looks like one complete photon at each site is, according to this version of events, two half photons. The fibrils of each are stretched to much greater distances than usual, but still retain their ability to communicate practically instantly (Cordus Conjecture L.6.15). Changing one reactive end at one site therefore changes the other, and that change can be immediately observed at the other site.

From the Cordus perspective the entanglement would be somewhat delicate, since the cordi could be broken by external disturbances to the hyff. This macroscopic form of entanglement of photons is apparently an uncommon event that requires deliberate construction by the Experimenter.

This CoFS principle is not limited to the photon, but applies to particuloids generally. As will be described later, all 'particles' are cordi, and therefore the CoFS effect is accessible to other particles too. Thus CoFS is suggested as the underlying principle for the pairing of electron orbitals, coherence, and condensed states. From the cordus perspective a CoFS means that *both* RE modes of the particuloid (e.g. electron) are fully occupied at any one time, but not by the same electron. It is an important principle with wider applicability. It is subsequently used to explain superfluidity and superconductivity (see part 3.3), where it forms the basis for a new concept of 'network of orbitals'. The QM use of the term 'coherence' emerges as one application of CoFS, and the Pauli exclusion principle is

another. It is also important in understanding why quantum effects do not scale up to the macroscopic world. A derivative of the concept, called synchronous hyff emission direction states (SHEDS), explains the strong nuclear interaction (ref. 'Cordus in extremis') and is used to predict the internal structure of the proton.

4 Locality and Bell's theorem

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. Hence also *local realism*: that the properties of an object pre-exist before the object is observed. 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. The general interpretation is to accept Bell's Theorem and therefore conclude that no viable hidden-variable solution of any kind can exist.

The cordus model demonstrates that there is no problem with having all of superluminal effects, hidden variables, and some degree of locality. The cordus entanglement mechanism provides superluminal effects through the instantaneous communication through the fibril (ref. 'Cordus conjecture'). But doesn't Bell's theorem preclude this? From the Cordus perspective Bell's theorem is wrong. It is not applicable to the situation because it was built on the implicit but limiting premise that a particle is necessarily a single one dimensional (1D) point. This is a natural assumption given the prevailing 'particle' perspective in QM physics, but the theorem can only be valid to the extent that particles actually are 1D points. As Cordus shows, there is reason to believe that the issue can be considered very differently: that the 'particle' view is only an approximation of a deeper 'particuloid' existence. Therefore Bell's theorem is only an obstacle to hidden-variable solutions, if one assumes beforehand that the solution *must* be limited to only 1D particle designs. Cordus is not a 1D particle design and therefore Bell's theorem is irrelevant.

What about the assumption of 'practically instant' communication between the two sites? It implies an effect faster than the speed of light (superluminal): How is that explained? We acknowledge that is an incompletely resolved matter and offer some responses. The first is that the communication is not totally instantaneous because time is initially required to create the photons and separate the reactive ends. Second, the data can still only be transmitted at one or at most a few bits per frequency cycle. The latter arises because, according to the Cordus view, the hyff effect occurs at the speed of light (L.6.16), and is clocked at the natural frequency of the photon. So even if the data are transmitted instantly, they can still only can be pumped in and out as fast as the speed of light, and only as many bits per frequency cycle as cordus variables are being changed (which will be few).

Third, there is also the matter of passing vs. intrusive detection (L.3) to consider: if the photon is consumed in the process, or the entanglement lost, then a new entangled pair will need to be produced, and will require finite time to move into position. Thus intrusive detection will never be superluminal overall. Passing detection could allow the entanglement to be reused for another bit of information, though point two above still applies. Furthermore, the process of interrogating a photon consumes time, even if the photon is not destroyed (ref. 'Cordus in extremis', E.5.2).

An alternative perspective is that the cosmic speed limit does not apply to the fibril, even if it does to the hyff, and this is the current working model. After all, if a long wire were inside a sheath, i.e. a Bowden cable, then pushing one end instantly causes the other to protrude. The cordus is perhaps similar, and it is debatable whether or not any mass is being moved (or where in the frequency cycle the mass, if any, is being moved). That matter of speed aside, we have shown that a hidden-variable theory is indeed possible, and can explain entanglement, Bell's theorem notwithstanding. However whether or not locality is violated is a more complex case, and discussed next.

5 Principle of Wider Locality

Cordus suggests that the principle of locality is not viable in its current form. The current principle of locality assumes that a 'particle' is only affected by the values of the fields (electromagnetic, gravitational, etc.) at the infinitesimally small location of the 1D point. Cordus asserts that particles are not 1D, but are actually particuloids (appear to be particles). They have a span, and the reactive-ends have hyff zones around them. Therefore Cordus suggests that a principle of Wider locality 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, that hyff has access to spaces that the physical particuloid with its reactive ends does not.

Lemma M.1 continued

To sum up, the additional lemmas are:

M.1.5 Cordi may be in *complementary frequency states,* sharing modes for their reactive ends.

M.1.6 Communication across the fibril is instantaneous, whatever the span of the cordus. However the propagation speed of the hyff is limited to *c,* the speed of light in a vacuum

M.1.7 A principle of Wider locality 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, that hyff has access to spaces that the physical particuloid with its reactive ends does not.

6 Conclusions

What has been achieved?

This part has presented a novel conceptual solution to the otherwise paradoxical problem of entanglement. The dominant paradigm in conventional physics is that of a 'particle'. Cordus suggests that conceptual framework is flawed, and the cause of the weird predictions from QM. The cordus particuloid is a more coherent concept in that it offers explanations of phenomena that are otherwise puzzling, and does so with one conceptual consistent framework across a wide variety of phenomena.

This particular paper shows how entanglement is readily explained as a natural consequence of the cordus. This obviates the need for the usual spooky and metaphysical interpretations. The paper also introduces the principle of complementary frequency state synchronisation (CoFS). This is an important concept in that later papers show how it underpins the Pauli exclusion principle, coherence, and the strong interaction. It even allows the internal structure of the proton to be estimated.

More radically, Cordus suggests that Bell's Theorem is only applicable to 1D point particles, and is thus generally irrelevant. It is an artefact of the flawed 1D particle premise of conventional physics, and is not an obstacle to models of hidden variables.

Another radical suggestion from Cordus is that the principle of locality is not viable in its present form and needs to be widened. The problems with the current principle of locality, as evident in entanglement, are also an artefact of the prevailing 1D-particle framework of QM. Cordus proposes a simple principle of wider locality to solve this problem.

These are unorthodox predictions. The implications are that the 'particle' conceptual foundation of Quantum mechanics is invalid. The conventional disinterest in 'hidden variable' solutions is a consequence of over-reliance on a false-negative from Bell's theorem. QM only applies at the level at which small pieces of matter look like point particles, and is invalid at smaller scales. Thus QM is not applicable to the double-slit device. Nonetheless its statistical mathematics are useful as measures of average outcomes, though not as specific predictions. Likewise the QM descriptive explanations are untrustworthy. QM only describes the average outcome.