Can a sub-quantum medium be provided by General Relativity?

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Abstract. Emergent Quantum Mechanics (EmQM) seeks to construct quantum mechanical theory and behaviour from classical underpinnings. This paper explores the possibility that the field of classical general relativity (GR) could supply a sub-quantum medium for these sub-quantum mechanics. Firstly, I present arguments which show that GR satisfies many of the a priori requirements for a sub-quantum medium. Secondly, some potential obstacles to using GR as the underlying field are noted, for example field strength (isn’t gravity a very weak force?) and spin 2. Thirdly, the ability of dynamical exchange processes to create very strong effective fields is demonstrated through the use of a simple model, which solves many of the issues raised in the second section. I conclude that there appears to be enough evidence to pursue this direction of study further, particularly as this line of research also has the possibility to help unify quantum mechanics and general relativity.

1. The Sub-quantum Medium

In emergent QM the sub-quantum medium is the field out of which quantum behaviour emerges. There have been other investigations into the physical make up of a sub-quantum medium, such as stochastic electrodynamics (SED)[1] and Brady’s compressible inviscid fluid - an entirely new classical field that is posited to underpin quantum mechanics and electromagnetism.[2]

This paper proposes a sub-quantum medium that is already experimentally confirmed and is somewhat surprisingly stronger and more flexible than usually thought - classical general relativity (GR). Other proposals that are similar in some ways are Wheeler’s geons of 1957 - constructed of source free electromagnetic fields and gravity under the laws of standard QM[3] and Hadley’s 4-geons[4]. Hadley’s proposal is perhaps the most similar to that here, but Hadley assumes the independent reality of an electromagnetic field. This paper instead uses only GR as the fundamental field.

General relativity has some qualities that lend itself to consideration as a sub-quantum medium: its practically frictionless (i.e. inviscid), obviously covariant, couples to everything and its non linear regime allows for a rich variety of behaviour, most of it unexplored.

2. Potential Problems

(i) Gravity is weak. Solution: While the $e^{-}e^{-}$ force provided by electromagnetism is $10^{42}$ stronger than simple gravitational attraction, GR can transfer much more energy than electromagnetism. At optical frequencies gravitational waves can transfer $10^{30}$ times the power of light at the Schwinger limit. So only the 0Hz component of gravity is weak.
Figure 1. From East[6]: Mass change over time, for incident gravitational waves with three different frequencies. $\omega_0 M = 0.75$ is superradiant, while $\omega_0 M = 1$ shows complete absorption. The entire energy change happens over 10’s of wavelengths.

(ii) Gravity has a weak coupling. Solution: In order to model a quantum system (say a hydrogen atom), we require the quantum effects to be much stronger than the electromagnetic forces. Yet the coupling of gravity to the electron is much weaker than even the electromagnetic force. The solution to this problem lies in realizing that gravity can couple not only through '0Hz' effects but also through the exchange of gravitational wave energy. The Possible Mechanisms section below outlines how this could happen.

(iii) Gravity is quadrupole (spin 2). Solution: Emergence - underlying fields can give rise to apparent net fields of different spin. E.g. Monopole gravitational waves[5].

3. Possible Mechanisms
This paper posits that EmQM’s sub-quantum zero point field is the result of a run away superradiance - like effect (limited by non linear mechanics). Is the universe a black hole bomb?

This superradiant (see figure 1) energy exchange of the particle with its surroundings causes the particle to be subjected to huge forces - superradiance for example allows for a substantial fraction of the mass of a rotating black hole to change over time scales a few times the light travel time across the hole. The recent paper by East et al. studies black holes undergoing superradiance using a numerical method.[6]. It seems that the superradiance is on a knife edge with absorption - these effects happen at only slightly different frequencies. These large energy transfers could be the ZPF.

4. Discussion
If the pursuit of an emergent quantum mechanics is to prove fruitful, then the idea that a field like general relativity does not hold on the microscale may have to be re-considered, as with any EmQM theory there is no overarching 'quantum regime' for GR to stop working at. With general relativity still on the stage at $10^{-17}m$ and below, Occam’s razor perhaps suggests that we prove that general relativity is not the sub-quantum medium before a new field is invented.

The complete poster and paper is available from the author.

References
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