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back to namelist

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Conditions for Lorentz-invariant superluminal information transfer without signaling

We understand emergent quantum mechanics in the sense that quantum mechanics describes processes of physical emergence relating an assumed sub-quantum physics to macroscopic boundary conditions. The latter can be shown to entail top-down causation, in addition to usual bottom-up scenarios. With this example it is demonstrated that definitions of “realism" in the literature are simply too restrictive.

A prevailing manner to define realism in quantum mechanics is in terms of pre-determination independent of the measurement. With our counter-example, which actually is ubiquitous in emergent, or self-organizing, systems, we argue for realism without pre-determination. We refer to earlier results of our group showing how the guiding equation of the deBroglie-Bohm interpretation can be derived from a theory with classical ingredients only.[1-3] Essentially, this corresponds to a “quantum mechanics without wave functions" in ordinary 3-space, albeit with nonlocal correlations.

This, then, leads to the central question of how to deal with the nonlocality problem in a relativistic setting. We here show that a basic argument discussing the allegedly paradox time ordering of events in EPR-type two-particle experiments falls short of taking into account the contextuality of the experimental setup. Consequently, we then discuss under which circumstances (i.e. physical premises) superluminal information transfer (but not signaling [4]) may be compatible with a Lorentz-invariant theory.

Finally, we argue that the impossibility of superluminal signaling – despite the presence of superluminal information transfer – is not the result of some sort of conspiracy (á la “Nature likes to hide”), but the consequence of the impossibility of infinite precision of a state's preparation, or of the no-cloning theorem, respectively.

[1] G. Grössing, “The Vacuum Fluctuation Theorem: Exact Schrödinger Equation via Nonequilibrium Thermodynamics”, Phys. Lett. A 372 (2008) 4556-4563. quant-ph/arXiv:0711.495
[2] G. Grössing, S. Fussy, J. Mesa Pascasio, and H. Schwabl, “Extreme beam attenuation in double-slit experiments: Quantum and subquantum scenarios”, Ann. Phys. 353 (2015)

271–281. arXiv:1406.1346 [quant-ph]
[3] G. Grössing, S. Fussy, J. Mesa Pascasio, and H. Schwabl, “Implications of a deeper level explanation of the deBroglie-Bohm version of quantum mechanics”. Quantum Stud.: Math. Found. 2, 1 (2015), 133-140
[4] J. Walleczek and G. Grössing, “Nonlocal quantum information transfer without superluminal signalling and communication”, arXiv:1501.07177v2 [quant-ph]

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