Dynamical Quantum Non-locality

César E. Pachón[1], Leonardo A. Pachón[2]

[1]Escuela de Física, Universidad Industrial de Santander, Bucaramanga, Colombia

[2]Instituto de Física, Universidad de Antioquia, AA 1226 Medellín, Colombia

Abstract

Non-locality of correlations between systems is one of the hallmarks of quantum mechanics. Non-locality is responsible for unexpected features of system dynamics at the quantum regime such as tunnelling and entanglement; it has also recently been extensively exploited as a resource for quantum information [2]. The origin of non-locality of quantum measurements and its relations to the fundamental postulates of quantum mechanics, such as the uncertainty principle, have been only recently elucidated [3]. However, quantum interference problems involve two kind of non-localities: a non-locality expressed in terms of the Bell-inequalities (of kinematic nature, the one discussed in [3]) and the non-locality of the quantum equation of motion of a physical observable (of dynamic nature) [1, 4]. The latter has been barely discussed, explored or understood [4]. We trace here the origin of dynamical non-locality to the superposition principle mediated by the presence of non-linear interactions between systems and discuss the disappearance of non-locality in the classical realm. This relation adds to the more fundamental understanding of nature's quantum dynamics and allows us to establish and identify how the uncertainty principle and the superposition determine the non-local character of the outcome of quantum measurements. As a consequence, dynamical quantum non-locality emerges, naturally, as the responsible for the suppression of chaos, understood in the classical sense, in the quantum dynamics.

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Modality: Poster E-mail: pc.cesar1@gmail.com

References

[1] Y. Aharonov, H. Pendleton, and A. Petersen. Modular variables in quantum theory. *Int. J. Theor. Phys.*, 2:213–230, 1969.

[2] Harry Buhrman, Richard Cleve, Serge Massar, and Ronald de Wolf. Nonlocality and communication complexity. *Rev. Mod. Phys.*, 82:665–698, 2010.

[3] J. Oppenheim and S. Wehner. The uncertainty principle determines the nonlocality of quantum mechanics. *Science*, 330:1072, 2010.

[4] S. Popescu. Dynamical quantum non-locality. *Nature Phys.*, 6:151, 2010.