Deformed Space-Time and violation of Local Lorentz Invariance
A broader concept of locality and causality
to comprehend Bell's Inequalities, non-local Hidden Variables and bohmian Pilot Wave

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In 1935 Einstein Podolsky and Rosen stated, in the nowadays famous paper [1], that the Copenhagen interpretation of quantum phenomena along with the quantum mechanical formalism were incomplete. This conclusion was reached having in mind the second postulate of the Special Relativity Theory, that is Lorentz Invariance, whose consequence is the impossibility for any physical entity to travel faster than or even reach the speed of light in vacuum. In their famous gedanken experiment with two entangled particles generated together and brought far from each other, they showed that, according to the formalism of Quantum Mechanics, a measurement to determine the eigenvalue of an observable of one of the particles influenced and determined instantaneously the eigenvalue of the other particle despite the space-like interval between them. The conclusion was that some hidden variables had then to be present which had not been considered in the quantum mechanical formalism. In 1964 John Stewart Bell showed [2] that these hidden variables, if they exist, have to be non-local and hence pinpointed the true centre of all the problems and paradoxes of Quantum Mechanics: Lorentz Invariance [3].
After recalling these ideas mentioned above, the paper will be focused on showing that there exist nowadays all the theoretical and experimental concepts to tackle the problems of physics related to Quantum Mechanics or, more precisely, related to the apparent lack of locality and causality that are typical of quantum phenomena in order to give them a proper physical solution in term concepts susceptible of measurement. In an interview with the philosopher Renée Weber, John S. Bell stated that "*...those paradoxes (of Quantum Mechanics) are simply disposed of by the 1952 theory of Bohm, leaving as **the** question, the question of Lorentz invariance. So one of my missions in life is to get people to see that if they want to talk about the problems of quantum mechanics—the real problems of quantum mechanics—they must be talking about Lorentz invariance. ...*"[4]. This is precisely what it will be done in this paper.
First of all, it will be shown that the Special Theory of Relativity can be obtained from two more general postulates that do not include the constancy and invariance of the speed of light. Conversely, the existence of a conserved quantity with the dimension of a squared velocity is only a consequence of the two postulates [5,6]. In showing this, the tremendous unreachable limit of the speed of light, i.e. Lorentz Invariance, is loosed and its rigorous validity is restricted just to the electromagnetic phenomena where superluminal propagation and/or quantum non-local effects do not show up.
Secondly, it will be shown that the possible existence of velocities higher than the speed of light in vacuum has a meaning which extends far beyond the simple kinematical scope and in fact possesses a geometrodynamical reach. From here the concept of Deformed (non-minkowskian) Space-Time [7] will be introduced along with the Finzi Principle of Solidarity according to which each interaction (e.g. a photon), as it propagates, produces its own local deformed Space-Time. The main properties of the deformation will be shorty discussed, above all its possibility to move with a velocity much higher than the speed of light in vacuum, in fact a finite but unbound velocity. It will be shown that, although the deformation of the Space-Time cannot be detected directly, its effects on the propagation of photons or other particles can be detected and have already been revealed. With these three elements, i.e. the deformed Space-Time, its unbound velocity and its effects on particles, it will be made clear the possible connection of this new scenario with the de Broglie-Bohm concept of pilot wave which, in this perspective, gains its physical rank. Other analogies between the deformed Space-Time and the Quantum Potential of bohmian mechanics [8,9] are also possible and will be mentioned. Moreover, it will be also shown that the entanglement between quantum entities (particles) is physically and very naturally explained by the concept of deformed Space-time which guaranties a physical and hence causal constant interconnection between the entangled particles at a velocity much higher than 'c' that maintains the (non-lorentzian) locality of the phenomenon and hence allows to get rid of the unphysical idea of action at a distance.

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