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Quantum gravity and entangled particle states

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Quantum Gravitational (QG) Fluctuations at microscopic (Planckian scales) may induce, depending on the model, interesting properties of the vacuum", entailing non trivial optical properties (refractive index, possible birefringence etc), as a consequence of violation or modification of Lorentz symmetry, as well as decoherence of low energy matter in the QG background, leading in turn to modifications of the quantum mechanical (Einstein-Podolsky-Rosen) correlations of entangled particle states. The latter phenomenon is associated with an intrinsic breakdown of the generator of CPT symmetry (C=Charge, P=Parity, T=Time reversal) as a well-defined quantum mechanical operator, due to a theorem by R. Wald (strong form of CPT non invariance). The modifications of EPR correlators (termed omega-effect) are strongest in neutral Kaon systems, as opposed to B-systems, as a result of the existence of a specific CP violating decay channel in the former system. The talk will review such phenomena and the associated theoretical estimates, based on concrete models of QG foam (inspired from string theory, but not necessarily restricted to it), and discuss prospects for falsification in current and future facilities, such as upgrades of the DaPhiNE collider. The omega-effect, if realized in nature, is asmoking gun" signature of this type of CPT Violation. However, as will be discussed in the talk, not all models of QG are characterised by such an effect.

Relatore: MAVROMATOS, N. (King's College, London)