Warp-Speed Causal Connectivity

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Canonical quantum field theory in Minkowski spacetime suffers from the divergences occurring at very small distances and/or very high energy. This long standing issue is also manifested in the singular delta function appearing in the microcausality relation involving the commutator of the quantum field at two points separated in spacetime. It has been argued that an implication of a physical upper bound on allowed proper acceleration relative to the vacuum is that the canonical microcausality relation is modified to include dependence of the field on the four-velocity of the device measuring the field, so that the delta function is replaced by a function concentrated near the Planck scale of spatial separation between the two devices measuring the field, or at much larger separation when the relative speed of the two measuring devices is near the canonical speed of light [1]-[3]. A consequence is that the causal boundary, canonically defined by the light cone, is warped at these scales so that the timelike region extends into the canonical spacelike region. The speed of the associated causal connectivity can exceed the canonical measured speed of light. The condition for this warp-speed causal connectivity to occur optimally with instantaneous transmission is when the spatial component of the relative four-velocity of the two measuring devices is orthogonal to their spatial separation, and for spatial separations near the Planck scale. When the relative speed of the measuring devices is very large, the range for warp-speed causal connectivity may extend well beyond the Planck scale, but if the wavelength is much less than the range, the field is extremely reduced. It is also significant to note that the modified quantum field is Lorentz invariant, and causal connectivity backward in time remains impossible.