Utilizing Quantum Distinctness to Create Space and Time Frames

By Karl Svozil

Einstein's 1905 paper, "On the Electrodynamics of Moving Bodies," can be viewed as a foundation for operationalizing space and time frames through physical processes. Today, the SI system assumes the constancy of light's velocity in a vacuum for all inertial frames. Consequently, Alexandrov's theorem of incidence geometry, by mapping light cones into light cones, conventionalizes Lorentz transformations. This division results in the theory of relativity "decaying" into a conventional and a more physical part: the equations of motion are form-invariant with respect to those Lorentz transformations only if the velocity of light in vacuum is encoded therein.

The operationalization of light cones can only be executed with distinct particles and parties. However, such distinction is absent for (totally) entangled particles or the constituents of (totally) entangled multipartite states, at least in terms of entangled observables. Thus, relativistic space-time frames can only be created for distinct, disentangled parties and particles. In the extreme, a universe of (totally) entangled particles cannot produce space-time frames.

This limitation reduces the problem of operationalizing space-time frames to the well-known quantum measurement problem. This challenge is compounded in three ways: first, by the potential "erasure" of (dis)entanglement of quantum states through global unitary transformations; second, by the absence of a local operational means to assert the separation or disentanglement of a state from the rest of the universe; and third, by the possibility of "erasing" a quantum measurement, thus "forgetting" a measurement outcome.

From the quantum perspective, the concept of distinctness and irreversible measurement introduces means dependent “patchworks” of space-time scales that are defined relative to the quantum conceptualization.

Given sufficient time, the discussion will also address the unsatisfactory status of our theoretical notions of inertia, or mass.