

# Passage of Time in a Planck Scale Rooted Local Inertial Structure

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## Abstract

It is argued that the 'problem of time' in quantum gravity necessitates a refinement of the local inertial structure of the world, demanding a replacement of the usual Minkowski line element by a  $4+2n$  dimensional pseudo-Euclidean line element, with the extra  $2n$  being the number of internal phase space dimensions of the observed system. In the refined structure, the inverse of the Planck time takes over the role of observer-independent conversion factor usually played by the speed of light, which now emerges as an invariant but derivative quantity. In the relativistic theory based on the refined structure, energies and momenta turn out to be invariantly bounded from above, and lengths and durations similarly bounded from below, by their respective Planck scale values. Along the external timelike world-lines, the theory naturally captures the 'flow of time' as a genuinely structural attribute of the world. The theory also predicts expected deviations---suppressed quadratically by the Planck energy---from the dispersion relations for free fields in the vacuum. The deviations from the special relativistic Doppler shifts predicted by the theory are also suppressed quadratically by the Planck energy. Nonetheless, in order to estimate the precision required to distinguish the theory from special relativity, an experiment with a binary pulsar emitting TeV range gamma-rays is considered in the context of the predicted deviations from the second-order shifts.

**Keywords:** Flow of time; Temporal Transience; Special Relativity; Quantum Gravity; Planck Scale

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