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POS-34 - Quantum Reference Frames, 1+1 Newtonian Gravity, and Entanglement in a 3-Body System

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The notion of a quantum reference frame is needed to adequately describe quantum communication without a shared reference frame or the construction of a relational quantum theory. It was recently shown that when transforming quantum systems that have degrees of freedom referenced with respect to an external frame to that of a quantum reference frame, entanglement can be generated between the transformed degrees of freedom. In the present work we introduce a new quantum reference frame using the so-called $\rho\lambda$ coordinates to explore different types of entanglement properties that can emerge. This is analyzed using a one-dimensional system comprised of three Gaussian states. Additionally, we examine how $1+1$ Newtonian gravity affects this generated entanglement in both the previously considered quantum reference frame and in the $\rho\lambda$ case. It was found that under the $\rho\lambda$ coordinate transformation, the entanglement properties display interesting distributions using the logarithmic negativity as the quantifying measure of entanglement. We show that the interaction Hamiltonian generating the gravitational time evolution does not alter the entanglement properties. The kinetic energy of the particles however does alter the entanglement and evolves the system to an equilibrium state at large t regardless of initial covariance matrix parameters.

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