Thermalization of accelerated Brownian particles

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We consider a particle detector interacting with a massless scalar quantum field through the Unruh-DeWitt interaction Hamiltonian. We model the detector as a quantum oscillator of finite size. The detector-field system is shown to be mathematically equivalent to a quantum Brownian motion (QBM) model for an harmonic oscillator in an Ohmic environment, the role of which is played by the field. We evaluate the covariance matrix for an accelerated detector, identifying the regimes where non-Markovian effects become significant and discussing the effect of the size to the detector's response. We show that the late-time asymptotic state of the detector is a thermal state at the Unruh temperature.