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The stress-energy tensor of an Unruh-DeWitt detector

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In this talk, we present a theoretical model to describe a finite-size particle detector, focusing on the derivation of its energy-momentum tensor from a covariant Lagrangian formulation. The model encompasses both the quantum field associated with the detector (ϕ_{D}) and the elements responsible for its localization: a complex scalar field (ψ_{C}) and a perfect fluid. The local interaction between the detector and the complex field is designed to ensure the quadratic integrability of the detector modes, while the fluid plays a crucial role in defining the spatial profile of ψ_{C}, guaranteeing precise localization in space. Furthermore, we explore the physical properties of the resulting energy-momentum tensor, including all system components. We demonstrate that, under general conditions, the derived energy-momentum tensor is physically consistent and satisfies the energy conditions. This approach opens new perspectives for modeling detectors in quantum and relativistic scenarios, offering a robust framework for future applications in field theory.

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