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Title: Temperature and entropy-area relation of quantum matter near spherically symmetric outer trapping horizons

Abstract:

We consider spherically symmetric spacetimes with an outer trapping horizon. Such spacetimes are generalizations of spherically symmetric black hole spacetimes where the central mass can vary with time, like in black hole collapse or black hole evaporation. These spacetimes possess in general no timelike Killing vector field, but admit a Kodama vector field which provides a replacement. Spherically symmetric spacelike cross-sections of the outer trapping horizon define in- and outgoing lightlike congruences. We investigate a scaling limit of Hadamard 2-point functions of a quantum field on the spacetime onto the ingoing lightlike congruence. The scaling limit 2-point function has a universal form and a thermal spectrum with respect to the time-parameter of the Kodama flow, where the inverse temperature is related to the surface gravity of the horizon cross-section in the same way as in the Hawking effect for an asymptotically static black hole. Similarly, the tunneling probability in the scaling limit between in- and outgoing Fourier modes with respect to the the Kodama time shows a thermal distribution with the same inverse temperature, determined by the surface gravity. This can be seen as a local counterpart of the Hawking effect for a dynamical horizon in the scaling limit. The scaling limit 2-point function as well as the 2-point functions of coherent states of the scaling-limit-theory have relative entropies behaving proportional to the cross-sectional horizon area. Thereby, we establish a local counterpart, and microscopic interpretation in the setting of quantum field theory on curved spacetimes, of the dynamical laws of outer trapping horizons, derived by Hayward and others in generalizing the laws of black hole dynamics originally shown for stationary black holes by Bardeen, Carter

and Hawking. This is joint work with F. Kurpicz and N. Pinamonti (arXiv:2102.11547).