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Black hole induced false vacuum decay in a heat bath in (1+1) dimensions

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The possibility that a black hole catalyzes vacuum decay is an interesting and important topic both phenomenologically and theoretically. One of the issues is the choice of the vacuum state. To address it, we consider a (1+1)-dimensional toy model of a scalar field with inverted Liouville potential in an external background of a dilaton black hole. We study the decay of a general out-of-equilibrium state describing the evaporating black hole immersed in the thermal bath with a different temperature. We analytically derive the exponential suppression factor of the tunneling rate and show how they interpolate between the results of the previous study on those for the Hartle-Hawking vacuum and Unruh vacuum. We also find the non-thermal sphaleron configuration analytically when there is no dilaton barrier and construct the semiclassical solution describing tunneling onto this sphaleron. Our study would be the first step to examine the vacuum decay around a black hole in our cosmic history.

Primary authors: HU, Bowen (中国科学院大学杭州高等研究院); KAMADA, Kohei (HIAS UCAS)

Presenter: HU, Bowen (中国科学院大学杭州高等研究院)

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