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Static, stationary and inertial Unruh-DeWitt detectors on the BTZ black hole

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We examine an Unruh-DeWitt particle detector coupled to a scalar field in three-dimensional curved spacetime. We first obtain a regulator-free expression for the transition probability in an arbitrary Hadamard state, working within first-order perturbation theory and assuming smooth switching, and we show that both the transition probability and the instantaneous transition rate remain well-defined and finite in the sharp switching limit. We then analyse the detector for a massless conformally coupled field in the Hartle-Hawking vacua on the Bañados-Teitelboim-Zanelli black hole, under both transparent and reflective boundary conditions. A selection of stationary and freely-falling detector trajectories are examined, including the co-rotating trajectories, for which the response is shown to be thermal. Analytic results in a number of asymptotic regimes, including those of large and small mass, are complemented by numerical results in the interpolating regimes. The boundary condition at infinity is seen to have a significant effect on the detector.