Scalar absorption in Schwarzschild-de Sitter spacetimes

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The absorption problem for the massless scalar field by Schwarzschild-de Sitter black holes is analyzed. Unlike in the case of asymptotically flat spacetimes, a plane wave is not an asymptotic solution in spacetimes with a positive cosmological constant. Therefore, it is not possible to apply the usual definition of absorption cross section in such cases. However, it is possible to approximate the definition of absorption cross section for a small black hole in a spacetime which is asymptotically de Sitter. This is the so-called generalized absorption cross section, for which numeric results in the case of Schwarzschild-de Sitter black holes are presented. Results are also presented for the classical particle absorption via geodesic approach. Interestingly enough, the generalized absorption cross section agrees with the geodesic results in the high-frequency limit even when the black hole is not small. The greybody factors and emission rates for different couplings between the scalar field and the spacetime curvature are also computed numerically. The greybody factors and the emission rate in the low-frequency limit are non-vanishing and finite only in the case of minimal coupling between the scalar field and the spacetime curvature. Moreover, low-frequency limit of the generalized absorption cross section is shown to diverge if the coupling is zero and to remain finite if the coupling is nonzero. Results for the greybody factors are found analytically at low frequencies. Excellent agreement is obtained between the analytic and numeric results.