Falling charges into a Schwarzschild black hole: a quantum approach to radiation emission

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We analyze the electromagnetic radiation emitted by a charged particle undergoing radial free fall within Schwarzschild spacetime. Using the framework of quantum field theory in curved spacetimes, we obtain one-particle emission amplitudes, that is, transition amplitudes from the vacuum state to a one-particle state. From these amplitudes, one can calculate several physical observables related to the radiation emitted, such as the energy spectrum and the total energy emitted. We consider a range of scenarios in which the particle starts at different finite positions or originating from infinity with various initial velocities. Additionally, to better understand the divergences appearing in the absorbed radiation by the black hole, we compare these findings to the radiation produced by a charged, radially extended “string” undergoing a similar free-fall motion.