QUANTUM STATES FOR CHARGED SCALAR FIELDS IN REISSNER-NORDSTRÖM SPACETIME

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Superradiance is the (classical) phenomenon where a wave of a certain frequency, incident on a particular physical system, is scattered with a higher amplitude, thereby withdrawing energy from the system. A spinning black hole, with spacetime described by the Kerr solution, is one of those systems. Charged black holes, in a similar fashion to their (uncharged) spinning counterpart, allow for the existence of superradiant modes in the spectrum of a massless and electrically charged scalar field. The incidence of superradiant modes, in this case, extract energy and charge from the black hole. In the canonical quantization of a massless and charged scalar field in Reissner-Nordström spacetime, which describes the spacetime of a charged black hole, the superradiant modes play a part in the construction of possible quantum states. It is possible to construct analogs of the non-time-reversal-invariant states defined for the neutral scalar field in Kerr spacetime. We analyze these states by computing differences in expectation values of some observables between quantum states, which does not require renormalization. We also construct tentative equilibrium states, one which is as empty as possible at both past and future null infinities, similar to the Boulware state in Schwarzschild spacetime. The other equilibrium state is similar to the Hartle-Hawking state in Schwarzschild spacetime, the latter describing an ensemble of particles in thermal equilibrium with the black hole. Both of these Boulware-like and Hartle-Hawking-like states require the use of commutation relations involving the superradiant modes.