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Active irreversible process in quantum field theory

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We describe the dynamics of a quantum field coupled to a moving heat bath, in the formalism of the Markovian master equation for the field considered as an open system. We apply this to the superradiance of a rotating black hole, which provides a useful paradigm for understanding other irreversible active processes. Fermions can't superradiate, but work may be extracted from their motion-induced population inversion in the presence of two baths. We argue that this describes the triboelectric effect (the charging of rough surfaces by rubbing). We also apply this formalism to shock waves, fleshing out Zel'dovich's intuition that in this case "quantum mechanics helps understand classical mechanics", and Ginzburg's insight that "radiation during the uniform motion of various sources is a universal phenomenon rather than an eccentricity". Finally, we argue that our interpretation of the triboelectric effect offers a qualitatively new mechanism for CP violation in fundamental physics.

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