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Hawking radiation as a quantum caustic

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We describe the theory of black hole analogues in atomic Bose-Einstein condensates (BECs). An event horizon can occur in such systems if there is a region where the flow speed of the gas exceeds the speed of sound. Such sonic black holes create negative frequency modes that have a positive norm, resulting in negative energies within the Hamiltonian of elementary excitations. An analogue of Hawking radiation then occurs due to the excitation of pairs of atoms out of the condensate. In the vicinity of the event horizon the mode function also suffers a logarithmic phase divergence which heralds the breakdown of the classical wave description [Leonhardt et al., J. Opt. B: Quantum Semiclass. Opt. 5 S42 (2003)]. We examine the connection of this problem to that of caustics in optics in an effort to develop a theory of quantum caustics.

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