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(G*) Hawking radiation as a quantum caustic

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In optics, caustics are bright, sharp lines and shapes created by the natural focusing of light. Some examples include rainbows, the wavy lines on the bottom of swimming pools and the patterns produced by gravitational lensing. The intensity at a caustic diverges in the classical ray theory, but can be smoothed by taking into account the wave nature of light. In this work we consider a new type of caustic that occurs in quantum systems due to phase singularities; because phase is such a central concept in wave theory, this heralds the breakdown of the wave description and is an example of a quantum caustic. In particular, we consider analogue black holes which can be formed in a flowing Bose-Einstein condensate (BEC) gas. Waves flowing near the event horizon (describing analogue Hawking radiation) appear to suffer a logarithmic phase divergence, which is known as the trans-Planckian problem for gravitational black holes. We describe the regularization procedure required to cure this quantum caustic in our BEC system, and make connections to catastrophe theory.

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