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Quantum analog of Kerr black hole and Penrose effect in a Bose-Einstein condensate

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We propose to use quantum vortices for analog gravity. We implement an acoustic Kerr black hole with quantized angular momentum in a Bose-Einstein condensate. We show that the condensate's metric is equivalent to the Kerr's one, exhibiting a horizon and an ergosphere. We confirm that this metric is obeyed not only by weak density waves, but also by quantum vortices which behave as massive test particles. We use these topological defects to demonstrate a quantum Penrose effect, extracting the rotation energy of the black hole by quanta of angular momentum. The particle trajectories are well described by the time-like geodesics of the Kerr metric, confirming the potential of analog gravity.

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