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Wave equations in Kerr geometry

The Kerr metric is a two-parameter family of solutions of the Einstein vacuum field equations which describes the outer space-time geometry of a rotating black hole in equilibrium. Its importance in General Relativity stems from the black hole uniqueness theorems of Israel and Carter which characterize it as the unique set of solutions to the boundary value problem corresponding to black hole equilibrium states. The geometric properties of the Kerr metric have been described by Chandrasekhar as "having the aura of the miraculous", and have opened the door to the study from a rigorous mathematical perspective the long time dynamics of waves in Kerr geometry, as well as the phenomenon of super-radiance. I will review some of the results obtained on these questions in collaboration with Felix Finster, Joel Smoller and Shing-Tung Yau, and I will also indicate a number of open problems and perspectives.