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Topological Aspects of Entropy and Phase Transition of Kerr Black Holes

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Abstract: In the light of topological current and the relationship between the entropy and the Euler characteristic, the topological aspects of entropy and phase transition of Kerr black holes are studied. From Gauss-Bonnet-Chern theorem, it is shown that the entropy of Kerr black holes is determined by the singularities of the Killing vector field of spacetime. By calculating the Hopf indices and Brouwer degrees of the Killing vector field at the singularities, the entropy S=A/4 for nonextreme Kerr black holes and S=0 for extreme ones are obtained, respectively. It is also discussed that, with the change of the ratio of mass to angular momentum for unit mass, the Euler characteristic and the entropy of Kerr black holes will change discontinuously when the singularities on Cauchy horizon merge with the singularities on event horizon, which will lead to the first-order phase transition of Kerr black holes.

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