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Quasilocal Smarr relations for static black holes

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Smarr relations in terms of thermodynamical quasilocal variables are obtained for Schwarzschild and Reissner-Nordström black holes. Our treatment is based on Brown and York's Euclidean path integral approach for gravitational thermodynamics. The resulting expressions allow us to construct the relation between the quasilocal energy obtained in this setting and the Komar and Misner-Sharp energies, which are regarded as thermodynamical internal energy in other approaches. By considering some properties of the metric, it is shown that the obtained quasilocal Smarr relations can be regarded as thermodynamical realizations of Einstein equations. Extensions of these results to cosmological spacetimes are discussed.

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