

Smarr formulas for Einstein-Maxwell-dilaton stationary spacetimes with line singularities

We generalize the recent derivation <http://arxiv.org/abs/arXiv:1908.10617> of the Smarr formulas for Einstein-Maxwell stationary axisymmetric asymptotically locally flat spacetimes with line singularities to the Einstein-Maxwell-dilaton (EMD) theory with an arbitrary dilaton coupling constant. The line singularities include the Dirac and Misner strings for spacetimes with magnetic and NUT charges. Multiple black holes sitting on the symmetry axis and joined by struts are also included. Both the horizons and the line singularities are described as rods in Weyl coordinates and they are treated in a similar way. The derivation is based on Tomimatsu's approach to express the Komar integrals as the integrals over the symmetry axis and is directly applicable to rotating spacetimes. It is shown that the dilaton does not contribute to the bulk mass and angular momentum, while the dilaton exponents before Maxwell terms mutually cancel in the integrals over the rods, so the final Smarr relations preserve their form in the Einstein-Maxwell theory. They hold for each rod separately. In the case of Misner and Dirac string, they connect the mass, the angular momentum and the area of the string and include a spacelike analogue of the surface gravity. We apply this formalism to new rotating EMD black holes endowed with both electric and magnetic charges and the NUT charge. Thermodynamical interpretation is discussed.

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