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Beyond the Reissner-Nordstrom paradigm: static black holes with non-spherical horizons

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Abstract: Static (single) black holes (BHs) in electrovacuum can only have an electric monopole, and they are necessarily spherically symmetric. We discuss two different mechanisms to circumvent this result. In the first case, we show that static BHs in AdS-electrovacuum can have an arbitrary electric multipole structure, and present explicit examples of static BHs with no continuous (spatial) symmetries. The second example consists in asymptotically flat scalarized BHs in a class of Einstein-Maxwell-scalar (EMS) models. The corresponding BHs bifurcate from the Reissner-Nordstrom BH trunk, forming an infinite (countable) number of branches, and possess a large freedom in their multipole structure. Unlike the case of electrovacuum, the EMS model admits static, asymptotically flat, regular on and outside the horizon BHs without spherical symmetry and even without any spatial isometries, which are thermodynamically preferred over the electrovacuum state.

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