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Gravitational magnetic monopoles and Majumdar-Papapetrou stars. (English)

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Summary: During the 1990s a large amount of work was dedicated to studying general relativity coupled to non-Abelian Yang-Mills type theories. Several remarkable results were accomplished. In particular, it was shown that the magnetic monopole, a solution of the Yang-Mills-Higgs equations can indeed be coupled to gravitation. For a low Higgs mass it was found that there are regular monopole solutions, and that for a sufficiently massive monopole the system develops an extremal magnetic Reissner-Nordström quasihorizon with all the matter fields laying inside the horizon. These latter solutions, called quasi-black holes, although nonsingular, are arbitrarily close to having a horizon, and for an external observer it becomes increasingly difficult to distinguish these from a true black hole as a critical solution is approached. However, at precisely the critical value the quasi-black hole turns into a degenerate space-time. On the other hand, for a high Higgs mass, a sufficiently massive monopole develops also a quasi-black hole, but at a critical value it turns into an extremal true horizon, now with matter fields showing up outside. One can also put a small Schwarzschild black hole inside the magnetic monopole, the configuration being an example of a non-Abelian black hole. Surprisingly, Majumdar-Papapetrou systems, Abelian systems constructed from extremal dust (pressureless matter with equal charge and energy densities), also show a resembling behavior. Previously, we have reported that one can find Majumdar-Papapetrou solutions which are everywhere nonsingular, but can be arbitrarily close of being a black hole, displaying the same quasi-black-hole behavior found in the gravitational magnetic monopole solutions. With the aim of better understanding the similarities between gravitational magnetic monopoles and Majumdar-Papapetrou systems, here we study a particular system, namely a system composed of two extremal electrically charged spherical shells (or stars, generically) in the Einstein-Maxwell-Majumdar-Papapetrou theory. We first review the gravitational properties of the magnetic monopoles, and then compare with the gravitational properties of the double extremal electric shell system. These quasi-black-hole solutions can help in the understanding of true black holes, and can give some insight into the nature of the entropy of black holes in the form of entanglement.

MSC:

83C55	Macroscopic interaction of the gravitational field with matter (hydrodynamics, etc.)
81V17	Gravitational interaction in quantum theory
83C22	Einstein-Maxwell equations
83C57	Black holes

Full Text: DOI arXiv

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