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Discreteness of Dyonic Dilaton Black Holes

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Now, after decades of purely theoretical research, a new era begins in the study of black holes. Thanks to such projects as the Event Horizon Telescope, LIGO and VIRGO, eLISA and others, it will be possible to obtain observational data and to test various theoretical models. Therefore, it is important to close some gaps in the theories of black holes that have not been resolved in due time. One of these not fully investigated questions is the dyon black hole model in the presence of a dilaton field. Black holes with electric and / or magnetic charges are well studied, and solutions for them are represented by RN metric. However, in the presence of the dilaton field, the situation becomes much more complicated. We show that there are two classes of solutions that describe static spherically symmetric dyonic dilaton black holes with two nonsingular horizons. The first class includes only the already known solutions that exist for a few special values of the dilaton coupling constant. Solutions belonging to the second class have essentially different properties. They exist for continuously varying values of the dilaton coupling constant, but arise only for discrete values of the dilaton field at the horizon. For each given value of the dilaton coupling constant, there may exist several such solutions differing by the number of zeros of the shifted dilaton function in the subhorizon region and separating the domains of singular solutions. The obtained result disproves the existing triangular hypothesis that regular dyon-dilaton black holes can exist only for a certain discrete sequence of the dilaton coupling constant. Since the dilaton coupling constant is an external parameter in this model (and can be specified by a more fundamental theory of gravitation), the independence of the discreteness phenomenon from the value of this constant is a rather important result. The universal nature of the discreteness of regular solutions can lead to a number of new phenomena in the dyon-dilaton system of black holes.

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