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Hairy black holes in extended Einstein-Maxwell-scalar theories with magnetic charge and kinetic couplings

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We study static and spherically symmetric black hole (BH) solutions in extended Einstein- Maxwell-scalar theories which is classified in a subclass of the $U(1)$ gauge-invariant scalar-vector- tensor theories. The scalar field is coupled to the vector field, which has electric and magnetic charges. We investigate modifications to the Reissner-Nordström solution focusing on the three types of scalar-vector interactions, including derivative couplings. We solve the field equations analytically in two asymptotic regions which are the vicinity of the BH horizon and the spatial infinity, and clarify the condition for the existence of scalar hair. To understand the behaviors of solutions in intermediate scales, the field equations are integrated numerically for concrete models with different types of couplings. We find new hairy BH solutions with scalar hair in the presence of magnetic charge and kinetic coupling. The magnetic charge plays an important role in distinguishing hairy BH solutions originated from three types of different interactions at a large coupling limit.

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