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Black holes with primary scalar hair

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We present an algorithm to obtain exact black holes endowed with primary scalar hair within the shift-symmetric and Z_2-symmetric subclass of beyond Horndeski theories. These solutions depend, in addition to the conventional mass parameter, on a second free parameter encoding primary scalar hair. In the limit of vanishing scalar hair, the solutions smoothly reduce to the Schwarzschild, while, as the scalar hair increases, the metric solutions gradually depart from GR solutions. Notably, for a particular relation between mass and scalar hair, the central singularity completely disappears, resulting in the formation of regular black holes or solitons. Among these solutions, the well-known regular Bardeen solution emerges as a special case.

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