New black hole solutions in f(P) gravity and their thermodynamic nature

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Black holes are fascinating objects in the universe. They represent extreme deformations in spacetime geometry. Here, we construct $f(P)$ gravity and the first example of static-spherically symmetric black hole solution in $f(P)$ gravity and discuss their thermodynamics. Using the numerical approach and series solution, we discover the solution and demonstrate that it is a generalization of Schwarzschild. The solution is characterized by a single function that satisfies a non-linear fourth-order differential equation. Interestingly, we can analytically calculate the solution's specific heat, Wald entropy, and Hawking temperature as a function of horizon radius. After analyzing the specific heat, we discovered that the black hole is thermodynamically stable over a small horizon radius.