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General Nth order superintegrable systems separating in polar coordinates

The general description of superintegrable systems, with one polynomial integral of second order in the momenta and one more of N order, in a two-dimensional Euclidean space is presented. We consider Hamiltonian systems allowing separation of variables in polar coordinates. Both the classical and the quantum cases are discussed. The main properties of *standard* and *exotic* potentials are established as well. In particular, unlike the *exotic* potentials the general form of the *standard* ones satisfies a linear ODE. In the quantum case, we conjecture that a new infinite family of *exotic* potentials written in terms of the sixth Painlevé transcendent occurs.