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Superintegrable systems with spin induced by coalgebra symmetry

A method for deriving superintegrable Hamiltonians with a spin-orbital interaction is presented. The method is applied to obtain a new superintegrable system in Euclidean space with the following properties. It describes a rotationally invariant interaction between a particle of spin $1/2$ and one of spin 0. Its Hamiltonian commutes with total angular momentum $(\vec{J})$ and with additional vector integrals of motion $(\vec{X})$, $(\vec{Y})$ with components that are third-order differential operators. The integrals of motion form a polynomial algebra under commutation. The system is exactly solvable (in terms of Laguerre polynomials) and the bound state energy levels are degenerate and described by a Balmer type formula. When the spin-orbital potential is switched off the system reduces to a hydrogen atom.