Integrable Richardson-Gaudin models in nuclear physics

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The exact solution of the BCS pairing Hamiltonian was found by Richardson in 1963. Although it passed almost unnoticed, it was recovered in the last decade in an effort to describe the disappearance of superconductivity in ultrasmall superconducting grains. Since then it has been extended to several families of integrable pairing models, the Richardson-Gaudin (RG) models. However, only the rational family has been widely applied to mesoscopic systems where finite size effects play an important role. We have recently presented the first implementation of the RG hyperbolic family to nuclear structure. It gives rise to a separable pairing Hamiltonian with non-degenerate single-particle energies and two free parameters, one related to an interaction cutoff and the other to the pairing strength. These two parameters can be adjusted to give an excellent reproduction of Gogny self-consistent mean-field calculations in the Hartree-Fock basis.