CO.CO.MAT

Jorge Dukelsky
(Instituto de Estructura de la Materia, CSIC, Madrid, Spain)

Integrable Richardson-Gaudin models in mesoscopic physics

The exact solution of the BCS pairing model was introduced by Richardson in the early sixties. It passed unnoticed for decades, till it was recovered in the 2000 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 models. However, only the rational family has been widely applied to mesoscopic systems where finite size effects play an important role. In the thermodynamic limit, the exact many-body wavefunction provides a unique view to the Cooper pair structure in the BCS-BEC crossover. We have recently found two complementary implementations of the hyperbolic family in condensed matter. The first implementation gives rise to a p-wave pairing describing a gas of spinless fermions in a 2D lattice with $p_x + ip_y$ pairing symmetry. Using this new tool we study the quantum phase diagram which unlike the case of s-wave pairing displays a third order quantum phase transition. The exact wavefunction of the p-wave pairing Hamiltonian gives a beautiful insight into the nature of the quantum phase transition. The second implementation leads to a variation of the Kitaev wire Hamiltonian that is both number conserving and interacting, but still exactly solvable. This new Richardson-Gaudin-Kitaev model shares the features of the mean-field Kitaev model that have made it a paradigm of topological superconductivity.

21. November 2014, 14:00 Uhr

Universität Stuttgart, NWZII, Raum 2.136
Pfaffenwaldring 57, 70569 Stuttgart