

Abstract

Title: Ultra-cold atoms as universal quantum simulators: symmetry locked superfluid phases

I review the concept of ultra-cold atoms as universal quantum simulators for quantum many body systems, focusing on motivations, main targets and open problems. As a realistic example I then describe a setup of ultracold fermionic mixtures in optical lattices able to host superfluid phases with symmetry obtained by locking independent invariance groups of the normal state. Due to their peculiar symmetry, these phases can also show exotic soliton structures, as vortices with semi-integer flux and gapless non-Abelian Goldstone modes localized on them. The origin of the non-abelianity, the braiding properties, the mechanism and the consequences of fractionality for such vortices are discussed. The scenario proposed displays remarkable similarities to what arises in ultra-dense QCD matter, as in the core of some neutron stars. A discussion about the experimental detection of locked phases and non-abelian fractional vortices is as well provided.