

SEMINAR

Wednesday, 24th of April 2013 at 11:30

CNR-IOM DEMOCRITOS & SISSA - Trieste, Italy

Abstract

"Quantum simulations with ultracold atoms in optical lattices"

In this talk I will present two examples of quantum simulations with ultracold atoms in optical lattices. In the first part I discuss the properties of ultracold bosons in optical lattices at half-filling: using a similarity Hamiltonian renormalization procedure, we determine an effective spin-1/2 representation of the Bose-Hubbard model. This mapping allows to give analytical estimates of the correlation functions of the Bose-Hubbard model, which are in good agreement with DMRG results. The discussed analysis shows that, also at finite interaction, the 1D Bose-Hubbard model with suitably chosen parameters may be seen as a quantum simulator of the XXZ chain. In the second part I will discuss anisotropic Ginzburg-Landau and Lawrence-Doniach models describing a layered superfluid ultracold Fermi gas in optical lattices. We derive the coefficients of the anisotropic Ginzburg-Landau and the mass tensor as a function of anisotropy, filling and interaction, showing that near the unitary limit the effective anisotropy of the masses is significantly reduced. The anisotropy parameter is shown to vary in realistic setups in a wide range of values. We also derive the Lawrence-Doniach model - often used to describe the 2D-3D dimensional crossover in layered superconductors - for a layered ultracold Fermi gas, obtaining a relation between the interlayer Josephson couplings and the Ginzburg-Landau masses.