UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Avviso di seminario

Lunedì 3 aprile, ore 15.30

Dipartimento di Fisica
Aula U2-02

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Continuous and discrete supersolidity with ultracold atoms in optical cavities

The realization of a ‘supersolid' state of matter, simultaneously featuring frictionless flow and crystalline order has been a long standing goal in condensed matter physics. This quantum state requires the breaking of two continuous symmetries, the phase invariance of the superfluid and the continuous translational invariance to form the crystal. Since its first proposal for Helium almost 50 years ago, experimental verification of supersolidity remained elusive. A variant with only discrete translational symmetry breaking on a pre-imposed lattice structure, the ‘lattice supersolid’, has been realized based on self-organization of a Bose-Einstein condensate (BEC) in an optical cavity. However, lattice supersolids do not feature the high ground state degeneracy that characterizes the supersolid state as originally proposed. We realize such phase by coupling a BEC to the modes of two optical cavities crossing at an angle of 60°. We pump the homogeneous BEC with a laser beam far detuned from the atomic resonance but close to the cavity resonances. Upon a certain threshold power of the pump laser the light occupation in the cavities becomes non zero and a phase transition occurs. At the phase transition, the atomic profile ‘crystallize’ by acquiring a density modulation that can form continuously in space due to scattering of the pump light in the cavity modes. Changing the relative cavity detunings from the pump beam we can tune the symmetry of the system from U(1) to Z(2), therefore allowing the independent realization of a supersolid or a lattice-supersolid. Additionally using cavity-enhanced Bragg spectroscopy we probe the excitation spectrum of the supersolid across its phase transition and we map out a Higgs and a Goldstone pair. Due to the finite decay of the intra-cavity light field we can also monitor the evolution of these modes in real time.

Il seminario è rivolto in special modo agli studenti di dottorato