The Abdus Salam
International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization
IAEA International Atomic Energy Agency

Conference on Research Frontiers in Ultra-Cold Atoms
ICTP, Trieste, 4 - 8 May 2009

Evidence for supersolid behavior in a spin-1 rubidium gas

Kater MURCH
Dept. of Physics, Univ. of California, Berkeley, U.S.A.

Abstract:

I will present experimental evidence of the coexistence of two types of symmetry-breaking long-range order in a quantum degenerate gas of spin-1 ^{87}Rb atoms: crystalline magnetic ordering, which spontaneously breaks translational symmetry, and long-range phase coherence of a macroscopic wavefunction, which spontaneously breaks the $U(1)$ gauge symmetry associated with the particle number. Such a gas was prepared by gradually cooling non-degenerate, unpolarized, optically trapped gases into the regime of quantum degeneracy. Using a high-resolution magnetization-sensitive imaging method, we observe a phase transition below which the quantum gas forms a crystalline array of magnetic domains. Based on our previous experiments on the evolution of helical spin textures in such a gas, we ascribe this crystalline order to the competition between a short-range isotropic ferromagnetic interaction and a long-range anisotropic dipolar interaction. We confirm the phase coherence of this gaseous crystal by atom interferometry. Specifically, we use a form of Bragg spectroscopy to measure the first-order correlation function of the superfluid order parameter at variable distance. The coexistence of translational symmetry breaking, characteristic of a solid, and long-range phase coherence, characteristic of a superfluid, are hallmarks of the sought-after supersolid phase.