Engineering Ising-XY spin models in a triangular lattice

Juliette Simonet*[1], Julian Struck[1], Malte Weinberg[1], Christoph ölschläger[1], and Klaus Sengstock[1]

[1]Institut für Laserphysik - Universität Hamburg – Allemagne

Résumé

The emulation of gauge fields is of central interest since standard electromagnetic fields do not couple to the motional degrees of freedom of the chargeless atomic species investigated in optical lattices. However an effective Aharonov-Bohm phase can be engineered if the atomic wave function acquires a nontrivial phase while tunneling from one lattice site to another. In this perspective, shaken optical lattices constitute a versatile tool, which allows controlling both phase and amplitude of the tunneling parameters and thus generating artificial gauge potentials.
We report here on the experimental realization of staggered artificial magnetic fluxes on a periodically driven triangular lattice. The phase distribution of a superfluid submitted to staggered fluxes obeys both the discrete Ising (Z2) and the continuous U(1) global phase symmetry. The interplay of these symmetries naturally raises the question of coupled order parameters and new universality classes of phase transitions.

We analyze the behavior of the discrete and continuous order parameters measured for this two-dimensional spin-chirality coupled system. The strength of the staggered artificial gauge field is used to control the Z2 symmetry breaking, by lifting the degeneracy between the Ising states in analogy to a longitudinal homogeneous magnetic field in the standard Ising-Spin model. We observe a thermally driven Ising-type phase transition from an ordered, ferromagnetic to an unordered, paramagnetic state.
Both the experimental and theoretical analysis of the coherence properties of the ultracold gas demonstrates the strong influence of the Z2 symmetry onto the condensed phase.

*Intervenant