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Dynamics of Stripe Patterns in Supersolid Spin-Orbit-Coupled Bose Gases

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Supersolidity is an exotic phase of quantum matter which combines the characteristics of a superfluid with the crystalline spatial structure of a solid, resulting from the spontaneous breaking of both $U(1)$ phase symmetry and translational invariance. In spin-orbit-coupled Bose-Einstein condensates (SOC BECs), a spatially modulated density profile in the form of stripes emerges from the interference of two condensates with their Raman sidebands at finite momenta. Despite ground-breaking observations of this supersolid phase in equilibrium, it has long controversially been discussed whether the stripes are rigid or support crystal excitations at finite wavelengths. In this presentation, we discuss experimentally feasible excitation mechanisms of the spin Goldstone mode and elucidate the lattice-phonon character of the induced dynamics based on intuitive pictures as well as analytical and numerical results [1]. In particular, we demonstrate that the stripes in SOC BECs are by no means rigid, but that their translational, compressional, as well as rotational motion can be excited by applying suitable spin perturbations. These findings expose the rich hybridization effects of density and spin degrees of freedom in this system and establish SOC BECs as paradigmatic supersolids featuring the full dynamics of two coupled Goldstone modes.

[1] K. T. Geier, G. I. Martone, P. Hauke, W. Ketterle, and S. Stringari, Phys. Rev. Lett. **130**, 156001 (2023).

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