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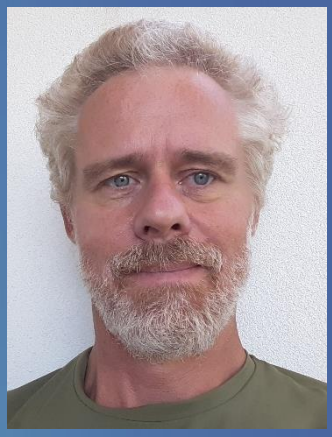

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Symmetry breaking and superfluidity in a dipolar supersolid

The supersolid is a fundamental quantum phase of matter that is predicted to combine the properties of solids with those of superfluids. It was theorized about 50 year ago, and since then it has been studied theoretically and searched experimentally in various physical systems, until very recently without success. I will discuss how a Bose-Einstein condensate of strongly magnetic atoms realizes the supersolid, exploiting a combination of attractive and repulsive long-range interactions to create a spontaneous, periodic density modulation without loss of coherence [1]. With experiments based on the study of the collective oscillations, it is possible to study its counterintuitive mixed properties. For example, compressional oscillations allow testing the simultaneous breaking of gauge and translational symmetries, which prove the coexistence of fluid and solid natures [2]. Rotational oscillations allow instead revealing a reduced moment of inertia for the supersolid, which is a direct evidence of superfluidity [3]. In the future, the high degree of control of the magnetic condensates may allow to investigate in depth the properties of the supersolid phase of matter.

References

[1] L. Tanzi et al., Observation of a dipolar quantum gas with transient supersolid properties, Phys. Rev. Lett. 122, 130405 (2019).

[2] L. Tanzi, S. M. Roccuzzo et al., Supersolid symmetry breaking from compressional oscillations in a dipolar quantum gas, Nature 574, 382 (2019).

[3] L. Tanzi et al., Evidence of superfluidity in a dipolar supersolid from non-classical rotational inertia, Science, published online 18/2/2021, DOI: 10.1126/science.aba4309.

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