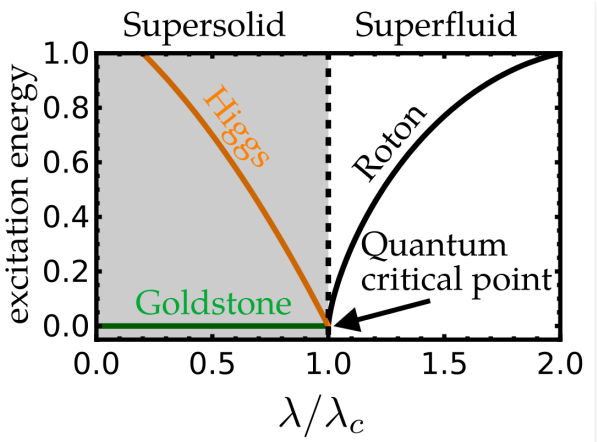
The Higgs mode of a dipolar Supersolid: From Quantum carpets and experimental efforts

Malte Schubert, Mathematical Physics and NanoLund, LTH, Lund University

The emergence of long-range order in a gas of dipolar bosons can be understood in terms of its elementary excitations. As the transition is approached from the unmodulated gas phase (Superfluid), the energy of the roton mode decreases rapidly and vanishes at the quantum critical point. In the supersolid phase, a gapless Goldstone mode and a massive Higgs excitation emerge. While the Goldstone mode has already been observed experimentally [1], detecting the Higgs mode remains considerably more challenging.



In this talk, I will explain how to approach the quantum critical point and how it shapes the spectrum of excitations [2,3]. I will also present how the Higgs mode in a dipolar supersolid can be decoupled from other excitations [2], enabling the study of the dynamics of massive Higgs quasiparticles [4]. Finally, I will discuss current experimental progress toward the detection of the Higgs mode.

[1] Guo, M., Böttcher, F., Hertkorn, J. *et al.*, "The low-energy Goldstone mode in a trapped dipolar supersolid," *Nature* **574**, 386–389 (2019).

[2] J. Hertkorn, P. Stürmer, K. Mukherjee, K. S. H. Ng, P. Uerlings, F. Hellstern, L. Lavoine, S. M. Reimann, T. Pfau, and R. Klemt, "Decoupled sound and amplitude modes in trapped dipolar supersolids," *Phys. Rev. Research* **6**, L042056 (2024).

[3] M. Schubert, K. Mukherjee, P. Stürmer, and S. M. Reimann, "Vorticity-Crystalline Order Coupling in Supersolids: Excitations and Reentrant Phases," *Phys. Rev. Lett.* **136**, 183401 (2026).

[4] K. Mukherjee, M. Schubert, R. Klemt, T. Bland, T. Pfau, and S. Reimann, "Quantum Carpets of Higgs Quasiparticles in a Supersolid," *Phys. Rev. Lett.* **135**, 223402 (2025).