Quantum Phase Transitions in a Long-Range Interacting System

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The presence of long-range interactions in a many-body system can lead to the formation of intriguing new quantum phases such as supersolids or charge density waves [1]. A well known effect of long-range interactions is the roton-minimum in superfluid Helium, which is expected to be a precursor of a phase transition to a supersolid. In this lecture, I will discuss ways to experimentally create such long-range interactions in quantum gases, and to study the emerging phases. In close connection to the first lecture, I will present measurements of a critical exponent at the quantum phase transition from a superfluid to a supersolid phase [2].

[1] R. Mottl, F. Brennecke, K. Baumann, R. Landig, T. Donner, and T. Esslinger: *Roton-type mode softening in a quantum gas with cavity-mediated long-range interactions*, Science **336**, 1570 (2012).

[2] R. Landig, F. Brennecke, R. Mottl, T. Donner, and T. Esslinger: *Measuring the dynamic structure factor of a quantum gas undergoing a structural phase transition*, Nature Communications **6**, 7046 (2015).