Dipolar quantum gases and liquids

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Dipolar interactions are fundamentally different from the usual van der Waals forces in real gases. Besides the anisotropy, the dipolar interaction is nonlocal and as such allows for self-organized structure formation similar to the Rosensweig instability in classical magnetic ferrofluids. In our experiments with quantum gases of Dysprosium atoms, we could recently observe the formation of a droplet crystal. In contrast to theoretical mean field based predictions the superfluid droplets did not collapse. We confirmed experimentally that this unexpected stability is due to beyond mean field quantum corrections of the Lee-Huang-Yang type. We also observe and study self-bound droplets in three dimensions, which can interfere with each other. These droplets are 100 million times less dense than liquid helium droplets and open new perspectives as a truly isolated quantum system. Under strong confinement in one dimension, we observe the formation of a striped phase. We confirm experimentally that the mutual phases between the stripes is random. We also rotate the droplets by a spinning magnetic field and observe that they can be rotated faster than the transverse trapping frequency.