Precision measurements and many-body physics with cold molecules

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I will discuss two recent advances in the cooling and understanding of ultracold molecules.

First, I will present our work on optical cycling and transverse laser cooling of a beam of fermionic ^{137}BaF molecules [1,2,3]. Their high masses and nuclear spins make these molecules sensitive probes for nuclear-spin-dependent parity violation and properties of the weak interaction. However, the nuclear spins also lead to a quasi-closed cycling transition currently involving up to 112 levels, which significantly exceeds the complexity in other laser-cooled molecules. Optical cycling and cooling are facilitated through carefully designed optical spectra tailored to this molecular structure. Our results pave the way for efficient state preparation, detection, and cooling in a wide variety of precision measurements using this species and other similar species.

Second, I will discuss numerical studies of strongly dipolar molecular Bose-Einstein condensates beyond the mean-field regime [4,5]. These simulations reveal small droplets produced by strong dipolar interactions outside known stability regimes. The simulations include realistic molecular interactions and therefore have direct relevance for current and future experiments.

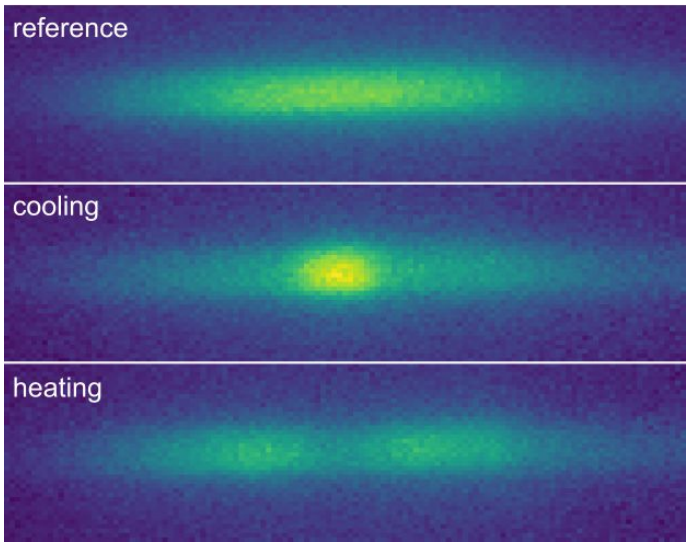

Figure 1: Laser cooling of BaF molecules [1].

References

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