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Meta-stable 1-D gases of polar molecules with attractive dipole forces[1]

ROBIN CÔTÉ, University of Connecticut

The recent achievements in the formation and manipulation of ultracold polar molecules have opened the gate to exciting new studies in several fields of physical sciences. Polar molecules could find uses in quantum information science and in precision measurements, while dense samples could provide a fertile ground for novel quantum gases because of their long-range and anisotropic interactions. Until now, stable dipolar gases were thought to require a repulsive dipole-dipole interaction, such as provided by parallel dipoles aligned perpendicularly to a two-dimensional (2-D) trap. However, to observe interesting new correlations and condensed matter phases, attractive interactions are needed. Here, we explore how meta-stable one-dimensional (1-D) samples of ultracold polar molecules could be created with attractive long-range dipole-dipole interaction. We show that a repulsive barrier due to a strong quadrupole interaction can stabilize a gas of ultracold KRb molecules and even lead to long-range wells supporting bound states. The properties of these wells can be controlled by external electric fields, allowing the formation of long chains of KRb polymers, and the further study of Luttinger liquid transition. We also discuss the general molecular properties necessary for the existence of a repulsive barrier.

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