

Optical transport system for an ultracold dipolar Er-K mixture in a box potential

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Ultracold dipolar mixtures provide a powerful platform for studying a wide range of quantum many-body phenomena, from supersolidity to impurity physics and polarons. In our experiment, we investigate a mixture of Erbium and Potassium. The large magnetic dipole moment of Erbium leads to anisotropic, long-range dipole-dipole interactions, which can induce density modulations, giving rise to insulating droplets or supersolid phases. Adding a second species, ⁴¹K, enables access to a richer phase diagram, allowing even the non-dipolar component to exhibit supersolid behaviour [1]. Impurities in such a dipolar supersolid environment may also give rise to novel polaron physics, where the impurity can influence the structure of the supersolid itself, potentially leading to highly non-linear effects [2].

In our experiment, the ¹⁶⁶Er and ⁴¹K mixture is transported from a magneto-optical trap to a glass science cell using an optical dipole trap. The science cell provides greater optical access and is currently set up with a homogeneous pancake trap implemented using a spatial light modulator. This configuration enables flexible control of the trapping geometry, allowing the study of degenerate dipolar gases in new geometries. Current efforts focus on upgrading to a high-resolution low-cost objective and high-field magnetic coils for the science cell, as well as improving the optical transport system. In particular, this poster presents the design, implementation, and testing of an optical transport system based on retroreflection through a movable corner cube.

[1] T. Bland *et al.*, *Phys. Rev. A* **106**, 053322 (2022).

[2] L. H. A. Simons *et al.*, *Phys. Rev. B* **111**, 054524 (2025).