Fermi surface deformations and collective modes in ultracold polar molecules

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Ultracold polar molecules possess strong electric dipole moments, providing a powerful platform for exploring exotic quantum many-body phenomena. When dressed with microwave fields, the dipole-dipole interactions can be tuned in terms of amplitude, sign, and spatial orientation [1, 2]. In degenerate Fermi gases, this consequently leads to dipolar many-body phenomena such as Fermi surface deformation [3, 4, 5] and collective excitations in the hydrodynamic regime [6, 7].

In this poster, we present our method to use a dual-color microwave scheme to enable full three-dimensional control of the intermolecular interaction [8] on our platform of ultracold fermionic NaK molecules, routinely creating a deeply degenerate dipolar Fermi gas at 0.25 T/T_F. We developed a systematic method to investigate the Fermi surface deformation and excitation of collective modes of the dipolar Fermi gas, enabling the quantitative analysis of dipolar many-body behavior across different interaction regimes set by the microwave field parameters.

This work sets the foundation for investigating the equilibrium properties and elementary excitations of dipolar fermionic many-body systems via polar molecules.

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