Stability diagram of degenerate Fermi gases of polar molecules with tilted dipoles

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A recent experimental realization of an ultracold quantum degenerate gas of $^{40}K^{87}Rb$ molecules [1] opens up a new chapter in exploring strongly dipolar Fermi gases and many-body phenomena arising in that regime. This includes the deformation of the Fermi surface (FS) for polarized systems, where the electric dipoles have a preferential orientation, which can be achieved using an external field. Compared to atomic magnetic species [2,3], this effect is significantly increased in ultracold Fermi gases of polar molecules, and the stability of the system is expected to strongly depend on its geometry. Here we generalize a previous Hartree-Fock mean-field theory [2] for the Wigner function, which now takes into account that the cloud shape in the ground state is determined not only by the trap frequencies, but also by the dipoles' orientation. In the special case of a spherically symmetric trap, the cloud is elongated in the direction of the dipoles, similar to the FS. We obtain here a universal stability diagram for dipolar fermions and calculate the corresponding FS deformation for an arbitrary orientation of the dipoles, demonstrating the great promise for the exploration of degenerate molecules in electric fields, where the strong dipole-dipole interaction dominates. These results are important for designing future experiments with polar molecules, as well as for the interpretation of measured data, including the dynamics and the time-of-flight expansion.

References

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