Time-of-flight Expansion for Trapped Dipolar Fermi Gases: From Collisionless to Hydrodynamic Regime

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Some time ago it was predicted that the momentum distribution of Fermi gas is deformed from spherical to cylindrical provided a dipole-dipole interaction in present [1]. A recent time-of-flight expansion experiment has now unambiguously detected such a Fermi surface deformation in a dipolar quantum gas of fermionic erbium atoms in the collisionless regime [2]. Here we follow Ref. [3] and perform a systematic study of time-of-flight expansions for trapped dipolar Fermi gases ranging from the collisionless to the hydrodynamic regime at zero temperature. To this end we solve analytically the underlying Boltzmann-Vlasov equation in the vicinity of equilibrium by using a suitable rescaling of the equilibrium distribution [4], where the collision integral is simplified within a relaxation-time approximation. The resulting ordinary differential equations for the scaling parameters are then solved numerically for experimentally realistic parameters for increasing relaxation times. Our analysis is, thus, useful for future time-of-flight experiments in order to determine the value of the underlying relaxation time from expansion data.

References

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