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ZNG – Theory for Dipolar Quantum Gases

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We study harmonically trapped three-dimensional ultracold Bose and Fermi gases in the presence of the short-range isotropic contact and the long-range anisotropic dipole-dipole interaction (DDI). The Hartree-Fock mean-field dynamics of such quantum systems can be described within the framework of the Zaremba-Nikuni-Griffin (ZNG) theory. Usually, the underlying Boltzmann-Vlasov (BV) equation is solved by the relaxation-time approximation for the collision integral, where the relaxation time is treated as a phenomenological parameter. We develop a formalism to determine the relaxation time microscopically for ultracold quantum gases at finite temperature, which allows us to include collision effects self-consistently in the BV formalism.

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Dynamics of spinor condensates in a microwave dressing field

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We experimentally study dynamics in a sodium antiferromagnetic spinor condensate as a result of spin-dependent interactions c and microwave dressing field interactions characterized by the net quadratic Zeeman effect q_{net}. In contrast to magnetic fields, microwave dressing fields enable us to access both negative and positive values of q_{net}. We find an experimental signature to determine the sign of q_{net}, and observe harmonic spin population oscillations at every q_{net} except near each separatrix in phase space where spin oscillation period diverges. Our data in the negative q_{net} region exactly resembles what is predicted to occur in a ferromagnetic spinor condensate in the positive q_{net} region. This observation agrees with an important prediction derived from the mean-field theory: spin dynamics in spin-1 condensates substantially depends on the sign of q_{net}/c. This work may be the first to use only one atomic species to reveal mean-field spin dynamics, especially the remarkably different relationship between each separatrix and the magnetization, of spin-1 antiferromagnetic and ferromagnetic spinor condensates.