Two-dimensional Condensation of Polar Molecules in a Synthetic Gauge Field

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In this presentation, we theoretically investigate the ground state properties of a two-dimensional ultra-cold polar molecule gas in the condensate phase and subjected to an effective vector potential induced by the Raman coupling between two rotational levels of the molecule. The interaction between molecules is considered to be dominant by the effective dipole moment induced by the Raman coupling, and the dipole moments are aligned by a DC field in the direction perpendicular to that of the two counter- propagating Raman beams. Based on the previous studies, such setup can facilitate to engineer an effective long-range interaction featuring not only the standard dipolar form but also a spatial dependence on the relative phase between two coupled rotational states. In the mean-field approximation, the ground state is found to possess three phases: separated phase, zero-momentum phase and Stoner-type phase. The first two phases appear when the system dynamics is dominated by the Raman coupling, while the last one appears when the particle interaction becomes dominant. Numerical results obtained by solving the Gross-Pitaevskii equation (GPE) agree with the variational analysis. Dynamical stability of the Stoner-type phase is examined numerically by the GPE real-time simulations.