Strongly correlated quantum phases with cold polar molecules

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The quest for quantum degenerate polar molecules marks one of the latest developments in the rapidly evolving field of ultracold gases. A characteristic property of these heteronuclear molecules is a finite permanent electric dipole moment, which allows for driving an anisotropic dipole-dipole interaction between the particles using static electric fields and/or microwave fields. This strong and tunable long-range interaction offers the opportunity for wide application in designing strongly correlated systems. We will present some examples of possible strongly correlated systems which can be obtaine in polar molecules such as crystalline structures, and Hubbard models with three-body interactions. This crystalline phase has potential applications as an alternative method to optical lattice for creating lattice structures for cold atomic gases with the advantage of a natural honeycomb and triangular lattice structure and thecoupling to phonons as a heat bath. Furthermore, the strong repulsion on short distances provide a reduction of inelastic collisions and consequently the long life-time makes these crystals very appealing for the usage as a quantum information storage devices.