ABSTRACT

COLD POLAR MOLECULES

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Cold polar molecules lead us to new territories such as engineered quan- tum simulation, quantum computation, quantum condensed systems, quantum collision dynamics and to searches for physics beyond the Standard Model. The electric dipole moment that polar molecules carry is the key. Applied laboratory electric fields can effectively mix opposite parity rotational states, inducing dipoles with the strength of a full atomic unit. These dipoles inter- act strongly with external fields and with each other at long range - features that can be used to produce new many-body effects and control internal and external molecular degrees of freedom. New explorations and applications are envisioned for polarmolecules. Placed on an optical lattice, molecules may provide a "toolbox" for creating spin-lattice Hamiltonians and electric dipoles that can be oriented in the lab frame for use as a quantum bits. For these reasons, considerable effort is focussed on mak- ing high density samples of trapped polar molecules conducive to studies of molecule-molecule collisions. There are several approaches being taken to pro- duce such high phase-space density samples of ground-state polar molecules with approximately 40 groups fully engaged or launching such an effort. One approach to cold polar molecules is buffer-gas cooling. Cold helium gas is used to cool molecules from their initial production temperature (usually ≈100-1000 K) to around 1 K. Once cold, molecules can be loaded into deep magnetic traps or extracted in the form of a beam. Several collisional studies have been made in this way, including those leading to an understanding of spin depolarization in Σ doublet and triplet molecules. Other techniques discussed in this talk will include guide filtering, single collision scattering and beam deceleration (Stark, microwave, mechanical and optical). Recent results on trapping of NH will be presented.