SYPS 1: Controlled Diatomic Molecules in the Ultracold Regime

Time: Tuesday 17:00–19:15 Location: K/HS1

Invited Talk SYPS 1.1 Tue 17:00 K/HS1

Feshbach resonances and the production of ultracold molecules — •Jeremy M. Hutson — Durham University, UK

This tutorial talk with give an overview of the routes available for producing samples of cold and ultracold molecules. It will briefly cover direct methods that cool samples of warm molecules to low temperatures. Example of such methods include buffer-gas cooling, beam deceleration, velocity selection, electrostatic Sisyphus cooling and laser cooling. However, the talk will focus on indirect methods that form ultracold molecules from ultracold atoms. It will describe the origins of the near-threshold energy levels of alkali-metal diatomics, which are responsible for zero-energy Feshbach resonances at magnetic fields where they cross threshold. Such resonances can be used to produce ultracold molecules by magnetoassociation. This has been achieved for a wide variety of alkali dimers in highly excited vibrational states, and a few of these have been transferred to the absolute ground state by STIRAP (Cs2, KRb, RbCs). There are prospects for extending magnetoassociation to other species, such as molecules containing Group II atoms such as Sr and Yb.

Invited Talk SYPS 1.2 Tue 17:30 K/HS1

New frontiers in quantum simulation with ultra-cold polar molecules — •Ana Maria Rey — JILA, NIST and Physics Department, University of Colorado-Boulder

Understanding the behavior of interacting electrons in solids or liquids is at the heart of modern quantum science and necessary for technological advances. However, the complexity of their interactions generally prevents us from coming up with an exact mathematical description of their behavior. Precisely engineered ultracold polar molecular gases have been proposed as a powerful tool for unraveling these challenging physical problems. In contrast to atoms, polar molecules have a rich internal structure and interact via strong long-range and anisotropic dipolar interactions. Although those properties are very appealing, their applicability in actual experiments has been difficult due to competing chemical reactions which substantially limit the lifetime of the molecules. In this talk, I will discuss developments at JILA on using arrays of KRb molecules for the investigation of ultra-cold chemistry, complex many-body phenomena and magnetism. I will discuss how trapping the molecules in crystals of light has allowed us to prevent chemical reactions and how joint experiment-theory work has allowed us to realize and characterize far-from-equilibrium interacting spin models. Finally I will discuss new directions towards the observation of quantum transport, spin-orbital physics and topological phases with polar molecular gases.

15 min. break

Invited Talk SYPS 1.3 Tue 18:15 K/HS1

Ground-state molecules near quantum degeneracy: the nuts and bolts — •Hanns-Christoph Nägerl — University of Innsbruck, Austria

Preparing atomic samples in the regime of quantum degeneracy has become routine in many laboratories worldwide. Entering the same regime for samples of ground-state molecules is a major challenge and has only recently become possible for dimer molecules composed of alkali atoms. I will give an overview over the experimental techniques that are used prepare samples of alkali dimer molecules (such as homonuclear Cs2, fermionic KRb, and bosonic RbCs) at ultralow temperatures in the nanokelvin regime in their rovibrational ground state with hyperfine state control. Pulling out all the stops of AMO physics it should be possible that one prepares ground-states samples of dipolar molecules with unity occupation in ground-state band of an optical lattice. Such samples will be a good start for the study of many-body quantum physics, e.g. extended Hubbard models, spin models and in general non-equilibrium physics beyond mere contact interaction.

Invited Talk SYPS 1.4 Tue 18:45 K/HS1

Prospects and future directions with quantum gases of ultracold polar molecules — •Silke Ospelkaus — Institut für Quantenoptik, Leibniz Universität Hannover

The long range dipolar interaction between polar molecules is expected to pave the way for a wealth of novel opportunities in physics and chemistry. They range from controlled quantum chemistry and intriguing novel dipolar quantum phases to quantum simulation and information. In this talk I will give an overview on possible future directions with quantum gases of polar molecules.