

Collisional cooling of ultracold molecules, and spin transport in optical lattices

Prof. Dr. Wolfgang Ketterle

MIT-Harvard Center for Ultracold Atoms, Cambridge, USA

I will talk about two frontiers of ultracold atom science. Collisional cooling is crucial to prepare quantum degenerate gases. It has been a long-standing goal to achieve such cooling of ultracold molecules. This has been realized by sympathetically cooling rovibrational ground-state triplet NaLi molecules with Na atoms and increase the phase space density by a factor of 20. Although triplet NaLi has an excitation energy of 0.9 eV (corresponding to 10,000 K), this is the first ultracold molecule for which a favorable ratio of elastic to inelastic collisions (greater than 50) has been realized.

Atoms in two different hyperfine states in optical lattices realize spin Hamiltonians. So far, only the isotropic Heisenberg model has been realized. Using lithium-7 atoms and Feshbach resonances to tune the interactions, we have created Heisenberg models with adjustable anisotropy, including the paradigmatic XY-model which can be exactly solved by mapping it to non-interacting fermions. Spin transport changes from ballistic to diffusive depending on the anisotropy.