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Molecular collision studies with Stark-decelerated beams

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Molecular scattering behavior has generally proven difficult to study at low collision energies. We formed a molecular beam of OH radicals with a narrow velocity distribution and a tunable absolute velocity by passing the beam through a Stark decelerator. The transition probabilities for inelastic scattering of the OH radiacls with Xe atoms were measured as a function of the collision energy in the range of 50 to 400 wavenumbers, with a high intrinsic energy resolution. The behavior of the cross-sections for inelastic scattering near the energetic thresholds was accurately measured, and excellent agreement was obtained with cross-sections derived from coupled- channels calculations on ab initio computed potential energy surfaces [Science 313 (2006) 1617-1620]. The possibilities to perform collision studies using either two Stark-decelerated beams in a crossed beam configuration or counter-propagating packets of molecules in a molecular synchrotron [Nature Physics, published online January 21, 2007; doi:10.1038/nphys513] will be discussed. Our experimental approach to the sympathetic cooling of polar molecules with ultra-cold Rb atoms will be presented as well. Time-permitting, measurements on the optical pumping of trapped polar molecules by black-body radiation [arXiv:physics/061221v] as well as our latest results on the electrodynamic (AC) trapping of, both, ground-state atoms and molecules [PRA 74 (2006) 063403] will be shown.