DECELARATING NEUTRAL DIPOLAR MOLECULES

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There currently is a great interest in producing cold molecules for the study of cold molecule-molecule collisions, molecular quantum collective effects, Doppler-free spectroscopy, frequency standards, as well as many other applications already realized for atoms. Slowing down of neutral molecules, a prerequisite for being able to eventually trap them, has proven to be considerably more difficult to be achieved, however. Laser-cooling schemes can not be applied to slow down molecules as no simple closed-level systems can be found; the unavoidable off-resonant fluorescence decay of molecules from the excited state to other vibrational levels in the electronic ground state hampers efficient momentum transfer.

There is an alternative method to slow down molecules, based on the interaction of a dipolar molecule with electric fields. Molecules possessing an electric dipole moment will gain energy upon entering an electric field when in an appropriate quantum state. This gain in Stark-energy ('potential' energy) is compensated by a loss in kinetic energy. If the electric field is switched off before the molecule has left the electric field the molecule will not regain the lost kinetic energy. By letting the molecules pass through multiple pulsed electric fields they can thus be slowed down and brought to a standstill.

In this contribution we report on the succesful implementation of a version of the Stark-decelerator to produce an intense pulsed beam of slow neutral metastable CO molecules. State-selected molecules are slowed down from 240 m/s to 155 m/s with a velocity distribution with a width of 4 m/s.