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Trapped molecular ensembles

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Our partners at FHI-MP have trapped a molecular ensemble. To experimentally demonstrate the trapping of molecules at FHI-MP we had to solve the problem of non-adiabatic transitions, which – at low electric field strength, i.e. around the center of a microtrap – lead to a substantial redistribution of CO* molecules into M=0 states. Molecules in these states experience almost no Stark effect and are therefore no longer trapped and lost from the deceleration process. When using the ¹³CO isotopomer, such losses are strongly reduced and efficient deceleration down to standstill can be achieved, because the hyperfine splitting lifts the degeneracy in zero electric field by about 50 MHz. Instead of using another isotopologue, trap losses due to non-adiabatic transitions can also be suppressed by lifting the degeneracy with a superimposed constant magnetic field, perpendicular to the electric field. For metastable ¹²CO, we have demonstrated that it is possible to almost completely suppress the non-adiabatic losses in this way [S. A. Meek, G. Santambrogio, B. G. Sartakov, H. Conrad, and G. Meijer, *Phys. Rev. A* **83**, 033413 (2011)]. This opens the possibility to decelerate and trap a whole variety of molecules on a chip, thus creating a *molecular laboratory on a chip* [S.A. Meek, G. Santambrogio, H. Conrad, G. Meijer *J. Phys.: Conf. Series* **194**, 012063 (2009)].

A particularly interesting feature of the chip decelerator is that it enables a whole array of tubular microtraps to be filled simultaneously. Using a specifically designed deceleration/acceleration sequence, we have demonstrated the filling of up to 200 microtraps directly from the pulsed molecular beam, the deceleration of the whole array of minima to standstill and spatial focusing of the re-accelerated CO molecules such that they all arrive at the same time on the detector [S.A. Meek, H. Conrad, G. Meijer, *Science* **324**, 1699 (2009)].

We have also observed associated molecules in a non-chip based apparatus at LENS but we cannot confirm that the molecules are trapped.