Deceleration and trapping He atoms on a chip

Allmendinger P.[1], Agner J.A., Schmutz H., Merkt F.

[1]*Physical Chemistry Laboratory, ETH Zurich, Switzerland*
allmendinger@xuv.phys.chem.ethz.ch

A supersonic beam of metastable He atoms in the (1s)(2s) $^1S_0$ state has been generated using a pulsed nozzle in combination with a pulsed electric charge. Depending on the temperature of the nozzle (T_{nozzle}), the initial velocity of the supersonic beam could be varied between 1800 m/s (T_{nozzle} = 300 K) and 1200 m/s (T_{nozzle} = 150 K).

A surface-electrode decelerator consisting of 44 parallel electrodes was then used to decelerate the atomic beam to zero velocity following photoexcitation to a Rydberg-Stark state with a large dipole moment (n = 30, k = 28, μ ~3400 Debye).

Full deceleration could be achieved in less than 100 µs and over a distance of about 30 mm. The operation principle of this decelerator is based on the concept of a moving-trap decelerator for polar molecules [1] and its recent adaption to decelerate H Rydberg atoms [2] and will be presented in detail. Our results demonstrate the possibility to generate a supersonic beam with velocities continuously tuneable in the range from less then 100 m/s to more then 2000 m/s.

The advantage of this new type of Rydberg-Stark decelerator over single-stage decelerators [3] is the possibility to decelerate heavier atoms and molecules.

References:
[1] S. A. Meek, et al., *Phys. Rev. Lett.*, **2008**, *100*, 153003.
[2] S. D. Hogan, P. Allmendinger, H. Sassmannshausen, H. Schmutz and F. Merkt, *Phys. Rev. Lett.*, **2012**, *108*, 063008.
[3] E. Vliegen, et al., *Phys. Rev. Lett,* **2004**, *92*, 033005.