A Molecular Fountain

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The resolution of any spectroscopic or interferometric experiment is ultimately limited by the total time a particle is interrogated. Here we present the first molecular fountain, a development which permits hitherto unattainably long interrogation times with molecules. In our experiments, ammonia molecules are decelerated and cooled using electric fields, launched upwards with a velocity between 1.4 and 1.9m/s and observed as they fall back under gravity. A combination of quadrupole lenses and bunching elements is used to shape the beam such that it has a large position spread and a small velocity spread (corresponding to a transverse temperature below 10μK and a longitudinal temperature below 1μK) when the molecules are in free fall, while being strongly focused at the detection region. The molecules are in free fall for up to 266ms, making it possible, in principle, to perform sub-Hz measurements in molecular systems and paving the way for stringent tests of fundamental physics theories [1].

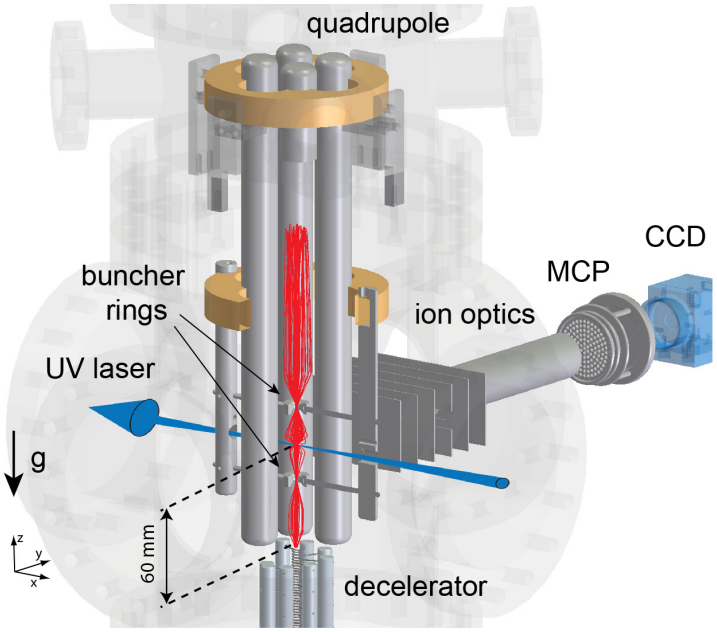

Fig. 1: Schematic view of the top part of the setup with simulated trajectories.

References

[1] C. Cheng, A.P.P. van der Poel, P. Jansen, M. Quintero-Pérez, T.E. Wall, W. Ubachs, and H.L. Bethlem, Phys. Rev. Lett. **117**, 253201 (2016).

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