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A molecular fountain HENDRICK L. BETHLEM, CUNFENG CHENG, AERNOUT P.P. VAN DER POEL, WIM UBACHS, LaserLaB, Department of Physics and Astronomy, Vrije Universiteit, Amsterdam, The Netherlands — 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 1.9 m/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 10 μK and a longitudinal temperature below 1 μK) when the molecules are in free fall, while being strongly focused at the detection region. The molecules are in free fall for up to 266 ms, making it possible, in principle, to perform sub-Hz measurements in molecular systems and paving the way for stringent tests of fundamental physics theories.

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