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back to namelist

Stefan Kuhn[1], Peter Asenbaum[1], Ugur Sezer[1], Alon Kosloff[2], Michele Sclafani[1], Georg Wachter[3], Michael Trupke[3], Benjamin A. Stickler[4], Stefan Nimmrichter[4], Klaus Hornberger[4], Ori Cheshnovsky[2], Fernando Patolsky[2], Markus Arndt[1]
[1]*University of Vienna, AT,*
[2]*Tel-Aviv University, IL,*
[3]*Vienna University of Technology, AT*
[4]*University of Duisburg-Essen, DE*

Cavity cooling of dielectric nanoparticles: Towards matter-wave experiments

Resonant laser cooling techniques have given a boost to the field of atomic physics throughout the last 30 years. Complex molecules and nanoparticles, however, cannot yet be controlled by these methods due to their complex internal level structure and the lack of addressable cyclic transitions. In reply to this need, cavity cooling has been proposed more than 15 years ago [1,2] and was recently realised experimentally with nanoparticles [3,4,5].
We will discuss our experimental results on transverse cavity cooling of free silicon nanoparticles in high vacuum [4]. In a next step we will aim at controlling even smaller particles inside silicon micro-cavity chips with the ultimate goal to facilitate matter wave interferometry experiments in a mass range of 106 – 107 amu [6]. Furthermore we will present first experimental studies on cavity-assisted detection and manipulation of the rotational motion of tailored silicon nanorods in high vacuum [7]. By monitoring the scattered light while the rods transit through the cavity field, we can track their dynamics in real time and observe optical forces and torques. These results will be beneficial for improving current cooling schemes and they represent a first step towards the realisation of rotational cooling.
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