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Laser cooling to quantum degeneracy1

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We have created Bose-Einstein condensates (BECs) of strontium using laser cooling as the only cooling method [1]. Our scheme is based on the combination of three techniques, favored by the properties of this element. Using a narrow intercombination transition, we prepare a laser cooled sample of 107 84Sr atoms in a large reservoir dipole trap at a phase-space density of 0.1. Further increase of the phase-space density has formerly been hindered by detrimental effects of the laser cooling photons, such as an effective repulsion between atoms by multiple scattering. To avoid these effects, we render atoms transparent for these photons in a small spatial region within the laser cooled cloud. Transparency is induced by a light shift on the optically excited state of the laser cooling transition. In the region of transparency, we are able to increase the density of the gas by accumulating atoms in a small dimple dipole trap. Atoms in the dimple thermalize with the reservoir of laser-cooled atoms by elastic collisions and form a BEC. Condensates of up to 105 atoms can be repeatedly formed on a timescale of 100 ms. Our method opens new prospects for the generation of a continuous atom laser. [1] Stellmer et al., arXiv:1301.4776 (2013). 1This work was supported by the Austrian Science Fund (FWF Project No. Y507-N20) and the European Commission (FET-Open Grant No. 250072). 2In collaboration with Simon Stellmer, Benjamin Pasquiou, and Rudolf Grimm (IQOQI, OEAW and Institute for Experimental Physics Center for Quantum Physics, University of Innsbruck).