Laser cooling of atoms using a frequency comb

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Despite the prominent role of laser cooling in modern atomic physics, with applications ranging from quantum sensors to high-precision spectroscopy and ultracold chemistry, laser cooling techniques are still limited to atoms with simple energy level structure and closed transitions that are accessible by currently available continuous wave (cw) laser sources. Using mode-locked femtosecond or picosecond lasers with high pulse repetition rates which produce optical frequency combs (FCs) was recently proposed to extend the range of applicability of laser cooling [1, 2]. Due to their pulsed light emission, FCs provide high peak powers needed for efficient frequency conversion via nonlinear crystals or high harmonic generation. Simultaneously, FCs preserve long coherence times needed for efficient laser cooling since their spectrum consists of a series of narrow, phase coherent frequency comb lines. The first experiments that demonstrate FC cooling of atoms and ions have recently appeared in the literature [3-6]. We will present results of Doppler cooling of neutral rubidium atoms on a single-photon transition using a frequency comb – a cooling scheme that is analogous to cw laser cooling as only a single comb line is involved in the cooling process [6].

The talk will also present recent activities at the Institute of Physics in Zagreb aimed towards establishing a national research centre specialized in advanced laser and optical techniques. The CALT – Centre for Advanced Laser Techniques, is a strategic research infrastructure project of the Republic of Croatia funded by the European Regional Development Fund (ERDF). CALT's activities; which comprise research, education, and providing access to laser facilities; will address socially important issues through planned research activities in the four domains: Quantum technology, Plasma technology, Nano and Bio systems, and Ultrafast dynamics. [7].

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