A system for laser cooling and trapping of neutral Cesium atoms for the first experiment of Synchrotron ion-recoil momentum spectroscopy

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Laser cooling and trapping of neutral atoms have made very important contributions to science in the past years that were directly recognized by the award of the Physics Nobel Prize in 1997 and, indirectly, in 2001, for observation and studies of Bose-Einstein condensation. Last year, at the LNLS, we set up a system for laser cooling and magneto-optical trapping of neutral ^{133}Cs atoms using the $6^2S_{1/2}$ $6^2P_{3/2}$ infra-red transitions near 852 nm. To generate the coherent radiation to trap and repump the atoms we employed two distributed Bragg reflector diode lasers. To diminish the frequency jitter linked to the environment conditions, the lasers were not mounted on the vacuum chamber table but on a separated homemade vibration isolated pneumatic table. Both the trap and the repump laser frequencies were adjusted to optimise the ion count. Owing to the vibration isolation of the lasers mounts and the stability of the side of fringe locking homemade electronics, we have observed a continuous operation of the trap over one week. By the competition between heating and cooling processes in the magneto-optical trap, the equilibrium temperature of the spatially confined atomic sample is estimated to be 124 μK , which corresponds to an average kinetic energy of only 10.7 neV. The production of these ultra-cold targets became possible the measuring of the small momentum transferred to the cold cesium ions in the UV photon ionization process. Before this experiment, no attempt had being made to use laser-cooled targets for spectroscopic studies with Synchrotron radiation as the ionization beam.

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