Laser Sources for a New Optical Clock Using Cold Metastable Magnesium Atoms

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A new optical frequency standard is under construction in a collaboration between DFM (Danish Institute of Fundamental Metrology) and NBI (Niels Bohr Institute). This standard will utilize the 32 Hz narrow resonance at 656 THz (457 nm) in an ensemble of cold Mg-atoms. We present two laser sources used in this setup. One laser will be used as the oscillator for the frequency standard and the other laser is needed for a new cooling scheme for metastable Magnesium atoms.

Two requirements exist for the 656 THz oscillator. First, the laser must be prestabilized to a narrow linewidth so that the narrow atomic resonance can be resolved. Secondly, the laser must provide enough power to efficiently excite the atoms on the clock transition. Our setup consists of four main parts - master laser, optical amplifier, frequency stabilization of the master laser and setup for frequency doubling. The preliminary output power of the amplifier is more than 300 mW. The laser will be frequency stabilized by using a high finesse optical cavity as the discriminator with an observed linewidth of 29 kHz.

An alternative trapping and cooling scheme is currently investigated. The aim is to reduce the temperature further and at the same time use small compact diode laser sources instead of the currently used large and expensive laser systems. These laser sources will be used in an attempt to trap and cool Mg atoms in a long-lived sublevel within the 3P manifold. We are building up three laser setups - one for trapping which initially will use a Ti:Sapphire laser and two diode lasers for repumping.

We have constructed one laser source based on a 766 nm diode laser and frequency doubling cavity. This setup runs with a 600 mW Amplified Diode Laser System (TA 100 from TOPTICA). For optimum doubling efficiency the laser radiation is enhanced by a resonant external ring cavity. Radiation of 383 nm is obtained by a 5-mm-long nonlinear LBO Brewster cut crystal. More than 40 mW of UV light is generated and available for the cooling of atoms.

[1] J. Hald, V. Ruseva, J. Henningsen, J. W. Thomsen, D. N. Madsen, F. Y. Loo, A. Brusch, and N. O. Andersen, *Construction of a Magnesium based Optical Clock* (Proceedings of the 10th International Metrology Congress (2001)).