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Argos™

Application Note: Laser Cooling of Atoms

Professor Tom Killian's research group at Rice University (Houston, Texas) is using an Aculight® Argos™ continuous wave (CW) optical parametric oscillator (OPO) in experiments with laser-cooled atomic gases to study interactions between atoms at very low temperatures. The team is working to produce exotic states of matter in which quantum mechanics dominates.

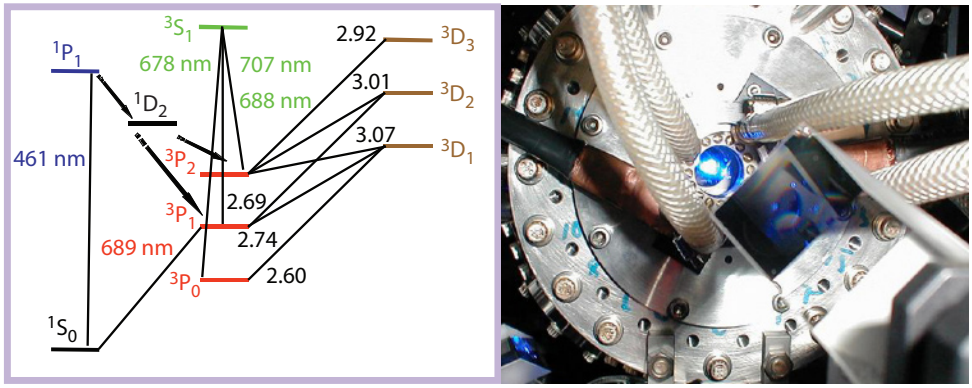

Figure 1: Strontium energy level diagram (left) and magneto-optical trap (right).

In Prof. Killian's experiments, strontium atoms are cooled to around 1 mK. The experiments use six near-resonant laser beams that are simultaneously fired into a chamber where a beam of strontium atoms is loaded into a magneto-optical trap (figure 1). The 3-µm CW OPO "re-pumps" the strontium atoms that have decayed to an energy level where they are lost to the magneto-optical trap. Re-pumping is achieved by tuning the CW OPO's pump laser (using temperature and piezo tuning of the fiber oscillator) to tune the mid-infrared idler wavelength to the correct value. Resonance with the transition is maintained indefinitely by low bandwidth feedback from a wavemeter, which measures the OPO wavelength and sends the error signal back to the piezoelectric transducer (PZT) on the seed laser of the Argos pump laser.

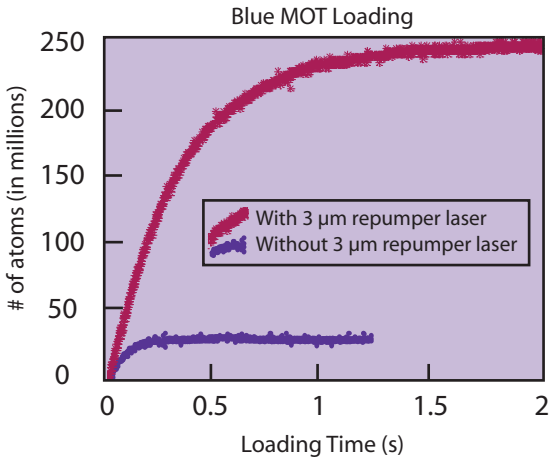

Figure 2: Number of trapped strontium atoms with and without re-pumping.

In this way, the number of trapped strontium atoms has been increased by almost a factor of 10 relative to measurements without the OPO. The increased number of trapped atoms allows the group to perform enhanced studies of atom–atom interactions.

References "Two photon photoassociative spectroscopy of ultracold 88Sr", Y.N. Martinez et al., "Inelastic and elastic collision rates for triplet states of ultracold strontium", A Traverso et al. submitted to Phys. Rev. Lett., Phys. Rev. A, 2008

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