A.3.9. Coherent Elliptical State Rydberg Atoms: Efficient Production Through the Use of Single Mode Diode Lasers--*B.D. DePaola, E. Horsdal-Pedersen**

The study of electron capture from CES has been extremely productive. What is lacking to make the picture complete is the study of charge capture from CES by highly charged ions. Currently, only two other laboratories in the world, the University of Aarhus and the University of Kentucky, have performed collisions experiments on CES; neither of these institutions has the means of extending their studies to include low energy highly charged ions. One of the reasons for this is that the Macdonald Lab is nearly unique among ion-atom collisions facilities in its capabilities for the production of high and low energy highly charged ions, as well as laser excited targets. The other reason is that in all other facilities which produce CES, the target duty cycle is too small to be efficiently used for all but the highest current projectile beams. We have therefore been working toward the production of a CES having a duty cycle of order 1 (compared to something of order 10^{-4}, which is what is the usual case). To achieve this we have replaced the three YAG-pumped dye lasers by three, single-mode tunable diode lasers in order to pump lithium atoms successively from 2s to 2p, 2p to 3d, 3d to *nl*, with n approximately 30. These transitions correspond to wavelengths of 670 nm, 610 nm, and 830 nm, respectively. The first transition is rather simply arrived at with lasers made from easily obtained commercial laser diodes. The second is rather difficult, requiring the cooling of a commercial laser diode to nearly liquid nitrogen temperatures, at which all of the optical and electrical properties of the diode become greatly changed. The third transition can be easily reached with commercially available diodes, but due to the much lower oscillator strength, more powerful lasers are required. Unfortunately, high power (> 200 mW) single-mode diodes are not available at this wavelength, requiring technology innovation on our part. This was achieved through the use of an anti-reflection-coated high power (nearly 1 Watt), multi-mode (transverse and longitudinal) diode, injection seeded by a low power single mode, tunable diode laser. The result was nearly 1 Watt of output in a tunable single-mode (longitudinal and transverse). Using our all-diode-pumping scheme, Rydberg atoms were produced in a quantity thought to be adequate for carrying out collisions experiments. What remains is to make the target more robust, and to switch the Rydberg atoms to CES. This project is part of the Ph.D. thesis work of T. Ehrenreich.

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