A.3.4. COLTRIMS with a Laser-Cooled Target--*B.D. DePaola, C.L. Cocke, and C.W. Fehrenbach*

Much of the usefulness of recoil-momentum spectroscopy comes from the fact that the target is cold. If it were not, the experiments would not work. For example, a room temperature helium atom has 4 a.u. of momentum and, since a typical momentum transfer in an ion-atom collision can be 1-2 a.u., the target temperature would render impossible a meaningful measurement of the recoil ion momentum without special provisions. In the present COLTRIMS systems this difficulty is overcome by the use of a supersonically cooled gas jet which provides a helium gas target having an internal temperature below 0.2 K, or a momentum spread below 0.1 a.u. Nevertheless, the COLTRIMS technique, though incredibly useful, still suffers on two accounts: (1) the target species is restricted to those gases or vapors which can be sufficiently cooled through supersonic expansion. For example, lithium would be a problematic target due to both nozzle clogging and dimer production. (2) Even with 0.2 K helium, COLTRIMS resolution is still limited by target temperature. One possible solution to these limitations is the use of a laser cooled and trapped target, instead of a supersonic jet. To this end we have constructed a magneto-optical trap (MOT) to cool and contain rubidium atoms. The MOT is in working order and a recoil spectrometer has been designed. The density of the trapped atoms has been measured to be 4 x $10^{10}/cm^3$ in a 1 mm spot, sufficient for the charge transfer measurements we have in mind.

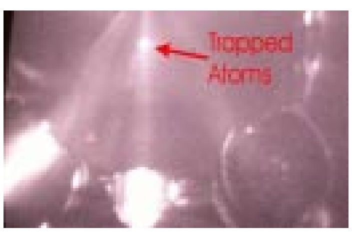

Figure 1.

A photo of the cloud of trapped atoms is shown in Fig. 1. In recoil momentum spectroscopy, instrumental resolution is generally better along the time-of-flight axis. Because we wish to measure the Q-valve with the best possible resolution (in order to determine final states of the projectile) and because the Q-valve is simply related to the component of recoil momentum along the projectile axis, our spectrometer is of the “longitudinal momentum” [1] type. This work is the Ph.D. project of Hai Nguyen.

Reference

1. R. Moshammer *et al*., NIM B 108, 425-445 (1996).