

H. Nguyen*, R. Brédy*, H. Camp*, K. M. Wilson*, T. Awata†, and B. D. DePaola*

*J. R. Macdonald Lab, Department of Physics, Kansas State University, Manhattan, KS 66506 U.S.A.

†Department of Physics, Naruto University of Education, Takashima Naruto-cho, Naruto, Tokushima 772-8502, Japan

Cold Target Recoil Ion Momentum Spectroscopy (COLTRIMS) has become a powerful tool to study collisions. However, traditional methods for cooling the target, namely supersonic expansion is not suitable for targets with optically active electrons since these species generally form clusters or dimers upon expansion. Thus, the study of laser excited targets is problematic. Furthermore, even after supersonic expansion, initial target temperature still limits recoil ion momentum resolution. With recent advances in recoil ion momentum spectroscopy, measurements with laser excited targets are now possible through MOTRIMS (Magneto Optical Trap Recoil Ion Momentum Spectroscopy). Atoms trapped in a MOT exhibit extremely low temperatures ($\sim 200\mu$ K) previously not obtainable from COLTRIMS apparatus, improving recoil ion momentum resolution. Furthermore, certain numbers of atoms in the MOT are in the first excited state and available for collisions studies [1].

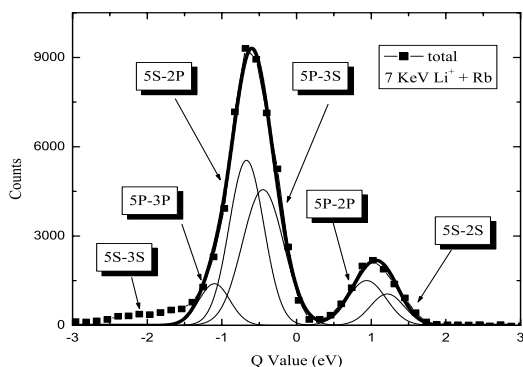


Fig. 1. Total Q-value spectrum for 7 keV Li^+ + $\text{Rb}(5s, 5p)$

In the present work, 7 keV Li^+ collides with trapped $\text{Rb}(5s, 5p)$. However, there are several energetically degenerate channels in charge cap-

ture process as shown in figure 1. The degeneracies at its worst for resonant collision *i.e.* Rb^+ on Rb where, for example, transfer from $5s$ to $5s$ is exactly degenerate with transfer from $5p$ to $5p$. We will show how the extreme Q-value resolution of MOTRIMS along with excited state fraction control *via* turning on and off the trapping lasers, the overlapping channels can be resolved.

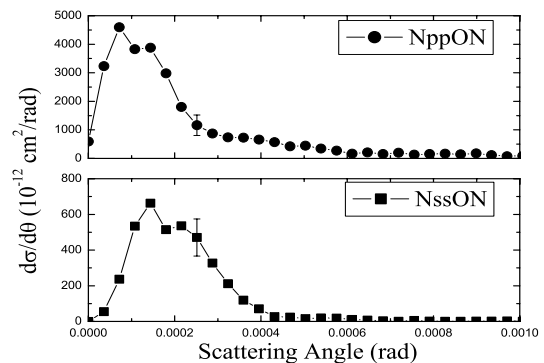


Fig. 2. Differential cross sections for energetically degenerate channels

In summary, MOTRIMS allows *in situ* measurements of target excited state fraction and kinematically complete relative cross sections even for many systems having energetically degenerate channels. Results for 7 keV Li^+ + $\text{Rb}(5s, 5p)$ will be presented.

Acknowledgement: Supported by the Chemical Sciences, Geosciences and Biosciences Division, Office of Basic Energy Sciences, Office of Science, U. S. Department of Energy.

References

- [1] X. Flechard, H. Nguyen, E. Wells, I. Ben-Itzhak, and B. D. DePaola, Phys. Rev. Lett. **87**, 123203 (2001).