Coincident Rutherford Backscattering Spectrometry

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1 Introduction: The Novel CRBS Technique

Coincident Rutherford Backscattering Spectrometry (CRBS) is a novel combination of traditional Rutherford backscattering spectrometry (RBS), time-of-flight (TOF) coincidence, and position-imaging techniques. This combination aims at investigation of charge-state distributions of both backscattered and recoil ions in violent ion-atom collisions. CRBS provides much more detailed information than conventional RBS [1].

2 Why to Conduct this Work?

Several facts motivated us to elaborate CRBS experiment:

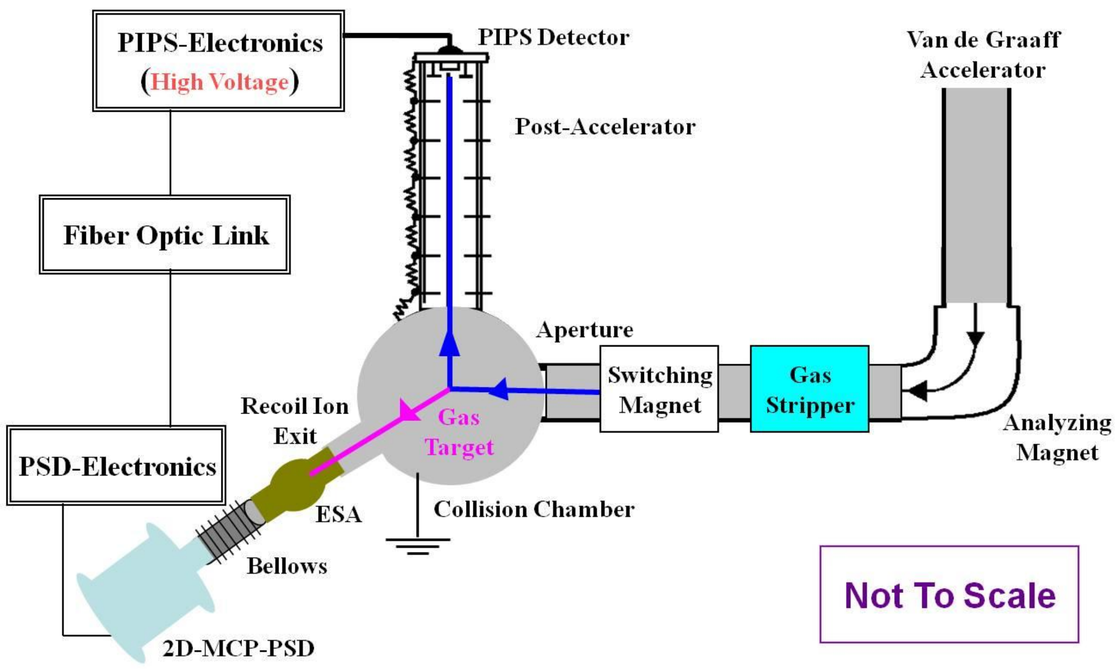
1- The study of charge-state evolution of ions in matter plays a prominent role in many applications.

2- The understanding of the many-body collision processes of charge changing reactions in ion-atom collisions is still lagging behind, due to the high degree of complexity of many-body reactions.

3- The study of charge-state distributions of ions backscattered from gaseous targets is not frequent.

3 CRBS Approach and Experimental Setup

1- A special experimental setup was designed, fabricated, and installed at the end station of the RBS-beamline in the University of Jordan Van de Graaff Accelerator (JUVAC) [1]. This is a schematic diagram of the CRBS setup.



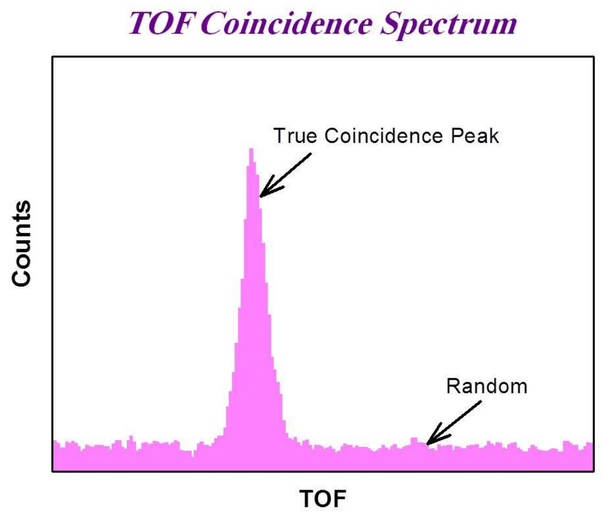
2- The heart of the CRBS experiment is the coincident detection of the backscattered projectile and the recoil target from individual events.

3- The projectile ions backscattered at 90° in the upward direction perpendicular to the plane formed by the ion beam and the gas jet were charge-analyzed by a multi-stage post-accelerator column [2], and detected by a passivated implanted planar silicon (PIPS) detector.

4- The recoil ions scattered through a certain angle in the downward direction in the scattering plane were also charge-analyzed by a parallel plate electrostatic analyzer (ESA), and finally detected by a two dimensional micro-channel-plate position sensitive detector (2D-MCP-PSD).

5- The signal from each detector was then electronically processed and the data were collected and saved in list mode for off-line processing and data analysis using the power of the Kmax data acquisition software.

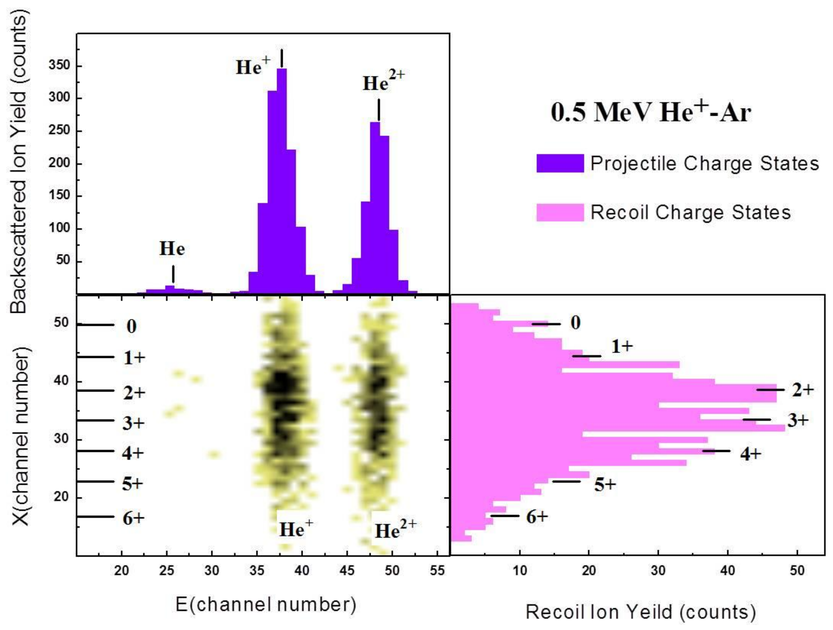
6- The first step in data analysis was to construct the coincidence spectrum of the measured TOF for all detected ion pairs.



7- Events which correspond to real coincidences (true coincidence peak) were selected and a "playback" experiment can always be performed in the off-line analysis mode to examine the correlation between the charge-states of recoil ions and backscattered projectiles.

4 CRBS Results: He^+-Ar Collision

This is a two-dimensional scatter plot representing coincidences between the backscattered projectiles and recoil ions for the 0.5 MeV He^+-Ar collision system.



5 Conclusions

1- An overall recoil ion and projectile ion correlation was recorded, where the backscattered projectile ions of the same charge-state were shown to result from different reaction channels.

2- The CRBS proved more powerful than conventional RBS.

6 References

1- H. Sa'adeh, R. Ali, D.-E Arafah, Nucl. Instrum. Methods Phys. Res. Sect. B 269 (2011) 2111-2116.

2- D.-E. Arafah, J.D. Mayer, H. Sharabati, A. Mahoud, Phys. Rev. A 39 (8) (1989) 3836-3841.