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An electrostatic charge state selector for ion-atom collisions: Design, spectral line-shapes and performance

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Abstract. An electrostatic charge state selector has been constructed for charge transfer studies in ion atom collisions. Its design and performance have been discussed illustrating with examples of some data taken using heavy ion beams from the pelletron accelerator. Expressions for the determination of charge state fractions from the observed charge spectrum in voltage scanning mode of operation and also the line shapes have been discussed analytically in detail.

Keywords. Ion-atom collision; charge state fractions; electrostatic charge state selector; spectral line-shapes.

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1. Introduction

In ion-atom collisions several single or multi-electron transfer processes occur between the projectile and the target atoms resulting invariably in a change of the charge carried by the incident ion. It is often required to associate the observable event in the collision process to the corresponding charge state of the ion after the collision has taken place. Thus analysis of the charge state of the ion after the collision becomes necessary. The final charge state information on the ion also provides vital information in some special cases. In the case of energetic heavy ions channeled through a thin crystal, for example, the 'frozen' fraction of the incident charge state is an important parameter in deriving capture cross sections (see e.g. ref. [1]). In recent years our group has undertaken a series of investigations concerning various aspects of ion-atom collisions in a solid target. A charge state selector was required to resolve the charge states of the ion after the collision process. We describe here the construction of a simple electrostatic charge state selector and illustrate its performance with examples of some of the data taken using BARC–TIFR pelletron accelerator. Analytical derivations of the possible line-shapes of the charge spectrum and procedure for the determination of the fractions of particles of different charge states from the observed spectrum are also presented.