High-resolution x-ray spectroscopy to probe quantum dynamics in collisions of $Ar^{17+,18+}$ ions with atoms and solids

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High-resolution x-ray spectroscopy has proved to be a very powerful tool to investigate quantum dynamics in highly charged ions (HCI) collisions with matter of whatever nature, dilute or condensed. In particular, the population of projectile HCIs' excited states (in their quantum component $n\ell_j m_j$) can be accurately determined and also tracked, for instance, during their transport in dense medium. Those studies gave rise to many results over the past two-decades enabling the identification of the different processes involved and highlighting specific effects that occur in dense targets compared to dilute media. Of course, the situation very much depends upon the collision system and the projectile velocity that define the collision regime. Here, we specifically put into perspective the results obtained in the so-called low and high energy collision regimes, investigating either ion-atom or ion-solid collisions [1]. Comparative studies of Ar^{q+} np excited state populations are presented when Ar^{17+} or Ar^{18+}collide either with gaseous targets of N_2, Ar, and CH_4 or with carbon solid foils at different projectile energies, 13.6 MeV/u [2] or 7 keV/u [3]. As an example, Figure 1 exhibits high-resolution x-ray spectra obtained with gaseous targets in the high (left) and low (right) collision regimes that reveal very different interaction dynamics in the population of excited states by the single electron capture process. It clearly illustrates the well-known $1/n^3$ law at high velocity, and the preferential population in high n levels ($n \approx 8-9$ here) at low velocity. In solid, same high resolution spectra have been recorded. At high velocity, beside evidence for collective response of the target electrons produced by the wake field induced by HCI passing through solid-bulk, damping due to (intra- and inter-shell) excitation and ionization processes can be quantified. In the low velocity regime, spectra are characteristic of the multistep collisions that lead to production of more dressed ions.

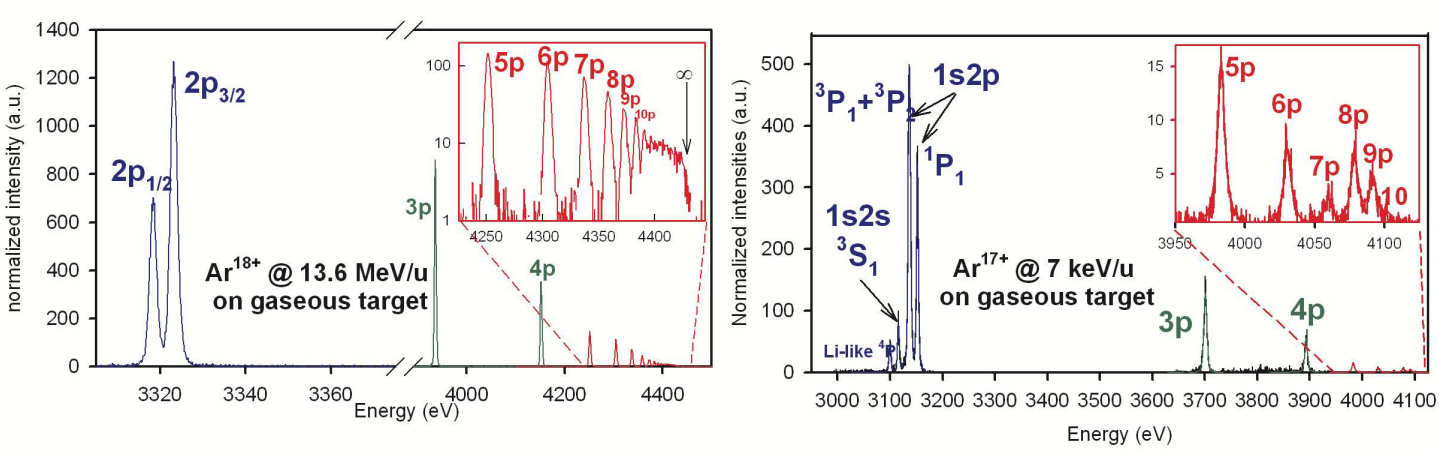

Figure 1: *High-resolution x-ray spectra obtained at high collision velocity (left) and at low velocity (right) with highly charged argon ions on N_2. or Ar gaseous targets*

References

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