Journal of Physics: Conference Series **635** (2015) 022003 doi:10.1088/1742-6596/635/2/022003

Angular differential cross sections for double and single capture in fast ion-atom collisions

A Mondal and M Purkait

Department of Physics, Ramakrishna Mission Residential College,

Narendrapur, Kolkata-700103, India

Keywords Collision, cross sections

Synopsis We investigate angular differential cross sections for double-electron and single-electron capture in ion-atom collisions for the intermediate and high energy region. We see the diffraction pattern in the spectrum of differential cross sections in the high energy range, i.e. another peak at 0.75 mrad in addition to Thomas peak at 0.47 mrad have been observed.

Electron capture by multi-charged ions from atom is of interest in many fields such as astrophysics, plasma production, planetary and upper-atmospheric reactions and irradiation of living matter. All mentioned areas need a full understanding of the mechanisms involves in ion-atom and molecular collisions. In classical picture, the H^+ projectile (P) scatters on one target electron (e) such that this electron (e) scatters on the target nucleus (N) and finally becomes bound to the projectile. Then, energy and momentum conservation requires that the electron (e), when initially at rest in the target frame, is scattered at 60º with respect to the projectile trajectory and this binary collision (p-e) thus gives the characteristic proton (p-e-N) Thomas projectile scattering angle of 0.47 mrad. Only two peaks at $\theta_P = 0$ mrad and $\theta_p = 0.47$ mard (θ_C) have been identified both experimentally and theoretically. Recently, third peak at θ_p =0.75 mrad for the 7.5 MeV $H^+ - He$ collision have been reported experimentally [1-2]. So our analysis for the multiple scattering events reveals a peak at $\theta_P \geq \theta_C$ only if two or more electrons are involved in the processes. However, such multiple scattering is explained by taking the higher order term in the transition amplitude, which may written as

$T_{if} = <\psi_f^- | V_i | \phi_i> + <\psi_f^- | U_f | \psi_i^+>$, where ϕ_i is the asymptotic initial state wavefunction, V_i is the interaction potential between the projectile and the helium atom, ψ_f^- is the approximate final state wavefunction, U_f is the final state perturbation and ψ_i^+ is the exact initial sate wavefunction. The initial asymptotic state is given by

$$\phi_i = e^{i\vec{k}_i.\vec{R}_i}\, \varphi_{He}(\vec{x}_1, \vec{x}_2).$$

The final state wavefunction is approximated by $\psi_f^- = e^{i\vec{k}_f.\vec{R}_f}\, \phi_i(\vec{x}_2)\, C_{T-e_1}(\vec{x}_1)\, C_{P-e_2}(\vec{s}_2)\, C_{P-T}(\vec{R}_f)$, where C_{P-e_2} represents the interaction between the projectile and the passive electron in the target ion, C_{T-e_1} represent the interaction between the target nucleus and the captured electron, and C_{P-T} is the scattered Coulomb wave between the projectile and the residual target. The exact initial state wavefunction is approximated as

$$\varphi_i^+ = e^{i\vec{k}_i.\vec{R}_i}\, \phi_{He}(\vec{x}_1, \vec{x}_2)\, C_{P-e_1}(\vec{s}_1).$$

We will represent theoretical results for SC and DC cross sections for ion-atom collisions in the intermediate to high energy range, and compared them with the available experimental data.

References

[1] M. Gudmundsson *et al* 2010 *J. Phys. B: At. Mol. Opt. Phys.* **43** 185209

[2] M. Gudmundsson *et al* 2010 *J. Phys. B: At. Mol. Opt. Phys.* **44** 175201

E-mail: mpurkait_2007@rediffmail.com

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd