Model potential approach for Positronium - Alkali atoms ionization

D. Ghosh[1] and C. Sinha[2]

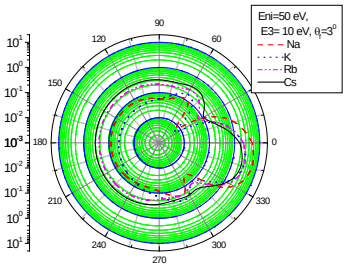
[1]Michael Madhusudan memorial College, Durgapur, Burdwan, India
[2]Theoretical Physics Dept, Indian Association for the cultivation of science, Kolkata- 700032

Synopsis: Model potential approach have been made to calculate the single ionization (SI) cross sections of Alkali atoms by Positronium (Ps) impact and comparisons are made between SI cross sections of Li, Na, K, Rb and Cs for symmetric and asymmetric velocity sharing. Calculations are performed in the framework of Coulomb distorted Eikonal approximation (CDEA). Interesting qualitative features are noted in the study.

The methodology of solving a problem in atomic scattering is often aided by using different target with same projectile and making a comparative analysis of the scattering cross sections. In collision Physics, alkali atoms as targets are addressed both theoretically and experimentally due to their major interests for application. Further, from the theoretical point of view, the quasi-one electron models of the loosely bound outermost electron and a stationary effective potential due to frozen inner shell electrons are the appealing features of the alkali atoms involved in collision processes. As a projectile, on the other hand, use of positronium becomes interesting as mono-energetic beams of positronium atoms [1] has enabled the first energy controlled experiments of the Ps impact ionization [2]. New experimental techniques and theoretical methods are enabling increasingly stringent tests of the understanding of basic atomic and molecular collision phenomena as well as of fundamental antiparticle-matter interactions. This paper addresses a theoretical study of Ps impact ionization of Lithium, Sodium, Potassium, Rubidium and Caesium atoms. Such collision processes find interests as the alkali targets possess simple structures, low ionization potentials and large polarizabilities, while the projectile is the simplest particle- antiparticle (electron-positron) system.

The present calculations are done using the Coulomb Distorted Wave Eikonal Approximation [3] within the scope of the pseudo-potential formalism [4]. The complexity of working with many electron atom is circumvented by visualising it as essentially an one electron atomic species. In the positronium - matter interaction the nature of Ps atom also calls for a quantum mechanical many body calculation of the interacting electron - positron system in the Coulomb field of the nuclei as an external static potential. Thus the theoretical prescription is rather complicated and as such one has to resort to some simplifying assumptions for the theoretical models of such a many-body reaction process.

The present target ionization (by Ps impact) is different from the pure single ionization of the target atom/ ion by positron /electron impact [5,6] and as such the present triple differential cross sections (TDCS) additionally carries the information about the influence of the Ps on the target electron distributions. Depending on the kinematics of the particular collision process, many interesting features are noted in the present work. Study of the equal energy sharing and the velocity matching between the ejected electron and the positronium shows that both the kinematics depend on the incident energy and the collision geometry.



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E-mail: dipalighoshwb@gmail.com