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Inner-shell ionization cross section of gold by electron and positron impact

Yogesh Kumar[a]* and Monoj Kumar[b]

[a] *Department of Physics, D.A.V College, Muzaffernagar 251001, India*
[b] *Department of Physics, Meerut College, Meerut 250001, India*

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Abstract. The theoretical modified Khare (BEB) model has been used to calculate the total cross sections for L_1, L_2 and L_3-subshells ionization of gold atom due to electron and positron impact for projectile energy varying from the threshold of ionization to 60 times the threshold energy For L subshells the present cross section due to electron and positron impact cross sections are in remarkable agreement with available experimental data and other theoretical cross sections. Total L shell ionization cross sections have been also calculated in the energy varying from the threshold of ionization to several MeV by electron impact. It is found good agreement with available experimental data. The investigation for other atoms is in progress.

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Key words: atomic ionization, electron impact, positron impact

1 Introduction

Electron and positron impact ionization cross sections for inner shells are needed in many areas of research such as fusion physics, plasma physics, space physics environmental protection, material analysis by various techniques etc. [1, 2]. The ionization cross sections find important application in field such as atmosphere physics, radiation science, astrophysics, etc. Furthermore, the positron being an antielectron, a comparison of the electron impact ionization cross sections with those by positron impact helps to understand the basic deference between the matter-matter and matter-antimatter interactions. Over past six decades many experimental and theoretical studies have been carried out to estimate the electron and positron impact inner-shell ionization cross sections by various groups. Experimentally L shell ionization cross sections have been measured by

*Corresponding author. *Email address:* `siwachmanoj7675@gmail.com` (Y. Kumar)

Palinka *et al.* [3], Middleman *et al.* [4], Ishii *et al.* [5], Shima *et al.* [6], Hoffmann *et al.* [7], Schneider *et al.* [8], Lennard *et al.* [9], Reusch *et al.* [10] etc. at different times by electron impact. Many theoretical researchers like Scofield [11], Khare *et al.* [12-14], Kim *et al.* [15], Haque *et al.* [16], etc. have calculated inner ionization cross sections due to electron impact. Scofield [11] proposed a model to calculate the ionization cross sections over wide incident energies taking into account the relativistic effect in relativistic plane wave born approximation (PWBA) through Dirac equation. His cross sections exhibit nice agreement with experimental data at ultrarelativistic energies. However, these methods fail at impact energies near threshold of ionization. Khare *et al.* [12-14] have calculated the electron impact ionization cross sections for Inner-shell for a numbers of atoms. They have employed the Plane Wave Born Approximation (PWBA) with corrections for exchange, coulomb and relativistic effects. Along with the longitudinal interaction, the contribution of transverse interaction to the ionization cross section is also included. Recently many researchers like Haque *et al.* [16] etc. have calculated the inner shell ionization cross sections by modifying the different model from threshold to ultra relativistic range.

A positron, due to its positive charge, is accelerated while passing through the atomic field, where an electron is accelerated. Furthermore, because of the distinguishability of a positron from an electron, exchange scattering does occur in positron-atom scattering. These differences have led to a number of investigations in which the ratio of the inner shell ionization cross sections of atoms, by electron and positron impacts at the same impact energy, are measured [8,9]. For positron impact, only limited researchers [8,9] have carried out the inner ionization cross sections of atoms. Schneider *et al.* [8] have the measured the absolute L_3-subshell ionization cross sections of gold by positron and electron impacts and found that at low impact energies the positron impact cross sections are much lower than those due to electron impact. Lennard *et al.* [9] have also obtained the ratio of L3-subshell ionization cross sections $\sigma(e-)/\sigma(e+)$ and found less than one in the energy range. Theoretically Khare *et al.* [12-14] have calculated the total ionization cross sections due to positron impacts for L shell for a numbers of atoms. They found the ratio of the electron-impact ionization cross section $\sigma(e-)$ to the positron- impact ionization cross section $\sigma(e+)$ is quite close to unity at high impact energies.

In 1999 Khare *et al.* [17] purposed model to calculate the ionization cross sections for molecules by combining the useful features of two models Kim *et al.* [18] and Saksena *et al.* [19] . In Khare (BEB) method, calculated cross sections [20-22] were in between in better agreement with the experiment data over a wide energy varying from threshold to several MeV. This model have been modified by Y. Kumar *et al.* [23] to obtained the K shell cross sections for many atoms (6⇐Z⇐92) in the energy varying from the threshold of ionization to 1 GeV by electron impact. They have replaced factor 1/(E_r+I+U) by 1/(E_r +f), where E_r = relativistic energy of the incident particle, I=target particle's binding energy, U=target particle's kinetic energy and $f=\eta I_r/(1+\xi Z)$ is a factor which depends on atomic number (Z), here η and ξ are the experimentally fitted parameter and I_r=target particle's binding energy with relativistic correction. The calculated cross sections were in good agreement with available experimental data. In present investigation we have