Fitting Equation of K-Shell Cross Section of Mg and Fe Atoms

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الخلاصة:

تم في هذه الدراسة اقتراح صيغة رياضية مقبولة للمقاطع العرضية الأيونية للقشرة K للعنصرين المغنيسيوم (z=12) والحديد (z=26) بطريقة تصادم الالكترونات. اعتمدت هذه الدراسة أساساً على الصيغة الرياضية التي أعدها الباحث. و قد وجد من خلال هذه الدراسة ان الصيغة الرياضية المقدمة للقشرة K تطبق بشكل جيد مع شكل و سلوكية المقاطع العرضية الأيونية للعناصر المختارة إضافة إلى ان هناك اتفاق مناسب و مقبول مع قيم المقاطع العرضية الايوينة المحسوبة.

Abstract:

An analytical formalism is suggested to describe the K shell ionization cross section for two atomic elements Mg (z=12) and Fe (z=26) by electron impact.

This study is essentially based on the analysis of the calculated K ionization cross section given by Sbell. The proposed expression had been found to be fitted with the shape and behavior of Sbell expression with an acceptable agreement in the values of the Sbell calculation.

Introduction:

The effective area of the collisional region on the effectiveness of two particle interaction which is called simply "cross section" while the production and a vacancy on the atomic K shell is called K shell ionization cross section.

The ionization cross section data and their dependence on the atomic number and electron energy particularly near the ionization threshold are required for many fields in physics, such as, radiation

physics, surface and thin film analysis using electron probe microanalysis, Auger electron spectroscopy, electron energy loss spectroscopy and transmission electron spectroscopy [5,6,7].

Theoretical and experimental researches have been done during the past decades to determine the cross section associated with the inner shell ionization of neutral atom due to electron impact [3,4,5,6,8].

An analytical expression of K and L shells cross sections of neutral atoms by electron impact had been achieved by [1,2].

In this work, an analytical formalism will be presented to K shell ionization cross section of atoms.

Theory:

In order to obtain an analytical formalism for K shell ionization cross section for Mg and Fe atoms, a curve fitting had been used to plot the data obtained from literature with high resolution. After plotting each figure of each electron using Sbell formalism [8], the first derivative of the data were calculated by Matlab with the help of the code Runge – Kutta fourth order of the suggested analyzed formalism which is given by:

$$\frac{d\delta}{dE} = W_0\left(\exp\left(-(E-W_1)^{n_1}/2(E_0)^{n_2} + 2\log(E-W_2)/W_3\right)\right) \quad \ldots.(1)$$

Where:

δ: is the collisional cross section

E_o is the average energy.

W_o is the cross section at energy E_o.

W_1, W_2, W_3, n_1 and n_2 are fittings parameters.

This formula will be used to interpret the calculated data in the next section.

Results and Discussion:

Eq.(1) was used in this work to describe the K shell ionization cross section for Mg (z=12) and Fe (z=26) atoms over a wide range of incident electron energies between (10 – 10^h) keV. The calculated data for Mg atom by Sbell formalism [8] as a function of incident energy is drawn in Fig. (1a) where as the result obtained by Eq.(1) suggest to this work was drown in Fig.(1b).

One can notice from this figure that there is a similarity in the shape and behavior of the calculated K shell ionization cross section by Sbell [8] and Fe atom obtained by Fig.(1) proposed in this work.

Furthermore, there is a good agreement in the values of the calculated cross section and that obtained by using Eq.(1) expect at high incident energy, the cross section obtained from Eq.(1) seems to be bigger values than that of the calculated cross section by Sbell.

The calculated data for Fe atom by Sbell formalism as a function of incident energy is drown in Fig.(2a) where as the result obtained by Eq.(1) suggest to this work is drown in Fig.(2b).

One can see from Fig. (2) that there is a similarity in the shape and behavior of the calculated Fe atom by Sbell [8] and Fe atom obtained by Eq.(1). In addition, that there is a good agreement in the values of K cross section obtained by Sbell and that obtained by Eq.(1). except at incident energy 10^2 kev,and 10^3 kev, the cross section seems to be for calculated Fe atom higher than obtained by Eq.(1).

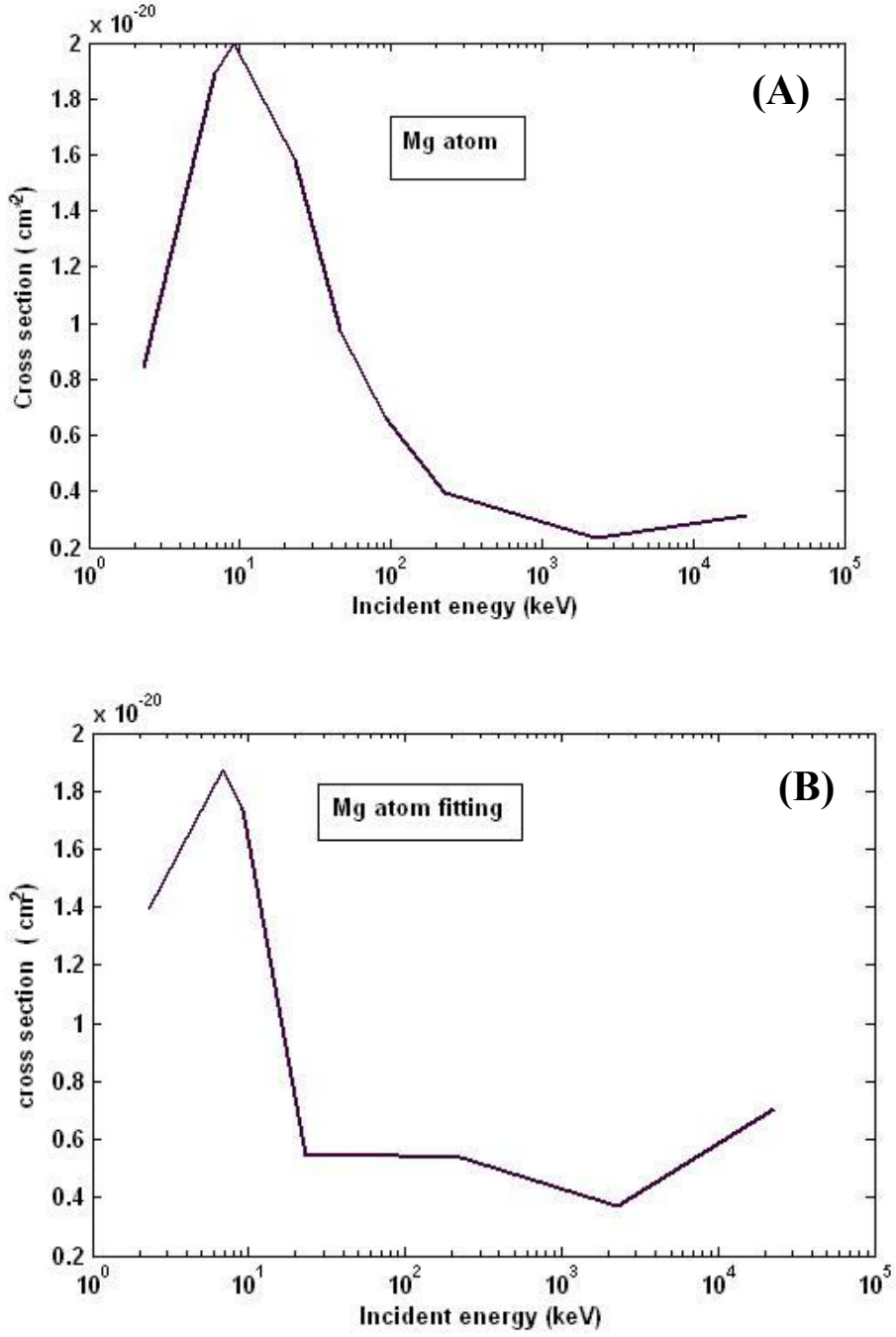

Fig (1): K- shell ionization cross section as a function of incident energy for Mg atom.
A- The calculated data for Mg atom [8].
B-The result obtained by fitting Eq(1) for Mg atom

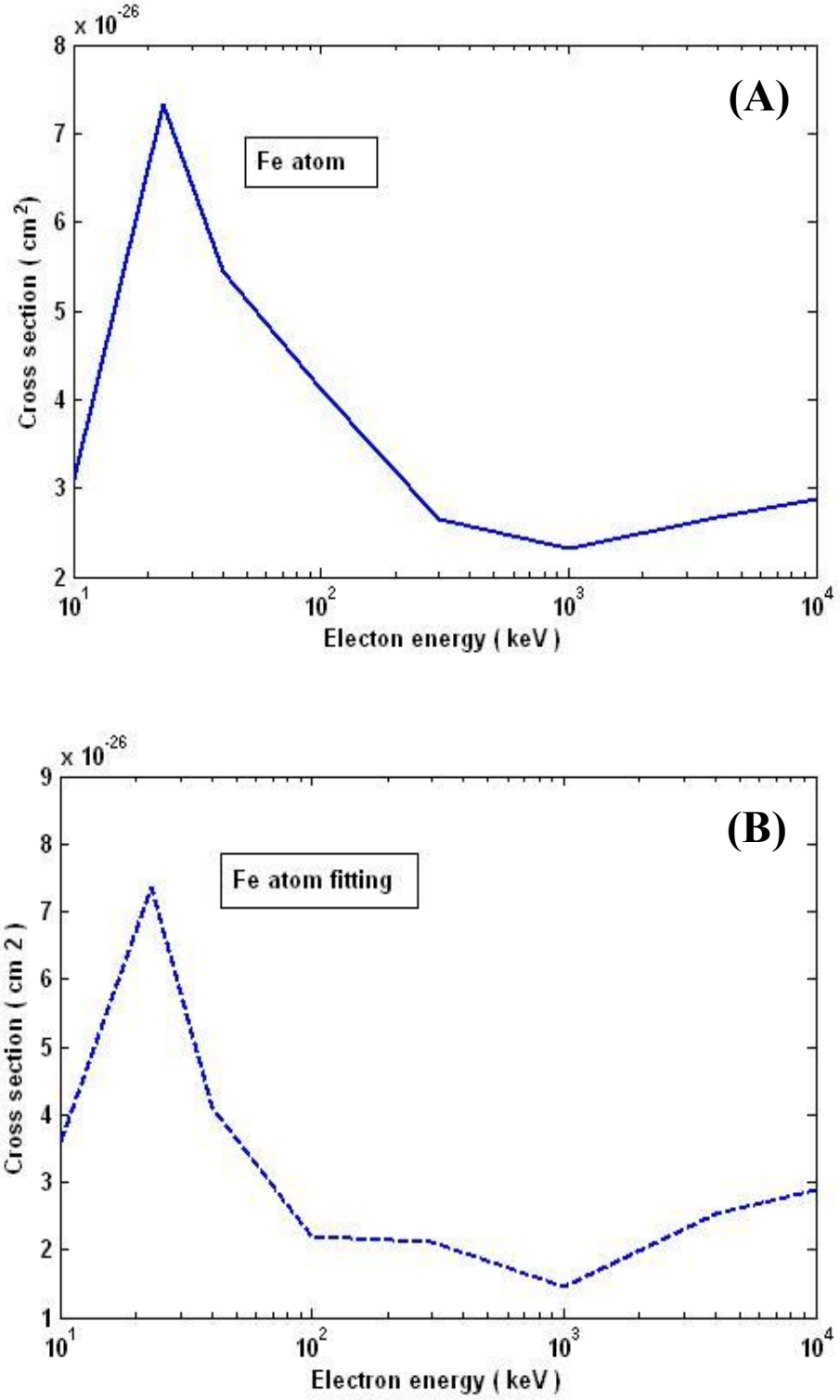

Fig (2): k shell ionization cross section as a function of incident energy for Fe atom.
A- The calculated data for Fe atom [8].
B-The result obtained by fitting Eq(1) for Fe atom

Conclusions:

The analytical expression proposed in this study in general, gives a convenient and good approach to produce the K shell ionization cross section of two selected atoms Mg and Fe with that obtained by Sbell formalism.

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