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Calculation of the coherent (Rayleigh) and incoherent (Compton) cross section by using CSC model.

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Abstract

In this research work ,the cross section of coherent scattering "Rayleigh" and incoherent "Compton" for the compound energy range 1keV-50kev1000ev-50000ev , discuss for W and Cd by employing the equation which is related to "Rayleigh" scattering while program "Compton" scattering ,the cross section has been discuss by Klien-Nishina equation . All these equations obtain by employing CSC(cross section calculations) through language machine of Fortran 90 which provides a high flexibility and extreme accuracy in the calculating many physical parameters such as attenuation and scattering coefficients for any chemical compound or alloys.

Key wards: Rayleigh scattering, Compton scattering, Coherent scattering, CSC model, Cross section.

Physics classification : QC 170-197

I-Introduction:

The scattering is a process of the interaction of the electromagnetic radiation with matter which can be classified into two kinds: first type is the coherent scattering (Known as (Rayleigh scattering) happens when , a photon collides with an atom as a whole and due to the huge mass of the atom in comparison with the radiation quanta , the atom absorbs less amount of the photon thus the photon will deflects without lose much of its energy. the second type is the incoherent scattering (Compton scattering) in which single photon collides with unbound and free electron here the electron will recoils due to accruing discreet amount of incident photon ,and the least will transfer with less energy[1]. the interaction cross section define as the effective area for the scattering effect measured in barns and equals to 10-24cm\ atom . the accurate knowledge of the cross section is of great importance in different applications engineering, medical and scientific application whic is useful to determine the attenuation coefficients and protection shields for reactors and the equipments of radiography and medicine [2]. There are many tables of differential cross sections for coherent and incoherent for different compounds and pure elements but these tables do not meet the increasing needs for these values [12,14]. The research aim is to present the cross section of Cd and W in energy range of 1keV-1MeV depending on a theoretical model named CSC (cross section calculations) including programming the special equations for cross sections related to each scattering process in machine language Fortran 90 despite the difficulties.

II-The equations included in Cross Section Calculation (CSC) model:

All calculations in present work is related to the differential cross section in the energy range of perfumed 1KeV–1MeV by employing the model CSC .For the incoherent scattering the differential equation of Klein –Nishina is presented by [14].

$$\frac{d\sigma_{Incoh}}{d\Omega} = \frac{d\sigma_{KN}}{d\Omega} S(x,z) \qquad (1)$$

Where $\frac{d\sigma_{KN}}{d\Omega}$ is the cross section area for the Compton scattering and S(x,z) is the inelastic scattering function with $x = (\frac{\sin\theta}{2\lambda})$ where $\sin\theta$ the scattering angle ,Z is the atomic number the incident photon which has wave length $\lambda(A^0)$ furthermore the differential solid angle for the Compton scattering is given by

$$d\Omega = 2\pi \sin\theta d\theta$$

$$\frac{d\sigma_{KN(Incoh)}(\theta)}{d\Omega} = \frac{r_e^2}{2}[1+k(1-\cos\theta)]^{-2}[1+\cos\theta^2 + \frac{k^2(1-\cos\theta)^2}{1+k(1-\cos\theta)}] \qquad (2)$$

Where K is the photon energy in terms of rest mass energy of electron; r_e classical radius of electron 2.8179380.10-15m and mec2 = E(eV) / 511003. 45 by the equation the incoherent cross section (Compton scattering). for the Rayleigh scattering cross section by the following equation [15].

$$\sigma_{coh} = \frac{3}{8}\sigma_T \int_{-1}^{1} d\sigma_T(\theta)[F(x,Z]^2 d(\cos\theta) \qquad (3)$$

The atomic form factor F(x,z) represent the ratio of scattered radiation amplitude of an atom to that electron [16].Thus the formula for coherent differential cross section can be written as follow :

$$\frac{d\sigma_{coh}(_{Raylieg})}{d\Omega} = \frac{d\sigma_T}{d\Omega}[F(x,z)]^2 \qquad (4)$$

Where $\frac{d\sigma_T}{d\Omega}$ is the area of the differential cross section for Thomson scattering given

by

$$\frac{d\sigma_T(\theta)}{d\Omega} = \frac{r_e}{2}(1+\cos^2\theta) \qquad (5)$$

The values of the function S(x,z) and F(x,z) are depend upon the tables of Hubble [14] which based on the nonrelativastic Hartree-Fock wave function which is fed in subroutines and running form mathematical equation in Fortran machine language .its worth to mention that the percentage composition of any compound .

III- Result and discussion

The Compton interaction is one in which only a portion of the energy is absorbed and a photon is produced with reduced energy. This photon leaves the site of the interaction in a direction different from that of the original photon. Because of the change in photon direction, this type of interaction is classified as a scattering process. In effect, a portion of the incident radiation "bounces off' or is scattered by the material. There are actually two types of interactions that produce scattered radiation. By the equation (2 and 4) the incoherent and coherent cross sections were evaluated as shown in table (1).which represents a wide spectrum of energies in which the probabilities of the Compton and Rayleigh scattering is maximum .here we choose this range in order to avoid of pair production occurs which is exactly happened at 1.022 MeV. By comparison of the data table (1) the coherent cross section proportional to the incident photon energy as shown in Fig.(1) which appears at low energies and at utmost is occurs at several Electron volt this means that phenomena is observed. but for the inelastic scattering of low photons occurs at 5KeV and clear that the cross section in the energy range of 1000eV and 10000eV decreases these figs referes to the inversely relation between the incident photon and area of cross section for the incoherent scattering process $\sigma_{Incoh} \alpha \frac{1}{h\nu}$.

Table (1) represents the cross section area for Rayleigh and Compton scattering in Barns atomic units of Cadmium Cd.

E (KeV)	Coh(barn/atom)	Incoh(barn/atom)
1000	1461	1.004
1500	1388	1. 808
2000	1306	2,585
3000	1140	4.044
4000	988	5.395
5000	857.7	6.635
8000	588.8	9.849
10000	479.6	11.6
20000	219.5	16.8
30000	123.4	19.42
40000	80,6	20.5
50000	56.97	21.2
60000	42.25	21.5
80000	25.82	21.53
200000	5	18.62
300000	2.322	16.52
400000	1.335	14,94
500000	0.865	13.71

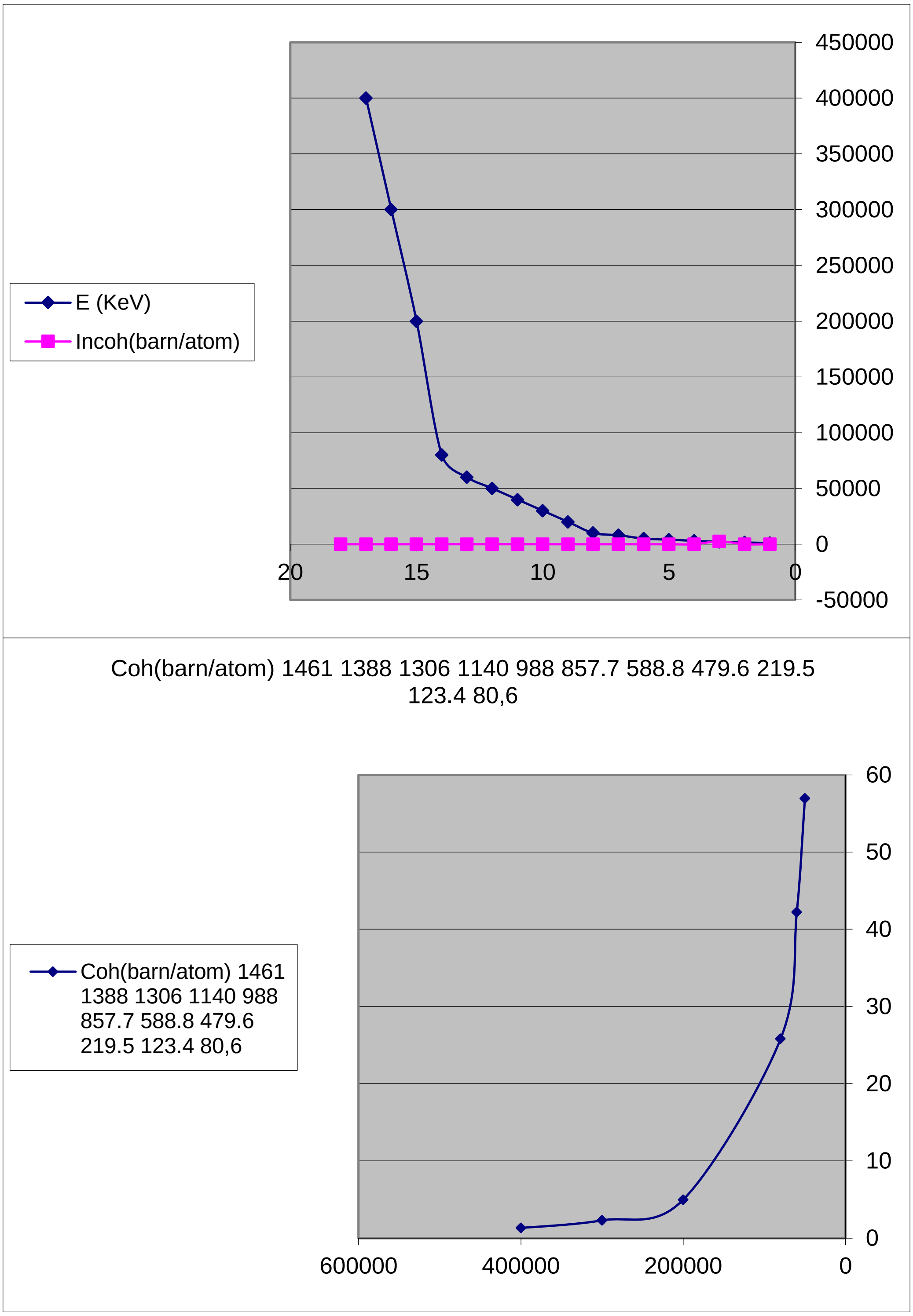
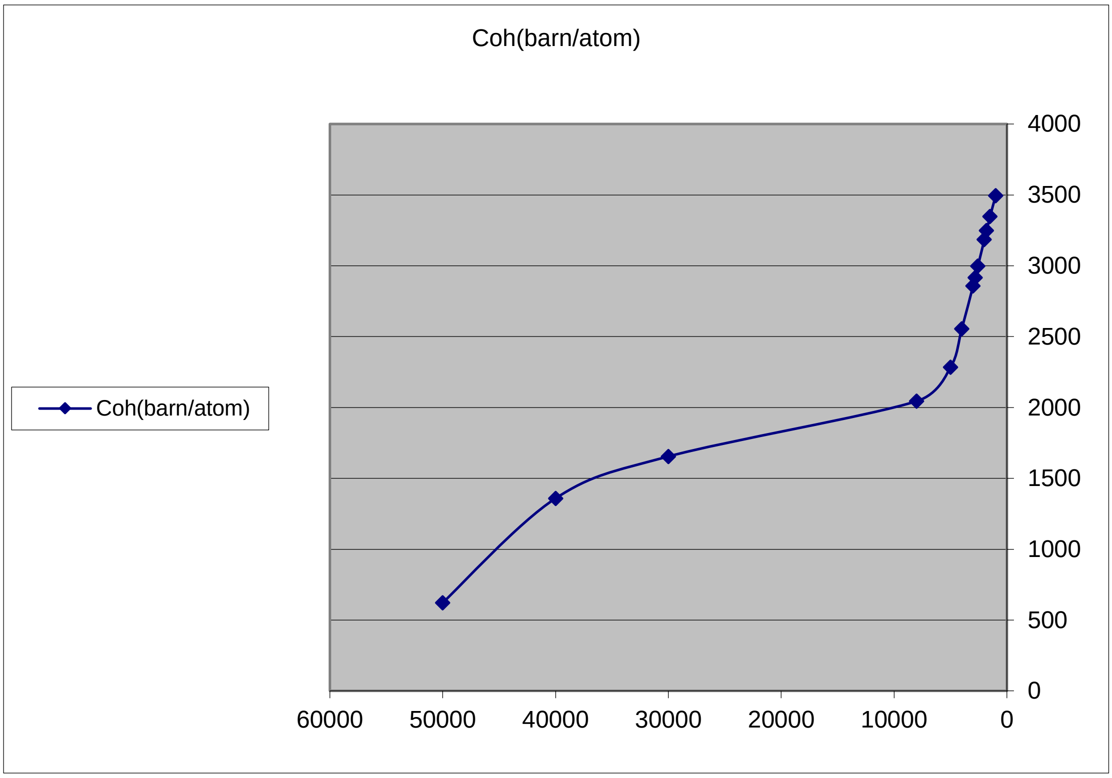


Fig.(1) The relation between incident photon energy and cross section area for Rayleigh scattering for Cd

Table (2) represent the cross section area for Rayleigh and Compton scattering in Barns atomic units of Tungsten W.

E (KeV)	Coh(barn/atom)	Incoh(barn/atom)
1000	3494	1.325
1500	3347	2.294
1800	3248	2.864
2000	3184	3.213
2575	2997	4.239
2820	2917	4.669
3000	2858	4.984
4000	2555	6.675
5000	2284	8.276
8000	2044	9.777
10000	1654	1.242
20000	1358	1.484
30000	621.5	22.12
40000	367.5	26.78
50000	171.4	30.11



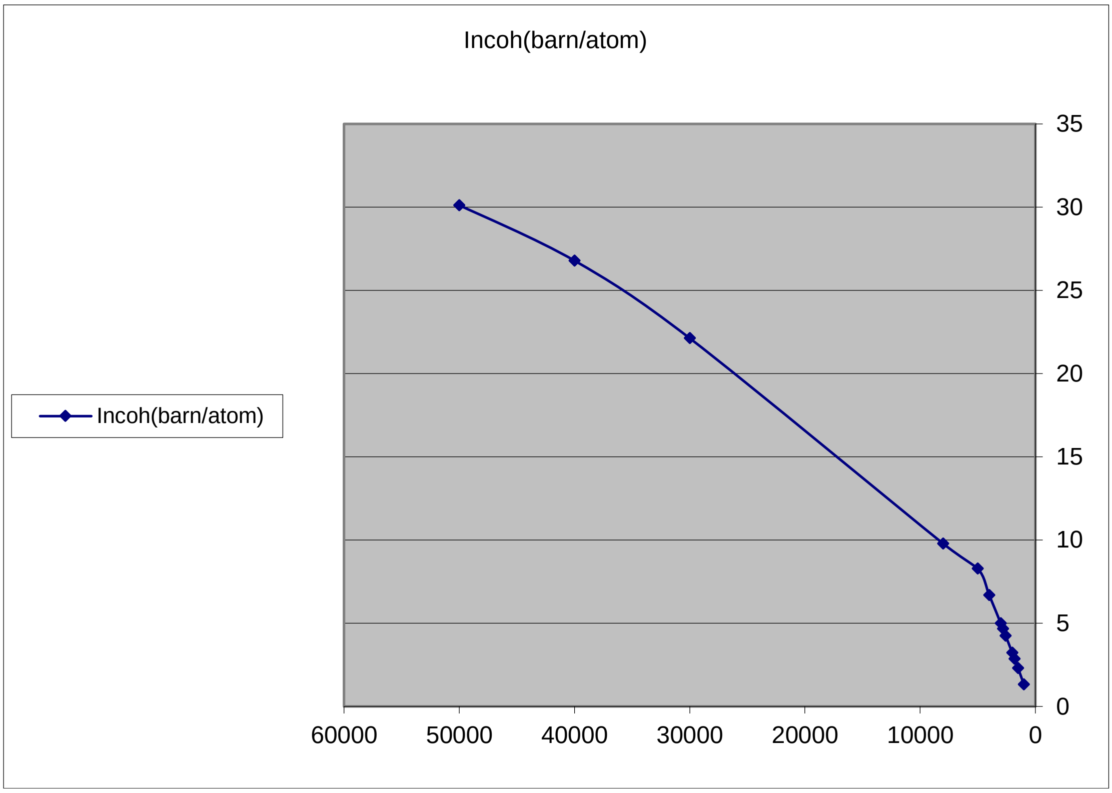


Fig.(2) The relation between incident photon energy and cross section area for Rayleigh scattering for W

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ايجاد مساحة المقطع العرضي المتشاكه (استطارة رايلي) وغير المتشاكه (استطارة كومبتون) لعنصري التكنستنW و,الكادميوم Cd ضمن مدى الطاقة 1KeV- 50KeV باستخدام النموذج الرياضي (CSC)

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الخلاصة

الهدف من هذا البحث حساب مساحة المقطع العرضي المتشاكه (رايلي) والغير متشاكه (كومبتون) لعنصري الكادميوم Cd و التنكستن W لمدى طاقي 1000 eV- 50000 eV باستخدام المعادلات الرياضية الخاصة باستطارة رايلي اما بالنسبة لاستطارة كومبتون فقد تم حساب المقطع العرضي لها من خلال معادلة Klien-Nishina حيث تم برمجة جميع المعادلات الخاصة باستخدام نموذج (Cross section calculations (CSC) بلغة فورتران 90 والتي أثبتت مرونة عالية ودقة متناهية في حساب الكثير من المعاملات الفيزيائية مثل معاملات التوهين والاستطارة وغيرها ولأي مركب كيميائي او سبيكة .

الكلمات المفتاحية: استطارة رايلي، استطارة كومبتون، الاستطارة المتشاكهة، نموذج (CSC)، المقطع العرضي.

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