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Research Article

Study Stopping Power Collision in one of Nuclear Element

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Abstract

The retarding force of the charged particles when interacts with matter causing loss of particle energy, this physical phenomenon in nuclear physics called stopping power. it has a lot of important applications such as in nuclear medicine and privation effects of radiations. The charge particles are alpha and beta particles. in this paper we studies the stopping power, collision and the stopping power of radioactivity of nuclear elements and to find the relationship between stopping power collision and stopping power of radioactivity, with arrange of CSDA range for the low energy electrons data of element F. the CSDA range he CSDA range it is an average distant length of the moving charge particles when it is path slows to stop. By using approximation of CSDA range we can calculate the rate of the loss in the energy at any point along the path of the travel by assuming these energies loss at points of the track are equal to whole stopping power loss. The CSDA range can be found by reciprocal integration of the total stopping power. from the Figures (3),(4),(5) and(6)we can get good results

الخلاصة

ان إعاقة الجسيمات المشحونة عند تفاعلها مع المادة يسبب خسارة في طاقة الجسيمات، هذه الظاهرة الفيزيائية في الفيزياء الذرية والفيزياء النووية تسمى قدرة الايقاف. ان قدرة الايقاف لها الكثير من التطبيقات الهامة في مجال التأثيرات الذرية, الطب النووي ومجال الإشعاعية. ان الجسيمات المسؤولة تتمثل بجسيمات ألفا وجسيمات بيتا.

في هذا البحث، قمنا بدراسة قدرة الايقاف، التصادم وقدرة الايقاف للنشاط الإشعاعي في العناصر النووية وإيجاد العلاقة بين قدرة الايقاف التصادمية وقدرة الايقاف في النشاط الإشعاعي، مع ترتيب لمجموعة CSDA (التباطا المستمر لتقريب المدى) لبيانات طاقة الإلكترونات الواطئة للعنصر F. أن نطاقCSDA يمثل متوسط طول الازاحة للجسيمات المشحونة المتحركة عندما يكون المسار مؤديا إلى حالة الإبطاء. وباستخدام تقريب مدى CSDA يمكننا حساب معدل الخسارة في الطاقة في أي نقطة على طول مسار الانتقال على افتراض ان خسارة الطاقة في نقاط المسار تساوي كل فقدان قدرة الايقاف. من التكامل المتبادل الإجمالي لقدرة الايقاف يمكن أيجاد مدى. CSDA

Introduction

Charged particles when passing through can ionize the atom of the matter, the speed of the charge particles loss energy in many stopping point. The stopping power of the particles can be estimated for Avery unites of the track length by $-dE/dx$.

The stopping power is determined by the nature of the matter and the particle energy.

The ion pair needs an amount of energy and the amount of ionization along the tracts is related to stopping power of the matter. The property of the matter determent the stopping power, the loss of the energy for Avery points along the track describes the event of the particles during its travel. Both units and numerical values are identical.

Collision Stopping Power

The collision stopping power is resulted from energy of incident of electrons on the atoms of matter. The differential cross-section per atomic electron $d\sigma/dW$ for inelastic collisions leading to an energy transfer of$W$, the stopping power of mass collision can be denoted as:

$$\frac{1}{\rho}S_{coll}=\frac{N_A}{A}Z\int W\frac{d\sigma}{dW}dW \qquad (1)$$

Where Z the atomic number of the medium, ρ its density N_A is Avogadro’s number, A the atomic weight of the medium. The ionised energy loss is estimated from Bethe-Bloch formula [2]:

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$$S_{coll} = \frac{2\pi r_e^2 m_0 c^2}{\beta^2}\frac{Z}{A}\left\{\ln\left[\frac{\tau^2(\tau+2)}{2(I/m_e)^2}\right]+\left(1-\beta^2\right)+\frac{\tau^2/8-(2\tau+1)\ln 2}{(\tau+1)^2}-\delta\right\} \qquad (2)$$

Where $r_e$the radius of the electron, $m_o c^2$is rest energy of the electron, $\delta$is the density effect, $\beta$the electron velocity, I is the mean excitation energy and τ is the energy of the incident electron on its rest energy. The polarization of the atoms of the matter is result when an electron passing through it. This leads to decreases of electric field of the electron. The extent is in turn leading to decrease in the stopping power. For high energy value, the density can be approximated as [3]:

$$\delta \approx 2\ln\left[\frac{28.816}{I}\sqrt{\frac{\rho Z}{A}}\right]+2\ln(\tau+1)-1$$

The mean excitation energy values can be seen in the following table 1for various matterles

Element	Atomic number	Mean Excitation Energy I [eV]
Beryllium	4	63.7
Carbon (graphite)	6	78
Aluminum	13	166
Iron	26	286
Copper	29	322
Germanium	32	350
Tungsten	74	727
Lead	82	823
Uranium	92	890

Stopping Power of Radiative

The deflection of the electron path when passing electron through electric field

Causing radiative energy loss, this phenomenon is called bremsstrahlung. The collision occurs in electron, emitted photon and the value of the scattering of nucleus can be neglected because of it high mass. The deflection of the electron path will be more when the nucleus charge is high; therefore the energy loss is significant especially when the atomic number of the matter is high. The deflection of an electron path can occur even at low energies. And this of the deflection is proportionate with electron energy. So the collision losses decrees when energy electron increase. The energy loss becomes significant for contribution of the Bremsstrahlung phenomenon especially above 10 MeV for high atomic number and about 100 MeV for low-atomic number of the matter. The radiation photons of the incident electrons have a wide spectrum starting from zero to kinetic energy and the photons number proportionate inversely with there energy. The increase in the electron energy causing increase in the forward peaked of the emitted photons. In the following Figure the bremsstrahlung cross-sections differential is function of the photon energy for 4 values of electron energy for the lead and Copper [4].

…(3)

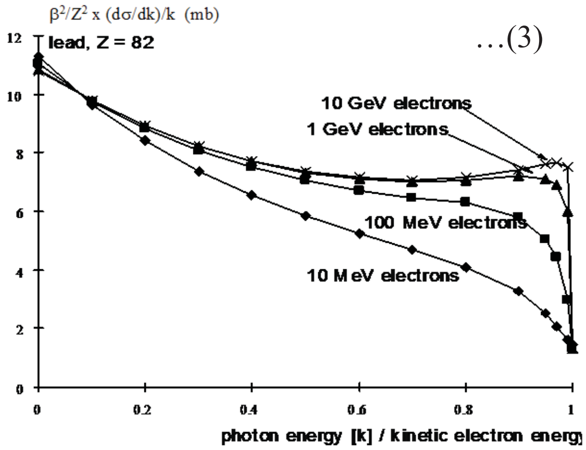

Figure (1. a) bremsstrahlung cross-sections for Lead (for 4 different electron energies) [4].

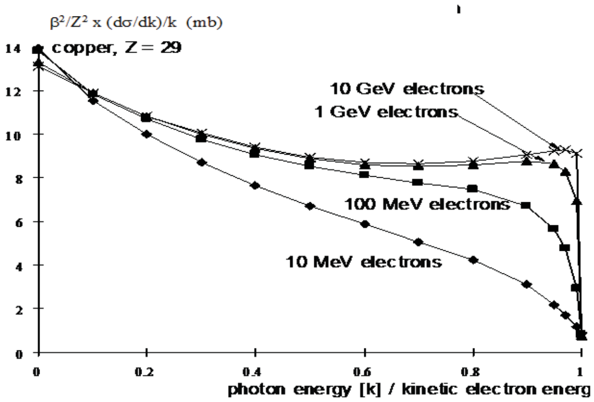

Figure (1. b): Bremsstrahlung cross-sections of Copper element (4 different electron energies) [4].

Total Stopping Power

Its total stopping power of electron and positron means the energy loss for every unit of the path length as a loss of ionization, excitation and the radiations. And this is can be revealed by analytical expressions involving the use of these energy loss. a lot of works has been conducted now a days [5-8], the total stopping power in nuclear physics has a lot of application like in nuclear spectroscopy, surface layer analysis and semiconductor detectors[9,10]. The collision losses of electrons and positron are depends on the natures and properties of the materials. By using spatial formula to evaluate this loss of the electron [11]. in the last few years there have been some important development in the techniques and theories that inside the physical properties in solid concept like ionic charge, atomic number [12-18], valence electrons and these inside has relation with property of the chemical bond that explain and to categorize a lot of essential properties of the solid. Although this relation does not give an accurate hints for every matter but we can get benefit to study the properties of the materials. Below the two Figures show the total stopping power of collision for Lead and Graphite

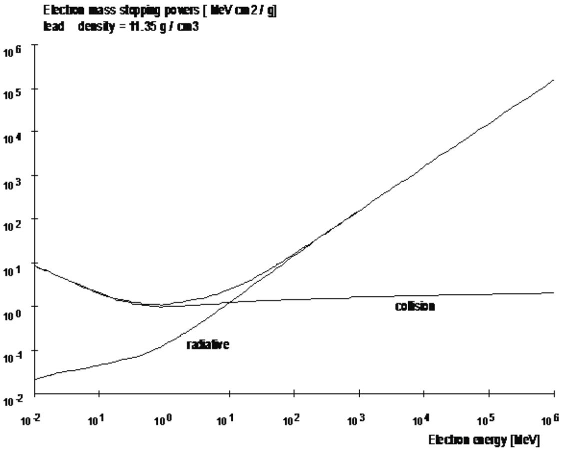

Figure (2a) stopping powers as an energy function (Graphite element) [2].

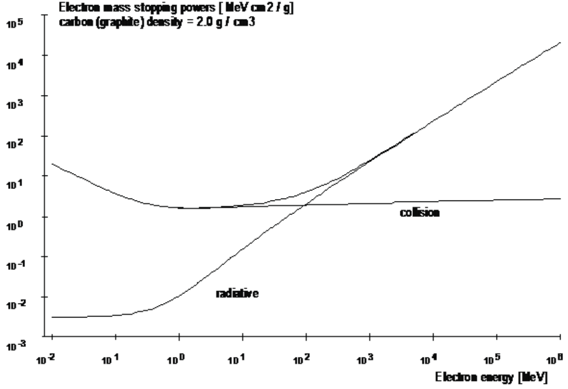

Figure (2b) stopping powers of Electron for lead as energy function [2].

Results and Discussions

From Theoretical point the results can be found by calculating stopping power collision and radiative stopping power together with CSDA data for F element. In the Figures 3a and 3b, the calculations represent a function of stopping powers to kinetic energy, for both sets Lin/Logelectron value after and before for F element.

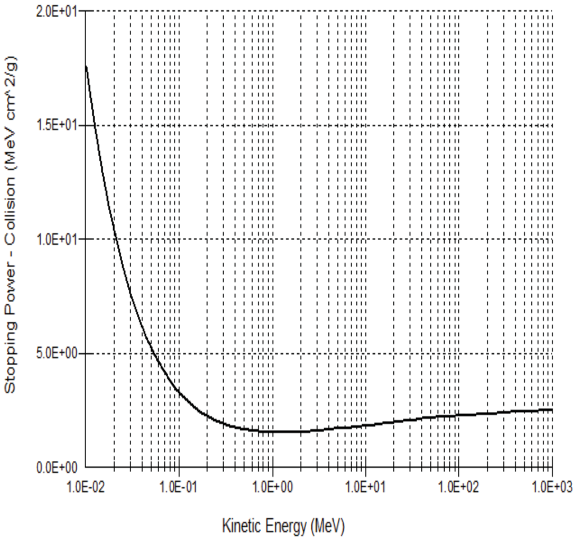

Figure (3a) shows total powers collision as a function to kinetic energy.

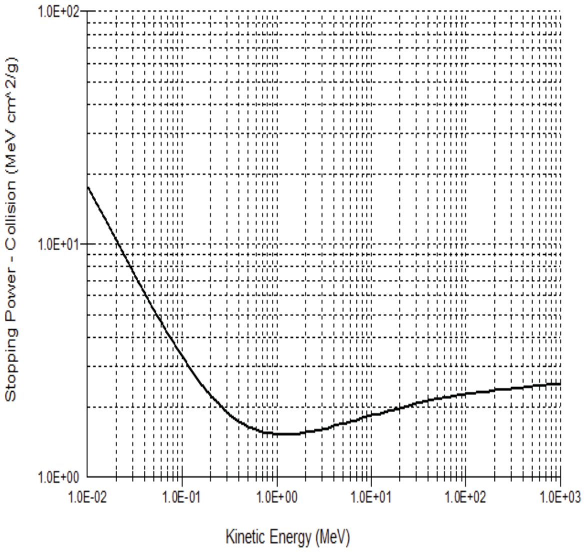

Figure (3b) the function Sets Lin/Log electron data of F element

Figures 4a and 4b denote to the stopping powers recitatives as a kinetic energy function after and before set Lin/Log electron data of F element.

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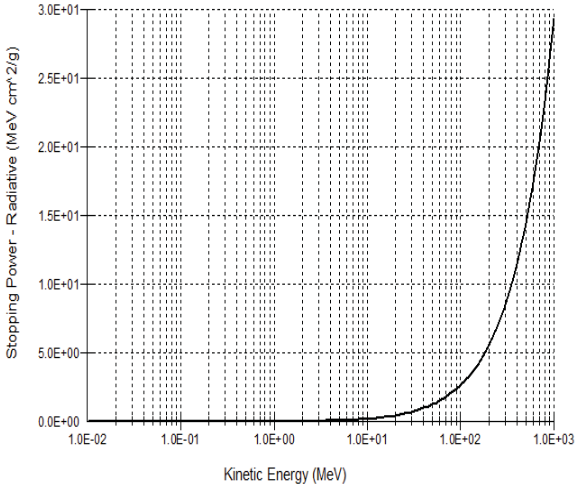

Figure (4a) radiative Stopping power as a kinetic energy function.

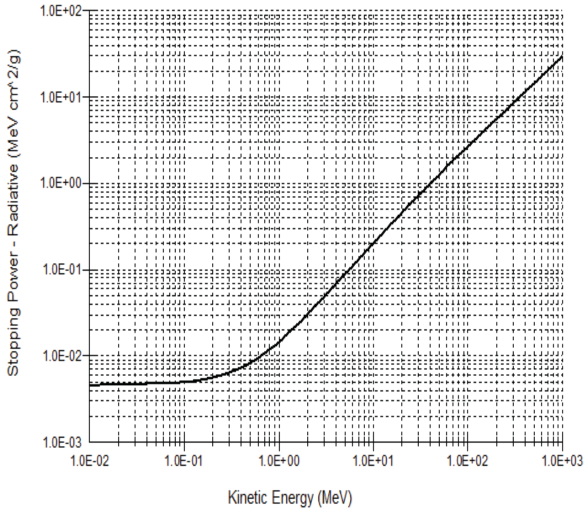

Figure (4b) Set Lin/Log data of radiative stopping power as a kinetic energy function.

Figures 5a and 5b for the total stopping powers function of kinetic energy after and before Lin/Log electron data for F element.

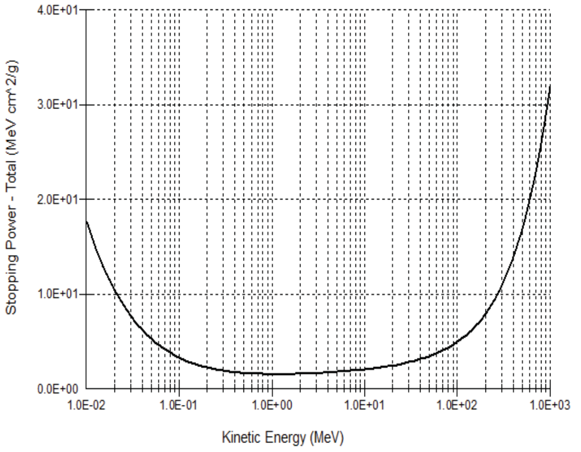

Figure (5a) the sum of stopping power as a kinetic energy function.

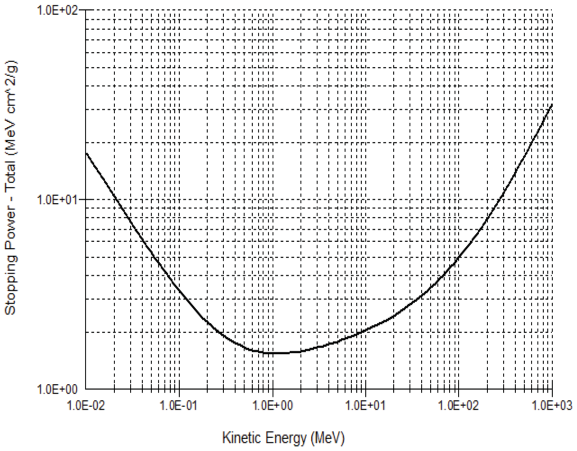

Figure (5b) Lin/Log the sum of stopping power as kinetic energy function.

The CSDA approximation for the range tracks the distance for charging all particles travelling when become to rest. The rate of lossing energy in CSDA approximation, in every point of its path, is assuming equal losses to total stopping power. We can obtain it from the integrating of total stopping power reciprocal to energy.

Figures 6a and 6b show the CSDA range the result of calculations.

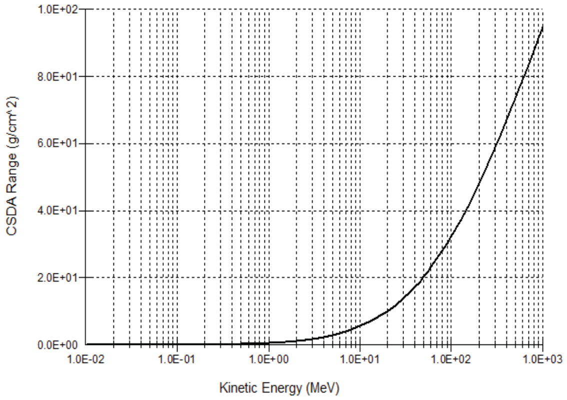

Figure (6a) CSDA calculations as a function of kinetic energy.

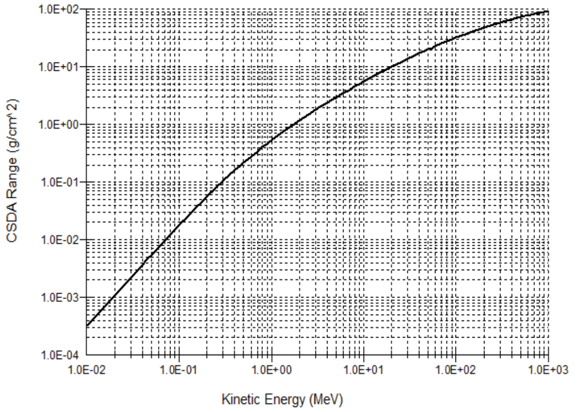

Figure (6b) Lin/Log CSDA range function to kinetic energy.

Conclusions

From the study of the total power we conclude that the collision of stopping power of electrons proportionate inversely with energy, it means for lower energies of electrons we can obtain height result of collision of stopping power.

The stopping power of radiative electrons increases when the energy increases. While the loss of the energy at any point on the path of the charge particle equals to the sum of stopping power in CSDA approximation.

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