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Calculation of Electron Impact Excitation Cross Sections

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1- **Abstract:** The atomic data of the various atomic processes are essential for the interpretation of laboratory and astrophysical spectroscopic data. We have contributed to calculation of the cross sections and coefficients rates of the excitation which are obtained by Semi-experimental methods. The objective is to evaluate the status of electron-impact excitation data for Carbon and to generate the recommended datasets for use in analysis spectra.

2- **Mots clés:** Atomic processes, Electron-impact excitation, Cross sections, Simulation methods.

3- Introduction:

Interactions between electrons, ions and atoms in plasma are important in modeling the radiative properties of ions and atoms in order to analyze and interpret spectra [1]. We collected some data on different methods to evaluate the cross sections of excitation of ions and electron-influenced atoms. In this paper, we study the excitation process with an electronic effect of carbon to evaluate excitation cross sections using semi-experimental analytical formulas gathered from scientific articles that have studied these formulas to estimate the accuracy of results theoretically calculated methods [2, 3].

4- Theoretical Methods:

4-1- Cross sections for electron impact excitation of carbon:

The Cross section of excitation carbon in terms of collision force $\Omega\left(\frac{E}{\Delta E}\right)$ through the following analytical expression [2, 3]

$$\sigma_{if} = 1.1969 \times 10^{-15} \times \frac{\Omega_{if}}{W_i E_e} \qquad (1)$$

Where E_e is the energy of the incident electron, W_i the statistical weight of the initial state, Ω_{if} the collision strength.

Two types of formulae have been used for the fit procedures. The formula of type 1 and 2 is defined by:

Type 1: $$\Omega_{if}(X) = A + \frac{B}{X} + \frac{C}{X^2} + \frac{D}{X^3} + E \ln X \quad (2)$$

Type 2: $$\Omega_{if}(X) = \frac{A}{X^2} + Be^{-FX} + Ce^{-2FX} + De^{-3FX} + Ee^{-4FX} \quad (3)$$

$X = \frac{E_e}{V_{if}}$, V_{if} is the excitation energy.

4-2- Results and Discussion:

The results obtained from the calculation of cross sections for electron impact excitation of carbon as a function of the collision strength in terms of fitting coefficients are shown in the fig.1-4. We note that there is an increase in the values of cross sections with the increase of energy and then decrease in the curve and this is due to the increase in temperature.

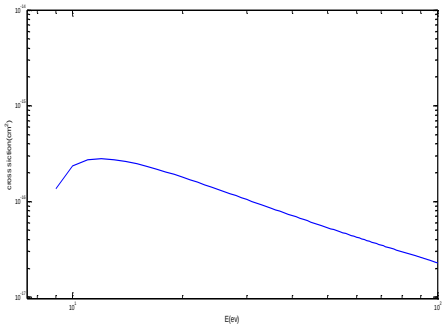

Fig1: Electron-impact excitation cross section for the transition ($2^3P \rightarrow 3^3D$)

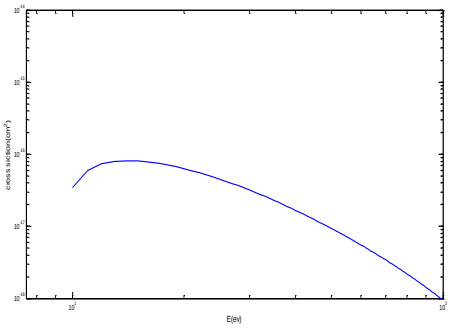

Fig2: Electron-impact excitation cross section for the transition ($2^3P \rightarrow 2^5S$)

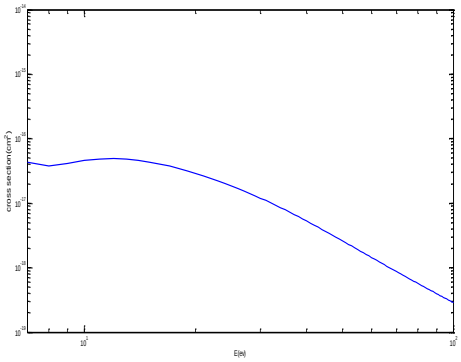

Fig3: Electron-impact excitation cross section for the transition($2^3P \rightarrow 2^1P$)

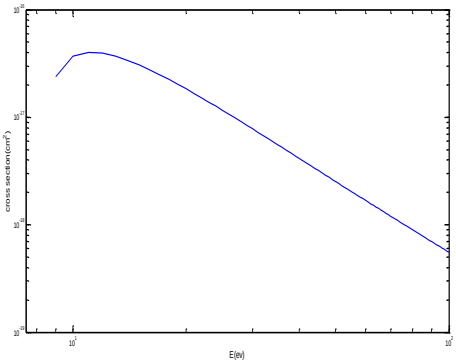

Fig4: Electron-impact excitation cross section for the transition($2^3P \rightarrow 3^3S$)

5- Conclusions

We found that there are several different methods that enable us to calculate the theoretical and semi-empirical cross sections of excitation. The effective cross sections of electron impact excitation of carbon are calculated by the influence of the electron by applying two types of written collision force in terms of synthesis factors equipped for a set of transitional atomic states.

- We found difficulties in the application of analytical equations when calculating the excitation cross sections. On the other hand, the lack of availability of the results calculated by code FAC [4] (Flexible Atomic Code) and the comparison with our results obtained.

6- References

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[4] Gu M. F., FAC 1.0.7, http://kipac-tree.stanford.edu/fac/