ISSN 2231-3478 (Print)
JUSPS-B Vol. 34(4), 37-40 (2022). Periodicity-Monthly
Section B
(Online) ISSN 2319-8052

JOURNAL OF ULTRA SCIENTIST OF PHYSICAL SCIENCES
An International Open Free Access Peer Reviewed Research Journal of Physical Sciences
website:- www.ultrascientist.org
Estd. 1989

Study of Charged Particles Scattering with Atomic Target

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http://dx.doi.org/10.22147/jusps-B/340401

Acceptance Date 10th June, 2022, Online Publication Date 28th June, 2022

Abstract

In this paper, we have reported the calculated results of anisotropy parameter (P_l) and angular momentum transfer parameter ($L_\perp$) for positron (electron) scattering by Calcium (Ca) atom using close coupling approximation method in the framework of R-matrix theory at 20eV. Since this theory has deep root in nuclear physics, it also provides better results in atomic and molecular physics. The authors have compared the reviewed results with available theoretical results. A good agreement between these results shows that the present method gives better understanding for the positron (electron)-atom scattering.

Key words : Electron, Positron, Calcium and Close Coupling

Introduction

The investigation of charged particle scattering with atomic targets provides a vital meeting point for contemporary quantum scattering theory and experiment. There is a considerable development in the theoretical as well as experimental investigation of positron (electron)-atom collision. Actually positron (electron) excitation of atom has been traditionally characterized by measurement of differential cross sections, which are specific for scattering. Another detailed way of measurement of positron (electron) impact excitation is characterized by positron (electron) impact anisotropy and angular momentum transfer parameters.Calcium is playing an important role in human life. Knowing its importance a doctor may suggest Calcium test if anyone has kidney failure. Calcium is involved in numerous intra and intercellular path ways that control the function of living cells. This is one of the reasons of selecting Calcium as the target.

M. Croissiaux *et al.*[1] presented few results for electron scattering by Calcium at 250MeV. Milisavljevic *et al.*[2] calculated differential cross section for 4^1P_0 state of Calcium at 2.93eV by electron. Fursa and Bray[3] applied convergent close coupling method to calculate the excitation of 4^1P state of Calcium at 10-55eV. Saxena *et al.*[4] have reported close coupling calculation in the framework of R-matrix theory for electron-Barium excitation at 20eV at DAE-BRNS Symposium. Mahmudul Hasan *et al.*[5] have studied elastic scattering of electrons from Calcium atoms. KR Verma *et al.*[6] have been reported few results for electron and positron collision with neon at intermediate energies. Recently, Sanjida Afroz *et al.*[7] studied the scattering of electrons and positrons from atomic targets over the energy range 1eV-0.5GeV. Also, L.H. Scarlett *et al.*[8 & 9] have been studied the electron-scattering results using Convergent Close Coupling approximation method.

Theory :

The close coupling approximation method[10] in the framework of R-matrix theory is used to calculate the reported parameters. The dynamics of positron (electron) calcium scattering are calculated under R-Matrix formulism. The parallel calculations have been furnished by Verma *et al.*[6] for neon atom. In this connected study, the linear components of polarization P_1, P_2 and P_3 can be obtained by alignment and orientation parameters as

$$P_1 = 2\lambda - 1$$
$$P_2 = \frac{-2\sqrt{2}R_e\langle a_0 a_1\rangle}{\sigma} \quad (1)$$
$$P_3 = \frac{2\sqrt{2}I_m\langle a_0 a_1\rangle}{\sigma}$$

Here, a_0 and a_1 are the excitation amplitude corresponding to $m_f = 0$ and 1 respectively. $\langle\ \rangle$ denotes the spin average values.

With these polarization parameters, anisotropy parameter (P_l) and angular momentum transfer parameter ($L_\perp$) can be written as

$$P_l = (P_1^2 + P_2^2)^{1/2} \quad (2)$$

and $$L_\perp = -P_3 \quad (3)$$

The potential used in above calculation has already been given in[4].

Results and Discussion

Figure (1) shows the variation in anisotropy parameter which is also called as polarization component for Calcium at impact energy 20eV for $^1S_0 \rightarrow {}^1P_1$ transition. We have compared our reviewed results P_1 (for electron impact) and P_2 (for positron impact) with the distorted wave (DW) results of Stauffer[8]. At smaller scattering angles, less than 40^0, our results show lower magnitude. At 120^0, P_1 and P_2 show almost the same value of P_l.

Anisotropy Parameter (P_l) For Calcium

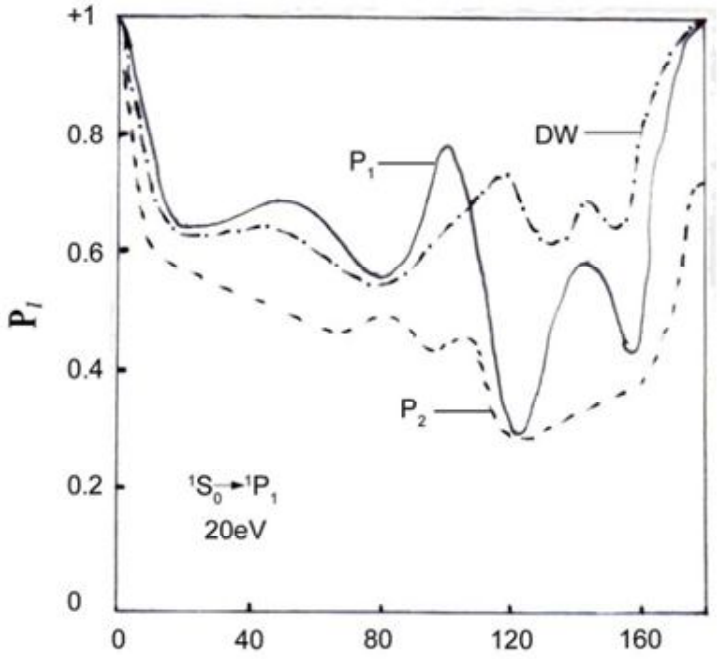

Figure (1): Scattering Angle (deg.)

Angular Momentum Transfer Parameter ($L_\perp$) For Calcium

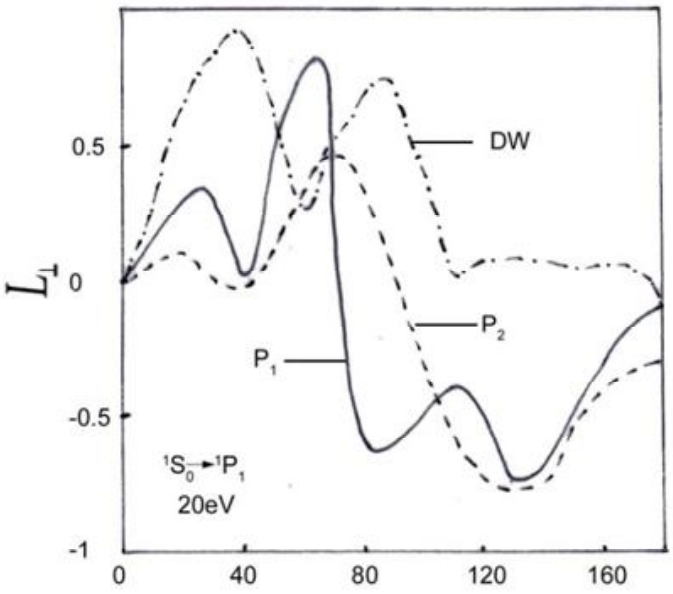

Figure (2): Scattering Angle (deg.)

Figure (2) depicts variation of angular momentum transfer parameter ($L_\perp$) on excitation of positron and electron impact from Calcium at 20eV. Here also comparisonis made with other theoretical result of Stauffer[11]. It is noted that the distorted wave result shows higher magnitude in comparison to P_2. Around 80^0, scattering angle, it is seen that all the results having the same value of angular momentum transfer parameter, which can be seen again at above 160^0. These results are encouraging one for us. Here we have found that our results using this theory given remarkable outcome at lower energy levels. I am hopeful to apply this theory for heavy charged particle like proton in near future.

Conclusion

It has been concluded that in general the present close coupling approximation yields the better values of differential calculations of specific parameters for the excitation of Calcium. The results are in good agreement with available experimental data and other theoretical results. Many interesting features are found for the $^1S_0 \rightarrow {}^1P_1$ transition. The other transitions are still in progress and will soon be reported in future publication. Therefore this reviewed work would accelerate more calculations in this direction. The authors also plan to extend the present calculation for other atoms.

Acknowledgement

We are thankful to the Principal, Bareilly College, Bareilly (U.P.), for providing necessary infrastructure. Also, we are grateful to Hon'ble Vice Chancellor, MJP Rohilkhand University, Bareilly for promoting the research facilities.

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