Formation of H(2s) in Proton – Lithium Inelastic Scattering

M. A. Abdel-Raouf[1], S. A. Elkilany[2]

[1]*Physics Department, College of Science, UAEU, Al-Ain, United Arab Emirates,*
assad@uaeu.ac.ae

[2] *Department of Mathematics, Faculty of Science, Kafr Elsheik University, Kafr Elsheik, Egypt*

The inelastic collisions of protons with lithium atoms are treated via elaborate coupled statics Green's function iterative method [1,2]. In addition to the elastic channel, the formation of H(2s) in the charge exchange channel is considered. The total cross sections are calculated for wide range of incident energies using 8 partial wave expansion techniques.

A schematic representation of the scattering system is given in Fig. (1), where Zp and MA are, respectively, the number of protons and neutrons of the target nucleus. r and x are the position vectors of the valence electron and the incident proton, respectively, relative to the nucleus. ρ is the relative distance between them.

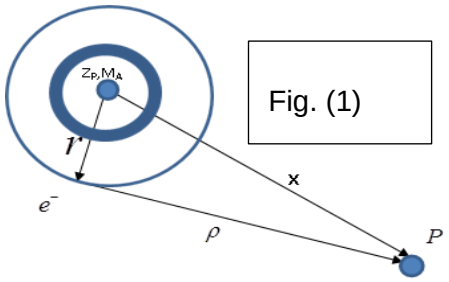

Fig. (1)

The total Hamiltonian of Channel 1 is given by

$$\mathrm{H} = H^{(1)} = H_{Li(2s)} - \frac{1}{2\mu_{\mathrm{m}}}\nabla_x^2 + \mathrm{V}_{\mathrm{int}}^{(1)} = -\frac{1}{2\mu_M}\nabla_r^2 - \frac{Z_{eff}e^-}{r} + Vc - \frac{1}{2\mu_{\mathrm{m}}}\nabla_x^2 + \mathrm{V}_{\mathrm{int}}^{(1)} \qquad (1)$$

While that of Channel 2 has the form

$$\mathrm{H} = H^{(2)} = H_{H(2s)} - \frac{1}{2\mu_{\mathrm{m}'}}\nabla_{x'}^2 + \mathrm{V}_{\mathrm{int}}^{(2)} = -\frac{1}{2\mu_{M'}}\nabla_\rho^2 - \frac{2}{\rho} - \frac{1}{2\mu_{\mathrm{m}'}}\nabla_{x'}^2 + \mathrm{V}_{\mathrm{int}}^{(2)} \qquad (2)$$

V_c is the core potential, $V^{(1)}_{int}$ and $V^{(2)}_{int}$ are, respectively, the interaction potentials of the first and second channels. The orbital wavefunctions of the lithium are obtained using an elaborate variational approach, whilst the H(2s) wavefunction is taken as $\left(\frac{1}{\sqrt{8\pi}}\right)(1-\rho/2)e^{-\frac{\rho}{2}}$. In Figures (2) and (3), respectively, are found the total elastic and H(2s) formation cross sections obtained using 8 partial waves expansion (with total angular momentum ranging from 0 to 7). The case in which the second channel is composed of the lithium ion and a mixture of H(1s) and H(2s) states is under investigation. A detailed comparison between our results and those obtained by other authors will be presented in the conference.

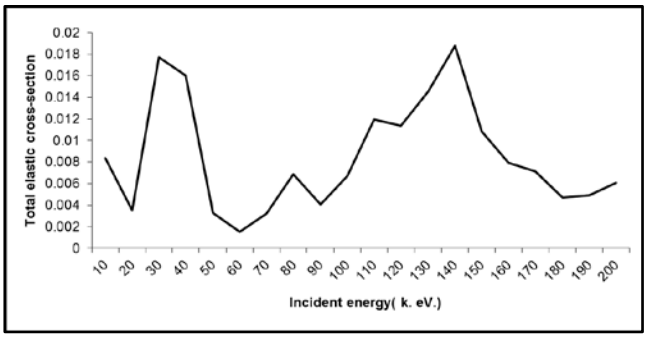

Fig. (2): Variation of the total elastic cross section (in a_0^2) with the incident energy (in eV).

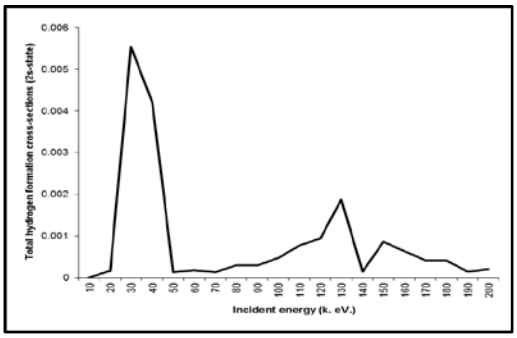

Fig. (3): Variation of the total H(2s) cross sections (in a_0^2) with the incident energy (in eV).

References:

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[2] S. Y. El-Bakry and M. A. Abdel-Rsaouf, Nuovo Cimento **19**, 637, (1997.