Effect of re-correction in the recoil energy of Projectile for the X-ray Production Cross-section by low energy Proton

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Introduction

Particle Induce X-ray Emission (PIXE) is an efficient and powerful analytical tool for major, minor, and traces elemental analysis in a variety of fields like biology, environment, medicine, archaeology, and forensic science. This technique also used for analyzing the composition of rocks, metals, ceramics, and other materials. PIXE is one the very favorable techniques because it is non-destructive, and very fast. PIXE technique has several other advantages, such as, requirement of analysis of very low concentration of trace elements, quantity of the sample is very limited etc. In this technique ion beam is used to ionize the inner shell of target atoms of the sample and then vacancy is filled by upper-shell's electrons, which leads to emission of a characteristic x-rays. Energy and intensity of these x-rays are used for identification of the elements and for elemental composition in the sample [1]

The accurate knowledge of X-ray production cross sections is important for these applications. Available literature shows discrepancy between theoretical and experimental x-ray production cross section [1-3]. The process of x-ray production cross section can be affected due to presence of various other physical processes, such as, Auger process, Coster–Kronig transition, Auger process in which the vacancy of a singly ionized atom is transferred from one of the inner shells to another and the difference in energy is released by the emission of one of the outer-shell electrons. Coster–Kronig transition, in which transitions do not produce, x-rays directly; they redistribute the primary vacancies between the different shells and between the different sub-shells of the same shell. As a result, these processes can change the intensity of the x-rays. Hence, precise knowledge of various processes is important in order to have accurate knowledge of X-ray production cross sections and correct estimation of the elemental composition of the sample.

In previous study, the effect of different data sets of fluorescence yield, emission rate and also effect of screening constant was investigated where, no significant improvement observed in the discrepancy between theory and experimental data [4,5].
In ion atom collision, although the recoil energy for low mass ions, is not significant, its effects has been investigated on K shell x-ray cross section in the case of H^+ ions impact on Cu target.

Theoretical Model:

Plane wave Born approximation (PWBA) and energy-loss Coulomb-repulsion perturbed-stationary-state relativistic (ECPSSR) theoretical predictions is used [6].which is known as ECPSSR theory, the details of theoretical model describe in details elsewhere [6-12] ECPSSR theory includes various physical processes, such as, projectile energy loss, Coulomb deflection of the projectile, perturbation of electron's stationary state (polarization and binding), as well as relativistic effect.

Result and Discussion:

The X-ray cross section have been calculated for K shell for H^+ ions incident on Cu for various energies where experimental data available [1].. Calculations were performed without considering recoil energy and with a re-correction for the recoil energy. Results of both the calculations are shown in plot (figure 1.) and also compared with the experimental data. In these calculations emission rates and fluorescence yields are taken from Campbell [8] and Krause [9].

Since theoretical model has this correction but if we consider again it in projectile then the discrepancy between experiment and theoretical x-ray cross section for K shell seems to be reduced from 12% to 5% due to the re-correction of recoil energy (figure 1.).This demonstrates theoretical need to correction to reduce discrepancy with experiment. For have a clear picture, a systematic investigation is being done to check the effect on various targets and projectiles combinations, which will be presented during the symposium.

Acknowledgement: Author is thankful for the research fellowship provided by Banaras Hindu University under Ph.D. registration No. (PHY/RES/RET (Qualified-2013/2013-2014/923 dated 20.11.2013).

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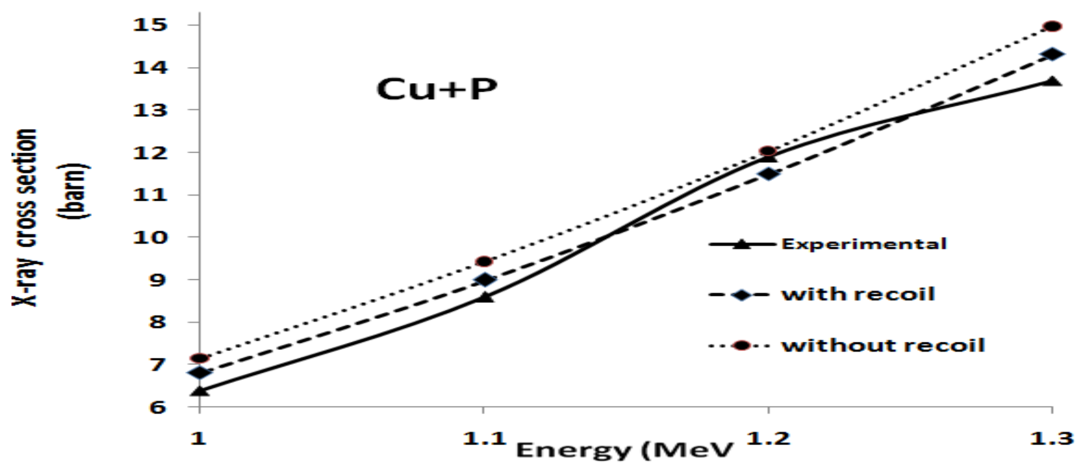

Figure 1. Plots for K shell x-ray production cross sections for H^+ ions on Cu target. The dotted (Without recoil) and dashes curve (with recoil) are the theoretical calculations and solid line represent the experimental data taken from reference [1].