Investigation of Screening effect on production of K-shell X-ray by low energy Proton

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Introduction

Measurement of ionization Cross-sections by impact of a charged particle is a useful tool for elemental composition analysis and it is also provide knowledge about various atomic properties, and fundamental research involving projectile charge change and energy loss, recoil ion production, vacancy rearrangement in target atom and X-ray production cross section. It has been observed that when theoretical K -shell X-ray production cross-section from low energy H^+ ions with atoms are compared with the experimental cross section significant discrepancy observed particularly in low energy region [1]. This unsolved problem motivated to carry out detailed study for proper understanding of the excitation mechanisms and atom –ion interaction processes. Theoretical model ECPSSR also fail to explain the direct ionization cross section for low velocity projectile in several study [4]. In ECPSSR based theoretical investigation the need of more accurate value of the binding energy of the active target electron (U_{2s}) was suggested. It is important to mention here that U_{2s} is mainly depend on the screening constant (s_{2s}) for the concerning electron in the sub shell. The screening constant is calculated from the Slater 's rule. Therefore it is interesting to investigate the effect of screening constant's value on the x-ray production cross section. In this work, a specific case of s electron was chosen for the investigation and ECPSSR calculations were carried out for Cu ($4s^1$) and Ag ($5s^1$) targets using low energy H+ projectile. Further interest to investigate these x-ray production cross section was that the ECPSSR under predicts the cross section for Ag target and over predicts the cross section for Cu target. Another target Cd (Cadmium) has been selected to see the effect of screening values.

Model details

The details of the ECPSSR model are described else where [2,3,7] which is based on the PWBA and it also includes the effect of projectile energy loss (E), Coulomb deflection of the projectile trajectory (C), polarization effects of the target electron and relativistic (R) effects. In the present work investigation of the effect of the screening constant on X-ray production cross section has been studied for s-electron (for K-shell x-ray production).In the present calculation for K-shell emission rate [8,9] and fluorescence yield[6] has been taken.

Results and discussion:

ECPSSR calculations for K-shell x-ray production were carried out for H+ projectile for low energy range for which experimental data is available [1]. The value of screening constant was s=0.30 as per Slater's rule for k-shell electron. In this work the value of screening constant was varied in steps up to the 50% (up and down) from the suggested value in order to see it's effect on the x-ray production cross section. Results for Cu ($4s^1$) target are shown in figure 1 and compared with the available experimental data [1]. The agreement between experimental and theoretical data seems to improve very little when once consider s= 0.45 and it deviates further for lower value i.e. s= 0.15 compare to the standard value (s=0.30). On the other hand for Ag ($5s^1$) target, the results of ECPSSR calculations show about 30% deviation from the experimental data for choosing the screening constant value calculated using the Slater's rule for k-shell electron for the standard value s=0.30. Further calculation show almost no change in the x-ray production cross section with the variation of s value as shown in figure 2.in similar way we have calculated x-ray cross section for Cd target, calculation are shown in figure 3. From these calculations we see almost no effect in K-shell X-ray production cross section due the change in screening factor. For L-shell, calculations are being done and results will be presented later.

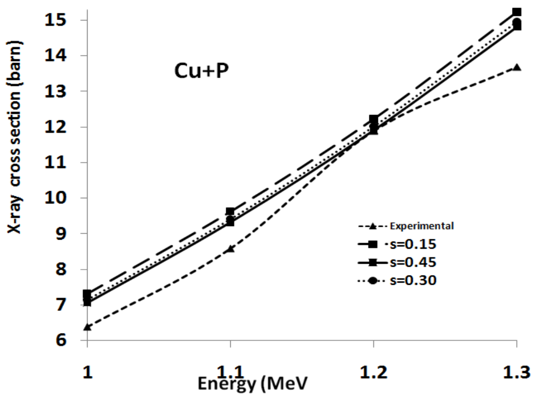

Figure 1: fig. shows K shell X-ray production cross section calculated for Cu target using low energy proton beam and compared with experimental data was taken from [1].

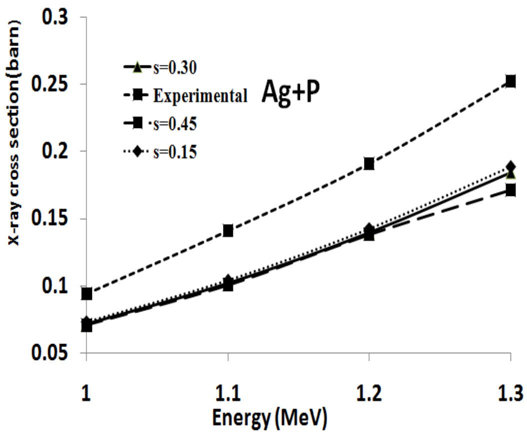

Figure 2: fig. shows K shell X-ray production cross section calculated for Ag target using low energy proton beam and compared with experimental data was taken from [1]

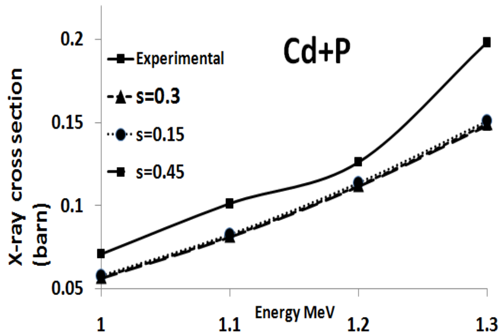

Figure 3: fig. shows K shell X-ray production cross section calculated for Cd target using low energy proton beam and compared with experimental data was taken from [1]

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