

High-resolution x-ray spectra from highly charged Si, S and Cl ions showing evidence of fluorescence active resonant states

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Synopsis We have measured the x-ray spectra from highly charged Si, S and Cl ions in collisions with thin foils using a high-resolution x-ray spectrometer. The observed lines have been assigned to various transitions in H-, He- and Li-like ions. For proper identification of line positions, the theoretical calculations have been carried out using a state-of-the-art MCDF code including QED effects, with which the experimental data is in excellent agreement. We have also observed, for the first time, x-rays arising out of the decay of long-lived resonant states in the He-like ions of each species. Details will be presented.

Atomic and ionic systems with two or more electrons are known to possess doubly excited or ‘resonance’ states, which are actually discrete states embedded in the first ionisation continuum [1]. The dominance of fluorescence over autoionisation for some He resonance states has been studied experimentally in recent literature [2]. Theoretical studies have also been carried out in the last decade [3]. Saha et. al. [4] have given a criterion for this dominance based on the symmetry properties of the state, and have predicted detectable levels of fluorescent decay from some doubly excited states of He, which are conventionally classified as autoionising states. Since the symmetry properties are independent of atomic number Z , this criterion should hold for highly charged He-like ions also.

In this abstract, we present the first confirmation of these predictions, through the experimental observation of the $2p3d^1P^o \rightarrow 1s3d^1D^e$ transition in the high resolution x-ray spectra of He-like Si, S and Cl ions. The experiment was carried out at the 14MV pelletron accelerator facility at TIFR, Mumbai. A well-collimated beam of highly charged ions of energy 80 MeV was made incident on a thin carbon foil of thickness $30 \mu\text{g}/\text{cm}^2$. The spectra were recorded using a high resolution bent-crystal spectrometer, which is described in detail in [5]. Briefly, this instrument consists of a curved crystal of ADP, mounted on a Rowland circle of diameter 25.4 cm, in Johansson geometry. The detector is a P-10 gas-flow type proportional counter.

A typical spectrum in the case of 80 MeV Si ions is shown below (see figure 1). Various groups

of lines are seen, of which the prominent lines below 2050 eV are due to transitions from $N = 2$ to $N = 1$. The remaining lines, above 2100 eV are all due to transitions from $N = 3$ to $N = 1$. Similar trends are seen in S and Cl spectra also.

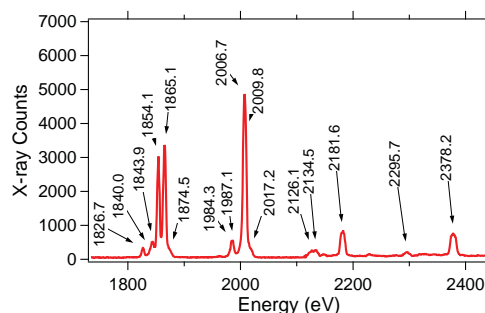


Figure 1. Typical x-ray spectrum from 80 MeV Si ions (Doppler corrected)

References

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