Molecular Orbital interpretation to the couplings in collisions of 2.5 and 3 MeV $Xe^{10+,12+}$-Au and Zr systems

Punita Verma*[1], Kajol Chakraborty*†, Ruchika Gupta*†, Sarvesh Kumar*, Gaurav Sharma‡, Deepak Swami‡, Samit K. Mandal†, C.P. Safvan‡.

[*] Department of Physics, Kalindi College, University of Delhi, New Delhi, India
[†] Department of Physics and Astrophysics, University of Delhi, Delhi, India
[‡] Inter University Accelerator Center, Aruna Asaf Ali Marg, New Delhi, India

Synopsis Super heavy quasimolecules formed during slow, heavy-ion, heavy-atom collisions provide a tool for investigating the inner shell couplings. Correlation diagrams have been drawn for the Xe-Au, Zr collision systems which allow a satisfactory qualitative explanation for the experimentally observed enhanced cross sections.

Super-heavy quasi-atoms or quasi-molecules can be approached in relatively slow, heavy ion-heavy atom collisions which are slow compared to the orbital velocity of the innermost electrons K or L. A renewed interest has been generated recently in these super-heavy atomic systems with united atomic numbers far beyond existing matter (i.e.$Z_{UA}=Z_1+Z_2>100$, Z_1 and Z_2 being the atomic numbers of the projectile and target respectively). The normal Dirac equation for a point charge cannot be solved beyond $Z_{UA}=137$. By providing vacancies in the inner shells of the projectile inner shell couplings can be investigated by an observation of x-ray emission in the separated partners or in the quasi-molecule itself.

The Low Energy Ion Beam Facility (LEIBF) at Inter University Accelerator Centre (IUAC), New Delhi with its 10GHz ECR ion source was used to bombard 2.5 & 3 MeV $Xe^{10+,12+}$ ions on 640μg/cm^2 Au targets and 250μg/cm^2 Zr target on a carbon backing of 40μg/cm^2. X-Rays emitted were detected by a KETEK SDD and a CANBERRA LeGe detector.

The intensity ratios and cross sections have been measured for Xe and Zr L X-rays and Au M X-rays. Au M_α and Zr L_α have been observed with higher intensities as compared to Xe L_α X-rays (Figure 1). As the charge state of projectile was increased, enhanced intensities of target X-rays has been observed, an effect observed similarly by Ying *et al.*[1]. The results agree with previous known values[2]. These observations indicate an additional phenomena apart from well known electron capture or coulomb ionisation. Molecular Orbital approach is applicable to collision systems in the quasi-molecular regime <1 (adiabaticity parameter) which is the case for these collision systems.

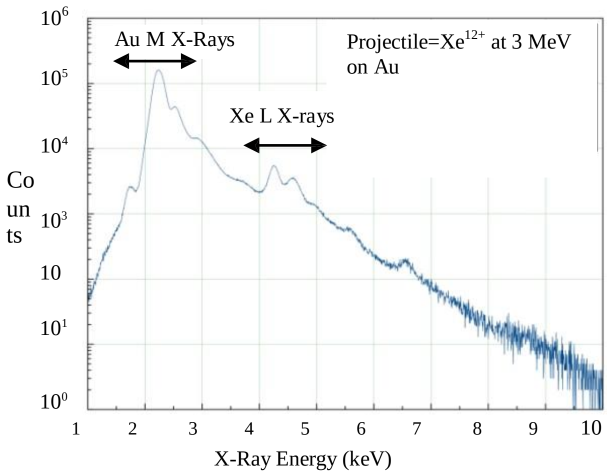

Figure 1. 3 MeV Xe^{12+} on Au target X-ray spectra

Diabatic correlation diagrams for Xe on Au and Xe on Zr collision systems indicate clearly the finite probability of direct ionization of 4f and 3d shells of the united atom. For Xe on Au collison system, the incoming vacancies in the outer shells of Xe may experience an easy transfer to Au M through the correlated Xe 3p levels and united atom (Z=133) 4d levels. The latter are further correlated to the Au 3p levels. High intensity ratios of Au M X-Rays observed thus seems to be obvious. Zr L X-rays exhibit similar behaviour. Either symmetric or antisymmetric systems in the low energy region will be investigated further for clarity of vacancy transfer mechanism at these low energies [3].

References

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[1] E-mail: drpunitaverma.nature@gmail.com