A.2.4. Elastic Scattering of Electrons from Metastable Ions — Formation of Triply Excited States--*Patrick Richard and Chander Bhalla*

The collision of a (1s2s) ^{3}S metastable ion with a quasi-free target electron can lead to the capture of the electron into an excited state nP (n$\exists$2) while a 1s projectile electron can be excited into a n'P' (n'$\exists$2) state, producing a double vacancy in the K-shell, i.e., a hollow ion. The experimental signature of the production of triply excited ionic projectile states would be the detection of the electrons resulting from the decay by autoionization of such states. The process can be written schematically as

$$e^- + (1s2s)\ ^3S\ \Psi\ (2snPn'P')\ ^{2S+1}L_J\ \Psi\ e^-_A + (1s2s)\ ^3S \qquad (1)$$

which can be referred to as resonance elastic scattering or dielectronic excitation plus decay. A schematic of this process is shown in Fig. 1 of Section A.2.3 for $F^{7+} + e^-$.

We have observed triply excited hollow ionic states in $B^{3+} + e^-$ [see Benis, *et al.*, Abstract #86] and $F^{7+} + e^-$ [see Zavodszky, *et al.*, Abstract #76] systems. Figure 1 shows the data for the F^{7+} case.

In the process of this research we have discovered a method of producing ion beams with and without a metastable component. The metastable fraction in an ion beam depends on the ion beam energy at which the stripping of the ion occurs. It is possible to produce a beam of a given energy by stripping the ion either in the terminal of a tandem Van de Graaff accelerator or after acceleration, resulting in beams with different metastable fractions. Ion stripping in the terminal of the tandem occurs at a lower energy than ion stripping after acceleration. If a configuration can be found, whereby the terminal stripping occurs at an extremely low energy, then it is possible that no 1s2s state would be excited, and therefore, there would be no metastable ^{3}S states formed. We came to this interpretation of the metastable components based on the observation that the Auger electron spectra from the beams produced by terminal stripping and post-acceleration stripping are different. This difference in spectra provides us with a unique way of identifying triply excited resonance states formed by the interaction of quasi-free target electrons with metastable ions.

(P.A. Zavodszky, H. Aliabadi, M.W. Gealy, E.P. Benis, T.J.M. Zouros, C.P. Bhalla, T.J. Gray, and P. Richard collaborated on this research project.)

<u>Publications Related to the Formation of Triply Excited States</u>:

Abst. #76: "Evidence for Triply Excited Hollow Ionic States," by Zavodszky, *et al.*

Abst. #86: "Production of Triply Excited in Li-like Boron," by Benis, *et al.*

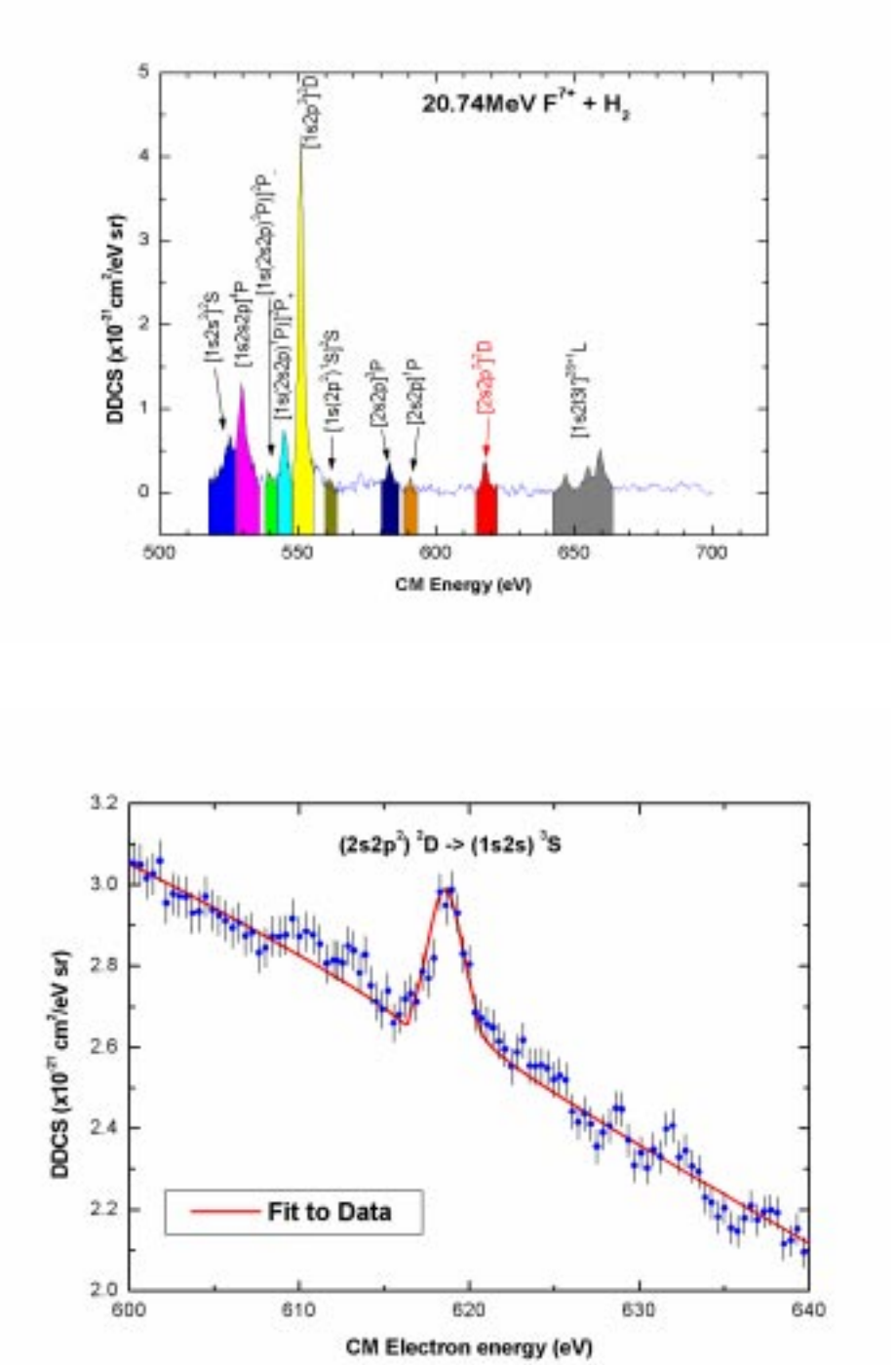

Figure 1. Zero degree Auger electron spectra for 20.74 MeV F^{7+} + H_2 (upper figure). Experimental and theoretical cross sections for the $(2s2p^2)$ ^2D triply excited state formed by electron elastic scattering from the $(1s2s)$ ^3S metastable ion (lower figure).