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THRESHOLD BEHAVIOR IN ELECTRON EXCITATION OF Na

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Total cross sections and optical excitation functions for electron collisional excitation of atoms have generally involved the most strongly bound excited states. In particular, high-energy-resolution studies tend to concentrate on these states in order to achieve acceptable S/N. However, the higher states often play a major role in plasmas, and can exhibit very different excitation behavior. We have built an apparatus to study the optical excitation functions in the threshold region for more highly excited states of metal atoms. A high-flux atomic beam from a recirculating oven is used to produce a relatively dense and concentrated target, while minimizing work-function drifts due to metal vapor coatings on the electron optics. A long, cylindrical trochoidal monochromator is used to minimize space charge effects in the monochromator and thereby achieve acceptable electron currents and S/N for these small excitation cross sections. About 25% of the optical emission is reflected to a photomultiplier.

Optical excitation functions for the 6S, 4D, 5D, and 4P states of Na have so far been measured with electron energy resolutions of 30 – 100 meV. These states are characterized by 0.5 – 1.5 eV of binding, and are highly polarizable. The *S* and *D* state excitation functions rise very rapidly at threshold to a nearly constant value, then slowly decrease with increasing collision energy. The energy range in which they rise to a maximum varies, but is in all cases less than 100 meV. There is some evidence for individual resonances at the present resolution and S/N, but these are not pronounced in the S and D state data. In contrast, the P state excitation rises more gradually and clearly shows structure. There are theoretical reasons to expect a sequence of resonances, which may not be resolved at our present resolution.[1] Data for 4D and 4P state excitations are shown in Figures 1 and 2. These have been normalized to the data of Ref. 2 at the higher energies.

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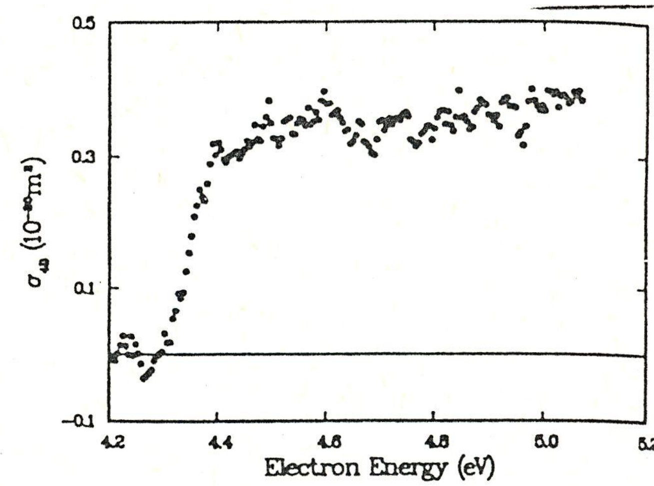

Figure 1. Optical excitation function for the Na, 4D-3P transition, obtained with ~ 40 meV energy resolution.

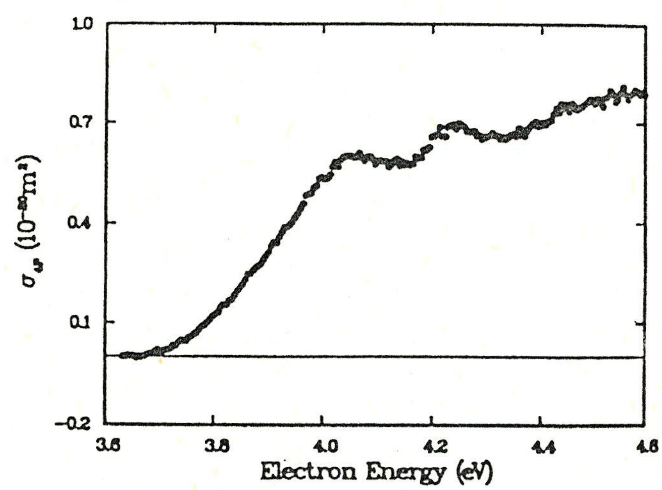

Figure 2. Optical excitation function for the Na, 4P-3S transition, obtained with an electron energy resolution of ~ 50 meV.

References

1. H. L. Zhou, B. L. Whitten and D. W. Norcross (private communication).

2. J. O. Phelps and C. C. Lin, Phys. Rev. A 24, 1299 (1981).