An electron-electron coincidence \([e,2e]\) technique was used to investigate atomic ionization by electron impact in the neighborhood of autoionizing resonances. Differing binary \((I^+\) and recoil \((I^-\) lobe intensities in coplanar \((e,2e)\) ejected-electron angular distributions were analyzed in terms of interference cross-terms, between opposite parity final-state continua, that change sign when \(\theta_{ej} \rightarrow \theta_{ej} + 180^\circ\) in the angular distributions. The magnitude of these cross-terms varies rapidly with ejected-electron energy across overlapping autoionizing resonances. The energy variation in the interference terms may be examined by obtaining the sum \((I^+ + I^-)\) and difference \((I^+ - I^-)\) of \((e,2e)\) energy spectra measured at ejected-electron angles \(180^\circ\) apart.

### Cadmium \((e,2e)\) interference experiments

Comprehensive sets of cadmium \((e,2e)\) measurements and their analysis were completed at up to eight scattering angles between 2 and 18°, corresponding to values of momentum transfer 0.2 to 1 a.u.. The sum and difference spectra have been compared with calculations that included \(J = 0 \rightarrow 7\) partial waves with phases for \(J = 0, 2\) shifted by the amounts found for the small angle experiments. The shape of the calculated sum and difference spectra then agrees well with the experimental results for all scattering angles; the magnitudes of the calculated difference spectra (normalized to the sum spectra) differ considerably from the experiments [1-3].

### Exchange effects in \(Cd\) \((e,2e)\) energy spectra

As the scattering angle was increased from 2° to 15° the relative peak intensities of the \(3P_1\) and \(1P_1\) \(4d^95s^25p\) autoionizing resonances in the \(Cd\) \((e,2e)\) sum spectra changed by a factor of three. This is due to electron-impact exchange processes and has been explained in terms of a semi-empirical model which seeks to parameterize all the data in terms of a single constant [4].

### \(Cd\) \(J = 3\) autoionizing levels

A by-product of the \((e,2e)\) experiments was the observation at \(\theta_{sc} = 18^\circ\) of previously undetected \(4d^95s^25p\) \(J = 3\) levels. The parity favored/unfavored nature of the autoionizing process for these levels resulted in striking intensity variations within the momentum-transfer and \(P_3\) spectra [5].
DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
Cd photoelectron experiments

In a collaboration with researchers from ORNL and UCF, electric dipole-quadrupole interference effects in cadmium photoelectron spectra were measured [6]. As well as being of interest in their own right, these experiments are the direct photon analogue of the (e,2e) experiments and provide valuable information for the analysis of the (e,2e) experiments. The experiments represent the first observation of interference between dipole and quadrupole amplitudes for the photoexcitation of autoionizing levels of different parity. Furthermore, for the cadmium target used, these levels correspond to extremely low photon energies (< 15 eV) for which the non-dipole effect is a fraction of 1% of the dominant dipole amplitude. Such tiny effects may be detected because of the rapid variation of the interference amplitude $\sigma_{12}$ as the photon energy is swept through an autoionizing resonance. Thus the experiment and the data analysis closely follow the techniques used in the (e,2e) experiments. The photoelectron experiment detected the dipole-quadrupole interference between $4d^95s^25p J=1$ and $5p6p^5P_2$ autoionizing resonance.

Selected Publications