Presented at the Fourth International
Conference on Beam Foil Spectroscopy,
Gatlinburg, Tennessee, Sept. 15-19, 1975.

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September 15, 1975

Prepared for the U. S. Energy Research and
Development Administration under Contract W-7405-ENG-48

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RADIATIVE DECAY OF THE 2^3P STATES OF HELIUMLIKE ARGON*

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We would like to report preliminary results on a measurement of the lifetimes and wavelengths of the allowed E1 decays from 2^3P states of heliumlike Ar XVII. These decays are observed using a vacuum ultraviolet monochrometer to view the decay radiation of the transitions 2^3P_2 - 2^3S_1 and 2^3P_0 - 2^3S_1.

Previous studies of the 2^3P states of high Z (Z > 10) heliumlike atoms have been mainly concerned with measuring lifetimes for the 2^3P_2 state. This state has been observed by viewing the M2 radiation emitted in the decay 2^3P_2 - 1^1S_0, which for $Z \gtrsim 18$ becomes the dominant decay mode, exceeding the E1 mode, 2^3P_2 - 2^3S_1.[1,2]

The M2 decay of the 2^3P_2 state was first observed in Ar XVII by Marrus and Schmieder,[3,4] and its lifetime was found to be 1.7(3) nsec. This measurement was complicated by the inability to resolve the M1 decay 2^3S_1 - 1^1S_0 of 3104 eV from the M2 decay of 3126 eV using high resolution (~ 200 eV) Si(Li) detectors. Subsequent measurements have been made on S XV, Cl XVI, Ti XXI, V XXII, and Fe XXV by Cocke, et al.[5] and Gould, et al.[6] Cocke, et al., were able to resolve the M2 decay by making use of a doppler tuned spectrometer,[7] with a resolution of ~3 eV.

The 2^3P_0 state can normally only decay by E1 to the 2^3S_1 state, and as such has not been observed for Z > 10. For nuclei with hyperfine structure, the effect of mixing of the 2^3P_2 and 2^3P_0 states with the 2^3P_1 state (which in high Z atoms is quenched to the ground 1^1S_0 state by spin-orbit mixing with $^1P_1$ states) has been demonstrated in V XXXII.[6]

In our studies we are using a 1/2 meter Seya-Namioka Monochrometer, mounted with the entrance slit perpendicular to the beam line. The instrument views the decaying atoms at 90° from the beam line. The grating is a tripartite replica grating, coated with platinum, and most of our data has been taken with the slits at 200 microns, giving instrumental widths of 3.9 angstroms. The detector is a Bendix Continuous Dynode electron multiplier, operated in the pulse counting mode.

Presently we have been able to measure the lifetimes of the two states and are now working on an accurate wavelength measurement. Lifetime data was accumulated in the following manner.

The 2^3P_2 - 2^3S_1 and 2^3P_0 - 2^3S_1 wavelengths are calculated to be 559.8(17) and 662.3(20) angstroms, respectively.[8] After bending and focusing the 140 MeV Ar beam from the Lawrence Berkeley Laboratory super-HILAC, we collimated the beam through 1/4 inch collimators 12 feet apart. At this beam energy the acceptance angle of the monochrometer contributes 4.8 angstroms to the linewidth. Time-of-flight lifetimes were measured using a 49 $\mu gm/cm^2$ carbon foil mounted on a moveable track, and scaling counts while looking at fixed wavelength points in the background, 10 angstroms above and below the line center, as well as directly under the line center. The data points were normalized to the integrated beam current collected in a Faraday cup. With beam currents of 300 charge namp we observed count rates of ~3 counts per second.

Three separate lifetime measurements were made for the 2^3P_2 - 2^3S_1 decay, and two for the 2^3P_0 - 2^3S_1 decay. The data was analyzed by averaging the background count rates, subtracting them from the data, and fitting the resulting signal count rates to single exponentials.

For 2^3P_2 - 2^3S_1 we took eight data points over 9 cm. For 2^3P_0 - 2^3S_1 we took 13 data points over 17 cm. For the 2^3P_0 - 2^3S_1 decay, the five closest points to the foil do not lie on an exponential decay curve and had anomalously high count rates. The concave nature of the decay curve cannot be explained by cascading through the 2^3P_0 state. At this time we do not know how to account for this observation and these points are ignored in fitting the data. Fitting the last eight points with a single exponential we obtain the lifetime.

The results of these experiments are shown in Table I where for comparison calculated lifetimes are given, both including Lamb Shift effects, and neglecting them.[6] The quoted error includes the error in fitting the lifetimes, plus a 6% uncertainty in the beam energy. These errors are added algebraically. Other systematic errors are calculated to be well under 1%.

0 0 0 0 4 4 0 2 2 3 2

TABLE I. OBSERVED AND PREDICTED LIFETIMES

($2^3P - 2^3S_1$) of Ar XVII (nsec)

	$2^3P_2 - 2^3S_1$	$2^3P_0 - 2^3S_1$
Observed	1.62(8)	4.87(44)
Predicted without Lamb Shift	1.51(4)	4.70(12)
Predicted with Lamb Shift	1.52(4)	4.82(12)

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* Work supported by the Energy Research and Development Administration.

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