Isotope Shift in the Mo Spectrum*

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The isotope shift in the molybdenum spectrum was measured with a Fabry-Perot interferometer, using separated isotopes. For the line 16 578*K*, a definite minimum isotope shift of −8.9 mK was observed between Mo^{96} and Mo^{97}. The negative sign indicates that the direction of the shift is opposite to that predicted by the volume effect.

THE nuclear spin of Mo^{95} and Mo^{97} and the isotope shift between these isotopes were measured previously.[1,2] The present investigation started at the University of Wisconsin[3] and was continued at Montana State College[4] and at Denver Research Institute, University of Denver.

The experimental setup consisted of 5 parallel hollow cathode tubes and a modified Steinheil three-prism spectrograph with a Fabry-Perot interferometer in the parallel beam between the collimator and the first prism. The spacers used in the interferometer were of lengths 15, 18, 20, and 25 mm. The coating on the plates was silver in most of the exposures and multilayer dielectric in the others. The reflectivity exceeded 90%.

High-purity isotopic samples of the seven molybdenum isotopes (92, 94, 95, 96, 97, 98, 100) were available,[5] each isotopic sample being greater than 90% pure.

Two multiplets were observed: ${}^5P^0(4d^55p) \rightarrow {}^5S(4d^55s)$ resonance lines, and the ${}^5P^0 \rightarrow {}^5D(4d^45s^2)$ series. The intense resonance lines could be read on all plates for all samples, but not all lines of the ${}^5P \rightarrow {}^5D$ series could be read. Because of interfering hyperfine structure in the odd isotopes, the isotope shifts for Mo^{95} and Mo^{97} could be measured only for one line (16 578*K*; ${}^5P_3{}^0 \rightarrow {}^5D_4$). This line shows a very narrow hfs, which was unresolved by the interferometer.

Because of the large amount of data involved, the photographic plate readings were converted to wave number differences on the Datatron 205 computer at the Denver Research Institute, University of Denver. The programing was done by one of the authors.

The experimental isotope shift values for the line 16 578*K* are shown below:

92–94	94–95	95–96	96–97	97–98	98–100	
21.3	1.8	22.4	−8.9	16.7	25.0	(mK)

Errors were not calculated for each reading separately; an over-all analysis indicates that the average error is about ±2 mK. Theoretical values for the simple volume effect (using a semiempirical formula of Crawford and Schawlow[6]) were about 1.5 times the observed values, when a nuclear radius of $1.2\times10^{-13}A^{\frac{1}{3}}$ cm was used. Observed values were taken as positive when they agreed in sign with the volume effect.

There is a definite minimum in the isotope shift for isotopes 96–97 (neutron numbers 54–55), with a reversal of the sign of the shift. This minimum isotope shift has been observed by Hughes[7] at the same neutron numbers in the ruthenium spectrum.

Observed discrepancies between the shifts for $4d^55s$ and $4d^45s^2$ configurations were satisfactorily explained as caused by screening.

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[2] H. Arroe, *Studier over Spektralliniers Struktur* (Nordisk Bogtrykkeri, Copenhagen, 1951), pp. 46–51.

[3] Supported by the Office of Ordnance Research.

[4] Supported by the Research Corporation and later by a grant by the National Science Foundation.

[5] Produced by the Y-12 plant, Carbide and Carbon Chemicals Corporation, and obtained by allocation from the U. S. Atomic Energy Commission.

[6] M. Crawford and A. Schawlow, Phys. Rev. **76**, 1310 (1949).

[7] R. Hughes, Bull. Am. Phys. Soc. **4**, 262 (1959).