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We believe a nuclear resonance effect between a kaonic and a nuclear transition in ^{98}Mo has been observed. Our measurement gives $I(n{=}6\rightarrow5)/I(n{=}7\rightarrow6) = 0.35 \pm 0.2$. Dynamic E2 mixing caused kaons to be strongly absorbed from the atomic state $|n = 6, \ell = 5\rangle$ in agreement with theoretical predictions.

Several authors(1) have considered the effect of dynamic E2 mixing of the states of nuclei and hadronic atoms. The effects were generally believed to be small. However, M. Leon(2) found that for certain nuclei the effect would be significant for kaonic atoms and would drastically alter the intensity ratios of some of the x-ray lines. The effect occurs when the energy of a nuclear excited state nearly equals a kaonic atom deexcitation energy. Leon predicted that in ^{98}Mo the ratio $I(n = 6\rightarrow5)/I(n = 7\rightarrow6)$ should be attenuated from 0.93 (no mixing) to 0.18 (with mixing). We found the ratio to be 0.35 ± 0.2 . Mixing of the $|\text{kaon } n{=}6, \ell{=}5\rangle$ $|\text{nucleus } 0^+ \text{ ground state}\rangle$ with the $|\text{kaon } n{=}4, \ell{=}3\rangle$ $|\text{nucleus } 2^+ \text{ excited}\rangle$ caused kaons to be strongly absorbed from the new $|n = 6, \ell = 5\rangle$ eigenstate.

Using the new high efficiency kaon beam at the Bevatron, we obtained the kaonic x-ray spectra of ^{98}Mo and ^{95}Mo. In a previous paper(3,4) we reported the intensities of the kaonic x rays of ^{nat}Mo. We noticied that the $n = 6 \rightarrow 5 + n = 8 \rightarrow 6$ intensity was lower than for neighboring elements but were not certain of its significance before testing some pure isotopes of Mo. In the original spectrum of ^{nat}Mo, the $n = 8 \rightarrow 6$ and $6 \rightarrow 5$ peaks are almost resolved and we can estimate that 0.7 of the x rays belonged to the $6 \rightarrow 5$ transition. This leaves $I(6 \rightarrow 5) = 0.08 \pm 0.02$. In the new spectra the $8 \rightarrow 6$ and $6 \rightarrow 5$ lines are well resolved, but the numbers of x rays are small due to limited accelerator time.

Table I shows the results of our measurements. We could not make a new calibration of the number of kaons stopped. Therefore, absolute intensities are given for the new data by setting the ^{98}Mo $n = 8 \rightarrow 7$ intensity equal to that of ^{nat}Mo. There should be no isotope effect for $8 \rightarrow 7$ transitions. We know the relative number of kaons stopped in ^{98}Mo and ^{95}Mo and found $I(8 \rightarrow 7)$ equal for the two targets.

The new data verify that radiative kaonic transitions $n = 6 \rightarrow 5$ are significantly fewer in Mo than for nearby elements. If we interpolate between $Z = 37$ and 50, we expect $Z = 42$ to be 0.25 ± 0.05. See Fig. 1 of Ref. 4 . Instead we find 0.08 ± 0.02.

From the data of Table I, ^{98}Mo gives $I(6 \rightarrow 5)/I(7 \rightarrow 6) = 0.35 \pm 0.2$ in agreement with Leon's calculation. The question might be raised as to why the $6 \rightarrow 5$ intensities of ^{nat}Mo and ^{95}Mo are so low. Consider the isotopic composition of ^{nat}Mo. Three of the isotopes, 94, 96, and 98 are even-even with 0^+ (spin, parity) ground states and 2^+ levels in the region of 800 kev. They constitute 49.3% of ^{nat}Mo. Thus considerable mixing and attenuation are expected.

It is not understood why ^{95}Mo ($5/2^+$ ground state) also exhibits attenuation. We chose it as a control mainly because it was not an even-even nucleus and was available. It has several levels around 780 keV but they would not be expected to contribute significantly to the mixing unless their quadrupole moments were inordinately large. A better control would be ^{92}Mo.

In conclusion, we have for the first time observed the effect predicted by Leon, that kaonic atom intensities need not be smooth functions of Z if the nucleus has a correctly placed excited state that is reachable from the ground state by an E2 transition. The measured attenuation gives a constraint on the width and energy shift of the previously inaccessible kaonic $n = 4, \ell = 3$ level.

We express our appreciation to the Bevatron Engineers, especially Christoph Leemann, for the new beam and to the Nuclear Instrumentation Group for the latest models of their x-ray spectrometers.

FOOTNOTE AND REFERENCES

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TABLE I. Intensities of Mo kaonic x-ray lines. Data for ${}^{nat}Mo$ were taken from Ref.3. Column 1 lists the targets. Columns 2 and 3 give the principal quantum numbers of the initial and final states. Intensities in x rays per kaon stopped in the targets are listed in column 4 and their statistical errors in column 5.

Nuclei	n_i	n_f	I x rays per K_{stop}	ΔI
${}^{nat}Mo$	8	7	0.21	± 0.016
	7	6	0.21	± 0.015
	8	6	0.03	± 0.01
	6	5	0.08	± 0.02
${}^{98}Mo$	8	7	*0.21	± 0.035
	7	6	0.17	± 0.035
	8	6	0.05	± 0.03
	6	5	0.06	± 0.03
${}^{95}Mo$	8	7	0.21	± 0.044
	7	6	0.29	± 0.052
	8	6	0.04	± 0.04
	6	5	0.07	± 0.04

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