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A CORRECTED COMPILATION OF DATA ON THE LIFE-TIME OF THE T2P3/2 STATE OF CESIUM

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Author

Link, John K.

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University of California

Ernest O. Lawrence
Radiation Laboratory

A CORRECTED COMPILATION OF DATA ON THE LIFE-TIME OF THE ⁷²P STATE OF CESTUM

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UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

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A CORRECTED COMPILATION OF DATA ON THE LIFETIME

OF THE $7^2P_{3/2}$ STATE OF CESIUM

John K. Link

May 1966

A Corrected Compilation of Data on the Lifetime
of the $7^2P_{3/2}$ State of Cesium

John K. Link

Inorganic Materials Research Division,
Lawrence Radiation Laboratory and
Department of Chemistry, University of California,
Berkeley, California

May 1966

The lifetime, τ_m , of an electronic state m can be computed from f -values for specific transitions depopulating the state if and only if f -values for all depopulating transitions are known. Equations (1) and (2) give the necessary relations.

$$1/\tau_m = 1/\sum_n A_{mn} \quad (1)$$

$$f_{nm} = 1.51\lambda_{mn}^2 A_{mn} g_m/g_n \quad (2)$$

Where λ_{mn} is the wavelength for the transition in cm, g_m and g_n the statistical weights of the upper and lower states respectively, and A_{mn} the transition probability for the transition in sec^{-1} .

Altman and Chaika¹ in their recent paper on "Determination of the Lifetime of the Excited $7^2P_{3/2}$ State of Cesium from Double Resonance Experiments" fail to use these relations properly by trying to convert reported f-values for the $6^2S_{1/2} - 7^2P_{3/2}$ transition to a lifetime for the $7^2P_{3/2}$ state. The $7^2P_{3/2}$ state can decay to four lower states by allowed transitions: $6^2S_{1/2}$ (4555 Å), $7^2S_{1/2}$ (29,318 Å), $5^2D_{5/2}$ (13,605 Å), and $5^2D_{3/2}$ (13,427 Å).

Tolman,² Minkowski and Mühlenbruch,³ Kvater,⁴ and Vainshtein⁵ report f-values only for the $7^2P_{3/2} - 6^2S_{1/2}$ transition so their numbers can only be used to compute an upper limit for the lifetime. It should be noted that Tolman² makes the same error in trying to convert his single f-value to a lifetime. Stone⁶ does give theoretical f-values for all four transitions, but they lead to a lifetime which is at least a factor of ten too short. Althoff⁷ only reports a lower limit of 1.6×10^{-7} sec for the lifetime and not 1.16×10^{-7} as Altman and Chaika¹ list in their paper. A corrected version of their comparison table follows where the starred * values are theoretical.

A Corrected Comparison Table on the Lifetime
of the $7^2P_{3/2}$ State of Cesium

Reference Number	2	3	8	7	4	9	6	5	1
$\tau \times 10^7$ sec	<8.6	<5.4	2.5	≥ 1.6	<4.9	1.21*	.07*	<2.9*	2.5

A recent (vapor pressure independent) measurement of the lifetime of the $6^2P_{3/2}$ state of Cesium¹⁰ agrees with the results of Kvater⁴ to better than 10%. If Kvater's result for the $7^2P_{3/2} - 6^2S_{1/2}$ transition probability is combined with Altman and Chaika's lifetime for the $7^2P_{3/2}$ state, one concludes that 51% of the transition probability is in the 4555 Å transition. This should be compared with Heavens⁹ calculated value of 36%.

Acknowledgement. This work was performed under the auspices of the United States Atomic Energy Commission.

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