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A CORRECTED COMPILATION OF DATA ON THE LIFETIME OF THE $7^2P_{3/2}$ STATE OF CESIUM

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May 1966

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

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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.

$$1/\tau_m = 1/\sum_n A_{mn} \tag{1}$$

$$f_{nm} = 1.51\lambda^2_{mn} A_{mn} g_m/g_n \tag{2}$$

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 Chaika[1] 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 $^2D_{1/2}$ (13,427 Å).

Tolman,[2] Minkowski and Mühlenbruch,[3] Kvater,[4] and Vainshtein[5] 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 Tolman[2] makes the same error in trying to convert his single f-value to a lifetime. Stone[6] 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. Althoff[7] only reports a lower limit of 1.6×10^{-7} sec for the lifetime and not 1.16×10^{-7} as Altman and Chaika[1] 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 Cesium[10] agrees with the results of Kvater[4] 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 Heavens[9] calculated value of 36%.

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