

PHOTO-IONIZATION CROSS-SECTIONS OF CALCIUM VAPOR

Newsom (1966) has obtained some relative absorption cross-section measurements for calcium vapor from the series limit at 2028 Å down to 1660 Å, using photoelectric techniques at an instrumental band width of about 1.1 Å. He found that the ratios of the absorption cross-sections at the peaks of the auto-ionization lines at 1885.9 and 1765.10 Å to that at the $4s^2 \rightarrow 4snp \ ^1P_1$ series limit were not consistent with the cross-sections obtained by Ditchburn and Hudson (1960). This inconsistency could be due to the fact that Ditchburn and Hudson used photographic techniques, although there is also some doubt as to the accuracy of the vapor-pressure curve (Tomlin 1954) assumed by these authors. In an attempt to resolve this disagreement, and to place Newsom's results on an absolute scale, we have obtained absolute cross-sections for calcium vapor at an instrumental band width of 0.075 Å in the vicinity of the series limit and of the auto-ionization lines at 1885.9 and 1765.10 Å.

TABLE 1
COMPARISON OF RECENT COMPILATIONS OF VAPOR-PRESSURE
DATA FOR ATOMIC CALCIUM

TEMP (° K)	VAPOR PRESSURE (IN TORR)			
	Honig (1962)	Nesmeyanov (1963)	Hultgren (1963)	Tomlin (1954)
800	1.18×10^{-3}	1.39×10^{-3}	1.18×10^{-3}	1.07×10^{-3}
900	2.32×10^{-2}	1.17×10^{-2}	2.09×10^{-2}	2.51×10^{-2}
1000	2.37×10^{-1}	1.38×10^{-1}	2.03×10^{-1}	3.12×10^{-1}
1100	1.62	8.37×10^{-1}	1.28	2.29

Details regarding the basic theory and experimental arrangements employed in this laboratory for the determination of absolute cross-sections of metallic vapors have been described previously (Hudson 1964; Hudson and Carter 1965). The apparatus consists essentially of a 2.2-m normal incidence monochromator, behind the exit slit of which is a temperature regulated furnace serving as an absorption chamber. The largest error in such a determination is due to the lack of reliable vapor-pressure data. In Table 1 we list the vapor-pressure data given in several review articles (Honig 1962; Nesmeyanov 1963; Hultgren, Orr, Anderson, and Kelly 1963) and that given by Tomlin (1954). One expects the vapor pressure to vary linearly with the reciprocal of the temperature, but Tomlin's (1954) data show a change in the slope of such a straight line plot which occurs at the melting point of calcium (1083° K). Nesmeyanov's (1963) data, on the other hand, show a random deviation from a straight line over the temperature range of interest. The sets of vapor-pressure data given by Honig (1962) and Hultgren (1963) are both linear functions of the reciprocal temperature. They are in exact agreement at 800° K with a ± 12 per cent difference at 1100° K.

Table 2 lists the absolute atomic absorption cross-sections obtained using both the Honig and the Hultgren vapor-pressure data. The average of these two with the estimated total error is listed as the best estimate of the cross-section. The error is the result of summing a 5 per cent random error in the data and systematic errors of about 10 per

cent in the temperature calibration, path-length determination, and vapor-pressure data. The ratio of our best estimate to that of Newsom (1966) and to that of Ditchburn and Hudson (1960) is also listed. The latter varies by a factor of 5, while the former may be taken to have a constant value of 1.5 ± 0.2 .

Our results therefore confirm the relative values obtained by Newsom (1966) and not those obtained by Ditchburn and Hudson (1960). We believe that the change to photoelectric techniques and the use in this laboratory of reliable vapor-pressure data have yielded more accurate results. Thus Newsom's published values for the atomic absorption cross-section of calcium, multiplied by our factor of 1.5 (in order to place them on an absolute scale), should be reliable to within the stated accuracy of ± 15 per cent except for those lines whose apparent width is 0.10 \AA .

TABLE 2
COMPARISON OF THE RESULTS OBTAINED FOR THE ATOMIC
ABSORPTION CROSS-SECTION OF CALCIUM

	ABSORPTION CROSS-SECTION M_B (10^{-18} cm^2)					RATIO OF BEST ESTIMATE TO NEW- SOM	RATIO OF BEST ESTIMATE TO DITCH- BURN AND HUDSON
	Honig (1962)	Hultgren (1963)	Best Estimate	Newsom (1966)	Ditch- burn and Hudson (1960)		
Series limit at 2028 \AA	1 09	1 25	1.2 ± 0.14	0 9	0 45	1 3	2 7
Line at 1885.9 \AA	19 3	23 6	21.5 ± 2.3	14	30	1 5	0 72
Line at 1765.10 \AA	36 0	37 3	37 ± 2.5	21	70	1 7	0 53

This research was supported by the U.S. Air Force under contract AF-04(695)-1001.

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December 30, 1966
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REFERENCES

- Ditchburn, R. W., and Hudson, R. D. 1960, *Proc. Roy. Soc.*, **256A**, 53.
 Honig, R. E. 1962, *RCA Rev.*, **23**, 567.
 Hudson, R. D. 1964, *Phys. Rev.*, **135**, 1212.
 Hudson, R. D., and Carter, V. L. 1965, *Phys. Rev.*, **137**, 1212.
 Hultgren, R., Orr, R. L., Anderson, P. D., and Kelly, K. K. 1963, in *Selected Values of Thermodynamic Properties of Metals and Alloys* (New York: Wiley).
 Nesmeyanov, A. N. 1963, in *Vapor Pressure of the Chemical Elements*, ed R. Gary (New York: Elsevier Publishing Co.).
 Newsom, G. H. 1966, *Proc. Phys. Soc.*, **87**, 975.
 Tomlin, D. H. 1954, *Proc. Phys. Soc.*, **67B**, 787.

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