

Lawrence Berkeley National Laboratory

Recent Work

Title

RADIO FREQUENCY STARK SPECTRA AND DIPOLE MOMENT OF BaS

Permalink

<https://escholarship.org/uc/item/4hj713nv>

Authors

Melendres, C.A.

Hebert, A.J.

Street, K.

Publication Date

1968-10-01

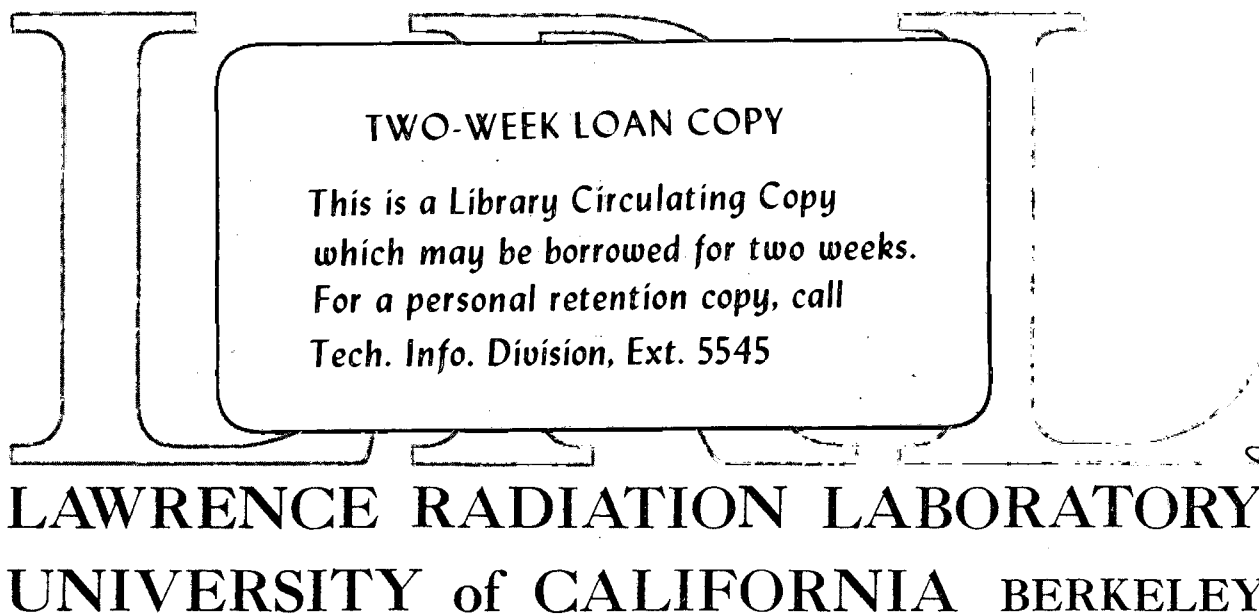
eg. 2

RADIO FREQUENCY STARK SPECTRA AND DIPOLE MOMENT OF BaS

C. A. Melendres, A. J. Hebert, and K. Street, Jr.

October 1968

AEC Contract No. W-7405-eng-48



UCRL-18550
eg. 2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

RADIO FREQUENCY STARK SPECTRA AND DIPOLE MOMENT OF BaS*

C. A. Melendres[†], A. J. Hebert, and K. Street, Jr.

Department of Chemistry and
Lawrence Radiation Laboratory
University of California
Berkeley, California 94720

October 1968

The radio frequency Stark spectra of $^{138}\text{Ba}^{32}\text{S}$ have been observed at moderate fields using a molecular beam spectrometer that has been described previously.^{1,2} A single spectral line corresponding to the $J=1$, $m_J = \pm 1 \rightarrow J=1, m_J=0$ transition was observed for the three lowest vibrational states. Spectral frequencies obtained at field strengths of 30, 45, 60, and 75 volts/cm were fitted with the usual second order Stark equation³

$$\nu = 3.8019 \times 10^{-2} \frac{\mu^2 E^2}{B}$$

where ν = transition frequency, MHz

E = field strength, volts/cm

μ = dipole moment, Debye

B = rotational constant, MHz.

Correction for fourth order Stark effect was negligible. The following ratios of μ^2 to the rotational constant, B , were obtained:

ν	$\frac{\mu^2}{B}$ (D ² /MHz)
0	0.03816 (10)
1	0.03841 (12)
2	0.03872 (18)

No rotational constants for BaS have been published in the literature, however, Clements and Barrow have recently obtained a value for B_0 for the ground rotational state from a study of an absorption band system of BaS⁴. Using their value of $B_0 = 0.10308(4) \text{ cm}^{-1}$ and our experimental value of $(\mu^2/B)_0$, the value $\mu = 10.86 \pm 0.02 \text{ D}$ is obtained for the dipole moment of the $v=0$ state of BaS.

The quantity $\frac{\mu}{\epsilon_r}$ is sometimes used as a relative measure of "ionic character" in comparing chemical bonds.⁵ The near equality of this quantity for BaO (0.85)⁶ and BaS (0.90) indicates the close similarity of bonding in these two molecules. Further, the 6% increase in $\frac{\mu}{\epsilon_r}$ in going from BaO to BaS reflected a similar 6% increase found in going from CsF to CsCl.

The rather broad line widths of the spectral lines (from 10 to 15 KHz) and difficulties in generating a molecular beam of BaS did not permit the study of the Stark spectra at strong electric fields. Further details of the present work appear elsewhere.⁷

REFERENCES

* This work was performed under the auspices of the U.S. Atomic Energy Commission. One of us (C.A.M.) acknowledges fellowship support from the Agency for International Development and the Philippine Atomic Energy Commission during the course of this work.

† Present address: Physics Department, Atomic Research Center
Philippine Atomic Energy Commission, Herran St.,
Manila, Philippines

1. A. J. Hebert, F. W. Breivogel, Jr., and K. Street, Jr., J. Chem. Phys. 41, 2368 (1964).
2. F. J. Lovas (Ph.D. Thesis), University of California, Lawrence Radiation Laboratory Report UCRL-17909, (November 1967).
3. P. Kusch and V. W. Hughes in Handbuch der Physik (Springer Verlag, Berlin, 1939) vol 37/1, p. 139.
4. Prof. R. F. Barrow, private communication. R. M. Clements and R. F. Barrow, Chemical Communications, London, 1968, to be published.
5. L. Pauling, The Nature of the Chemical Bond, 3rd edition (Cornell University Press, Mt. Vernon, 1960) p. 78.
6. L. Wharton, M. Kaufman and W. Klemperer, J. Chem. Phys. 37, 621 (1962).
7. C. A. Melendres (Ph. D. Thesis), University of California, Lawrence Radiation Laboratory Report UCRL-18344, (June 1968).

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or*
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.*

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

TECHNICAL INFORMATION DIVISION
LAWRENCE RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720