The Acetylene Bond Frequency in Heavy Acetylene (C_2D_2)

Gaseous heavy acetylene (C_2D_2)[1] at two atmospheres pressure and at total volume of 33 cc was exposed in a Pyrex tube to a mercury discharge. The line 4358 Hg caused Raman scattering. One scattered frequency could be measured definitely on four different plates. It is 1761 cm^{-1} and is ascribed to the acetylene bond vibration. The former investigations of Raman scattering on ordinary acetylene (C_2H_2) are shown in Table I.

TABLE I.

C_2H_2 (gas)		C_2D_2 (gas)
Segré[2]	1979 ±5 cm^{-1}	—
Bhagavantam[3]	1974	—
Daure and Kastler[4]	1978 ±5	—
This investigation	1973.1	1761 cm^{-1}

Since only a small sample of C_2D_2 was available it was considered essential to run ordinary acetylene (C_2H_2) under the same circumstances with the result shown in Table I.

If one were to predict the acetylene bond vibration for C_2D_2 from the known value (1973.1 cm^{-1}) of ordinary acetylene (C_2H_2) by the use of the equation pertaining to a simple harmonic oscillator:[5]

$$\nu = (1/2\pi)(k/\mu)^{\frac{1}{2}} \tag{1}$$

or

$$\nu_0^2\mu_0 = \nu_h^2\mu_h \tag{2}$$

one would obtain

$$\nu_h = (\mu_0/\mu_h)^{\frac{1}{2}}\nu_0 = [(13/2)/(14/2)]^{\frac{1}{2}} \times 1973 \tag{3}$$

$$\nu_h = 1901 \text{ cm}^{-1}.$$

Either Eq. (1) does not apply or the substitution of deuterium has a remarkable influence on the force constant k between the carbon atoms. The latter alternative is difficult to believe and therefore it is clear that the oscillator producing the acetylene bond frequency is not as simple as is implied by Eq. (1).

A very faint line at 3425 cm^{-1} appears on some of the plates but it is located very near to a mercury line so that further work is necessary to establish its definite existence. We hope to find the lower frequencies of C_2D_2 by greatly prolonged exposure.

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[1] We are greatly indebted to Professor H. S. Taylor for the loan of this sample which was prepared under his direction by Dr. J. C. Jungers; C. R. B. fellow from Louvain.
[2] Segré, Linc. rend. **12**, 226 (1930).
[3] Bhagavantam, Nature **127**, 817 (1931); J. Ind. Phys. **6**, 319 (1931).
[4] Daure and Kastler, Compt. rend. **192**, 1721 (1931).
[5] Mecke, Zeits. f. Physik **64**, 173 (1930).

The Azimuthal Asymmetry of Cosmic Radiation on Mount Evans, Colorado

Johnson[1] has shown that a knowledge of the variation of the east-west azimuthal asymmetry of cosmic radiation with altitude will be helpful in determining the nature of this radiation. Hence a measurement of this asymmetry at altitudes varying from 5000 to 14,000 ft. at the same geomagnetic latitude has been initiated. The following is a report of observations made on Mt. Evans, Colorado. The altitude and magnetic declination of the observation station were 14,085 ft. and 13.5°, respectively.

The apparatus consisted of a triple Geiger counter telescope which could be set at any zenith angle and rotated about a vertical axis. The copper cylinders of the counters were each 15 cm in length, 4 cm inside diameter and the distance between the centers of the outside counters was 14 cm. The axis of rotation was made vertical within 3 minutes by means of a sensitive level and this adjustment was checked several times daily during the period of observation.

Laboratory tests showed that the counting rate varied slightly with temperature. The temperature of the apparatus ranged from 4 to 19°C. The intensity of the radiation is a function of atmospheric pressure which varied from 18.30 to 18.55 inches of mercury. In an effort to compensate for these effects the counts were taken in the following order: E–W–E–W–E for approximately an hour in each direction. The ratios of each west to the average of the east readings immediately preceding and following this west were computed. A mean of these ratios was taken as the best value for the east-west asymmetry. The probable error, r, was computed from residuals, the theoretical probable error, R, was computed from the total number of counts and the total time in minutes.

The results are shown in Table I. Z is the zenith angle, C the total number of counts while W and E in this column stand for the magnetic west and east, respectively, T the total time in minutes, N the number of data and W/E the mean ratio of the west to east rates. In calculating W/E the accidental rate of 0.73 per minute was subtracted before the division was performed.

TABLE I.

Z	C	T	N	W/E	r	R
15°	West 19500	1200	15	1.016	0.0064	0.0067
	East 20313	1278				
30°	West 14831	1168	17	1.021	0.005	0.0077
	East 15837	1265				
45°	West 6424	718	10	1.019	0.010	0.019
	East 7402	886				

The agreement between r and R indicates that the apparatus was operating satisfactorily, and while the asymmetry is small the magnitude of the probable error, in addition to the finding of a greater westward intensity for each zenith angle, makes it highly probable that the observed asymmetry is real.

The equipment was built with funds provided by The

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[1] T. H. Johnson, Phys. Rev. **45**, 569 (1934).

Hyperfine Structure in Silver

Hyperfine structure has been found in the resonance lines of silver. An etalon of quartz plates with aluminum surfaces was used with a Zeiss spectrograph. The best results were obtained with a 23 mm spacer. The source was a water-cooled hollow cathode 8 cm long and 2 cm bore, with current supplied by a 2000-volt d.c. generator. Low current had to be used on account of self-reversals. The series of exposures described below was made with the 23 mm spacer as the current was changed by small steps from 0.7 ampere to 0.05 ampere. At 0.7 ampere both lines are much reversed and the wing of the reversal to the red is broader and more intense than the one to the violet for both lines. Only a few examples from the series will be described here.

At 0.34 ampere the reversal of λ3383 is much reduced and a hyperfine structure component begins to show on the red side. This reversal is shown by microphotometer trace I.

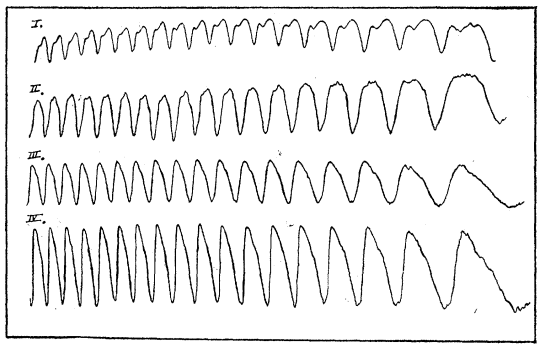

FIG. 1. Traces of fringe system of λ3383 showing reversal and h.f.s. I—0.34 ampere; II—0.17 ampere; III and IV—0.1 ampere.

Trace II shows that the reversal has practically disappeared at 0.17 ampere and the component on the red side is definitely visible on the original plate. Traces III and IV are made from two different exposures of λ3383 at 0.1 ampere. Here there is no sign of reversal although IV shows some broadening. The faint component is clearly visible on both traces and is unmistakable on original plates. At 0.08 ampere the intensity drops but there is not much change in the appearance of the ring system of the line. Measurements of plates exposed at 0.1, 0.08 and 0.05 ampere give an approximate separation of 0.06 cm^{-1}.

At 0.7 ampere the wings of the reversal of λ3281 are much farther apart than those of λ3383 at the same current, as might be explained by the larger J value of the P term of λ3281. The wing on the violet side in one order is very near the wing on the red side of the next lower order. At 0.34 ampere λ3281 has about the same appearance as λ3383 at 0.7 ampere. At 0.17 ampere it is about the same as λ3383 at 0.34 ampere. At 0.1 it is comparable to λ3383 at 0.17 ampere. The results for λ3281 are less easily reproduced than those for λ3383 and microphotometer traces are more difficult to obtain. At 0.05 ampere λ3281 shows its component in approximately the same manner as λ3383 does at 0.1 ampere but the intensity is naturally very much less. Measurements of plates exposed at 0.08 and 0.05 ampere give an approximate separation of 0.06 cm^{-1} also.

These results differ from those of Mohammad and Sharma[1] who, using high currents, found three components, two of about equal intensity, approximately 0.23 cm^{-1} apart and one faint component approximately 0.18 cm^{-1} to the violet of the middle component. Their results were not confirmed by Williams and Middleton[2] who, using a hollow cathode source and reflection echelon, found no structure. Williams' plates were examined by Tolansky[3] who concluded that any structure must be less than 0.05 cm^{-1} wide. Jackson[4] using a capillary tube as source and a reflection echelon concluded that 0.07 cm^{-1} was the upper limit for structure. It would seem, therefore, that the present results are not inconsistent with the conclusions of other recent observers.

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[1] Mohammad and Sharma, Ind. J. of Phys. **6**, 75 (1931 and 1932).
[2] Williams and Middleton, Nature **131**, 692 (1933).
[3] Tolansky, Proc. Phys. Soc. London **45**, 559 (1933).
[4] Jackson, Nature **131**, 691 (1933).

The Structure of the Hydrogen Sulfide Molecule from a New Vibration-Rotation Band at 10,100A

About one hundred lines in this band have been recorded photographically in the first order spectrum of a twenty-one foot grating. The absorption cell was seventy-one feet in length. Assignments have been made for the lines involving the energy levels up to $j=4$. From these the following molecular constants have been deduced:

	Normal state	*Excited state*
I_A	2.68×10^{-40} g cm²	2.81×10^{-40} g cm²
I_B	3.08	3.32
I_C	5.85	6.20
Bond angle	92° 20′	93°
H–S distance	1.35A	1.39A

This band is believed to be the $\nu_\sigma+3\nu_\pi$ combination band, with ν_0 at about 9911 cm^{-1}. The electric moment oscillates along the axis of least inertia, perpendicular to the symmetry axis of the molecule. A very faint absorption region was detected at about 11,000 cm^{-1} which is probably due to the combination $3\nu_\sigma+\nu_\pi$. These assignments are compatible with the vibrational interpretation given by Mecke[1] except that ν_σ should be at about 2630 cm^{-1}.[2] Since the absorption at 3790 cm^{-1} is probably due to the $\nu_\sigma+\nu_\delta$