results fairly well, more data are needed to determine the actual temperature dependence.

A two-meter, brass, K-band cell with no internal dielectrics except the mica windows was used to contain the absorbing gas. After the OCS was introduced into the cell and allowed to come to equilibrium, all the transitions were measured without any additional adjustment in pressure. The pressure was checked at intervals with both a thermocouple and a McLeod gauge and did not vary more than 1 percent during the time of measurement. The measurements at dry ice temperature were made keeping this same quantity of gas in the cell.

The microwave energy was supplied by a $2K33$ reflex klystron operating at 24,326 Mc, the frequency of the $J=1\rightarrow2$ transition. The higher transitions were obtained by generating harmonics of this frequency in a crystal multiplier and filtering out the lower frequencies. Thus, transitions were obtained at 48,652 Mc, 72,978 Mc, and 97,304 Mc, corresponding to the $J=3\rightarrow4$, $5\rightarrow6$, and $7\rightarrow8$ transitions, respectively.[5] This klystron was double modulated with a 20-caps sawtooth voltage and a very small 100-kc sine wave voltage. The energy was detected after passing through the cell by a silicon crystal built into the wave guide, and the 100-kc output was fed to a receiver tuned to this frequency and thence to
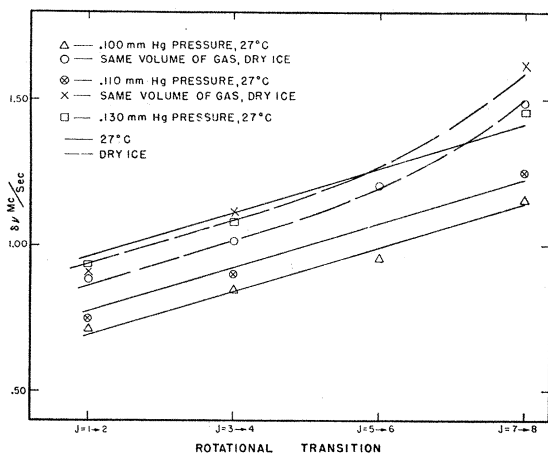

FIG. 1. Plot of $\delta\nu$ as a function of rotational transition.

an oscilloscope. The displayed pattern very closely approximated the derivative of the absorption line.[6] To provide markers for measuring the peaks of this derivative curve, the output of another $2K33$ klystron, operating cw, was mixed with a variable signal of the order of 0.5 Mc and with energy from the swept klystron. The combined output was detected and fed to a receiver tuned to about 25 Mc, thus giving three marker pips on the oscilloscope when the two klystrons were operating at a frequency separation of about 25 Mc. The frequency spacing of these markers was determined by the low frequency oscillator and could be varied to superimpose either two of them on the line derivative peaks. The markers were of the order of 20 kc wide.

Great care was taken to eliminate broadening due to power saturation and to minimize reflection amplitudes. Since the derivative shape was considerably distorted when it appeared on the side of a reflection, the symmetry of the peaks was taken as a criterion for minimum reflection effects. Measurements at the different temperatures and for the several transitions were made in various orders to avoid systematic errors. The purity of the sample was checked by searching for the absorption lines of NH_3 and other gases that absorb in the same frequency range. None were found.

Our value of the line breadth parameter for the $J=1\rightarrow2$ transition at room temperature is 6.1 ± 0.35 Mc/mm which checks quite well the width reported by Townes, Holden, and Merritt[7] for this transition.

Further experiments are in progress to extend the measurements both to a greater variation in temperature and to more transitions.

We would like to express our appreciation to Dr. W. V. Smith for suggesting the need for this experiment.

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An Absolute Determination of the X-Line from ThC''

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THE X-line of ThC'' (Ellis' notation), which is a high energy internal conversion line from the K-shell, has been used by many workers as a calibrating line in β-spectroscopy. The binding energy of the deuteron, for example, has been measured in terms of the energy of this line.[1] It is therefore of some importance to get a reliable $H\rho$-value. Brown[2] has recently measured this value by a method similar to the present one, but his value, 9988.4 ± 2 gauss cm, did not agree with the relative measurements made by Hedgran and Lind.[3]

The present investigation was carried out in order to make an independent check of Brown's value. The experimental arrangement was about the same as that used in the measurements of the F, I, and L-lines of Th(B+C+C'')[4,5] and consists of a small semicircular β-spectrograph and two G.M.-tubes in coincidence. The main difference is that the two tubes are placed at right angles to each other (Fig. 1).
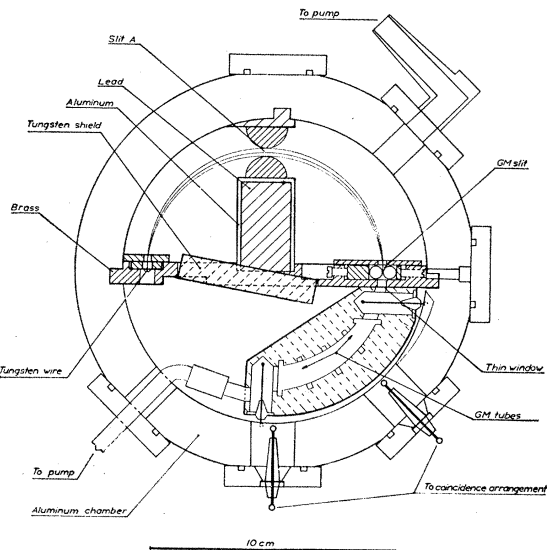

FIG. 1. Construction of the β-spectrograph.

The X-line is rather weak, but with this arrangement it was possible to register the line with a half-width of less than 0.1 percent and to get a peak of about 6 times the background, in spite of the small dimensions and the hard γ-rays from the sample. The line obtained was in good agreement with the calculated line shape. The source consists of an activated tungsten wire (diameter 12μ).

The field was measured along the path using a proton sample (H_2O) at the field corresponding to the high energy part of the line. A Hartree[6] correction was then made. The distance ($2\rho \simeq 95$ mm) between the nearest part of the wire, and the slit edge was measured by a calibrated comparator.

The individual results are seen in Table I. The first run was made with only a few points on the high energy side of the line.

TABLE I. ThC″ X-line.

Run	$\nu\rho$ Mc cm	$H\rho^a$ gauss cm	Statistical weight
1	42.5156	9985.4	1
2	42.5203	9986.5	2
3	42.5150	9985.3	2
4	42.5224	9987.0	4
5	42.5254	9987.7	4
Weighted mean value	42.5212	9986.7	Estimated error 15:10⁵

ᵃ Calculated by using $\gamma\rho = (2.67523 \pm 0.00006) \times 10^4$ sec⁻¹ gauss⁻¹, given by Thomas, Driscoll, and Hipple, Phys. Rev. 78, 787 (1950).

The second and third runs were made with about twice as many points on this part of the line. The two last runs were made with many points and half the statistical error in the individual measurements. This explains the different statistical weights.

The result $\nu\rho = 42.5212 \pm 0.0060$ Mc cm and $H\rho = 9986.7 \pm 1.5$ gauss cm, gives $E_\gamma = 2.61425 \pm 0.00050$ Mev. The γ-energy was calculated by using the atomic constants given by DuMond and Cohen[7] and the x-ray values given in Cauchois and Hulubei's tables.[8]

These values are in extremely good agreement with the values $\nu\rho = 42.528 \pm 0.008$ Mc cm and $H\rho = 9988.4 \pm 2$ given by Brown. It is therefore probable that the combined $H\rho$ value, 9987.4, is correct within an accuracy of about 1 part in 10⁴.

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Absorption by Telluric CO in the 2.3µ Region*

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SHAW and Howard[1] have recently reported measurements on the curve of growth of the line $R(2)$ of the CO fundamental occurring near 5µ in the solar spectrum. From this study the abundance of atmospheric CO above Columbus, Ohio was determined to be 0.09 atmos-cm per air mass. However, Goldberg, McMath, Mohler, and Pierce[2] have been unable to detect any appreciable absorption due to telluric CO in the overtone region of the solar spectrum at 2.3µ either at Lake Angelus, Michigan, or at Mt. Wilson, California. These workers suggest an upper limit of 0.006 atmos-cm per air mass above these stations. Because of this considerable difference in estimated amounts, the CO overtone region of the solar spectrum has also been studied at Columbus to determine whether values of CO abundance obtained from this band are consistent with those obtained from the fundamental. Unfortunately, as there are many lines of CH_4 and H_2O in this region, most of the telluric CO lines are obscured or are blended with other telluric lines. However, Professor Goldberg has kindly informed us[3] that the positions where lines $P(6)$ and $R(3)$ would occur are relatively free from interference by other lines of telluric origin, and these lines were accordingly selected for the present study. The second order of an original 7200-line/in. grating was used with a lead sulfide cell, and resolution was obtained comparable with that previously reported by Mohler, Pierce, McMath, and Goldberg.[4]

Figure 1 shows the curve of growth of line $P(6)$ of the CO overtone band, using data obtained during March, 1952. Goldberg[5] has shown how the atmospheric abundance of the absorbing gas can be estimated from these data if the gas is uniformly distributed with height and if a laboratory study of the absorption of the line is also made. These laboratory data for the line $P(6)$ are shown in Fig. 2.
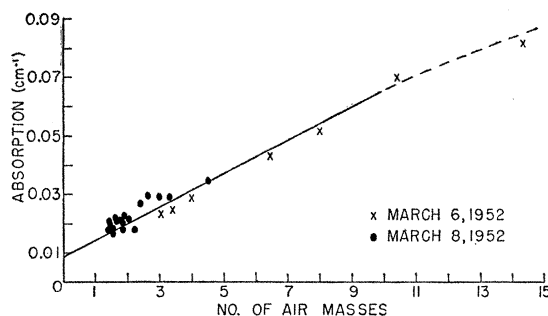

FIG. 1. Curve of growth of line $P(6)$ of the 0–2 CO band.

The abundance of telluric CO above Columbus, Ohio as determined in this manner, is 0.10 atmos-cm per air mass, which is in good agreement with the value previously reported from studies of lines in the fundamental band.

It is seen that the curve in Fig. 1 does not extrapolate to zero at zero air mass, but rather to a value of 0.0085 cm⁻¹. This residual absorption is attributed to solar CO and is probably almost entirely due to the line $R(30)$ of the $2-4$ band, which, as Plyler, Benedict, and Silverman[6] have shown, coincides practically with line $P(6)$ of the $0-2$ band. Only a small portion of this absorption is due to the solar component of the $P(6)$ line of the $0-2$ band. Absorptions of solar origin do not of course vary with solar altitude, and the observed value of 0.0085 cm⁻¹ agrees closely with the equivalent widths of the stronger lines of solar CO reported by Goldberg et al.[2]
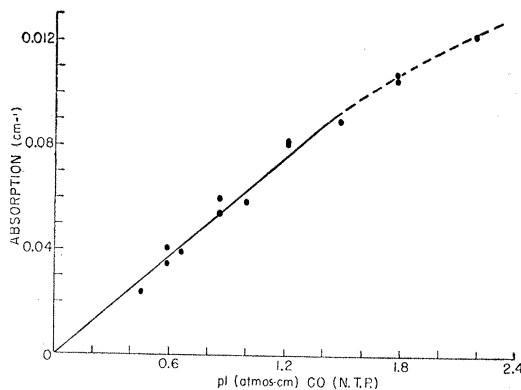

FIG. 2. Plot of absorption (cm⁻¹) vs p_l (atmos-cm) for line $P(6)$ of the 0–2 CO band. Absorption cell length 13.4 cm, temperature 40°C. Nitrogen was added to 74 cm Hg total pressure for all measurements.

The integrated absorption coefficient of line $P(6)$, obtained from Fig. 2, is 0.062 cm⁻² atmos⁻¹. This yields a value of 1.67 cm⁻² atmos⁻¹ for the integrated absorption coefficient of the entire overtone band and is entirely consistent with the values 1.64 and 1.69 cm⁻² atmos⁻¹ measured by two different methods by Penner and Weber.[7] It should also be noted here that if one assumes the value for the integrated absorption coefficient measured by Penner and Weber for the fundamental band, one obtains from our pre-