lowing the decay of 9-hr. Pd^{101}. Positrons of 3.0 Mev and conversion electrons of 0.6 Mev were determined with the spectrometer. Lead absorption curves taken on samples in which the electrons and positrons were taken out with beryllium showed characteristic x-rays and a 1.2-Mev γ-ray. In comparing the yield of positrons and x-rays, it was estimated that the decay proceeds $\sim$5 percent by positron branching and $\sim$95 percent by orbital electron capture. Gamma-rays corresponding to the 0.6-Mev electron as well as annihilation radiation were apparently in too low abundance to be seen readily.

Cross sections for the formation of the palladium isotopes from rhodium with 50-Mev deuterons could only be approximated principally because of uncertainties in the deuteron beam strength and in the target geometry with undeflected beam. Values are based on yields of x-rays and relative to each other are probably considerably more reliable than the absolute values.

Product	Reaction	$\sigma(\text{cm}^2 \times 10^{24})$
Pd^{103} (17 day)	*d*,2*n*	0.0024
Pd^{101} (9 hr.)	*d*,4*n*	0.24
Pd^{100} (4.0 day)	*d*,5*n*	0.28

The cooperation of Dr. Duane Sewell, Mr. J. T. Vale, and the 184-inch-cyclotron group is gratefully acknowledged.

This paper is based on work performed under Contract No. W-7405-eng-48 with the Atomic Energy Commission in connection with the Radiation Laboratory of the University of California, Berkeley, California.

[1] W. H. Sullivan, N. R. Sleight, and E. M. Gladrow, *Rhodium Radioisotopes Induced in Deuteron-Bombarded Ruthenium*, Declassified Plutonium Project Report No. MDDC-918.

Telluric Bands of Methane in the Fraunhofer Spectrum

ROBERT R. MCMATH, ORREN C. MOHLER, AND LEO GOLDBERG
McMath-Hulbert Observatory of the University of Michigan, Lake Angelus, Pontiac, Michigan
April 2, 1948

IN an earlier communication,[1] the writers described preliminary results obtained from a high resolution recording of the solar spectrum between 1 and 2μ. This initial investigation was carried out with a spectrometer consisting of a Cashman PbS cell employed in conjunction with a 15,000-line plane grating and 25-foot focal length lens arranged in Littrow fashion. Sunlight was imaged on the spectrometer slit by a 12-inch by 50-foot achromat mounted in the 70-foot McGregor tower of the McMath-Hulbert Observator.

Beginning in October, 1947, the lens optics were eliminated by the installation of a four-mirror Pfund-type spectrometer, employing a 15,000-line plane reflection grating loaned by the Mt. Wilson Observatory. The grating was specially ruled to produce a high concentration of energy in the green fourth-order spectrum. The over-all focal length of the spectrometer is 23½ feet. Also, the objective lens in the solar tower was replaced by a Cassegrain reflecting telescope of 10½-inch aperture and approximately 45-foot focal length. With this arrangement, the solar spectrum has been mapped with greatly improved resolution from 1 to 2.5μ. The spectrum was registered in the form of direct-intensity tracings by a Speedomax recorder, giving a dispersion of about 1.25 wave numbers per centimeter on the tracings. The slit width employed varied from 0.04 cm^{-1} at 1.6μ to 0.07 cm^{-1} at 2.2μ.

The new solar map contains not only a wealth of solar atomic lines but also numerous well resolved band structures originating in the earth's atmosphere. Of particular interest is a band system centered at 6003 cm^{-1}, or 1.6660μ, which appears to be due to absorption by atmospheric CH_4 molecules. This feature is clearly shown on many tracings, the first of which was obtained in August, 1947. The band consists of a zero branch in which 10 components are clearly shown, a positive branch made up of 11 components, and a negative branch showing 8 members. A tracing of the central *Q*-branch, together with the first two members of the *P*- and *R*-branches, is shown at the bottom of Fig. 1.

The 1.66μ band of methane has been investigated in the laboratory by Moorhead[2] and by Norris and Unger,[3] with relatively low resolution. On the laboratory tracings the zero branch is unresolved and, according to Norris and Unger, appears sharp and intense, with a slight broadening on the low frequency side. The observed broadening suggests that the line spacings in the *Q*-branch increase toward the low frequency end of the band, which is confirmed by the Lake Angelus tracings. The line spacing in the *P*- and

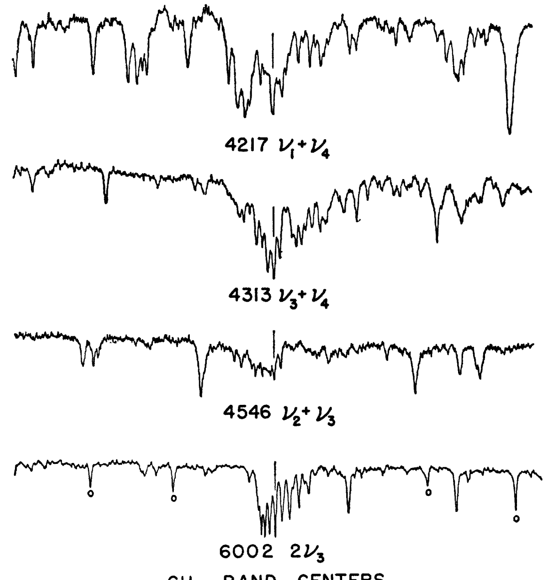

FIG. 1. Band centers of the CH_4 molecule in the absorption spectrum of the earth's atmosphere. The central vertical lines correspond to the listed wave numbers. The small circles in the lower tracing mark the 0–1, 1–2, 2–1, and 3–2 lines of the $2\nu_3$ band.

R-branches increases regularly with decreasing frequency, the extreme limits being 9.6 and 11.8 cm^{-1}; but the average value, 10.6 cm^{-1}, agrees exactly with that found in the laboratory. Of further interest is the absence of the first member of the P-branch, which is also missing from the laboratory spectrum.

The only important source of disagreement between the laboratory and solar observations lies in the wave numbers of the band components, which are systematically 3 cm^{-1} lower than those given by the laboratory measurements. In view of the much higher resolution obtained with the solar spectrometer, the discrepancy is perhaps to be expected. Infra-red wave-lengths at Lake Angelus are determined, by use of overlapping orders, with respect to visual Fraunhofer lines whose wave-lengths are known with high precision. In this way, the wave-lengths of infra-red lines can be determined with an error appreciably less than 0.1 cm^{-1}.

As a check on the identification of the 1.66μ band, a search was made for additional zero branches of the methane spectrum observed in the laboratory[4] at 4216, 4313, and 4546 cm^{-1}. Three prominent features were found close to the expected positions, as shown in Fig. 1.

Very recently, Migeotte[5] has observed 14 regularly spaced and intense lines in the 3.4μ region, which he ascribes to atmospheric methane. The spectroscopic evidence for the existence of methane in the earth's atmosphere therefore seems conclusive.

A preliminary analysis of the 1.66μ band indicates a high order of agreement with the theory of the CH_4 molecule as developed by D. M. Dennison and others.[6] The details of the analysis will be published in the Astrophysical Journal. We wish to acknowledge the helpful advice of Professors E. F. Barker and D. M. Dennison of the University of Michigan.

[1] McMath, Adel, Goldberg, Mohler, Phys. Rev. **72**, 644 (1947).
[2] J. G. Moorhead, Phys. Rev. **39**, 83 (1932).
[3] W. V. Norris and H. J. Unger, Phys. Rev. **43**, 467 (1933).
[4] Cf. Herzberg, *Infrared and Raman Spectra*, p. 308.
[5] M. V. Migeotte, Phys. Rev. **73**, 519 (1948).
[6] D. M. Dennison, Rev. Mod. Phys. **12**, 175 (1940).

Errata: Second-Order Corrections to Quadrupole Effects in Molecules

[Phys. Rev. **73**, 627 (1948)]

J. Bardeen and C. H. Townes
Bell Telephone Laboratories, Murray Hill, New Jersey

THE right-hand side of Eq. (1) should read:

$$\left(\frac{3eqQK}{8I(2I-1)J(J+2)}\right)^2\left(1-\frac{K^2}{(J+1)^2}\right)$$
$$\times\frac{(F(F+1)-I(I+1)-J(J+2))^2}{(2J+1)(2J+3)}$$
$$\times(I+J+F+2)(J+F-I+1)(I+F-J)(J+I-F+1).$$

The second line on the right of Eq. (2) should read:

$$[1-(K^2/(J+2)^2)][1/(2J+1)(2J+5)].$$

A Possible Influence of the Moon on Recurrent Geomagnetic Activity

Oliver R. Wulf and Seth B. Nicholson
U. S. Weather Bureau and Mount Wilson Observatory, California

March 24, 1948

THE tendency for magnetic activity to recur at 27-day intervals has suggested the rotation of the sun as the cause and has led to extensive studies to discover what solar features may be associated with the terrestrial magnetic activity. Recently we have given evidence[1] for a connection between the appearance of patches of bright flocculi at the east limb of the sun and the relatively abrupt recurrent onsets of terrestrial magnetic activity in 1943–44. We now wish to call attention to a correspondence between certain recurrent magnetic activity and the moon's declination.

Such 27-day recurrent magnetic activity is not always conspicuous. It can be readily seen in several series from 1930 to 1933, which are portrayed in Fig. 5 of reference 1.[2] The first series shown there began with the abrupt onset of February 12, 1930. The ten onsets in this series (designated by +'s) came within two days after the dates of maximum northerly declination of the moon.

In the second series, which began on April 19, 1930, the eight onsets (designated by ●'s) came within one day of maximum southerly declination of the moon.

In the third series, beginning on November 24, 1930, the eight onsets (designated by diamonds in Fig. 5—1) came within one day of maximum southerly declination.

In the fourth series (designated by X's), beginning on June 26, 1931, the onsets came three and then four days before the moon's maximum southerly declination. Directly following, there is a series, not designated in Fig. 5—1 but readily seen, with onsets on November 13 and December 10, 1931, January 7, February 3, March 2, March 28, April 22, and May 21, 1932, all of which occurred within two days of the dates of maximum southerly declination of the moon. Early in the long fifth series, designated by triangles and beginning with November 4, 1931, the onsets came four days after maximum northerly declination of the moon, but the lag decreased as the series progressed until at the end it was only one day.

The onsets of the three conspicuous mounds of activity in 1933 designated by squares in Fig. 5—1 occurred on the dates of maximum southerly declination of the moon.

In 1943–44 the onsets of the main series of mounds of activity, shown in Fig. 1 of reference 1, generally came near maximum northerly declination of the moon while those of the other series came near maximum southerly declination. The onsets in the main series lagged behind maximum northerly declination in the middle of the series by four or five days, but later by as little as one day.

In a well defined series which began about January 29, 1923, seven consecutive onsets all came two days or less before the dates of the moon's maximum northerly declination.

Other series can be found throughout the years in which the onsets do not come near the dates of maximum declination of the moon but they appear to be less prominent