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Venus: A Map of Its Brightness Temperature

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Abstract: *The 200-inch Hale telescope has been used to make high-resolution maps of the brightness temperature of Venus at wavelengths 8 to 14 microns. Resolution of about 1/30 of the disk reveals a general symmetry about the plane of the orbit, no day-night temperature effects, and a transient temperature anomaly in the southern hemisphere.*

Interest in the planet Venus has been heightened by the successful return of data from man's first planetary probe, Mariner II. Exciting new observations of Venus have also been made recently with large ground-based optical and radio telescopes and radar systems. We now report on high-resolution observations, made with the 200-inch Hale telescope at Palomar Mountain on the mornings of 13, 14, 15, and 16 December 1962, of infrared radiation emitted from Venus.

Infrared radiation is transmitted through the earth's atmosphere in a "window" of wavelengths 8 to 14 microns. We used a special photometer incorporating a mercury-doped germanium photoconductive detector cooled with liquid hydrogen (*1*) to measure the intensity of the 8 to 14 micron radiation emitted from Venus as collected and imaged by the telescope. The photometer was mounted at the *f*/16 focus in the east arm of the yoke. The focal plane aperture we used restricted the circular field of view through the telescope to a diameter of 1.5 seconds of arc, or about 1/30 the planetary diameter. The image of Venus was scanned by moving the telescope in right ascension at successive declination settings and thus building up a series of parallel profiles of output voltage deflections. By using the instrumental calibration curve and allowing for assumed atmospheric transmission losses, we converted the deflections into brightness temperatures. Such brightness temperatures are not unambiguously relatable to the actual kinetic temperature distribution because the sources of opacity and the energy transport mechanisms (time-dependent case) are not well known.

The strong limb-darkening obvious in Fig. 1 and also in the maps made on the other three nights is evidence that the emergent radiation comes from a range in depth over which the temperature increases significantly. This effect alone would produce a radially symmetric pattern rather than the bilaterally symmetric pattern shown. The data thus suggest that there is a real geographic variation of atmospheric boundary temperature. The simplest, but not the only, interpretation of this departure from radial symmetry is as follows. First, there is little or no difference in atmospheric temperature between the daytime and night-time portions of the disk, a result indicated by the previous work of Sinton (*2*) and Pettit and Nicholson (*3*). Gross differences would be expected if there were a significant diurnal temperature variation in the planetary atmosphere. Second, there is an apparent "insolation" effect. The portion of the planetary disk which is intersected by the orbital plane of Venus—that is, the "equatorial" zone if the planet were imagined to be rotating about a spin axis approximately normal to the orbital plane—appears to be about 10°K hotter than the "polar" regions. We have used quotation marks around the terms *insolation*, *equatorial*, and *polar* because such a mode of rotation *may* be inconsistent with the recent interpretation of radar observations (*4*). Fortunately, both kinds of observations can be repeated at various phases of Venus, perhaps with more sensitive and accurate equipment in a year or so, and other types of ground-based observations may also prove to be of significance to the question of rotation.

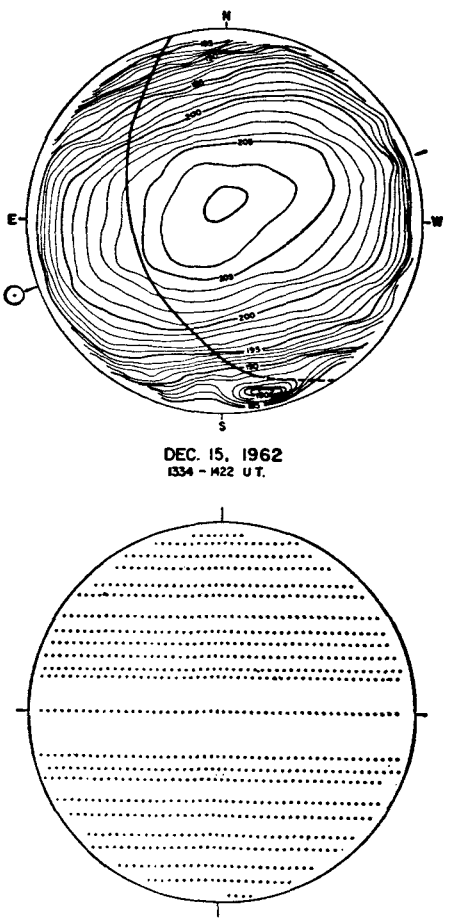

Fig. 1. Brightness-temperature contour map of Venus at wavelengths 8 to 14 microns. The bottom chart shows geographic location of points where the continuous scan records were sampled and reduced. The slightly crenulated pattern running in an east-west direction results from slight uncertainties in positioning the scans.

The other feature of interest in Fig. 1 is the anomalously warm area in the southern hemisphere of Venus, near the terminator. Observations of this region on the other three mornings, although not as detailed as those shown in Fig. 1, definitely show that the structure changes radically in temperature distribution and geographic extent over a 24-hour time interval, whereas the remainder of the disk remains unchanged. The feature may justly be described, therefore, as a storm in the atmosphere of Venus. Continued observation of such features in the future should provide a powerful means of investigating the dynamics of the atmosphere of Venus (*5*).

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References and Notes

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