Radio Emission of Venus at 3 cm and the Solar Activity

BECAUSE of the favourable observing conditions, the planet Venus has frequently been observed in the radio spectrum for some years now. Recently, precise observations at the wave-length 3·3 cm were made by Bibikova *et al.*[1]. These observations were made after the inferior conjunction in Summer 1961. The authors found that the temperature of the planet was distinctly dependent on its phase. The mean temperature observed was about 544° K for the mean phase 0·47, and the value derived from the phase dependence for the inferior conjunction was found to be about 372° K. This large day–night contrast in temperature gives some support to Sagan's[2] greenhouse model over Opik's[3] aerospheric model of the Venusian atmosphere.

Bibikova *et al.* have also compared their results with those obtained by Mayer *et al.*[4] for the 1958 conjunction. For the temperature difference of about 100° K between the two inferior conjunctions, they admitted (in one of their two suggested hypotheses) the possibility that the difference found may be caused by solar activity, because the observations were made at different phases of the solar cycle.

As can be seen from the data of Bibikova *et al.*, the differences between the individual temperature values are in some cases greater than their mean error. Thus the variability of the observed temperature must be real and an adequate explanation of this phenomenon must be sought.

We have therefore investigated the possible dependence of the Venusian temperature as given by Bibikova *et al.* on the instantaneous solar activity, represented by the daily Wolf's numbers R. When making correlations the longitude differences of the Earth and Venus must be respected. Because of the rotation of the Sun, this difference gives a shift in phase in the scales of the time of observation of the solar activity on the Earth and the influence of the activity on Venus. We therefore corrected all the dates of observations of Venus ($t_♀$) for this geometric effect and obtained fictitious dates ($t'_♀$) suitable for correlating the Venusian temperature $T_♀$ with R. To obtain a good correlation between the curves of $T_♀$ and R the $T_♀$ curve must be shifted to the left by about 8–9 days. The result using a supplementary shift, Δt, of 8·5 days is given in Fig. 1. In this case the ratio $\Delta T/\Delta R$ is about unity, and for $R = 0$ the dependence of $T_♀$ on the phase of the planet disappears. The resulting value for the temperature, reduced to the conditions without solar activity, is $T_♀ = 475°$ K.

In order to confirm this finding we have made a short analysis of the observations made by Mayer *et al.*[5] at λ3·15 cm during the 1956 inferior conjunction. The dispersion of the temperature values was greater in this case, and the correlation was not as detailed, but the

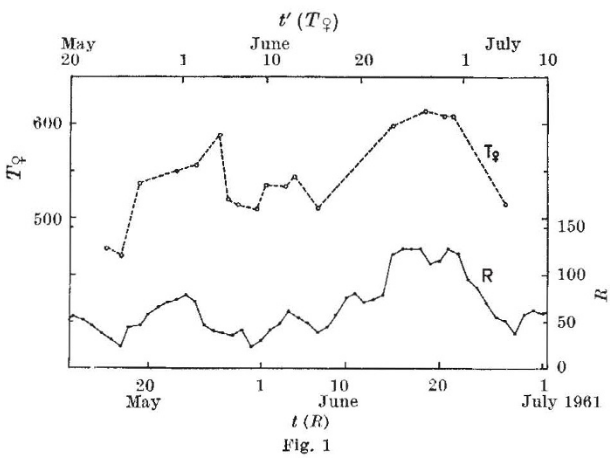

Fig. 1

results correspond in general to those for the 1961 conjunction. Only the reduced temperature for zero activity was lower and was estimated to be about 440° K. A more complete analysis of the dependence of Venusian temperature on solar activity, using data published by different authors for other frequencies, will be published elsewhere[6].

In both the cases mentioned the trend of solar activity was decreasing in the direction of the conjunction (in 1956 observations were made before and in 1961 after the inferior conjunction). This led Bibikova *et al.* to suspect that the temperature was dependent on the phase of the planet. The actual independence of temperature from the phase suggests a high speed of rotation. However, the rotation of a planet with an atmosphere must induce a general circulation, with transport of energy through the atmosphere. It is very difficult to compare present models of the Venusian atmosphere with existing radio measurements, as has been shown by Danilov[7] and Jastrow and Rasool[8]. The dependence of the observed temperature on the solar activity indicates that the influence of far-ultra-violet and X-radiation, produced by the hot active regions in the solar corona, must now be taken into account in the construction of the models of the Venusian atmosphere. The most difficult aspect of this problem is the great retardation of about 8 days in the transformation of the radiation energy from the active regions into thermal energy in the form of radio emission from the planet.

More systematic, detailed and accurate observations at different wave-lengths during the rising part of the commencing solar cycle are now needed in order to verify the present results and to obtain more information on this phenomenon at other wave-lengths.

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Observations of the Low-energy Photon Fluxes during the Solar Approach of the Ikeya-Seki Comet

A BALLOON-BORNE omnidirectional scintillation detector was aloft over Palestine, Texas (L value about 1·6), during the solar approach of the Ikeya-Seki comet on October 20, 1965. One of the aims of this experiment was to observe any possible enhancements to the low-energy atmospheric photon flux induced by the passage of the comet. The perihelion of the comet occurred on the 'dark' side of the Sun with an orbital inclination of about 40° to the ecliptic and therefore had an apparent perihelion of about 1° around the Sun as observed from the surface of the Earth.

The detector consisted of a cylindrical sodium-iodide (thallium doped) scintillator of diameter 5 in. and depth ½ in., yielding a geometric factor for an isotropic flux of 76·2 cm². The axis of the detector was vertical, and a 5 in. photomultiplier tube observed the scintillations from below. Pulse height analysis techniques (which were compatible with FM/FM telemetry systems on both the balloon package and the ground station) enabled a study of the atmospheric photon component in the energy intervals 100 keV–325 keV, 100 keV–660 keV, energies