servation, one obtains $F/F_{20}+F_{45}) =$ 1.694 and 1.730 in the South Equatorial Belt (SEB) and South Tropical Zone (STrZ) respectively (*5*).

All these models have a brightness temperature which remains constant to within $\pm 20°K$ with respect to wavelength. This is consistent with ground-based observations in the range from 8 to 14 μm (*6*) and in the range from 1 to 2 cm (*7*). Accordingly, we have adopted the value 1.72 ± 0.03. With the observed values of $\overline{F}_{20}$ and $\overline{F}_{45}$, this gives an effective temperature T_e for Jupiter of $125° \pm 3°K$, where the uncertainty is almost entirely in the calibration.

The ratio of total emitted power E to absorbed solar power S for Jupiter is given by

$$\frac{E}{S} = \frac{4\sigma T_e^4(1 - 2\epsilon/3)}{(1 - A)F_s(1 - \epsilon)} \approx 1.9$$

Here F_s is the solar flux at Jupiter's orbit, and $A = 0.42$ is the bolometric Bond albedo (*8*). The uncertainty in $(1-A)$ is at least as great as that associated with σT_e^4. Our measurements thus are not inconsistent with the value $E/S = 2.5 \pm 0.5$, previously determined by earth-based observations (*9*).

Future papers will deal with the basic data related to the global heat balance, the implications of our measurements on the vertical thermal structure of Jupiter's atmosphere, and the heat balance of local regions on the planet. Preliminary results (*5*) of these studies reveal, first, that temperatures and pressures agree with ground-based values (*4, 7, 10*) but do not agree with the Pioneer 10 radio occultation results (*11*), and, second, that the molar fraction of He is not greater than 0.4. As previously remarked (*1*), the measured temperature field is incompatible with model calculations for an atmosphere in radiative-convective equilibrium, so such calculations cannot be used as originally planned (*12*) to obtain a more accurate estimate of the He abundance.

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Pioneer 11 Meteoroid Detection Experiment: Preliminary Results

Abstract. *The concentration of meteoroids of mass ~ 10^{-8} gram in interplanetary space, in the asteroid belt, and near Jupiter has been measured. The data confirm the Pioneer 10 observation that the asteroid belt is not highly populated with small meteoroids, suggest that the high concentration of small particles around Jupiter is the result of gravitational focusing, and provide an indication of the mass distribution of meteoroids in interplanetary space.*

The first measurements of the population of small meteoroids outside the orbit of Mars were made with the meteoroid detection experiment on Pioneer 10 (*1*). The Pioneer 10 detector was sensitive to particles of mass ~ 10^{-9} g. A similar experiment on Pioneer 11, sensitive to particles of mass ~ 10^{-8} g, has now provided us with data on the mass distribution of meteoroids in interplanetary space. The meteoroid detectors on Pioneer 11 are pressurized cell penetration detectors like those on Pioneer 10 except that the cell wall exposed to the meteoroid environment is 50 μm thick, twice as thick as those on Pioneer 10 (*2*). There are 234 pressurized cells on each spacecraft, divided into two data channels to increase reliability. The data from 108 cells are processed by the channel 0 instrument, whereas the data from the other 126 cells are processed by the channel 1 instrument.

The time history of the meteoroid penetrations on the channel 0 instrument is shown in Fig. 1. The Pioneer 10 data are also shown for comparison. The approximate heliocentric range is indicated on the upper scale.

On Pioneer 11 the penetration rate was high between 1.00 and 1.15 astronomical units (A.U.). There were no meteoroid penetrations between 1.15 and 2.3 A.U. The penetration rate between 2.3 and 5.0 A.U. was lower than that measured between 1.00 and 1.15 A.U. There was no increase in the penetration rate in the asteroid belt and hence no evidence that the asteroid belt is a significant source of small meteoroids.

The Pioneer 11 data can be compared directly with the Pioneer 10 data for interplanetary space because the interplanetary trajectories were similar. The penetration rates differed by about a factor of 2 near 1 A.U., in agreement

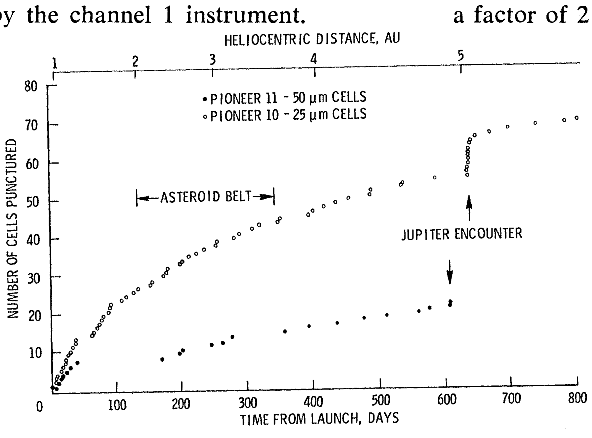

Fig. 1. Time history of meteoroid penetrations detected on the Pioneer 11 channel 0 instrument. Pioneer 10 data are shown for comparison.

with data obtained when pressurized cell meteoroid detectors of the same material and sizes as the Pioneer 11 and Pioneer 10 detectors were used in Earth orbit on Explorer 23 (*3*).

The Pioneer 11 data confirm the existence of a gap in the meteoroid environment beginning near 1.15 A.U. Although the gap extended to 1.34 A.U. in the Pioneer 10 data, it is poorly defined for the larger particles detected by Pioneer 11 because of the low data rate. The penetration rate measured on Pioneer 11 between 2.3 and 5.0 A.U. is less by about a factor of 2.5 than that measured by Pioneer 10. The mass distribution in this region of space is therefore, to the accuracy established with the few meteoroid penetrations obtained, essentially the same as that near 1 A.U.

There were two meteoroid penetrations indicated on the channel 0 instrument while Pioneer 11 was near Jupiter. In addition, a spurious count was registered soon after the second penetration while the spacecraft was near periapsis and the radiation was high. This finding has raised some question about whether the two indicated meteoroid penetrations were actually penetrations or whether they also were induced by radiation. A more thorough investigation is required before any conclusions can be reached. It is clear, however, that no more than two meteoroid penetrations occurred in the channel 0 detectors during encounter.

The Pioneer 11 encounter trajectory was vastly different from that of Pioneer 10, and the encounter data cannot be compared directly. If the meteoroids near Jupiter are gravitationally focused toward the planet from solar orbits, the channel 0 instrument on Pioneer 11 should have registered about two penetrations during approach to periapsis and none after periapsis, which is what happened. Thus, the data obtained during the Pioneer 11 encounter are consistent with the concept that the high concentration of small particles near Jupiter is the result of the fact that meteoroids in solar orbits are gravitationally focused toward the planet.

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Atmosphere of Jupiter from the Pioneer 11 S-Band Occultation Experiment: Preliminary Results

Abstract. *Two additional radio occultation measurements of the atmosphere of Jupiter were obtained with Pioneer 11. The entry measurement leads to a temperature profile that is substantially in agreement with those obtained with Pioneer 10, showing temperatures much higher than those derived from other observations. The exit measurement is not usable because of the discontinuous drift of the spacecraft auxiliary oscillator, presumably due to the trapped radiation belts of Jupiter. The combination of two Pioneer 10 measurements and one Pioneer 11 measurement yields an oblateness of 0.06496 at 1 millibar and 0.06547 at 160 millibars. Measurements in the Jovian ionosphere indicate a number of layers distributed over about 3000 kilometers, with a topside temperature of about 750 K.*

The Pioneer 10 spacecraft was the first to perform a radio occultation experiment in the atmosphere of Jupiter and its satellite Io (*1, 2*). Analyses of data from these occultations revealed the existence of an atmosphere on Io, as well as indications of unexpectedly high temperatures in the atmosphere of Jupiter amounting to about 400 K at a pressure of about 500 mbar as compared to approximately 130 K at comparable pressures as deduced from Earth-based spectroscopy and the Pioneer 10 infrared radiometry experiment (*3*). This obvious disagreement was difficult to explain; however, one possibility was the existence of obscuring dust layers in the upper levels of the Jovian atmosphere, a possibility that was supported by the observation in the Pioneer 10 occultation results of markedly higher temperatures at pressures of 1 to 30 mbar on the sunlit side, implying heating by sunlight absorbed by dust or other particulate matter suspended in the atmosphere. In view of the nature of the Pioneer 10 results, the Pioneer 11 measurements, taken at different latitudes and conditions of geometry, offered the prospect of elucidating the cause of the disagreement.

Pioneer 11 flew by Jupiter on 3 December 1974. The geometry of the occultation is shown in Fig. 1, which is a view of the Pioneer 10 and Pioneer 11 trajectories and Jupiter as seen from Earth. The closest approach of Pioneer 11 to Jupiter, which occurred near the time of the crossing of the orbital planes of the Galilean satellites, occurred at about 5:21:37 G.M.T. on 3 December while Pioneer 11 was behind Jupiter, thus precluding any further occultation experiments with the satellites. The entry into occultation occurred at a latitude of about 79.5°S and a longitude of about 239°W, on the dark limb of Jupiter where the solar zenith angle (SZA) was 92.5°. The exit occurred at a latitude of about 20°N, a longitude of about 91°W, and an SZA of about 79.1°. From Fig. 1 it is evident that Pioneer 11 was traveling about twice as fast as Pioneer 10, for a rate of change in the projected radial distance from the center of Jupiter of about 40 km per second. Thus, the time needed for the radio beam to traverse the distance from the top of the ionosphere to the lowest level of penetration was only about 2 minutes. The occultations occurred while the spacecraft was much closer to Jupiter than in the case of Pioneer 10, with the distance from the limb being about 98,000 km at entry and about 120,000 km at exit.

Occultation data were taken at Deep Space Network station 43 near Canberra, Australia, and station 14 at Goldstone, California. Both closed-loop and open-loop data were taken; however, because of the rapid changes in the frequency of the signal due to the high velocity of the spacecraft relative to Jupiter, no closed-loop data in the atmosphere of Jupiter were obtained and only open-loop data were used for analysis. These data were obtained from open-loop receivers having a bandwidth of about 16 khz and recorded by direct and FM recording on analog tape recorders. These data were then digitized at a rate of 40,000 samples per second and digitally filtered with a 300-hertz filter bandwidth, with the use of a local oscillator (L.O.) function derived from signal spectra computed from the raw digitized data. The decimated data were then passed through the digital phase locked loop receiver program, which computed the changes in frequency and amplitude of the received signal with time and provided the basic data for further analysis.

A series of spectra of the decimated signal as a function of time during the