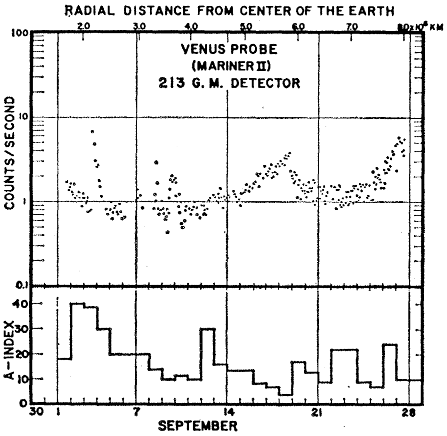

Fig. 2. Data reported in September 1962. (Top) Counting rate. (Bottom) Magnetic A indices.

ing. At rates in the range 26.6 per second to about 60 per second the "short gate" system gives the approximate rate, indicates the number of times (one, two, or three) which the "long gate" register has overflowed, and, with some reservation, makes it possible to use the "long gate" reading for obtaining a more accurate rate, if it appears that one is entitled to assume substantial constancy of counting rate over a time period of some 47 seconds.

The upper portions of Figs. 2 and 3 show data observed in interplanetary flight during September and October 1962. Each point corresponds to an average over five sampling periods. The expected minimum counting rate is about 0.6 count/sec because of galactic cosmic rays, whose interplanetary intensity in the general vicinity of Earth's orbit is about 3 particles cm^{-2} sec^{-1} during the present period of reduced solar activity. Such a minimum counting rate is indeed seen to have been approached during portions of the period covered by Figs. 2 and 3. In general, the data attest to a remarkable "cleanliness" of interplanetary space in respect to the types of radiations to which this detector is sensitive (see *1*). Marked increases of counting rate are noted on the following dates: 3, 8, 9–10, 15–19, and 25–28 (?) September, and 8–9, 12–15, and 23–24 October 1962.

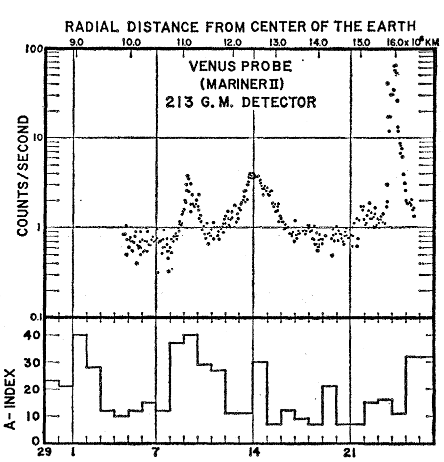

Fig. 3. Data reported in October 1962. (Top) Counting rate. (Bottom) Magnetic A indices.

No proper interpretation of these peaks has yet been made. The following general lines of interpretation are being investigated: (i) changes in directionality or intensity and/or energy spectrum of particles in the solar wind; (ii) solar cosmic rays; (iii) galactic x-rays (see above). It is expected that the following other lines of evidence will contribute to an understanding of the significance of these peaks:

1) Mariner II magnetometer measurements.

2) Mariner II plasma probe data.

3) Data from the ionization chamber and two other (thick-walled) Geiger-Mueller tubes in Mariner II.

4) Data from a set of thin-window 213 detectors in the Iowa equipment in Explorer XIV, particularly near apogee (which is at 16.4 earth radii).

5) Data from the magnetometer in Explorer XIV.

6) Terrestrial data on geomagnetic and auroral activity.

7) Data from rocket, balloon, and low-altitude satellite equipment near Earth.

8) Radio and optical observations of the Sun.

Pending completion of a thoroughgoing study, we have plotted the daily average Fort Belvoir magnetic A indices from the weekly Boulder reports (*2*) in the lower portions of Figs. 2 and 3 with the idea of testing whether or not our counting rate peaks have any correspondence to geomagnetic effects which are presumably caused by changes in the solar wind. There is some indication of correspondence, but the relationship to this crude index of geomagnetic activity does not appear to be intimate, and no conclusions are proposed at this time.

The planetary encounter, now expected on 14 December, continues to represent the observing period of greatest interest for this experiment (*3*).

James A. Van Allen
Louis A. Frank
Department of Physics and Astronomy, University of Iowa, Iowa City

References and Notes

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2. Billings, Trotter, LaVelle, "Preliminary reports of solar activity" (High Altitude Observatory, Boulder, Colo.).
3. We are grateful to Hugh R. Anderson and Leonard A. Parker of the Jet Propulsion Laboratory, California Institute of Technology, for continuing cooperation on all aspects of payload integration and data handling. Substantial experimental and data analyses have been provided by H. K. Hills and C.-S. Wang of our laboratory. Our work has been supported in large part by a contract with the Jet Propulsion Laboratory.

21 November 1962

Cosmic Dust

The objective of the cosmic dust experiment on Mariner II is to make a determination of the flux of dust particles in interplanetary space by direct measurement techniques similar to those used in recent satellite experiments. Prior information concerning distributions of dust particles in interplanetary space has been obtained from analyses of photometric studies of the zodiacal light and the solar corona. Dubin and McCracken (*1*) have compared the measurements from the satellite experiments with these photometric observations and have demonstrated that the spatial density of cosmic dust may be greater near the earth than in interplanetary space by at least three orders of magnitude. The cosmic dust detector on the Mariner II spacecraft is at present extending the direct measurements to interplanetary space.

The experiment consists of one metallic sensor plate (3.5×10^{-2} m^2) with an acoustical transducer bonded to it (*2*). The electrical signal from the detector is proportional to the mechanical impulse received by the sensor plate from an object impacting on its surface. The electronic instrumentation is capable of differentiating two momentum ranges differing in magnitude by a factor of 10. The minimum threshold sensitivity, as determined by low-velocity calibration techniques (*3*), is $7.4 \pm 1.7 \times 10^{-4}$ dyne-sec.

At both momentum levels the system is capable of counting and storing three events until they are telemetered to earth, whereupon the system is reset for more data. An in-flight calibration signal occurs after each telemetry readout and thus repeatedly demonstrates the operation of the electronic section of the experiment. The solid viewing angle of the system is approximately π steradians.

So far, 950 hours of data have been studied, and all information indicates that the experiment is functioning properly. During the portion of the flight represented by these data, the detector plate was approximately perpendicular to the ecliptic plane and facing in the direction of flight. Thus, it was primarily sensitive to particles in retrograde heliocentric orbits, although impacts from particles in direct heliocentric orbits with low relative collision velocities were a possibility.

During this period, one definite hit was recorded on the more sensitive momentum channel. Some of the data will be re-examined in order to check several possible hits which are classified questionable at the present time.

However, an estimate of the flux can be made by computing the flux necessary for a 0.9 probability of at least one impact for the time of the measurement.

With an area-time product of 1.2×10^5 m^2 sec, a flux of 6×10^{-6} particles/m^2 sec srad is obtained. If an average collision velocity of 55 km/sec for this retrograde flux is assumed, the mass of the minimum detected particle is $1.3 \pm 0.3 \times 10^{-10}$ g.

A few brief remarks can be made concerning the direct measurements from earlier satellites and the preliminary results from the cosmic dust experiment on Mariner II. If an assumption is made that the flux of the dust particles in interplanetary space is omnidirectional, the flux of dust particles measured by satellites near the earth (see *3, 4*) is found to be about 10^4 times greater than the preliminary measurement from the Mariner II experiment.

From a similar experiment on Pioneer I, Dubin reported a measurement of dust particle flux in cislunar space (see *5*). The flux obtained from this measurement is 10^2 times greater than the preliminary Mariner II flux value. These direct measurements are showing a concentration of small dust particles near the earth.

The spacecraft has completed its scheduled 180-degree roll around the sun-probe axis. The detector plate is now primarily sensitive to particles in direct heliocentric orbits. A more effective comparison of the dust-particle flux in interplanetary space with that near the earth will be possible with the analysis of these data.

W. M. ALEXANDER
Goddard Space Flight Center, Greenbelt, Maryland

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28 November 1962

Interplanetary Magnetic Fields

Abstract. Preliminary analysis of Mariner II magnetometer data indicates a persistent interplanetary field varying between a least 2 and 10 gamma ($1\gamma = 10^{-5}$ gauss). The interplanetary field appears to lie mainly in the ecliptic plane, although there is a substantial, fluctuating, transverse component. The Mariner II data agree reasonably well with the prior Pioneer V observations. Typically, variations as large as 5 to 10 gamma in the field component radial from the sun are measured. Correlations with the Mariner II plasma measurements have been observed.

The orbit of Mariner II will take the spacecraft from its injection point just outside the earth on 27 August 1962 to the vicinity of Venus on 14 December 1962. The scientific instruments aboard the spacecraft are designed to provide observations in the vicinity of Venus and to measure several properties of the interplanetary environment over the range of heliocentric distances between 1.5×10^8 and 1.1×10^8 km. Among these instruments is a triaxial, fluxgate magnetometer with three orthogonal sensors. Readings of the *X*-,*Y*-, and *Z*-field components are separated by 1.9 seconds, and a complete set of triaxial readings is relayed to earth every 36.96 seconds. The accuracy of each reading is about 1 gamma (10^{-5} gauss). However, the observed field is the super-position of the interplanetary magnetic field and a nearly constant spacecraft magnetic field. Thus, only *changes* in the interplanetary field can be measured unless the spacecraft field can be independently determined. The two components of the spacecraft field perpendicular to the sun-spacecraft direction have been determined as described below, but not the radial component parallel to this direction. The results described herein were obtained in interplanetary space during late August and early September 1962, far enough from the earth to be unaffected by the earth's presence. No magnetic measurements were obtained either inside the geomagnetic field or in the region of the transition to interplanetary space.

Preliminary analysis of data from the earlier portion of the Mariner II flight has verified a number of widely accepted beliefs and confirmed the main features of prior, less complete observations. Probably the most important result is the convincing evidence that interplanetary space is rarely empty or field free. Magnetic fields of at least a few gamma are nearly always present, except perhaps for occasional, transient nulls. The fields usually vary irregularly with characteristic periods ranging from an observable lower limit of 40 seconds to several hours. The magnitude of the field component transverse to the sun-spacecraft direction (see $B\perp$, Fig. 1) agrees reasonably well with the Pioneer V observations (*1*). The magnitude is typically 5 gamma during times of small magnetic activity, rising to values of 20 gamma or more during magnetic storms, and falling to about 2 gamma during very quiet times. Occasionally, all three components of the field show almost no variations for periods of an hour or two. Such intervals appear to be of shorter duration, and to occur less frequently, than was indicated by Pioneer V data obtained in March and April 1960.

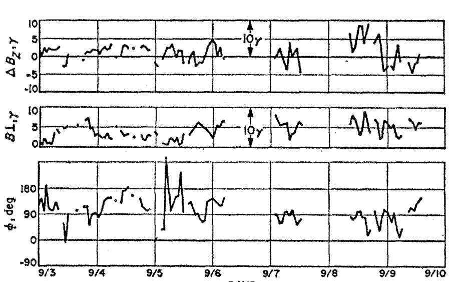

Fig. 1. Magnitude and direction of the interplanetary field. ΔB_Z is the variation in the radial field component. The absolute magnitude of this component is not known at this time because the *Z*-component of the spacecraft magnetic field is unknown. The $+Z$-direction is radially outward from the sun. $B\perp$ is the component of the interplanetary field perpendicular to the *Z*-direction. $B\perp = (b_x^2 + b_y^2)^{\frac{1}{2}}$ where b_x and b_y are derived from the *X*- and *Y*- measurements by subtracting the *X*- and *Y*- spacecraft magnetic field components. The angle $\phi = \tan^{-1} (b_y/b_x)$. During the period shown, the *X*-axis was nearly parallel to the direction of the north ecliptic pole. ϕ is a counter-clockwise angle in a view toward the sun. The values of each variable are hourly averages obtained during the 7 days after the spacecraft was stabilized.