The Mission of Mariner II: Preliminary Observations

Profile of Events

The interplanetary spacecraft Mariner II, designed and built by the Jet Propulsion Laboratory of the California Institute of Technology, was launched from Cape Canaveral by an Atlas-Agena propulsion system at 06h 53m 14s Universal Time on 27 August 1962. In addition to two radiometers designed to make close-up measurements of the electromagnetic radiation from Venus in the microwave and infrared spectral regions, it carries seven other scientific instruments to observe various features of the interplanetary medium. Preliminary results of some of these experiments are discussed in the papers which follow.

Mariner II is, by a large margin, the most successful interplanetary space probe which has ever been sent out from the earth. It will pass closer to another planet than any of its predecessors. No other attitude-stabilized spacecraft has operated so far into space. Rocket propellants have never before been stored in space for so long and then used successfully. This is the deepest penetration into space at which a craft has been commanded and which, in response, performed maneuvers successfully. Far more data from translunar space have been recorded on earth from Mariner II than were ever received before—720,000 data bits per day for more than 75 days (as of 20 November 1962).

Some of the significant events in the voyage of Mariner II are listed below; the times are given in days after launch and the distances from the spacecraft to the earth in gigameters (1 Gm = 10^9 meters = 1 million kilometers = 621,370 miles).

1) 2.39 days, 0.72 Gm: The interplanetary experiments were begun.

2) 8.73 days, 2.41 Gm: The orbit was corrected in response to radio command from earth.

3) 38.73 days. 9.96 Gm: The spacecraft stopped falling behind the earth and began to overtake it (that is, earth and spacecraft had equal angular velocities about the sun).

4) 65.40 days, 19.10 Gm: The spacecraft passed the earth (that is, heliocentric longitude of earth and spacecraft were the same).

5) 65.57 days, 19.23 Gm: The interplanetary experiments were turned off by radio command from earth because of the malfunction of one of the solar power panels.

6) 73.61 days, 23.56 Gm: Interplanetary experiments turned on again by radio command from earth after solar power returned to normal.

7) 81.0 days, 28.5 Gm: New distance record was attained for the transmission of telemetry data, and surpassed that set by Pioneer V in June 1960. The Pioneer V record for one-way transmission of a radio signal (36.15 Gm) will have been surpassed at 90.18 days if Mariner II is still operating at that time.

8) 109.33 days, 57.70 Gm: Mariner II will pass by Venus at a distance of 0.04 Gm from the center of the planet.

Solar Plasma Experiment

Abstract. A preliminary summary of the data received from the Mariner II solar plasma experiment for the period 29 August through 31 October 1962 is presented. During this period there was always a measurable flow of plasma from the direction of the sun. The velocity of this ion motion was generally in the range 400 to 700 km/sec. Time variations, plasma density, and ion temperatures are also discussed.

The Mariner II solar plasma experiment is made with a single electrostatic spectrometer which always points to within less than ½ degree of the center of the sun. Positively charged particles of kinetic energy per unit charge, E/Q, within a certain range, and of near-normal incidence are allowed to pass through the spectrometer to a Faraday cup. The current to this cup is measured for each of ten ranges of E/Q, 3.7 minutes being required to obtain a complete spectrum.

Data were received from the interplanetary experiments on Mariner II almost continuously from 29 August through 31 October 1962. In this period, approximately 23,550 spectra were received from the plasma experiment; of these, approximately 20,200 have already been made available for analysis.

One of the principal results of the Mariner plasma experiment is the finding that there was always a measurable flow of plasma from the direction of the sun. The data are summarized in Fig. 1, which contains eight plots of the logarithm of the collected current versus time—one plot for each value of E/Q between 516 and 8224 volts. Each bar represents the total spread in measured current for the time corresponding to 256 spectra, or 15.77 hours.

The lines in Fig. 1 marked 130 and 140 correspond to approximately 10^{-11} and 10^{-12} ampere, respectively; thus, the vertical distance between these lines is equivalent to one decade of collected current. The largest current observed during the 63-day period was about 4×10^{-10} ampere. Measurements were also made at values of $E/Q = 231$ and 346 volts; however, the currents in these ranges of E/Q are not plotted because they were always below 10^{-13} ampere.

From Fig. 1 it can be seen that there was almost always a plasma flux at values of $E/Q = 1664$ and 2476 volts (corresponding to proton velocities of 563 and 690 km/sec). Only occasionally during this period did E/Q become as low as 516 volts (314 km/sec) or as high as 8224 volts (1250 km/sec).

Table 1 is a summary of the percentage of time the peak of the measured spectrum fell in each of the windows of E/Q.

There were eight geomagnetic storms during the period 29 August through 31 October. The geomagnetic storm which started at 2025 hours universal time, on 7 October has been studied in some detail. A sudden increase in plasma flux and energy occurred at about 1547 on 7 October, when the spacecraft was 8.55×10^6 km closer to the sun than the earth was. If one assumes that this plasma front was advancing with spherical symmetry and constant velocity from the center of the sun (at least for the region of space containing the spacecraft and the earth), then the velocity