N72-33796

RECENT PROBE MEASUREMENTS OF dc ELECTRIC FIELDS FROM IMP I

Dr. Thomas L. Aggson

Figure 1 shows the IMP I satellite. This was launched this spring into a rather eccentric orbit about the Earth. The electric field sensors are the long stem antennas. One pair was extended 91.5 m (300 ft) tip to tip and one pair extended to 45.7 m (150 ft) tip to tip. These antennas were used by many different experiments and were actually shared with some five other ac electric field experiments which monitored frequencies up to 10 MHz. But for the dc electric field measurements, these antennas were used as double floating probes. The inner portions of the antennas had an insulative coating to remove the active areas away from the plasma sheath of the spacecraft.

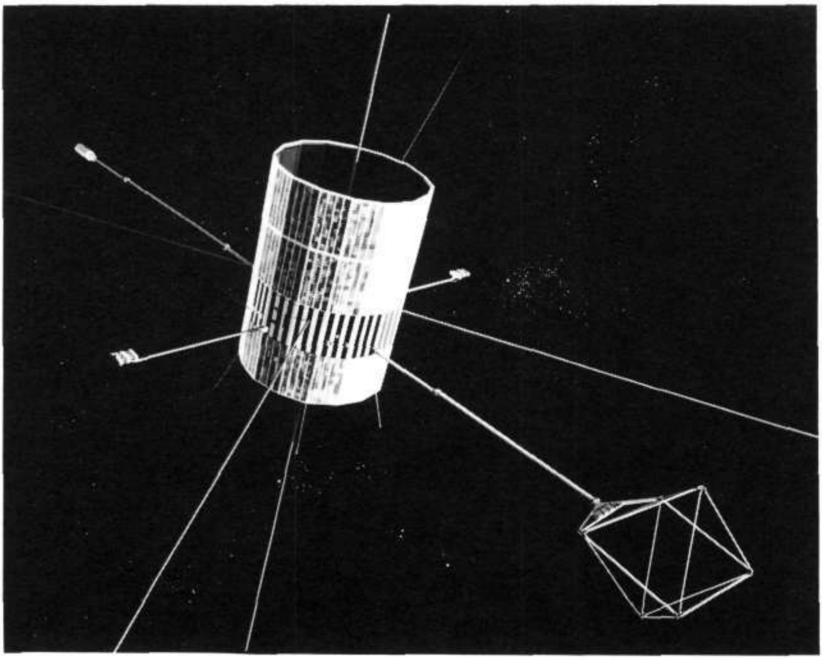

Figure 1–IMP I satellite.

We had tried this technique earlier on the OGO satellites with 9.2-m (30-ft) probes. They worked fine in the ionosphere, but they were not long enough to overcome the contaminating electric field of the spacecraft in the outer magnetosphere.

One point I would like to make here today is that we have tried this technique again in the outer magnetosphere on IMP I with much longer probes, and these longer probes were successful this time.

The data I want to show you are from a satellite crossing of the magnetosphere. Figure 2 shows the location of this crossing, the 25 min of data were gathered at point 2 on an outbound crossing. The experiment data are shown in Figure 3, in which two quantities are plotted. The lower graph is simply a plot of the ac electric field noise in the frequency band of 54 to 100 Hz. The units are microvolts per meter. The upper graph shows the γ component of the dc electric field as the satellite rotates with a spin period of some 2 min. I have plotted the dc electric field in the spinning coordinate system of the spacecraft to emphasize the vector component nature of the dc measurements.

The magnetopause occurs at about 12 Earth radii. The noise enhancement which occurs at the magnetopause is not completely understood, but it is not surprising. This phenomenon probably represents the excitation of one of several universal or two stream instabilities.

The first interpretation of the dc probe data is also somewhat straightforward. Considering the plasma from the point of view of magnetohydrodynamics, a change in electric field is equivalent to a change in the average plasma velocity. The electric field is related to the plasma velocity, of course, by the Lorentz invariants $\mathbf{E} + \mathbf{V} \times \mathbf{B}$.

Thus, what we are seeing in the upper graph is a transition from what appears to be a turbulent region of plasma in the magnetosphere into the uniforming streaming plasma in the interplanetary region where the electric field is some 10 mV m^{-1}.

This is what we should have expected. If we go back to Figure 2, the data show the satellite passing out into this streaming interplanetary region.

The magnetic field on this crossing was some 60 nT (60 γ); dividing that into the electric field 10 mV m^{-1} yields about 200 km s^{-1}, a reasonable value for the plasma flow in this region of the magnetosheath.

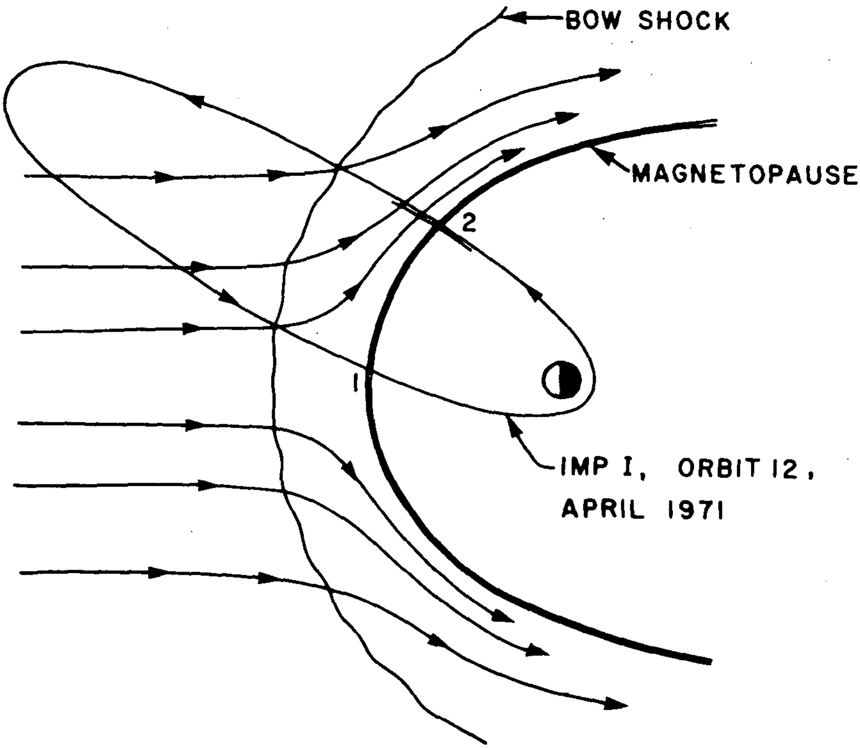

Figure 2–Satellite crossing of the magnetosphere.

I do not have time to show the measured electric field we observed on the inbound crossing of the magnetopause at point 1; it was much smaller, less than 1 mV m^{-1} in the magnetosheath. This is consistent with our understanding of the flow at the subsolar point; the flow becomes quite stagnant like a pilot tube.

In general, we observe fields of the order of 1 mV m^{-1} in the solar wind, with about a 40 percent jump at the bow shock. As the plasma becomes magnetized and the electric field is built up to several millivolts per meter in the magnetosheath, there is a large discontinuity at the magnetopause. Inside, the electric field varies from about 1 mV m^{-1} to tens of millivolts per meter in the auroral ionosphere.

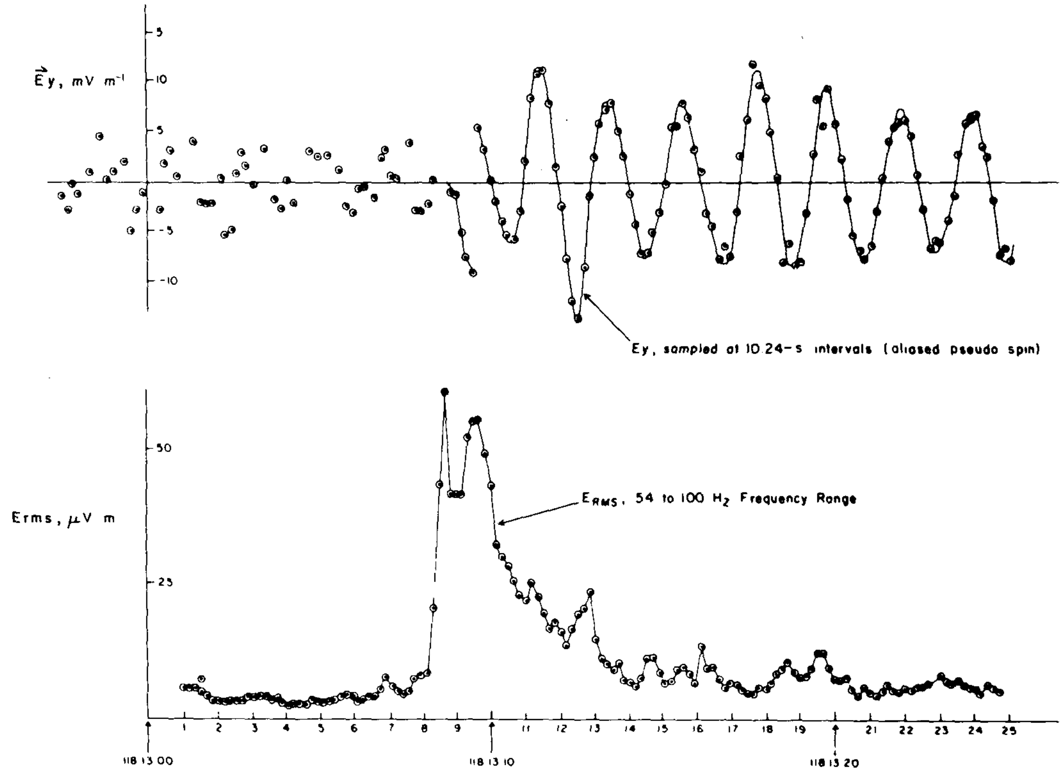

Figure 3—Electric field data. Lower graph is the ac electric field noise. Upper graph is the γ component of the dc electric field as the outbound satellite crosses the magnetopause; day 118, year 1971.