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COMMENT ON THE PIONEER VENUS ORBITER EVENT OF FEBRUARY 11, 1982: OF COMETARY OR SOLAR ORIGIN?

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Abstract. Analysis of Pioneer Venus Orbiter (PVO) and ISEE plasma and magnetic field observations associated with the PVO February 10-11, 1982 events strongly supports the solar origin of the events and not the cometary origin suggested by Russell et al. (1985b). The observation of the field fluctuations and helium enhancements at both Venus and Earth strongly supports the solar origin of the events. Helium enhancements are associated with solar events and not with cometary events. The sequence of the events -- the sheath, the magnetic cloud, and the trailing filament (with its increase in magnetic field magnitude) -- is entirely consistent with the solar origin of the events. Three additional observations strongly argue for a solar not a cometary origin of these events: in contrast to the observations at comet Giacobini-Zinner, no significant plasma wave activity was recorded at PVO at the time Russell et al. claim the cometary bow shock was crossed, thus arguing against the presence of a cometary bow shock; the Venera 13 and 14 magnetic field observations at Venus show that the solar wind was disturbed at this time, which is consistent with the solar origin of these events; and a Forbush decrease was recorded at Earth within a day after the observation of the events at ISEE-3, which also strongly argues for a solar wind and not a cometary origin of the events. We believe the available observations argue for a solar and not a cometary origin of these events.

Discussion

Russell et al. (1985b) provide no new information on the Pioneer Venus Orbiter (PVO) February 10-12, 1982 events. There are, however, a number of errors in their paper:

1) They state that the event seen at PVO was not seen at Earth. This is not correct. As shown in Figure 4 in Intriligator (1985) and reproduced in the current text as Figure 1, the clear rotation of the field and other features are evident in both the near-earth ISEE-3 observations and the PVO observations. Moreover, as stated in Intriligator (1985) enhanced helium abundances are observed at both ISEE-3 and PVO. Since the event was seen both at PVO and at Earth, this argues strongly for the solar origin of the event and not a cometary origin.

2) Russell et al. (1985b) claim that since enhanced helium was only observed before the symmetric increase in the magnetic field then the increase in field was of cometary and not solar origin. This claim is not correct. As discussed in Intriligator (1985), there is a sequence of events or regions that are associated with magnetic clouds -- the preceding sheath, the magnetic cloud, and the trailing filament. In the case of the February 10-12 event, the cloud (with its associated enhanced helium) is preceded by a sheath and followed by a trailing filament (i.e., the trailing filament is the event that shows the rapid increase in magnetic field magnitude). Thus the February 10-12 event follows the sequence associated with events of solar origin and not of cometary origin.

3) Russell et al. (1985b) state that previously increases in helium have not been associated with magnetic clouds. This is not correct. Intriligator and Miller (1984) showed that enhanced helium was associated with magnetic clouds (e.g., the August 1979 events). Crooker (1983) also associated magnetic clouds with increased helium. Klein and Burlaga (1982) associated magnetic clouds with driven shocks and also with coronal mass ejections. The term "driven shock" usually refers to a helium driver gas (Dryer, 1982; Zwickl et al., 1983) thus implying increased helium abundance. Similarly, a coronal mass ejection also usually refers to increased helium abundance (Crooker, 1983; Intriligator and Miller, 1984). Thus, Russell et al. are not correct since there have been previous associations of enhanced helium and magnetic clouds.

4) Russell et al. (1985b) state that Klein and Burlaga (1982) define magnetic clouds as "day-long phenomena." This is not correct. Klein and Burlaga employed hourly averages. They state that for their study they selected only those events that had a duration of about 1 day. They specifically state: "This set (of selected magnetic clouds) does not include all magnetic clouds that might have been present; it specifically excludes...those which pass the earth in less than several hours." Thus they indicate that they also observed events that lasted for only a few hours but that for this particular study they were focusing on the longer events. (Actually, we note that in their Table 1b, ten of the events had a duration of less than a day and five of the events in Table 1c also had a duration less than a day.) Thus, Russell et al. are not correct and, as discussed above, the duration of magnetic clouds often can be less than one day.

5) Russell et al. claim that both the plasma thermal ion pressure and the magnetic pressure increased across the filament boundary. This is not correct. As indicated in Intriligator (1985) at this time there was a decrease in plasma ion pressure and an increase in magnetic pressure. The ion spectra in Figure 5 in Intriligator (1985) indicate this quite clearly (see Figure 2 in the present text). To aid the reader in comparing these spectra Figure 3 in the current text shows the 0411 UT ion spectrum, which was

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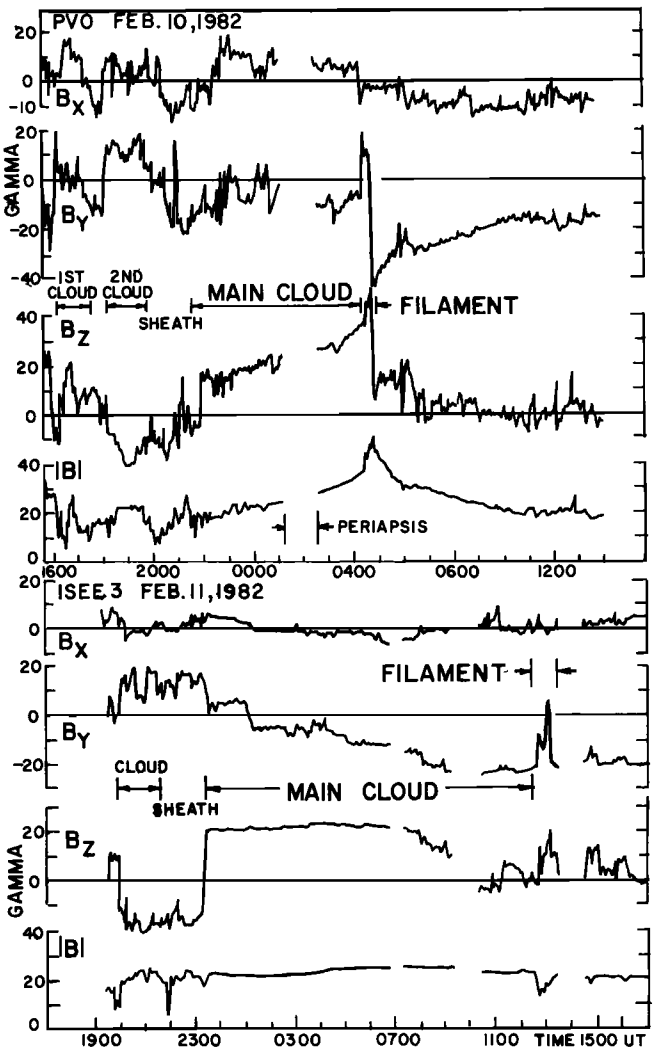

Fig. 1. PVO and ISEE-3 magnetic field measurements from Intriligator (1985). The sheath, the main cloud, and the trailing filament are evident in both data sets.

obtained before the first-filament boundary, and compares it with the subsequent spectra.

The 0411 UT spectrum is very relevant. It is the last complete spectrum obtained before the first filament boundary was crossed. Figure 4 emphasizes this by showing the individual data points for the spectrum starting at 0421 UT. The peak flux in this spectrum was obtained between 0426 05 UT and 0426 18 UT. There was a change of $\sim 14^{\circ}$ in ϕ, longitudinal flow angle (Intriligator et al., 1980) associated with the flux reading obtained during the scan starting at 0426 05--the peak energy step of the spectrum--and the subsequent scan which started at 0426 18 UT--one energy step above the peak energy step of the spectrum (Intriligator et al., 1980). There was a $\sim 7^{\circ}$ change in the longitudinal flow for the peak flux in the next energy step (see figure). Figures 3 and 4 indicate that the spectrum starting at 0411 UT is relevant and that it is the last complete spectrum obtained before the filament boundary.

There is no doubt that the intensity (height) and the temperature (width) associated with the H^+ peak in the 0411 UT spectrum are greater than those in the 0421 UT spectrum, in which measurements of observable plasma were primarily obtained after the filament boundary was crossed. Thus, Russell et al. are not correct and, as stated in Intriligator (1985), there is a decrease in plasma pressure when the magnetic pressure increases.

We have examined six of the claims in the Russell et al. (1985b) paper and have shown that each of them is incorrect.

Once again we conclude that the plasma spectra and field data presented in Intriligator (1985) strongly argue for a solar and not a cometary origin of these events:

i) The observation of the field fluctuations and helium enhancements at Venus and Earth strongly support the solar origin of the events;

ii) Helium enhancements are associated with solar events (e.g., "helium drivers," coronal mass ejections) and not with cometary events;

iii) The sequence of events -- the sheath, the magnetic cloud, and the trailing filament (with its increase in magnetic field magnitude) is entirely consistent with the solar origin of the events.

In conclusion, we note three additional observations that strongly argue for a solar not a cometary origin of these events:

iv) No significant plasma wave activity was recorded by the PVO plasma wave analyzer at the time Russell et al. claim the spacecraft crossed a cometary bow shock (Scarf, private communication). These plasma wave observations are presented in Figure 5. It is evident in Figure 5 that there is no significant activity in any of the plasma wave channels at 0427 or at 0435 UT. Moreover, the plasma wave observations in Figure 5 are markedly different and extremely quiet compared to those obtained in the recent ICE flyby of comet Giacobini-Zinner (Scarf et al.,

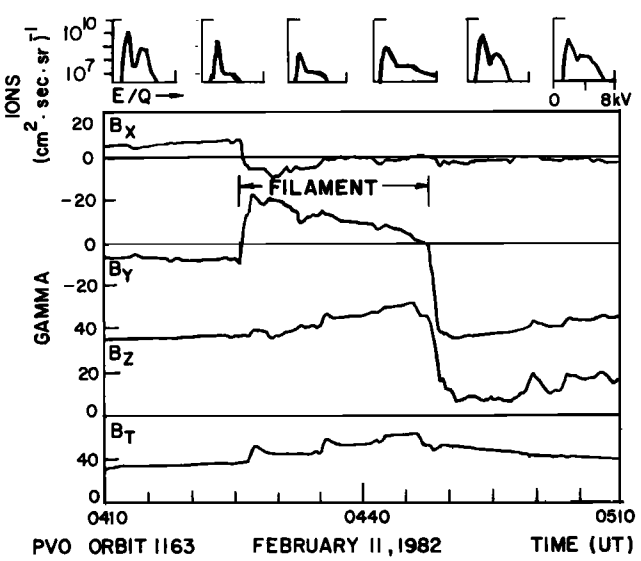

Fig. 2. Simultaneous plasma ion spectra and magetic field data associated with the trailing filament from Intriligator (1985). (Note the first ordinate tick is now correctly labelled 40 and not 10 gamma for the PVO magnetic field magnitude).

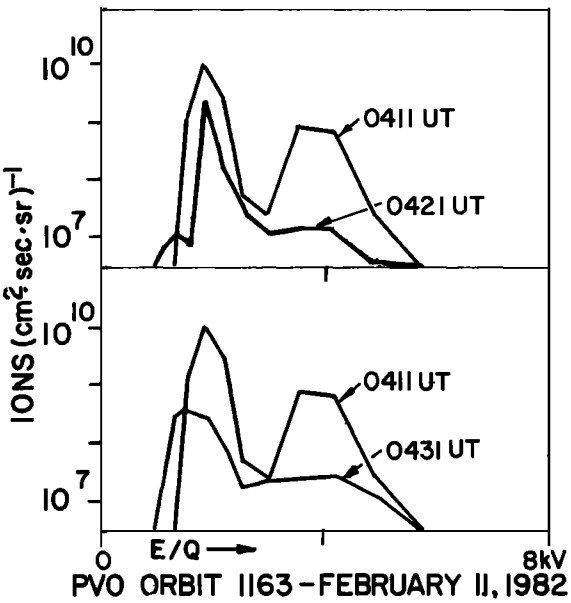

Fig. 3. Comparison of the 0411 UT ion spectrum with the 0421 UT ion spectrum and the subsequent spectrum. The 0411 UT spectrum was the last complete spectrum obtained before the first filament boundary was crossed (see Figure 4). It is evident that both the intensity (height) and the temperature (width) of the H^+ peak (the first peak) in the 0411 UT spectrum are greater than the intensity and temperature of the H^+ peak in the 0421 UT spectrum.

1986). The enhanced plasma wave activity observed on the ICE flyby of a real comet is not at all similar to the PVO observations obtained at 0427 and 0435 UT on February 11, 1982. This lack of plasma wave activity at 0427 and 0435 UT strongly implies that no cometary bow shock was present;

v) There are large differences between the Venera 13 and Venera 14 magnetic field observations (Russell et al., 1985a) on February 11, 1982 at Venus. This indicates the solar wind variability at this time. Russell et al. (1985 a,b) claim that "had the event been a solar initiated disturbance it (the Pioneer Venus

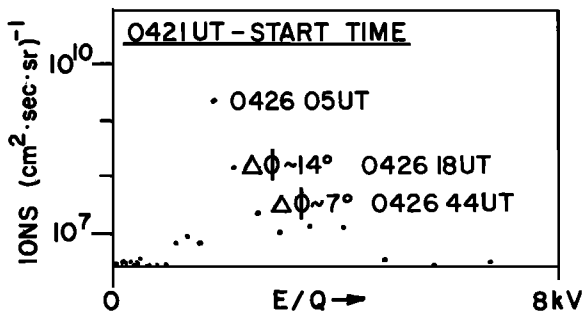

Fig. 4. The spectrum that began at 0421 UT. The peak flux reading (Intriligator et al., 1980) and the subsequent flux readings in this spectrum were obtained after 0426 UT. Unusually large changes in ϕ, the longitudinal flow angle (Intriligator et al., 1980) are associated with some of these flux readings.

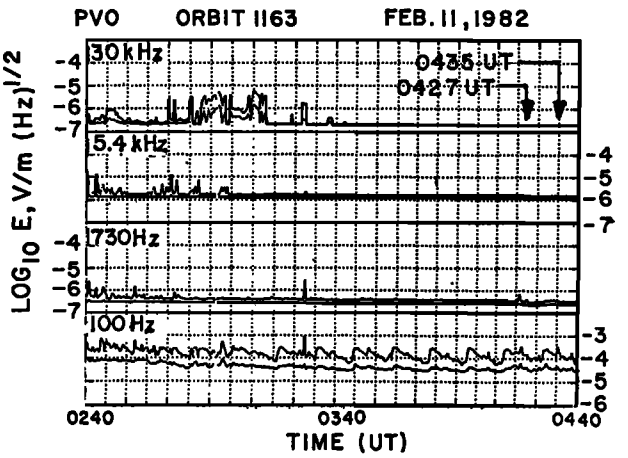

Fig. 5. PVO plasma wave observations on February 11, 1982. Note the lack of significant activity at 0427 and 0435 UT. These observations are markedly different and extremely quiet compared to those obtained on the ICE flyby of comet Giacobini-Zinner.

event) should have been seen almost unaltered by the Venus spacecraft." This is not correct since there are large differences in the magnetic field measured even between the Venera 13 and Venera 14 spacecraft. Thus, the Russell et al. (1985a,b) three spacecraft measurements do not present evidence for a cometary encounter; rather they show that the solar wind was disturbed, which is consistent with the solar origin of these events;

vi) A Forbush decrease was recorded at Earth within a day after the observation of the events at ISEE-3 (Storini and Intriligator, private communication). This also strongly argues for a solar and not a cometary origin of the events.

Conclusion

In summary, our careful examination of the available PVO and ISEE-3 observations strongly argues for a solar and not a cometary origin of these events. The claim that these events are of cometary origin requires some independent confirmation. We urge the conscientious reader to carefully examine the available observations. We believe these observations speak for themselves and argue for a solar and not a cometary origin of these events.

The reader should note that we object to some of the statements and new information in the Russell et al reply; however, present GRL editorial policy prohibits us from discussing their reply.

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