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# PIONEER VENUS OBSERVATIONS DURING COMET HALLEY'S INFERIOR CONJUNCTION

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## ABSTRACT

On February 4, 1986 Halley passed through inferior conjunction with Venus but was at high latitudes. Not all data for this time period have been received. However, the data that are available suggest that at most only weak effects associated with Halley were seen at Pioneer Venus. The data during this time, however, are useful for correlating with the behavior of the plasma tail.

## INTRODUCTION

Shortly before passing through perihelion and superior conjunction with the Earth, comet Halley passed through inferior conjunction with Venus. The Pioneer Venus data from this interval were of high interest for several reasons. If the region of influence of the comet were large, the plasma instrument, the plasma wave instrument and the magnetometer might be able to detect perturbations of the solar wind, and interplanetary magnetic field, or perhaps just waves associated with the ion pick-up process. Further, the solar wind and interplanetary field data obtained at this time would be useful in interpreting observations of the behavior of the ion tail as seen from Earth. Finally, good observations of the hydrogen corona in Lyman-$\alpha$ were obtainable from PVO and very difficult to obtain at this time from any other spacecraft.

Venus passed through superior conjunction with the Earth on January 23, 1986. During the period surrounding superior conjunctions communication between the Earth and Pioneer Venus is difficult. Venus is far away and radio noise from the Sun interferes with the telemetry signal. The first good post-superior conjunction data were not obtained until January 31. Communications after that steadily improved. Data obtained at Pioneer Venus during the ensuing month is important for studying how the solar wind properties affect the plasma tail of Halley but during this interval Halley was well out of the ecliptic plane. Halley did not return to the ecliptic plane until March 11, 1986 about which time it was joined by the Halley armada of spacecraft.

It is the purpose of this note to present the initial magnetic field data obtained at the Venus - Halley inferior conjunction and provide the magnetic field obtained during February 1986 to facilitate studies of the Halley plasma tail.

## INFERIOR CONJUNCTION

Figure 1 shows the geometry of the inferior conjunction of Halley looking down the tail toward the Sun in Halley-fixed coordinates. Since Halley is moving in a retrograde orbit about the Sun, Venus in this display moves from left to right. At inferior conjunction on February 4, Halley is at 0.60 AU and Venus at 0.72 AU. Halley is 21$^{o}$ above the Venus orbital plane as seen from the Sun. Thus if the tail axis were strictly radially out from the Sun at this time, the tail would pass .25 AU above Venus, the closest point of Venus to the tail axis of Halley being only 0.07 AU behind the nucleus. Despite the great distance of this passage, it is possible that Pioneer Venus grazed the edges of the hydrogen corona. Thus it is of interest to examine carefully the data during this interval. We note that, due to the great distance of Halley's tail axis from Venus even at closest approach, the distance to the axis changed only slowly around inferior conjunction.

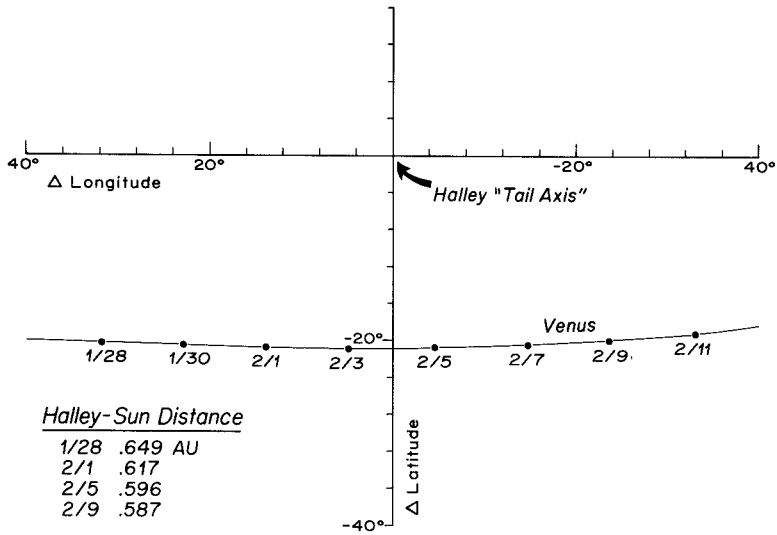


Fig. 1. The apparent motion of Venus relative to the tail of Halley surrounding inferior conjunction. Heliocentric longitude and latitude differences are shown.

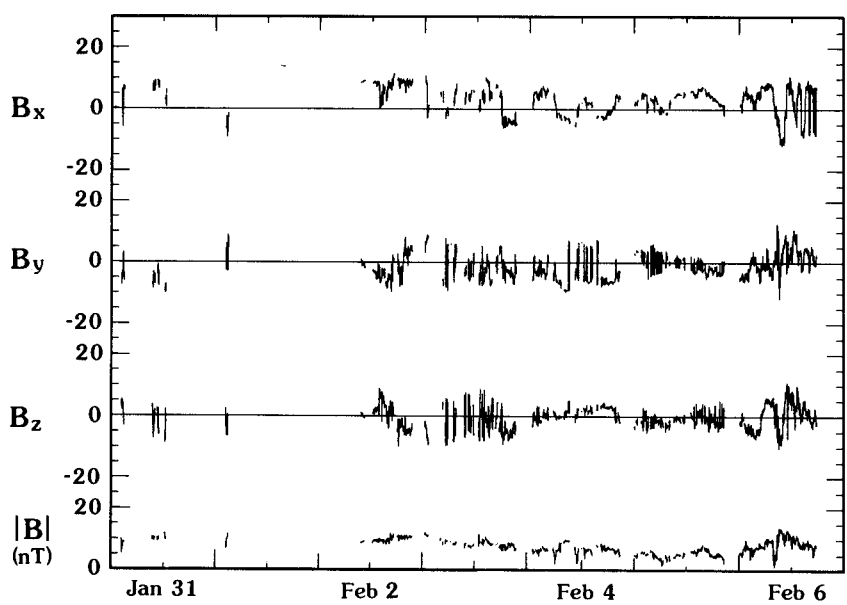


Fig. 2. One minute averages of Pioneer Venus magnetic field values in Venus solar orbital coordinates for the period surrounding the closest approach to Halley's tail axis. More data may become available in the future. Major tick marks are at 00 UT of the days indicated.

The period around inferior conjunction was one of special operations for Pioneer Venus. The spacecraft's spin axis was tipped and special modes were used for telemetry. Furthermore, solar activity was high. Finally, some computer bugs were present in the Ames software. All these conspired to make data gaps in our records. We expect some of these, especially those on January 31 and February 1, will be filled in later. Figure 2 shows the magnetic field in Venus solar orbital coordinates the analogue of geocentric solar ecliptic coordinates for the Earth. Seven days of data are shown here around closest approach. Closest approach occurred early on February 4. Since the comet tail passed far above Venus the distance to the tail axis changed only slowly during this period and we might just as easily have seen effects on February 3 and February 5 as on the 4th.

We have examined all the data obtained during this interval both the magnetometer and the plasma wave data and see no obvious signature of cometary effects. The magnetic field strength and direction is not atypical of those seen in the undisturbed solar wind. The plasma waves all seem to be typical of the solar wind interaction with Venus. A possible effect in these data is a reduced field magnitude on February 4 and 5. Values this low are infrequent in the solar wind at 0.72 AU, but present often enough that we cannot unambiguously ascribe this depression to Halley. Another possible effect is that the field is more X-directed on February 5 than usual. Again, this can occur under normal solar wind conditions.

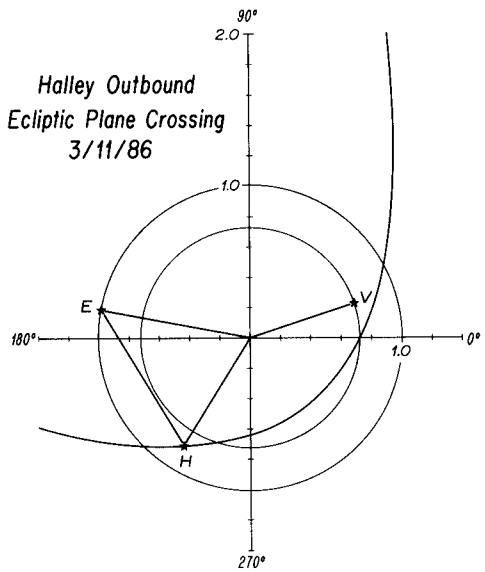


Fig. 3. Ecliptic plane projection of the locations of Venus, Earth and Halley at the time of the outbound ecliptic plane crossing of Halley.

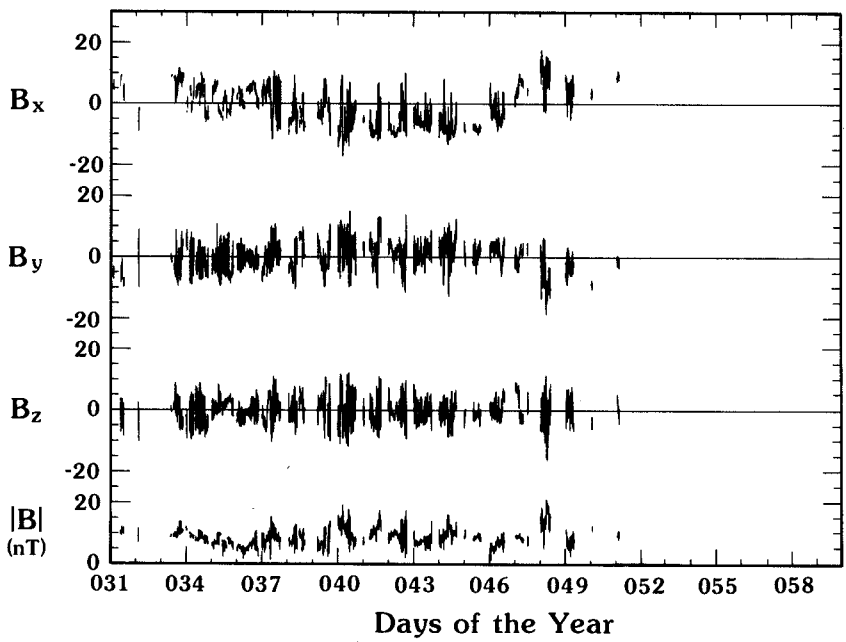


Fig. 4. One minute averages of Pioneer Venus magnetic field values in Venus solar orbital coordinates for the month after Venus' superior conjunction with the Sun as seen from Earth. The data gap after day 49 is due to the entry of Pioneer Venus into the Venus wake. Major ticks mark 00 UT of the day of year indicated.

## CORRELATIVE DATA

Figure 3 shows the location of the Earth and Venus as Halley crossed the ecliptic plane on March 11. Venus is 142$^{o}$ around from the ecliptic plane crossing. A corotational feature in the solar wind would take 11 days to corotate to Venus at this time. On February 4, this nominal corotation time was zero but at this time a corotating feature seen at Venus might in fact not be seen at the higher latitudes of Halley. Figure 4 shows all the data that are available at this time for the month of February. Some gaps still remain because of a software problem but toward the end of the month the missing data is due to the entry of the spacecraft into the magnetosheath and wake of Venus. The major features in these data are the two sector boundary crossings on day 37 and day 47. Data from the preceding and following months are not yet available to check the stability of this sector pattern.

## ACKNOWLEDGMENTS

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