International Sun-Earth Explorer 3/

International Cometary Explorer Description

# Mission Overview

The effective launch of ICE took place on 22 December 1983. As the spacecraft distance from Earth increased, tracking and data acquisition involved the NASA Deep Space Network (DSN). The necessity for this involvement is apparent if one considers that the ISEE-3 radio system was designed to transmit from the halo orbit at a geocentric distance of 0.01 AU, whereas the distance to the spacecraft at cometary encounter will be 0.47 AU. A major effort required for the ICE mission was the outfitting of antennas in the DSN to operate at the ICE frequencies. Current plans are to utilize the 64 m DSN (Goldstone, Madrid, Canberra) and the 300 m dish at Arecibo as the prime station. The anticipated data rate at encounter will be 1024 bit/s, although 512 bit/s may be used at other times. The acceptable performance is based on a bit error rate of 10\*\*-4. There will be additional coverage by the 64 m station at Usuda, Japan. Operations outside the month centered on the encounter date of 11 September 1985 are basically cruise-science measurements, which will be discussed in the next section. The ICE spacecraft will be approaching the aim point on the main plasma tail axis 10000 km from the nucleus. Some idea of the spatial scales associated with key instruments and their sampling times is given below for the expected data rate of 1024 bit/s.

|  |  |  |
| --- | --- | --- |
| **Instrument** | **Sampling period(s)** | **Spatial resolution (km)** |
| Magnetometer | 1/3 | 7 |
| Plasma Waves | | |
| 16 channel E | 1 | 21 |
| 8 channel E,B | 16 | 330 |
| Plasma Electrons | | |
| 2-d distribution | 24 | 500 |
| Energetic Protons | 32 | 660 |
| Radio Waves | 56 | 1200 |
| Plasma Ions | 1200 | 25000 |

For the sampling period indicated, the ‘spatial resolution’ is the distance travelled at the relative encounter speed of 20.7 km/s. These dimensions should be compared with the estimated distance between bow-shock crossings of about 175 000 km and a measured main tail diameter of 5000 km. Expressed in terms of time, we expect the spacecraft to be inside the bow shock for about 2 h 20 min and in the main plasma tail for about 4 min. The magnetometer will produce many measurements during the encounter period and we use it to illustrate possible scientific product. Current models of comets do not indicate a major amplification of the cometary magnetic field over the solar-wind value. However, major changes in field-line direction are expected. Well away from the comet the magnetic field should, on average, show the Archimedean spiral angle of 135deg or 315deg to the radial appropriate for normal solar-wind flow. Interior to the bow shock we expect a different, possibly somewhat chaotic, orientation tending to the ordered two-lobed configuration along the axis of the plasma tail. If the neutral sheet is encountered, a magnetic reversal should be recorded. The model-dependent nature of this description must be stressed. For example, the bow shock may or may not exist. We should know after 11 September 1985, and the model will be tested in this and in other respects. Obviously, we need data from as many different experiments as possible to complete our model testing. To enhance the science return from the encounter, a Guest Investigator Program was established by NASA.

# Mission Objectives Overview

The third International Sun-Earth Explorer (ISEE-3) was launched on 12 August 1978 as one element of a three-spacecraft mission that began in 1977. The original purpose was to study the solar-wind interaction with the Earth's magnetosphere. The spacecraft was maintained in a ‘halo orbit’ about the libration point, L1, where it monitored the solar-wind input. It completed four years of uninterrupted operation at that location. Several opportunities to use ISEE-3 in an extended mission phase were available. Among the most attractive scientifically were exploration of the distant geotail and an intercept of periodic Comet Giacobini-Zinner. Either or both of these options were available. The comet option was constrained to an intercept of Giacobini-Zinner in September 1985; specifically, an intercept of Comet Halley was not possible. In order to explore the comet option, a subcommittee of the ISEE Science Working Team (SWT) was formed at the request of the ISEE-3 Project Scientist, T. von Rosenvinge, and chaired by E. Smith. The subcommittee and the SWT as a whole found the option to be of considerable scientific interest, and a report entitled *Intercept of Giacobini-Zinner by ISEE* was issued in June 1982, and revised in May 1983. An *ad hoc* subcommittee of the Space Science Board recommended that NASA proceed with both the geotail option and the comet intercept. After an in-house review and a review of the readiness of the spacecraft to perform the intercept by the Goddard Space Flight Center, NASA approved the intercept with Comet Giacobini-Zinner. The maneuvers necessary to achieve the trajectory that would send the spacecraft into the distant geomagnetic tail and to an intercept of Comet Giacobini-Zinner were not simple. They were the brainchild of R. Farquhar, Flight Director for the Project. Basically, five gravitational encounters with the Moon were required to change the spacecraft's orbit. The last encounter was on 22 December 1983 when the spacecraft made a close swingby, passing only 120 km above the lunar surface. This maneuver effectively ‘launched’ the spacecraft from the Earth-Moon system. At the same time, the spacecraft was renamed the International Cometary Explorer (ICE) to correspond to its new mission.

# Additional Note

*Added in editing by A. Raugh, 2024-08-09*

In addition to the encounter with Comet 21P/Giacobini-Zinner, ICE also made observations of the solar wind upstream of Comet 1P/Halley. NASA ended operations and support for the ICE mission on 5 May 1997, but an independent, publicly funded project signed an agreement with NASA to attempt to reclaim the spacecraft as it passed by Earth in 2014. One thruster firing in July 2014 was successful, but a second firing failed (likely a lack of nitrogen). The spacecraft is still in a heliocentric orbit and is expected to return to the vicinity of Earth in 2031.