



NEAR Magnetometer

NEAR's Magnetometer Investigation (MAG) will conduct the first closeup search for coherent bodywide magnetism at an asteroid. Tantalizing hints of magnetic signatures were detected during Galileo's flybys of Gaspra and Ida, so 433 Eros may have a measurable magnetic field.

Experiment Profile

After slowly approaching and flying by Eros in February 1999, the NEAR spacecraft will be inserted into orbits of progressively smaller radii, culminating in a 35-km orbit. During the slow approach and flyby, the NEAR MAG should register fluctuation signatures of the possible shock and probable bow wave and wake boundary caused by the interaction of Eros with the solar wind. The radial location of this boundary gives a remote detection of the strength of the intrinsic magnetic field of Eros. The intrinsic field will be best determined from the prolonged spiraling into the final 35-km orbit. Solar wind variations may periodically push the wake boundary past NEAR.

Magnetometry at Eros

Eros is an S-asteroid, representative of the important class that dominates the inner asteroid belt. Scientists remain uncertain whether S-asteroids are undifferentiated bodies related to ordinary chondrite meteorites or whether they are geochemically processed bodies akin to stony-irons. The issue is an important test of our understanding of the connection between asteroids and meteorites.

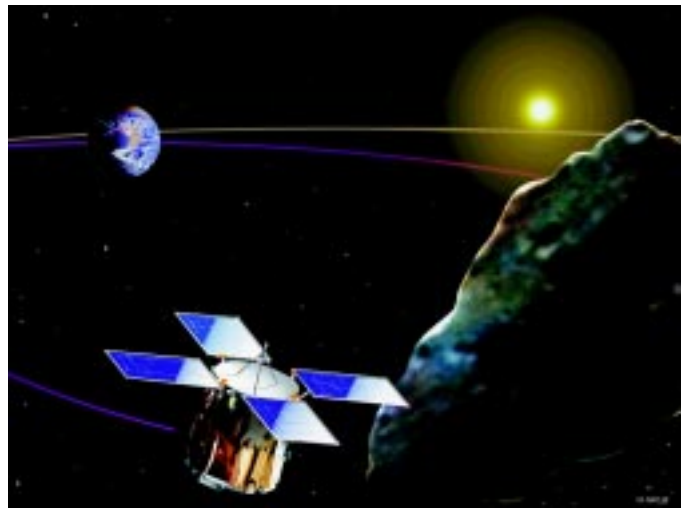
The NEAR magnetometer will probe the interior of Eros and help determine whether small asteroids are solid fragments of rock with densities and composition like those of meteorite samples or whether they tend to be porous piles of collisionally fragmented rubble with considerable void space. Many meteorites show measurable magnetization, but if Eros were a randomly re-accreted pile of fragments, one would not expect a significant coherent bodywide magnetic field.

If Eros were originally part of a differentiated parent body with an internal magnetic dynamo, much like the Earth, it should have a natural remnant magnetization

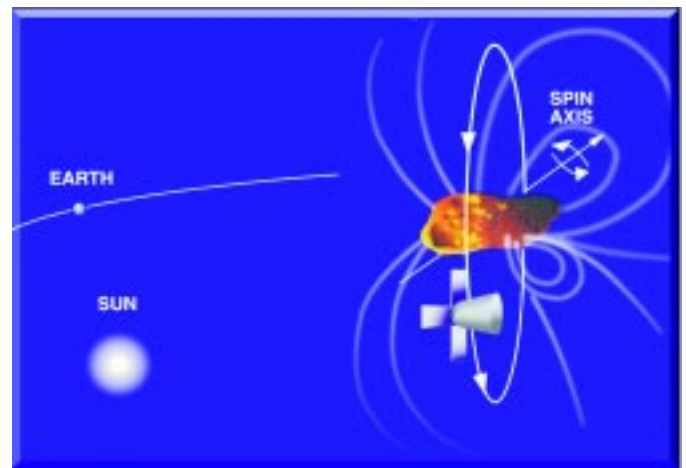
(NRM). Further, if Eros' composition was iron-rich during formation, the NRM should be easily measurable.

If Eros exhibits small NRM, the magnetic sphere of influence will be smaller than the 35-km NEAR rendezvous orbit, and the strength of the moment must be assessed indirectly by studying the magnetic perturbations associated with the Eros bow wave.

For intermediate NRM, the spacecraft may intermittently cross the Eros magnetopause, and magnetic fluctuation measurements will be used to assess these events.



Artist's concept of NEAR spacecraft approach through bow wave



NEAR spacecraft in orbit around Asteroid Eros

For large NRM, the spacecraft will remain entirely within the Eros magnetosphere for extended periods of time.

Description

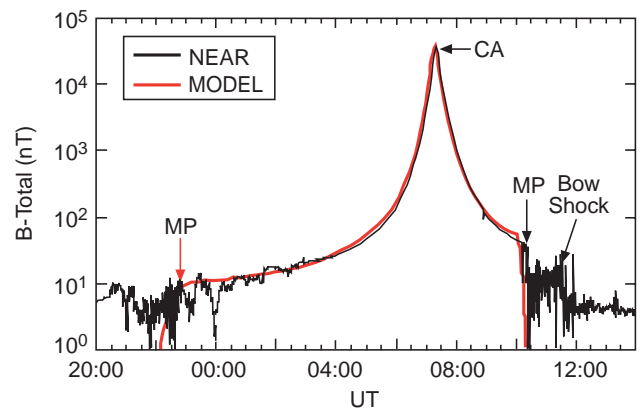
To minimize costs and spacecraft impacts, no booms are used. The sensor is mounted approximately 1 meter from the main spacecraft bus, on the high gain antenna feed support.

The heritage of this magnetometer includes APL and NASA/GSFC instruments aboard Voyager, UARS, Geotail, WIND, Freja, Viking, Pioneer, POGS, Giotto, AMPTE/CCE, Mars Observer, and DMSP. The NEAR magnetometer sensor mounting configuration is similar to that used on the successful Giotto mission to Comet Halley.

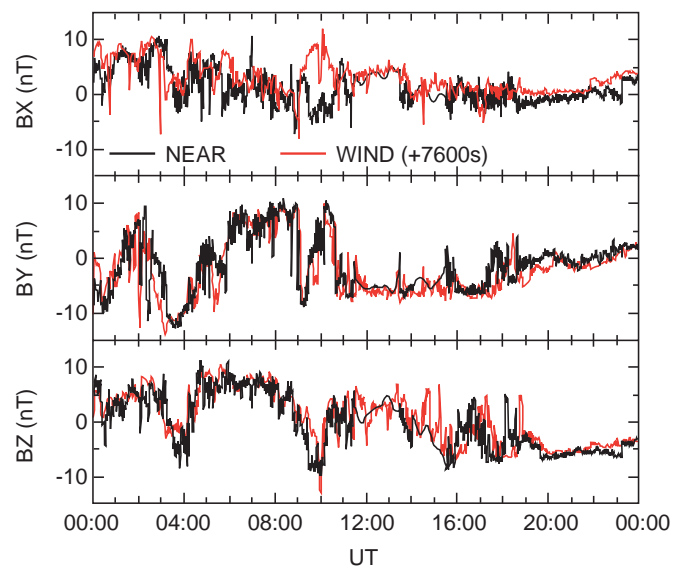
Incorporated in the design is a complete calibration of the magnetometer as well as the effect on the instrument of spacecraft magnetic interference. Using proven methods and the statistics of nearly a year in orbit, even magnetic signals due to Eros that are smaller than spacecraft noise can be reliably isolated.

An example of the in-flight calibration is shown in the data taken during the Earth flyby of NEAR on January 23, 1998. In the calibration plan was a comparison of the Earth's model field values and those measured by the NEAR magnetometer. The top panel shows this comparison of measured magnetic field on log of nanotesla (nT) versus time from 20:00 UT on January 22 to 14:00 UT on January 23. Closest approach (CA) is seen at about 7:30 UT with measurements for about 35,000 nT. The noisy magnetopause (MP) and bow shock are typical in value and fluctuation level. During this Earth flyby time period there was an opportunity to compare data with NASA's WIND magnetometer, located toward the sun from Earth's magnetosphere. The bottom three panels of January 20 display the 3-axis components (in Geomagnetic Solar Ecliptic coordinates) of both the WIND and NEAR measured magnetic field. The measurements are adjusted for solar wind transit time (WIND data were pushed forward 7600 seconds relative to NEAR). The remarkable similarity shows that better than expected noise levels have been achieved, approximately an order of magnitude better than the design goal of 5 nT.

A NEAR Magnetometer: January 22-23, 1998



B NEAR-WIND: January 20, 1998



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NEAR is a NASA Discovery Program mission