HINODE

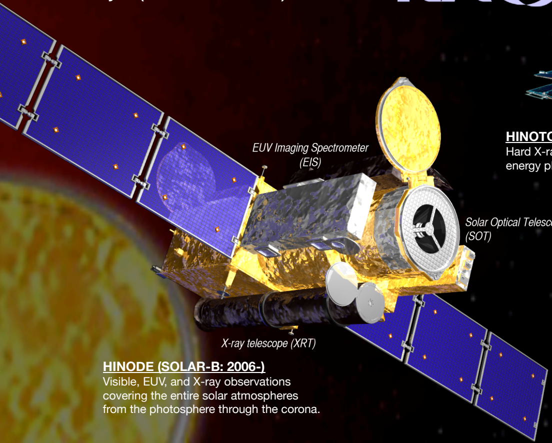
SPACE MISSION TO INVESTIGATE THE SUN

Y. Katsukawa, S. Tsuneta (NAOJ/NINS) T. Sakao, T. Shimizu, K. Matsuzaki (ISAS/JAXA)
T. Watanabe, Y. Suematsu, T. Sekii, H. Hara, R. Kano, M. Shimojo (NAOJ/NINS)

HINODE Mission

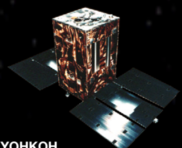
HINODE, Japanese for "sunrise," was launched Sept. 23, 2006, to study the Sun's magnetic fields and how their explosive energies propagate through the different atmospheric layers. The spacecraft's uninterrupted high-resolution observations of the Sun have an impact on solar physics comparable to that of the Hubble Space Telescope on astronomy.

The three advanced telescopes onboard HINODE were developed through international collaboration between ISAS/JAXA, with NAOJ as domestic partner, and NASA (US) and STFC (UK). The mission is operated by these agencies with contributions for downlink connections from ESA.



HINODE (SOLAR-B: 2006-)
Visible, EUV, and X-ray observations covering the entire solar atmospheres from the photosphere through the corona.

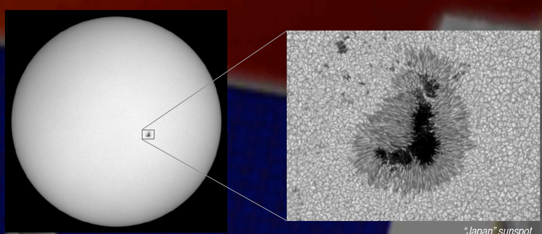
HINOTORI (ASTRO-A: 1981-1982)
Hard X-ray and γ-ray observations of high energy plasma produced by solar flares.



YOHKOH (SOLAR-A: 1991-2001)
Soft and hard X-ray observations provided pieces of evidence of "magnetic reconnection" as the energy converter of flares.

Microscopic Observations of the Sun

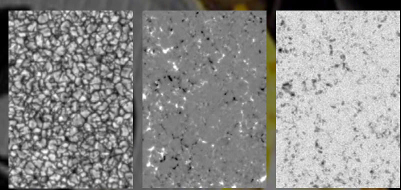
The Solar Optical Telescope (SOT) onboard HINODE provides continuous observations of the Sun's surface with unprecedented resolution free from the influence of the Earth's atmosphere, which allows us to study how magnetic fields emerge and evolve on the surface, and how they give rise to magnetic structures like a sunspot.



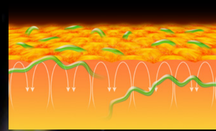
"Japan" sunspot

Ubiquitous Horizontal Magnetic Fields

HINODE discovered a new type of magnetic fields covering the Sun thanks to its high polarimetric sensitivity. These magnetic fields are called Transient Horizontal Magnetic Fields, and their properties are completely different from those of sunspots. Because total magnetic energies carried by the fields are enormous, the fields may play a crucial role in heating and acceleration in the outer atmosphere.



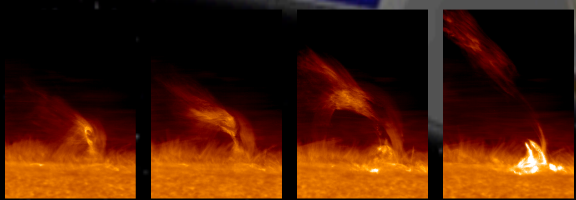
Continuum intensity   Longitudinal mag. field   Transverse mag. field



Artist's view of solar convection (granules) and horizontal magnetic fields.

Plasma Ejections in the Chromosphere

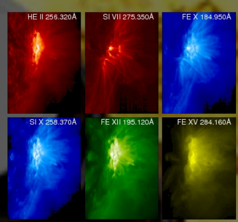
The chromosphere is the interface atmospheric layer between the photosphere and the corona. HINODE has detected plasma ejections over various spatial and temporal scales in the chromosphere. It has also witnessed signatures of magneto-hydrodynamic waves there. These phenomena are essential to understand how the magnetic energy is liberated and transferred in the solar atmosphere.

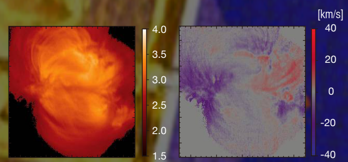


Dynamic plasma ejection in the chromosphere

Structures and Flows in the Corona

For understanding the physics of coronal heating and solar wind acceleration, it is crucial to measure temperatures, densities, and velocities using spectroscopic observations of emission lines from coronal plasma in the extreme-UV (EUV). HINODE discovered upflows near the roots of coronal loops for the first time, which indicate there are sources of heating and acceleration near the base of the corona.



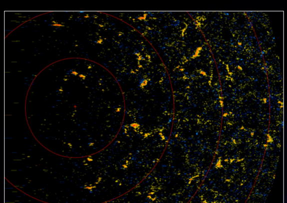


Intensities and Doppler shifts in an active region corona

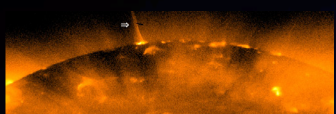
Active region corona seen in various EUV emission lines

Sun's Pole

Magnetic configuration of the Sun's poles was poorly observed so far because of projection shortening in spite of its importance in acceleration of high-speed solar winds. HINODE found polar fields consisting of magnetic patches of kilogauss field concentration. There are also field emergences taking place frequently in the polar regions, which produce bright points and jets seen in X-rays.



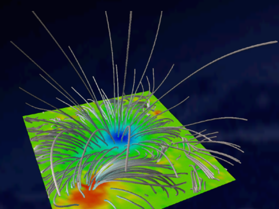
Magnetic landscape of the Sun's pole



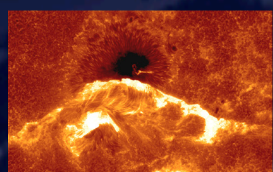
X-ray jet in a polar coronal hole

Origin of Massive Flares

Precise measurements of magnetic fields in the photosphere are a key to understand how enormous magnetic energies are stored and how the energies are suddenly released in a solar flare. Solar flares eventually trigger magnetic storms and aurora activity around the Earth. Solar observations with HINODE have helped progress toward realizing the space weather forecast.



Magnetic field configuration of a flare-productive active region.



Flare ribbons caused by electron beam bombardment of the chromosphere.