

Discovery of cool cloud-like structures in the corona with Hinode Solar Optical Telescope

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A solar observation satellite Hinode (Japanese for sun rise) was launched in September 2006. Hinode carried 3 advanced solar telescopes, visible light telescope, EUV imaging spectrometer, and X-ray telescope to simultaneously observe the photosphere, chromosphere, transition region, and corona.

In the performance verification phase of the Hinode spacecraft with its telescopes, we were tracking an active region AR10921 as it traversed the Sun from east to west. The active region reached the west limb of the solar disk on November 9 2006. At this point, we planned to observe spicules on the limb with a broadband filter dedicated to Ca II H line (3968Å). Sun consists of mainly Hydrogen and Helium with smaller amount of higher-Z materials. Ca II-H emission line (3968Å) comes from plasma with temperature of approx. 10^4 K, which is much lower than the coronal temperature of 10^{6-7} K.

In addition to spectacular spicules, which will be reported elsewhere, we find a large cloud-like structure located 10,000-20,000 km above the limb. Their intensity is less than 1% of that of the photosphere. The cloud has a very complex fine structure with dominant horizontal thread-like structure. Each horizontal fiber has a length of 1,000-10,000 km, and a thickness of about 400 km. (The solar optical telescope has a spatial resolution of 150 km at 3968Å.) Some features are moving horizontally with speed of 15-58 km/s. The structures also have clear vertical oscillatory motions. The periods and amplitudes of these oscillations are 130-250 seconds and 200-850 km, respectively. The vertical oscillatory motion sometimes has a coherence length of approx. 16,000 km.

The horizontal threads are most probably horizontal magnetic fields, and the vertical oscillation is a signature of Alfvén waves propagating along the horizontal magnetic fields. The Alfvén speed would be much larger than $16000 \text{ km} / 130\text{-}250 \text{ sec} = 130 \text{ km/s} - 64 \text{ km/s}$ to have the coherence length of 16000 km. The Alfvén speed for magnetic field strength of 10 G and plasma density of 10^{10} cm^{-3} is 250 km/s, which matches above estimate. The wave period is close to solar 3-5min oscillation. The wave propagating in the cloud would be driven by photospheric or chromospheric acoustic oscillations.

Though such observations are completely new, the features discovered here may have close connections with the H-alpha prominences. In the talk, we will discuss the relationship with H-alpha prominences, X-ray and EUV images taken with Hinode.