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NVST observations of magnetic activities in the highly dynamic solar chromosphere

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As the interface of the photosphere and corona of the Sun, the dynamic chromosphere has been investigated for many years. With the improvement of observational instruments, it is a good opportunity for us to further study the magnetic activities in the solar chromosphere. The New Vacuum Solar Telescope with a pure aperture of 980 mm is the primary facility of the Fuxian Solar Observatory in China.

The Hα channel is used to image the chromosphere in the high spatial and temporal resolution. In the Hα images, we find solid evidence of magnetic reconnection between two sets of small-scale, anti-directed loops with an X-shaped topology, which is highly consistent with the reconnection models [1]. We suggest that the successive slow reconnection changes the conditions around the reconnection site and triggers instabilities, thus leading to the rapid approach of the anti-directed loops and resulting in the rapid reconnection. In another small-scale reconnection event, the oscillation of newly formed loops after magnetic reconnection in the chromosphere is observed for the first time [2].

In the chromosphere, there exist many kinds of small-scale activities, such as spicules, surges, and Ellerman bombs. With NVST observations, we discover a new phenomenon, i.e., some dark or bright structures flying along curved trajectory, looking like cannonballs [Fig. 1]. In the simultaneous (extreme-)ultraviolet images, these cannonballs appear as brighter features compared to the surrounding area. The magnetic field observations reveal that the cannonballs are chromospheric material blobs launched due to the magnetic reconnection between emerging magnetic flux and the pre-existing loops [3].

Within active regions, there are a lot of chromospheric fibrils connecting the opposite polarities. Due to the shearing motion between the opposite-polarity patches, the field lines appearing as dark fibrils are highly sheared [4]. As the shearing motion goes on, the field lines can be greatly twisted to form a flux rope. If the twist number exceeds the threshold of kink instability, the flux rope will erupt, resulting in a solar flare. Fan-spine magnetic topology is favorable for the occurrence of solar flares through null-point reconnection. In the Hα images, a fan-spine structure is partly filled and outlined by the bi-directional material flows ejected from the reconnection site. In the Hα Dopplergrams, blueshift and redshift patches are observed to be located at the two sides of the null point [5]. Superposed on the Si IV profile from the Interface Region Imaging Spectrograph, there are several blueshifted deep absorption lines, indicating the movement of the cooler material toward the observer. The depth of the absorption lines also depends on the amount of cooler material. These results imply that this kind of spectral profiles can be used as a tool to diagnose the properties of cooler material above reconnection site.

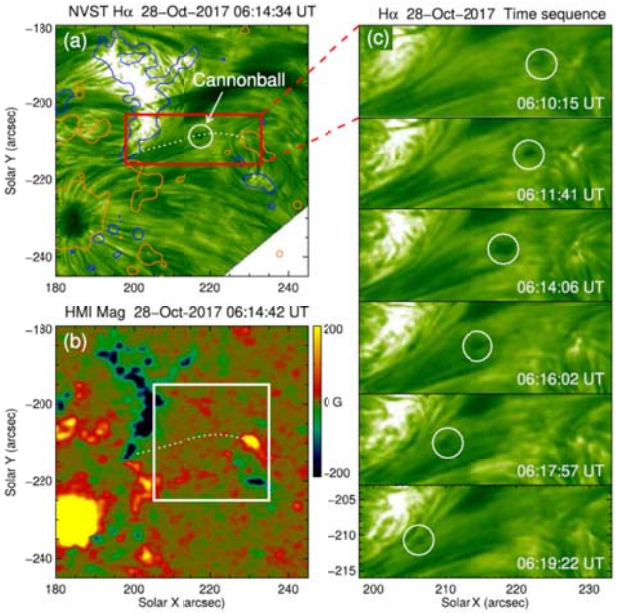

Fig. 1. (a)–(b): NVST Hα image and HMI line of sight magnetogram displaying the chromospheric cannonball-like structure and the underlying photospheric magnetic environment, respectively. (c): time sequence of Hα images showing the movement of the cannonball along a curved trajectory.

References

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