Observation of a Coronal Mass Ejection and its Source Region with NOrikura Green-line Imaging System (NOGIS)

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Abstract. NOrikura Green-line Imaging System (NOGIS), with its unique capability of Doppler imaging, was used to study a CME and its source region on 1999 May 7. The source region at the north-east limb consisted of two loop systems. Prior to the CME, one of the two loops moved toward the neighboring other loop in the plane of the sky. Then, the loop apparently touched and destabilized the other loop, resulting in the CME with a red-shifted motion. In the NOGIS field-of-view, the CME propagated non-radially in the plane of the sky. These observations indicate that the direction of mass ejection was determined by the magnetic field configuration around the source region and the location of the initial energy release in the magnetic field structure.

1. Introduction

The NOrikura Green-line Imaging System (NOGIS: Ichimoto et al. (1999)) is installed on a 10 cm coronagraph with a tunable birefringent filter. This instrument has a field-of-view from 1.03 to 1.33 $R_\odot$, which is suitable for observing CME source regions in the low corona, and observes the coronal green-line emission Fe xiv 5303 Å (1.90 MK). NOGIS can observe not only the intensity of the coronal emission line, but also its Doppler shift simultaneously. It measures the line intensities of the red-shifted (+0.45 Å) and blue-shifted (−0.45 Å) wavelength from the Fe xiv 5303 Å line center. The Doppler velocities can be observed up to ±25 km s$^{-1}$ and its accuracy is 0.6 km s$^{-1}$. By combining the apparent transverse velocities and the line-of-sight Doppler shifts, we are able to derive the three-dimensional motion of magnetic structures that is very important in studying the initiation of CMEs. In this paper, we briefly present an event observed on 1999 May 7. For more details, we would like to refer to Suzuki et al. (2006).

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2. Observation of CME and the Source Region with NOGIS

2.1. Activity of Loop Systems before the CME

Assuming that the photospheric magnetic fields were not significantly disturbed nor were they changed by the occurrence of the CME, we infer the pre-CME magnetic configuration by using post-event magnetograms. Figure 1 shows NOGIS intensity image on 1999 May 7 and current-free field lines (Sakurai 1982) calculated from the photospheric magnetogram of May 11, four days after the CME. Prior to the CME, the active region mainly consisted of two loop systems (L and S in Figure 1).

![Figure 1. (Left) NOGIS intensity image on 1999 May 7. (Right) Force-free field lines calculated from photospheric magnetic fields on 1999 May 11.](image)

Around 02:00 UT, the southern footpoint of the loop S started moving gradually toward the southern footpoint of the loop L. Figure 2 shows that the southern footpoint of the loop S around 22° latitude, apparently moved to the loop L (i.e. toward the lower latitudes). Estimating from the figure, the velocity of the motion in the plane of the sky was 0.2 km s\(^{-1}\), which is reasonable for typical shearing motion in active regions (Chae 2001).

2.2. Mass Ejection Observed with NOGIS

The motion of the loop S lasted until it touched the southern footpoint of the loop L. The loop touched and destabilized the other loop, resulting in the mass ejection at 04:33 UT. In the left image of figure 3, a dimming event (dark region) was seen at the footpoint of the loop L where the loop S touched. The right image in figure 3 shows the Doppler image during the ejection, in which bright (dark) regions show the red (blue) shift motions. From the dimming region, the mass was ejected with a red shift (a bright structure indicated by arrow in the figure). The line-of-sight velocity from the Doppler measurement was a few km s\(^{-1}\) on average, which was much less than the radial velocity of the LASCO CME (538 km s\(^{-1}\)).

Figure 4 shows the positional relationship between the dimming region (inferred from figure 3) and the CME. At the LASCO C2 heights, the CME was
Figure 2. NOGIS intensity latitude-time map at 1.08 $R_{\odot}$. The dashed line traces the motion of the southern footpoint of the loop S. The arrow shows the CME onset time.

seen at the latitude south of the dimming. Namely the dimming was located at the northern edge of the LASCO CME. It suggests that the mass was initially ejected south-eastward (to the lower latitude in figure 4) from the source region rather than radially.

Figure 3. (Left) A running difference image of NOGIS intensity images during the ejection. The dark region indicates the dimming. (Right) Mass ejection observed with NOGIS Doppler image. The arrow shows the ejected mass with the red shift.
3. Summary and Discussion

We studied the CME and its source region at the north-east limb on 1999 May 7. One of the two loops approached the other loop, and when the loop touched and destabilized it, the mass ejection took place. The mass with a red shift initially ejected south-eastward, not radially. Figure 5 is an overview of this event. The source region was not over the active region, but was at a lower altitude, at the footpoints of the two loops. The direction of mass ejection was therefore determined by the magnetic field configuration around the source region and the location of the initial energy release in the magnetic field structure.

Figure 5. An overview of the event on 1999 May 7 before the CME (left) and after the CME (right).

References

Sakurai, T. 1982, Solar Phys., 76, 301
Suzuki, I., Sakurai, T., & Ichimoto, K. 2006, PASJ, 58, 165