

SDO/AIA and Hinode/EIS observations of interaction between an EUV wave and active region loops

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Abstract. We study an EUV wave initiated in active region (AR) 11261 on 2011 August 4 by using the SDO/AIA and the Hinode/EIS. We found that: (1) the EUV wave interacted with AR loops between AR 11261 and AR 11263, and exited mass flows in these loops. (2) EIS observations of AR loops in AR 11263 revealed that at the time of the wave transit, the original red-shifted feature had an increase of about 3 km s^{-1} , and the original blue-shifted feature slightly weakened. These findings could be explained in the framework of a fast-mode magnetosonic wave interpretation for EUV waves.

Keywords. Sun: activity, Sun: corona, Sun: flares

1. Observations

On 2011 August 4, the AR 11261 produced an M9.3 class flare at the location of $N16^{\circ}W49^{\circ}$, which started at 03:41 UT and peaked at 03:57 UT. Following the onset of the flare, we observed an EUV wave. For studying the dynamics of the EUV wave, we get the time-distance slices along “A” as shown in Figure 1(a). From this slice (see Figure 1(b)), we note that this wave initially moved through the AR loops connecting AR 11261 and AR 11263 (marked by “L1” in Figure 1(a)) with a velocity of $486 \pm 9 \text{ km s}^{-1}$. At 04:00:24 UT, the wave arrived at the apex of the L1, and excited mass flows in the L1.

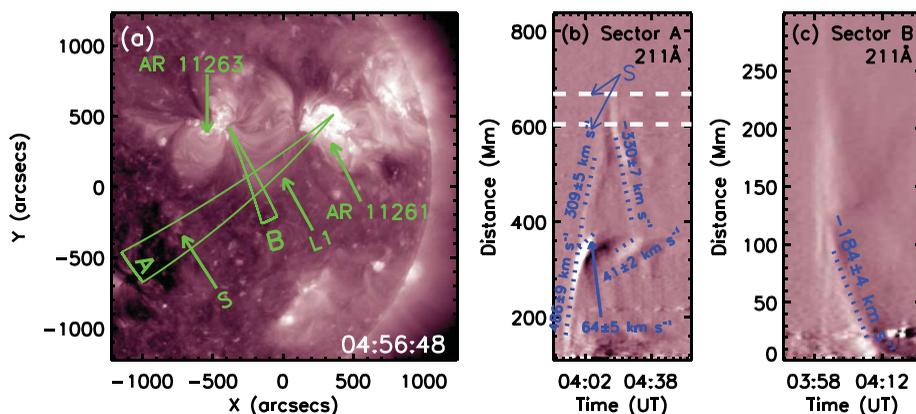


Figure 1. (a) An SDO/AIA 211 Å direct image showing two 10° wide sectors (“A” and “B”), which are used to obtain running difference space-time plots in (b) and (c).

From the time-distance plot of Sector “B” (see Figure 1(a) and (c)), we note that the mass flows gradually injected into the footpoints of L1, with a velocity of about 184 ± 4 km s^{-1} . Simultaneously, the wave pushed the L1 forward with a velocity of about 64 ± 5 km s^{-1} . This movement lasted about 10 min, inducing a maximum displacement of about 36 Mm. About 14 min later, another moving bright feature appeared at the apex of the L1 (see Figure 1(b)). It had a lower velocity of about 41 ± 2 km s^{-1} , but lasted a much longer time (about 15 min). When the coronal wave encountered a small-scale coronal structure (marked by “S” in Figure 1(a) and denoted by white lines in Figure 1(b)), a reflected wave appeared (see Figure 1(b)). The reflected wave had a velocity of 330 ± 7 km s^{-1} , which was a little higher than that of the incident wave (about 309 ± 5 km s^{-1}).

At about 04:01 UT, the east part of the EUV wave propagated to AR 11263 ($\text{N}17^\circ\text{W}18^\circ$) and was captured by Hinode/EIS. Figure 2 shows the Doppler velocity and line width for the Fe XII 195.12 Å line as a function of time. We note that when the coronal wave transit, some red-shifted features appeared or enhanced, and the corresponding line width obviously broadened. To quantitatively analyze these features, we calculated the averaged Doppler velocity and line width in areas “A” and “B”. At the time of the EUV wave transit (marked by the dashed lines in Figure 2(b) and (d)), the red-shifted feature in “A” increased by about 3 km s^{-1} and formed a sharp peak (marked by “vp” in Figure 2(b)), while the blue-shifted feature in “B” decreased to ~ 2 km s^{-1} and formed an un conspicuous peak. There also existed a sharp peak (marked by “wp” in Figure 2(d)) in the time profile of the line width. We note that the line width increased by about 7 mÅ in “A” and 5 mÅ in “B”.

2. Conclusions

Our observational results are consistent with the fast-mode magnetosonic wave interpretation for EUV waves. The wave disturbed the plasma at the apex of the AR loops connecting AR 11261 and AR 11263, and generated mass flows along these loops. In addition, the wave compressed the plasma of the AR loops in AR 11263, and induced that the original red-shifted feature increased, and the original blue-shifted feature slightly weakened.

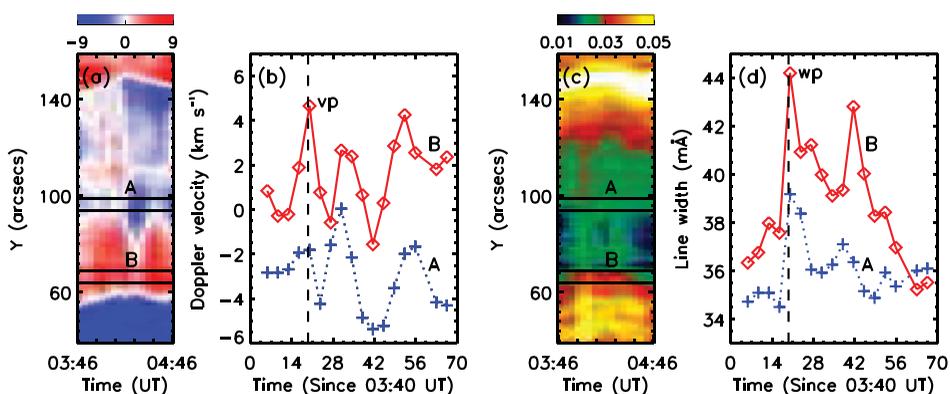


Figure 2. Doppler velocity (a) and line width (c) for the Fe XII 195.12 line as a function of time. Time profiles of averaged Doppler velocity (b) and line width (d) (calculated within “A” and “B” in this figure).