4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Longitudinal filament oscillations enhanced by two C-class flares

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Large-amplitude, longitudinal filament oscillations triggered by solar flares have been well established in the literature[1,2,3]. In this paper we report the multiwavelength observations of a very long filament in active region (AR) 11112 on 2010 October 18 [Fig. 1(a)]. The filament was composed of two parts, the eastern part (EP) and the western part (WP) [Fig. 1(d)]. We focus on longitudinal oscillations of the EP, which were enhanced by two homologous C-class flares in the same AR. The C1.3 flare was confined without a coronal mass ejection (CME). Both EP and WP of the filament were slightly disturbed and survived the flare. After 5 hr, eruption of the WP generated a C2.6 flare and a narrow jet-like CME. Three oscillating threads (thd_a, thd_b, thd_c) are obviously identified in the EP, and their oscillations are naturally divided into three phases by the two flares [Fig. 2]. The initial amplitude ranges from 1.6 to 30 Mm with a mean value of ~14 Mm. The period ranges from 34 to 73 minutes with a mean value of ~53 minutes. The curvature radii of the magnetic dips are estimated to be 29 to 133 Mm with a mean value of ~74 Mm. The damping times ranges from ~62 to ~96 minutes with a mean value of ~82 minutes. The value of τ/P is between 1.2 and 1.8. For thd_a in the EP, the amplitudes were enhanced by the two flares from 6.1 Mm to 6.8 Mm after the C1.3 flare, and further to 21.4 Mm after the C2.6 flare. The period variation as a result of perturbation from the flares was within 20%. The attenuation became faster after the C2.6 flare. This is the first report of large-amplitude, longitudinal filament oscillations enhanced by flares.

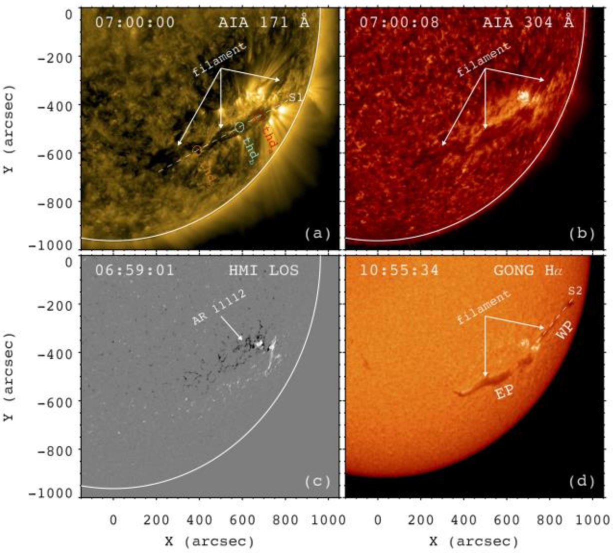

Fig. 1. (a-b) AIA 171 and 304 \AA images at 07:00 UT. (c) HMI LOS magnetogram at 06:59 UT. (d) GONG H-alpha image at 10:55 UT.

To reproduce part of the observations, we perform one-dimensional, hydrodynamic numerical simulations using the MPI-AMRVAC code[4,5]. Numerical simulations reproduce the oscillations of thd_a very well [Fig. 3]. The simulated amplitudes and periods are close to the observed values, while the damping time in the last phase is longer, implying additional mechanisms should be taken into account apart from radiative loss[6].

This work was supported by NSFC grants (Nos. 11773079, 11790302, 11533005) and the International Cooperation and Interchange Program (11961131002).

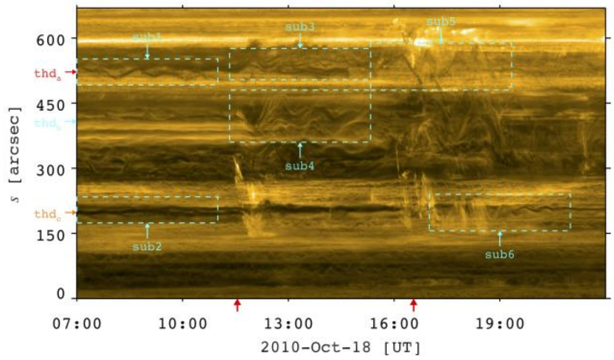

Fig. 2. Time-distance diagram of S1 in AIA 171 \AA. Horizontal arrows in red, cyan, and orange mark the positions of thd_a, thd_b, and thd_c, respectively. Six subregions within the cyan boxes are extracted to explore the longitudinal oscillations of EP.

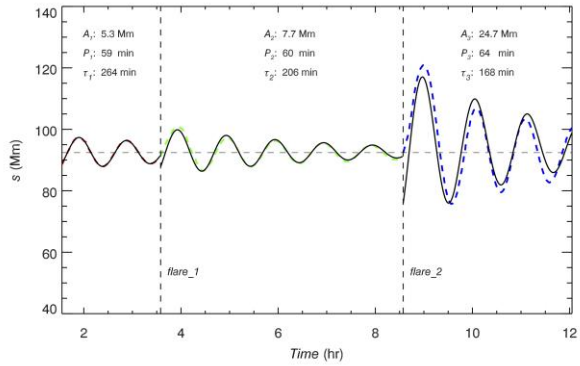

Fig. 3. Time evolution of filament mass center during its oscillations in numerical simulation.

References

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