7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

A solar white-light flare heated by comprehensive mechanisms

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White-light flares (WLFs) belong to a relatively rare type of flares characterized by a sudden increase in the visible continuum. The first solar flare ever observed, the so-called Carrington event[1], was a typical WLF. However, the heating mechanisms of WLFs remain unclear at present.

We present an X1.0 WLF on 2022 October 2 (SOL2022-10-02T20:25, as shown in Figure 1) observed by the Chinese Hα Solar Explorer (CHASE)[2] that provides two-dimensional spectra in the visible light for the full solar disk with a seeing-free condition. The flare shows a prominent enhancement of ~40% in the photospheric Fe I line at 6569.2 Å as well as the nearby continuum. The continuum near the Fe I line at 6173 Å from the Helioseismic and Magnetic Imager (HMI) on board the Solar Dynamics Observatory (SDO) is enhanced up to ~20%. At the white-light kernels, the Fe I line at 6569.2 Å has a symmetric Gaussian profile that is still in absorption and the Hα line at 6562.8 Å displays a very broad emission profile with a central reversal plus a red or blue asymmetry. The white-light kernels are cospatial with the microwave footpoint sources observed by the Expanded Owens Valley Solar Array (EOVSA) and the time profile of the white-light emission matches that of the hard X-ray emission above 30 keV from the Gamma-ray Burst Monitor (GBM) on Fermi.

A radiative hydrodynamic modeling[3] constrained by the hard X-ray and microwave observations reveals that the white-light emissions can be well produced by comprehensive mechanisms including nonthermal electron beam heating, radiative backwarming, and Alfvén wave dissipation.

References

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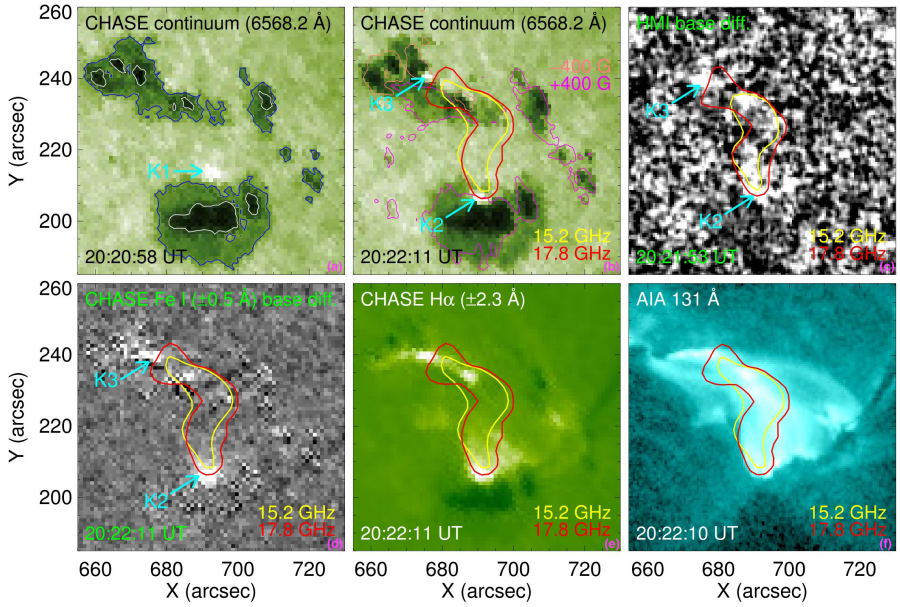

Figure 1. CHASE continuum, HMI continuum (base difference), CHASE Fe I (base difference), CHASE Hα, and AIA 131 Å images for the white-light flare. Three white-light brightening kernels (K1–K3) are indicated by three arrows in panels (a)–(c). The yellow and red contours in panels (b)–(f) show the microwave sources at 15.2 and 17.8 GHz, respectively.