9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Detecting Stellar CMEs Using Time-Domain Spectroscopy from LAMOST

Hong-Peng Lu[1, 2], Hui Tian[2]
[1] Guizhou University, Guiyang 550025, China,
[2] Peking University, Beijing 100871, China
e-mail (speaker): hplu@gzu.edu.cn

Coronal Mass Ejections (CMEs) are the most energetic eruptive phenomena in the atmospheres of late-type main-sequence stars, serving as major drivers of exoplanetary space weather and exerting significant influence on stellar evolution and exoplanet habitability [1,2]. While the advent of space-based photometric missions such as Kepler and TESS has enabled the detection of numerous stellar white-light flares, reports of stellar CMEs remain scarce. This presentation highlights our latest results on detecting stellar CMEs using LAMOST time-domain spectroscopy: 1. Multiple stellar CME candidates were identified through the Hα blue-wing asymmetry observed with LAMOST[3~5]; 2. Eruptive prominence events were studied by combining photometric observations from TESS with spectroscopic data from LAMOST; 3. A systematic analysis of Hα line profile characteristics during stellar prominence eruptions was conducted using LAMOST time-domain spectra.

Here we present one representative event detected from the LAMOST Medium-Resolution Survey: an extreme stellar prominence eruption observed on the M dwarf LAMOST J044431.62+235627.9[3], with the LAMOST time-domain spectra shown in Figure 1. The eruption was associated with a superflare lasting over 160 minutes, during which the Hα line profiles exhibited significant blue-wing enhancement in the impulsive and peak phases. The projected bulk and maximum blueshift velocities reached -228 km/s and -605 km/s, respectively, with portions of the erupting material exceeding the stellar surface escape velocity, suggesting a stellar CME. A two-cloud model applied to the most asymmetric Hα line profile yielded a prominence mass ranging from 1.6×10^{19}g to 7.2×10^{19}g. Notably, the prominence-to-star mass ratio is the highest among reported stellar prominence eruptions to date. Furthermore, the equivalent width (EW) of the Hα blue wing in this event is the largest on record and comparable to the quiescent Hα line profile of the host star. These findings demonstrate the unique capability of LAMOST time-domain spectroscopy to reveal dynamic stellar eruptive phenomena with important implications for stellar magnetic activity and exoplanetary space weather.

References
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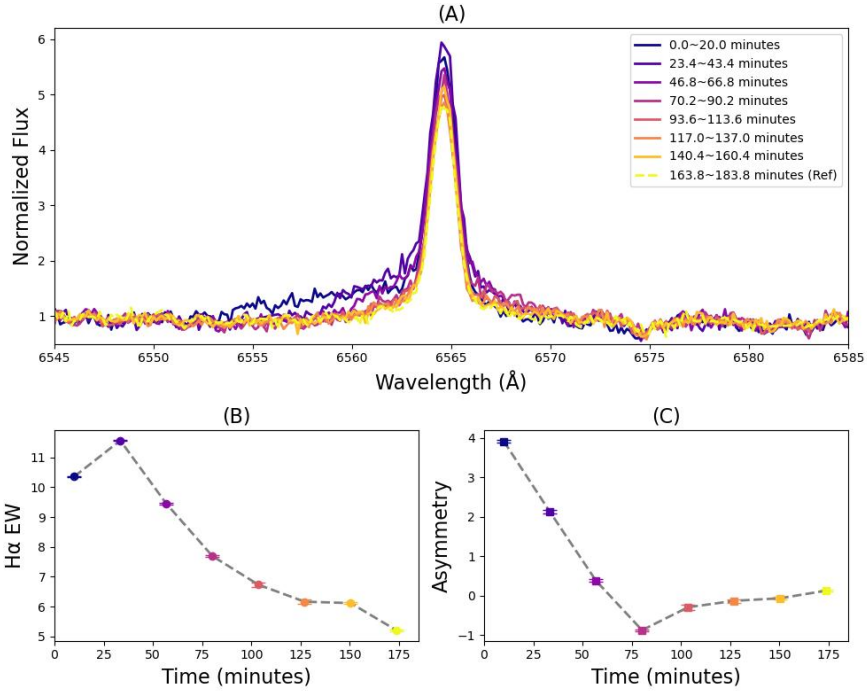

Figure 1. Evolution of the Hα line profile during a superflare on LAMOST J044431.62+235627.9[3]. (A) Normalized Hα profiles at different times. (B) Time variation of Hα equivalent width. (C) Difference between integrated blue (6552.6–6564.6 Å) and red (6564.6–6576.6 Å) wing fluxes.