Empirical Model of Atmosphere in a Mini Flare during Magnetic Reconnection

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Abstract: A spatio-temporal analysis of IRIS spectra of Mg II, C II, and Si IV ions allows us to study the dynamics and the stratification of the flare atmosphere along the line of sight during the magnetic reconnection phase at the jet base. Strong asymmetric Mg II and C II line profiles with extended blue wings observed at the reconnection site are interpreted by the presence of two chromospheric temperature clouds: one explosive cloud with blueshift at 290 km/s and one cloud with smaller Doppler shift (around 36 km/s). Simultaneously at the same location a mini flare was observed with strong emission in multi temperatures (AIA), in several spectral IRIS lines (e.g. O IV and Si IV, Mg II), absorption of identified chromospheric lines in Si IV broad, enhancement of the Balmer continuum and X-ray emission by FERMI/GBM. With the standard thick-target flare model we calculate the energy of non thermal electrons observed by FERMI and compare it to the energy radiated by the Balmer continuum emission. We show that the low energy input by non thermal electrons above 20 keV was still efficient to produce the excess of Balmer continuum.

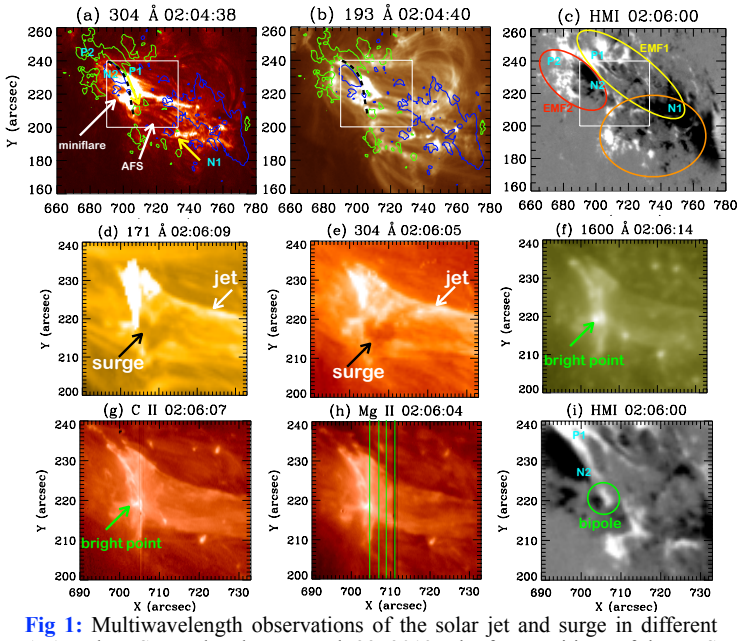

Fig 1: Multiwavelength observations of the solar jet and surge in different AIA and IRIS wavebands on March 22, 2019. The four positions of the IRIS slit are shown with green vertical lines in *panel h*.

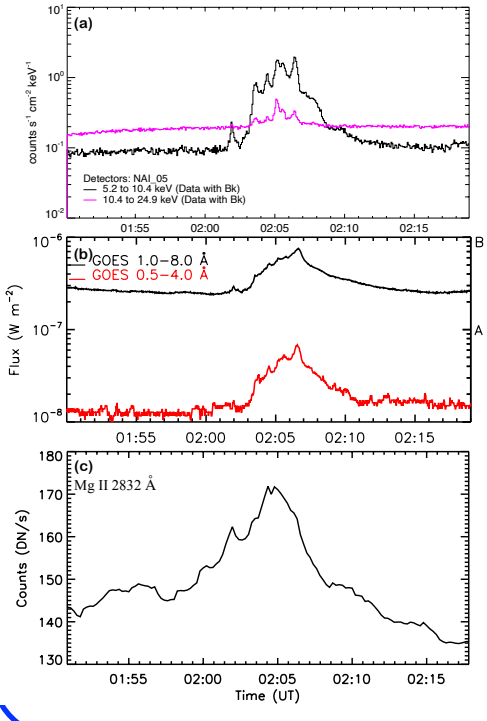

Fig 2: Intensity variation at the flare site observed in FERMI GBM, GOES, and IRIS SJIs. Panel(a): Soft X-ray (less than 20 keV) correspondence in FERMI GBM observations. There are fewer small peaks observed with hard X-ray correspondence (>20 keV, pink curve). Panel (b): GOES light curve for the B 6.7 class solar flare, shows the flare starts at 02:02 UT and peaks at ~ 02:06 UT with small peaks corresponding to GBM peaks. Panel (c): Intensity light curve at the bright point in Mg II 2832 Å SJIs.

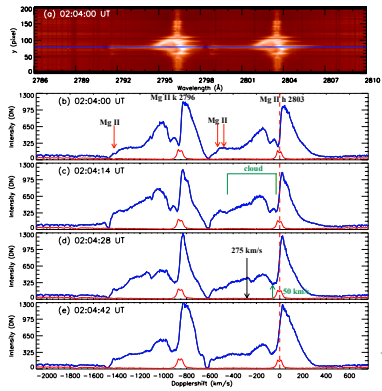

Fig3: *Panel a*: Mg II spectra at 02:04:00 UT along the slit position 1 before the UV burst. *Panels b–e from top to bottom*: evolution of the Mg II k and h line profiles. The horizontal green brace denotes the low-intensity value of the Mg II blue peak, a signature of the possible presence of an absorbing (red arrow in *panel d*) and emitting radiation cloud (black arrow in *panel d*) along the LOS. The reference profiles are shown in red. The vertical red dashed lines in *panels b–e* show the position of rest wavelength at 2803.6 Å.

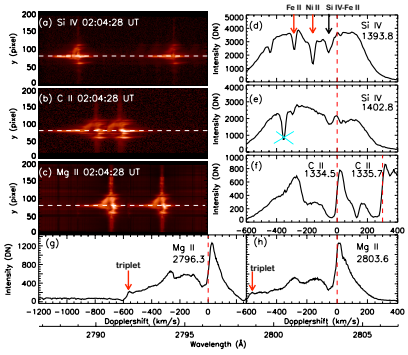

Fig4: Spectra and profiles of the jet base (UV burst) showing the extended blue wing of Si IV line, C II line and Mg II line. The black arrow in *panel d* indicates a dip due to self-absorption of Si IV line blended by a Fe II line. The cyan cross in *panel e* points a dip with missing data in the spectra. The dashed vertical red lines indicate the zero velocity. The red arrows in *panels g–h* indicate the emission of Mg II triplet lines.

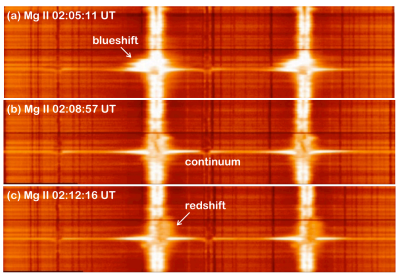

Fig5: Balmer continuum enhancement all along the wavelength range of the two Mg II h and k lines observed in IRIS spectra during (panel a) and after the mini flare (panels b-c) at the reconnection site. Blueshifts, and redshifts are indicated by two arrows in the Mg II k line wings.

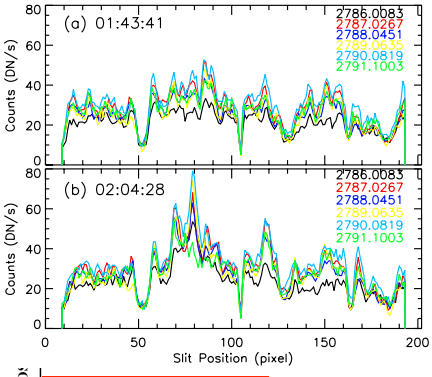

Fig6: Intensity variation at different wavelengths. The different colors shows the different wavelengths at the pre-flare (01:43:41 UT) and flare (02:04:28 UT) times. The intensity variation shows a constancy during the pre-flare time, whereas the curve shows a peak at y= 80 pixel during the flare time.

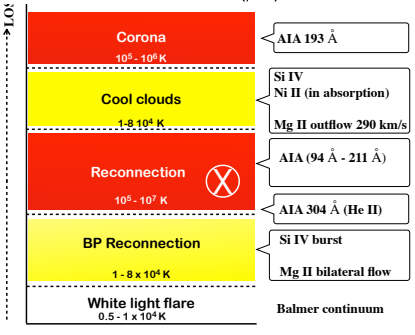

Fig7: Model of multi-layers of the mini-flare atmosphere during the jet reconnection in a BP region. It is based on the observations of emission or absorption of the IRIS lines and continua, and the images of AIA in the multi-temperature filters in the mini-flare. The LOS successively crosses cool and hot layers (white for minimum of temperature, yellow for chromosphere until transition region temperatures, red for coronal temperatures).

The results are published by Joshi, R., Schmieder, B., Tei, A., Aulanier, G., Lörinčík, J., Chandra, R., Heinzel, P., 2021, A&A 645, A80 and Joshi R., Schmieder, B., Heinzel, P., James, T., Chandra R., Vilmer, N., 2021 A&A (under review).