Determining Doppler Velocities of Solar Flares Using SDO EVE

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Abstract
Using SDO EVE MEGS-A2 data we are looking at solar flare ion emission lines to measure their doppler shifts. MEGS-A2 data comes in pixel units which must be converted into wavelength values. We can’t assume the conversion from pixel to wavelength (plate scale) is linear so we must fit the MEGS-A2 data to create an accurate plate scale. Using the newly derived plate scale, we calculated the Doppler shifts of each ion and their associated doppler velocities. We can use this information to discover which ions are blue- and red-shifted which may tell us at what height the magnetic reconnection of the flare occurs. We aim to do this during the impulsive and gradual phases to determine the flows and how they differ in the two.

Method
1. Determined the time for the preflare, impulsive phase, and gradual phase using GOES XRS data
2. Took a twelve-image median around the time for each phase
3. Chose eleven ions with high temperatures from the preflare spectrum (Table 3, Woods et al., 2012) and fit a gaussian to each emission line to find the peak in x-pixel value
4. Fit the eleven ions for each row of data from MEGS-A2 using a third-order fit
5. Created a wavelength scale using the fit x-pixel peak locations of each ion and their wavelengths from the CHIANTI database
6. Used EVE data from the impulsive and gradual phase of the flare and subtracted the pre-flare image to isolate the flare
7. Used the new wavelength scale to measure the doppler shifts of the eleven ions by fitting the flaring emission lines and finding their peak locations in wavelength values.
8. Used the doppler shifts to calculate the doppler velocities of each ion.

We find an updated pixel to wavelength scale to more accurately calculate Doppler velocities in Solar flares

Figure 1: Graph of six ions’ peak locations across 200 rows of data from MEGS-A2 all centered and normalized around their median

Figure 5: Wavelength scale found using a third order fit. The blue linear line clearly shows that the conversion from x-pixel number to wavelength is not linear due to the curved grating on the detector.

Future Work
- Create a new wavelength scale using a time after the gradual phase peak
- Expand the analysis to MEGS-A1 and MEGS-B
- Analyze other flares and using the new scale and same procedure.

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References
Woods et al., Ad.A., 2009, DOI: 10.1051/0004-6361/200911752

Results

Figure 2: Seven image median of the gradual phase of the flare. The median is taken to remove any detector background noise and particle hits and to increase the statistics for calculations.

Figure 3A: One MEGS-A2 row of pre-flare data showing ion emission lines. Figure 3B: Fe XI emission line isolated and its Gaussian fit to determine its peak location

Figure 4: Peak location of the He 304 ion in the pre-flare, impulsive, and gradual phase. This shows that there could be possible point source instrument effects that we are not accounting for yet.

Conclusion
We were able to calculate Doppler velocities, but unforeseen instrumental effects came up that will still need to be accounted for. We have ideas on how to address this but didn’t have enough time to proceed with them. One idea is to determine a wavelength scale using a later time after the gradual phase peak, where we can assume the plasma is at rest.