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Dynamics in the solar atmosphere due to emerging flux observed by HINODE and SDO

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Introduction

Magnetic flux emergence into the solar atmosphere can create violent events such as solar flares, jets and coronal mass ejections (CMEs) as the new flux interacts with the pre-existing field. For the past few years we have been at solar minimum meaning that major flux emergence events which form active regions, and the associated solar activity , has been at a minimum. We are now returning to a period of high activity on the Sun. We present data from the Solar Dynamics Observatory and the EIS instrument on Hinode on an active region present on the solar disk between the 20th October and 30th October 2010. New magnetic flux was observed to emerge into the pre-existing active region over a timescale of 4 days.

We use the HMI and AIA instruments on the Solar Dynamics Observatory as well as the EIS instrument on HINODE to look at flux emergence in the active region 11117. (AR1117).

Results

We use four images from a movie that we produced that shows the emerging flux region (EFR from this point) in the area of AR1117. We used the 720s cadence HMI magnetogram and the 171A wavelength on the AIA instrument. The images are laid out as the magnetogram at the top , then 171 Angstroms, then the intensity and velocity maps from EIS The images shown will be before the emerging flux, during the EIS obversation of this active region and at the end of the emerging flux.

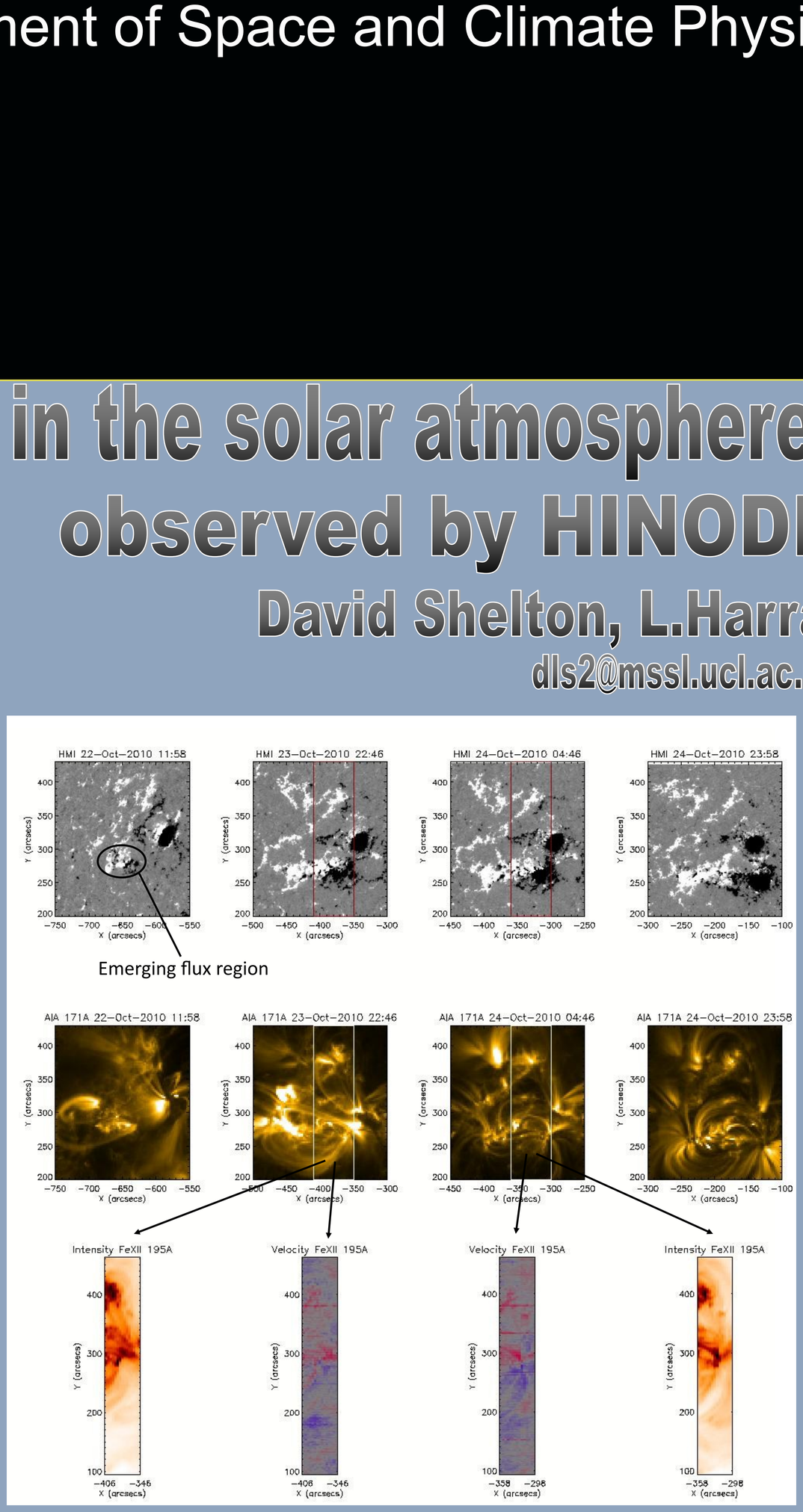

Figure 1 shows the flux emergence into a pre-existing magnetic field. Images are from the HMI and AIA instruments on SDO and the intensity and velocity maps from the EIS instrument on HINODE. The red (HMI) and white (AIA) boxes represent the location of the EIS data on the Sun.

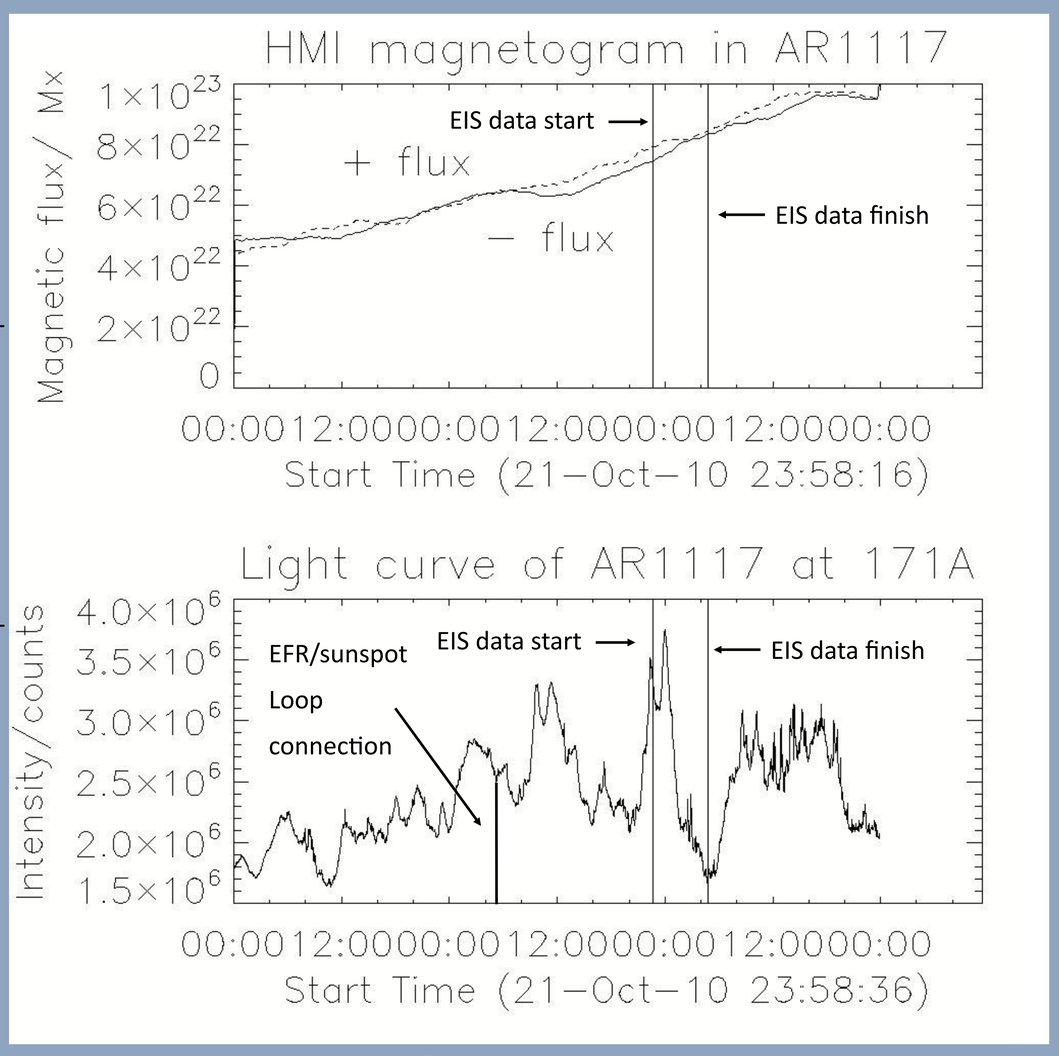

Figure 2 shows the magnetic flux evolution and light curve at 171A of the emerging flux region only.

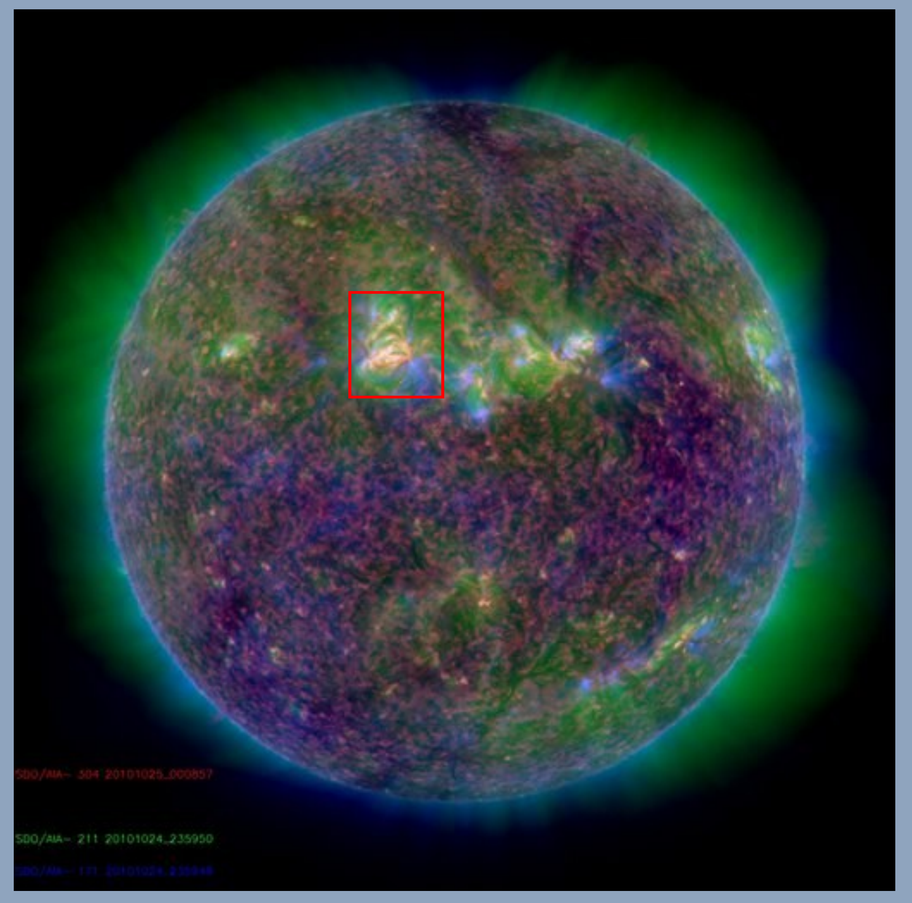

Figure 3 shows a 304A, 211A and 171A composite image of the Sun. The red box shows the area of the Sun we are studying.

Discussion

The AIA wavelength chosen looks at the upper corona and the HMI magnetogram is taken at 6173A (Fe I line) at the photosphere. The photosphere and corona are of most interest to us with regards to flux emergence as these are the areas of the Sun where flux emergence is believe to begin and grow. We take the Fe XII 195A line for our EIS intensity and velocity measurements (as shown in figure 1).

We detect flux emergence to the south east of the sunspot seen in the image.

Comparing our HMI images (figure 1), we see that the EFR expands rapidly over the space of 35 hours (11:58 22nd October and 22:46 23rd October). However, between the 23rd October at 22:46 and the 24th October 23:58, the expansion rate does not appear to be as fast.

At approximately 06:00 on the 23rd October, we start seeing loops connecting between the EFR and the pre-existing sunspot (as shown in the 171A light curve of figure 2 as a small vertical line). These connections result in an increase in intensity (in figure 2) approximately 2 hours later.

At the end of our EIS observations, we see some strong blueshifts in our velocity map, this corresponds to a low intensity region in our intensity maps. The strong blueshifts mean that we have strong outflows and a low intensity means a low density in the FeXII 195A wavelength.

Future work

We will explore the impact of the emerging flux region on the nearby sunspot.
We will determine the magnetic field magnitude and morphology at the point when the active region outflows are triggered.

References

[1] Van Driel-Gesztelyi & Culhane 2008

[2] Archontis 2010

[3] A guide to the Sun, Kenneth J. H. Phillips, 1992

[4]The Solar Corona, Leon Golub and Jay M. Pasachoff, 1997