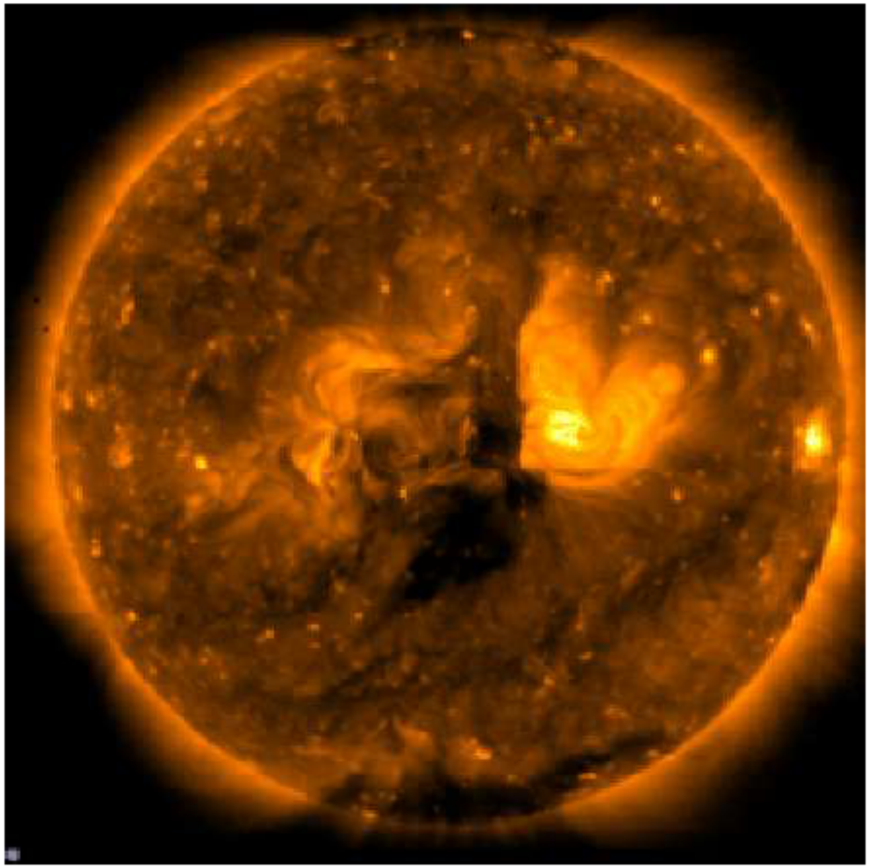
Dynamics of Coronal Bright Points as seen by SWAP, AIA and HMI

K Chandrashekhar[1] · S. Krishna Prasad[1] · D. Banerjee[1] · B. Ravindra[1] · Daniel B. Seaton[2]

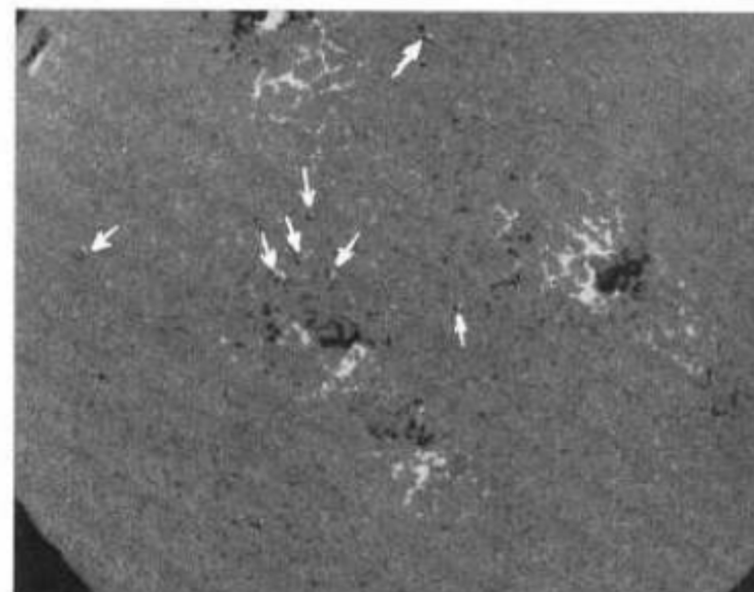
Dipankar Banerjee
Indian Institute of Astrophysics
KULeuven, Belgium

Coronal Bright Points



- Discovered: 1969
- Size: $\sim$ 20 Mm
- Life:$\sim$30 h. (1-60)
- Related with the photospheric magnetic field:
  1/3 emergence
  2/3 cancelation.

- Bright points are always found to be associated with small, opposite polarity poles in photospheric magnetograms.
- XBPs are likely signatures of small loops that connect the opposite polarities of some small-scale bipoles.
- Figure: (top) Portion of X-ray photograph taken at 14 june, 1973. (bottom) Corresponding magnetogram showing bipolar magnetic features corresponding to XBPs



CBPs as magnetic tracers

The rotation of small-scale magnetic fields is examined by XBP/CBP from its differential rotation profile.

There is a depth at which the XBP rotation rate coincide with the internal rotation rate over a wide latitude range. The depth is located at the top of the convection zone.

X-ray/EUV coronal bright points

Found in the 1960’s soft X-ray imaging data of sounding rocket programs.

Appear almost uniformly over the solar surface.

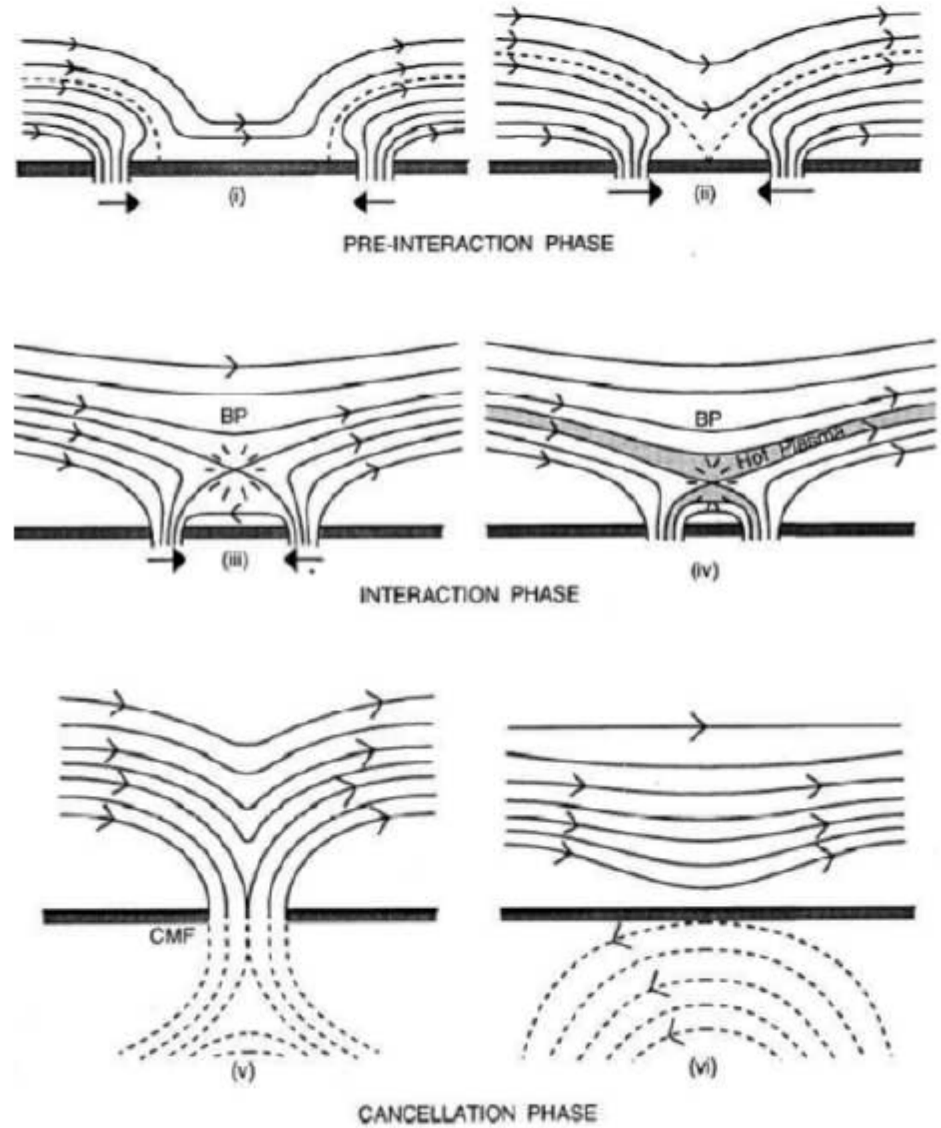
Bipoles are observed at photosphere below CBPs.

CBP associated bipoles are mostly canceling bipoles.

The number density does not change much in the11-year activity cycle.

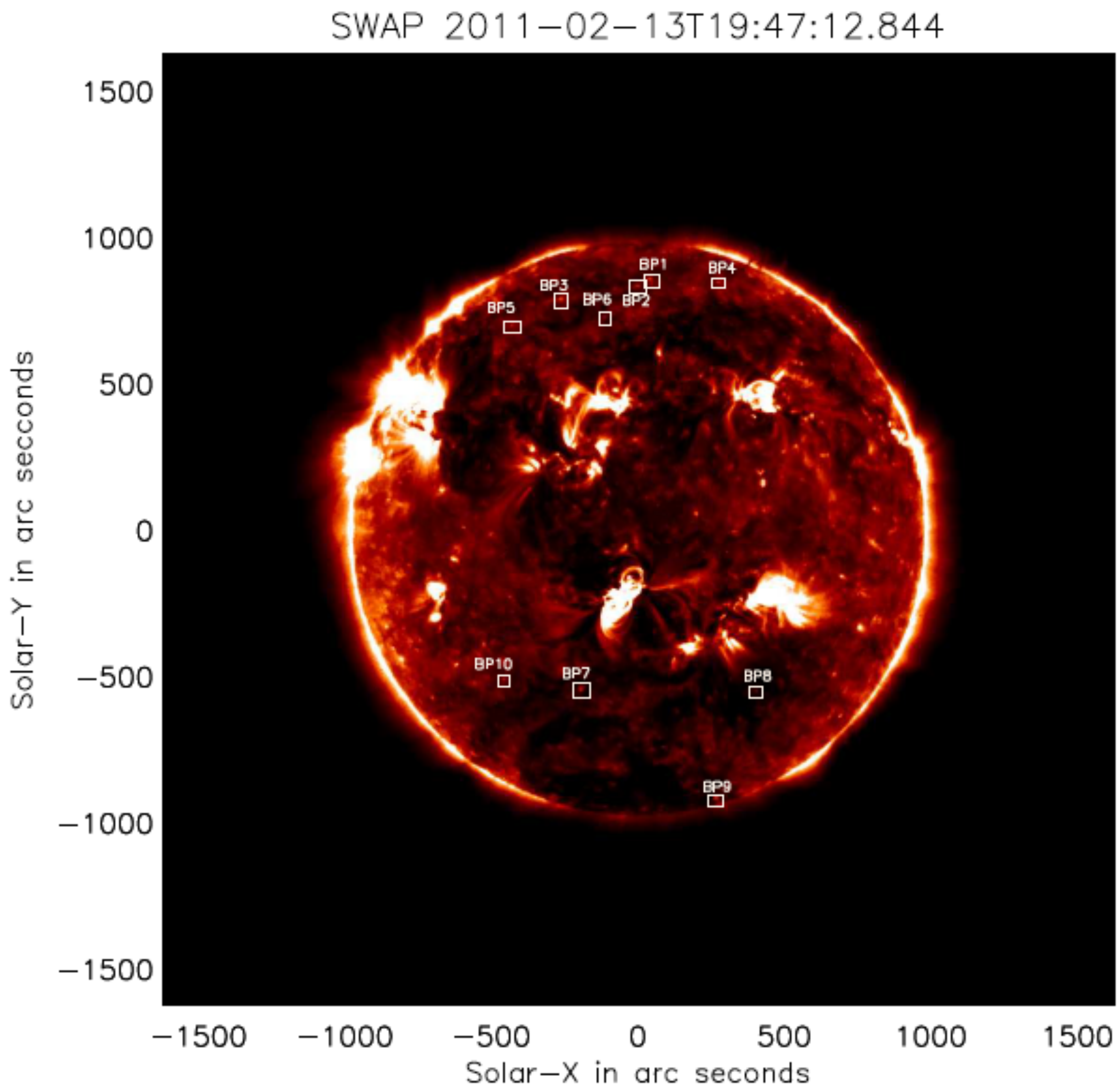
Differential rotation rate is quite similar to that of the quiet–Sun photospheric magnetic fields.

- The converging-flux model proposed by Priest, Parnell, and Martin (1994) describes how the approach of two opposite polarities creates an X-point that rises into the corona and produces a XBP by coronal reconnection. The model proposes a three-phase evolution: pre-interaction (approach), interaction, and finally cancellation.
- Figure: Three stages of the approach and interaction of the two equal opposite magnetic fragments, taken from Priest et al., 1994.

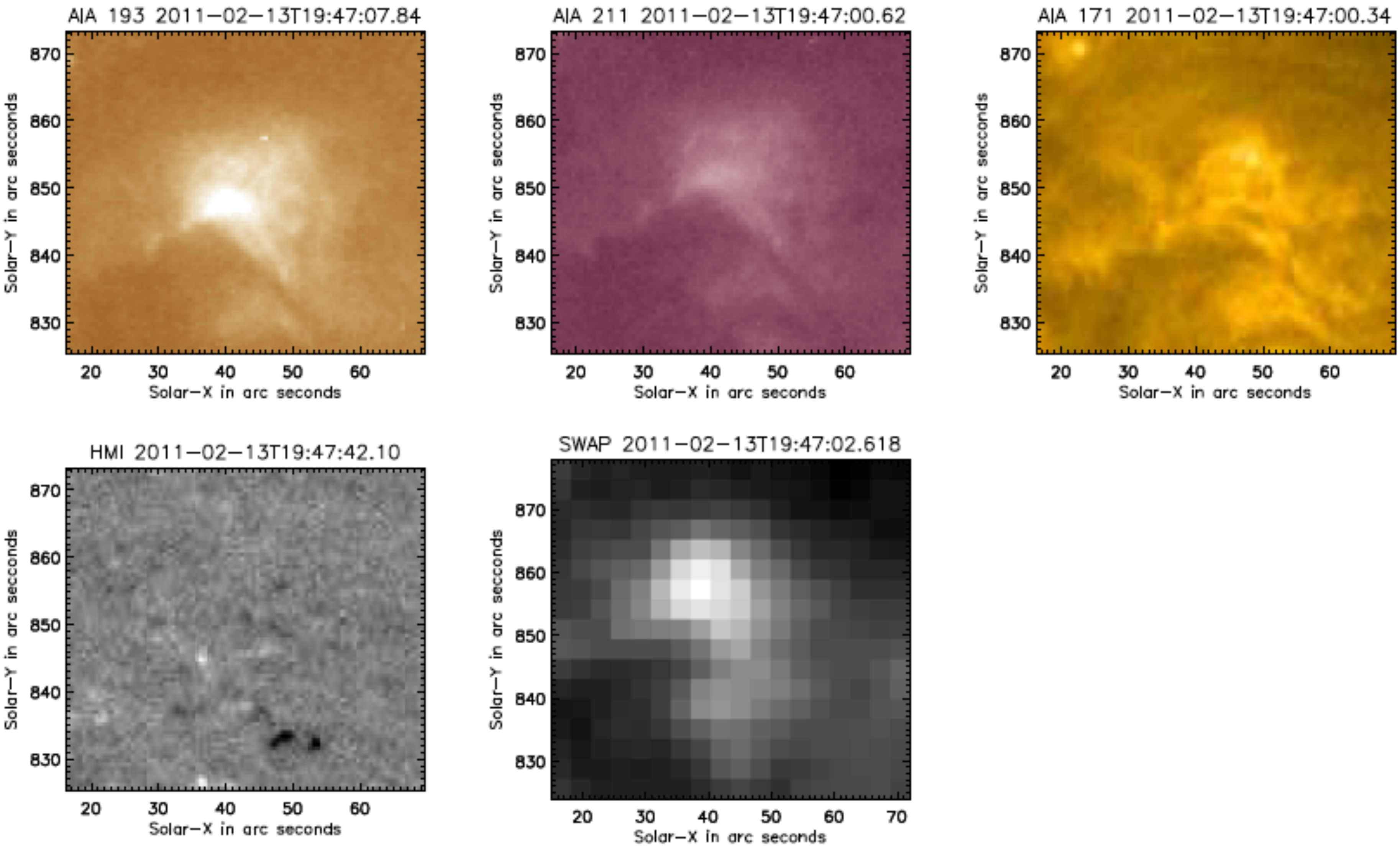


New observation with AIA, SWAP & HMI

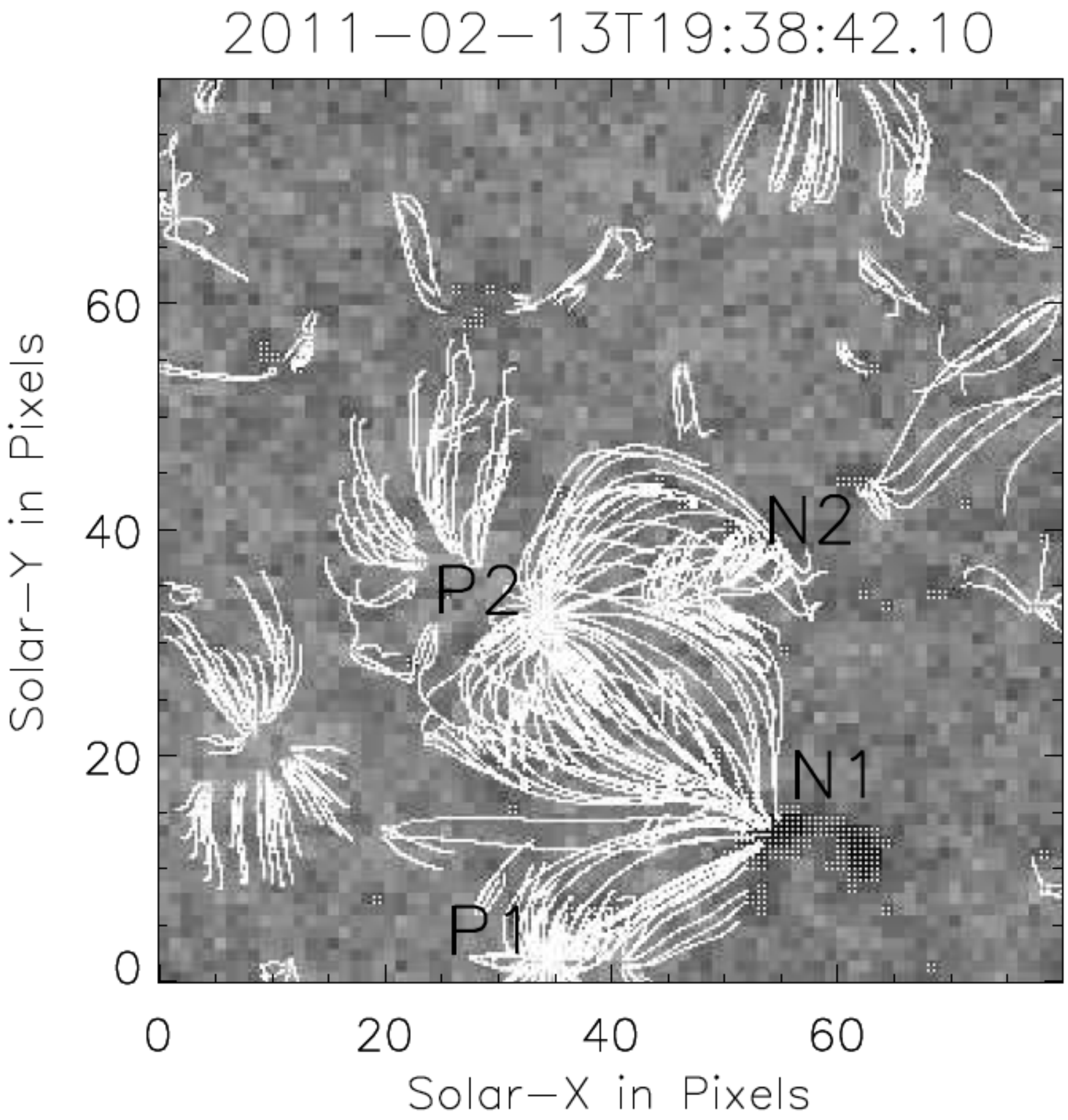
- SDO: For this study, we have used full-disk, Level 1.0 AIA and HMI images obtained during a period that ran from February 13, to February 15, 2011.
- SWAP: 7 hours starting from February 13, 2011 at 15:00 UT.
- ^Figure: SWAP full-disk image. The overlaid boxes mark the locations of the BPs studied here.



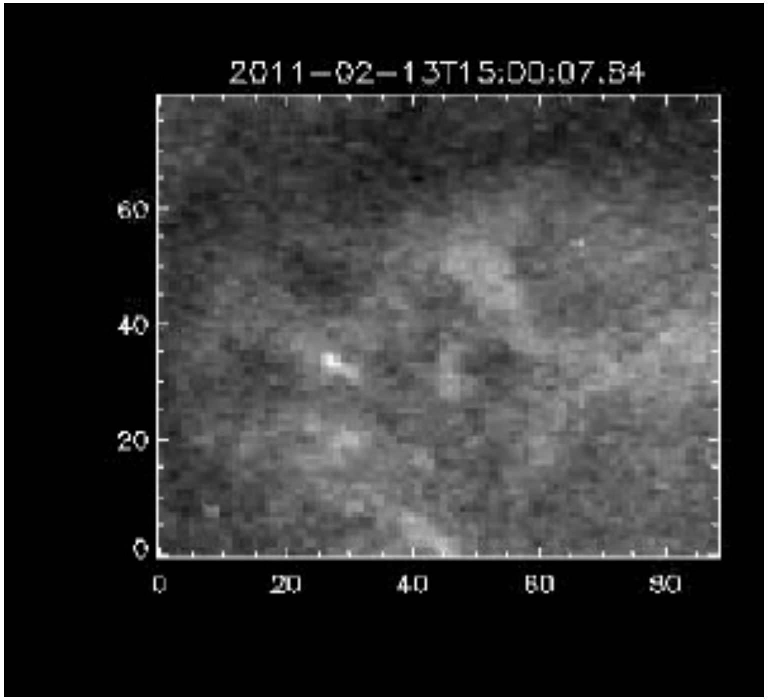
BP seen through different channels

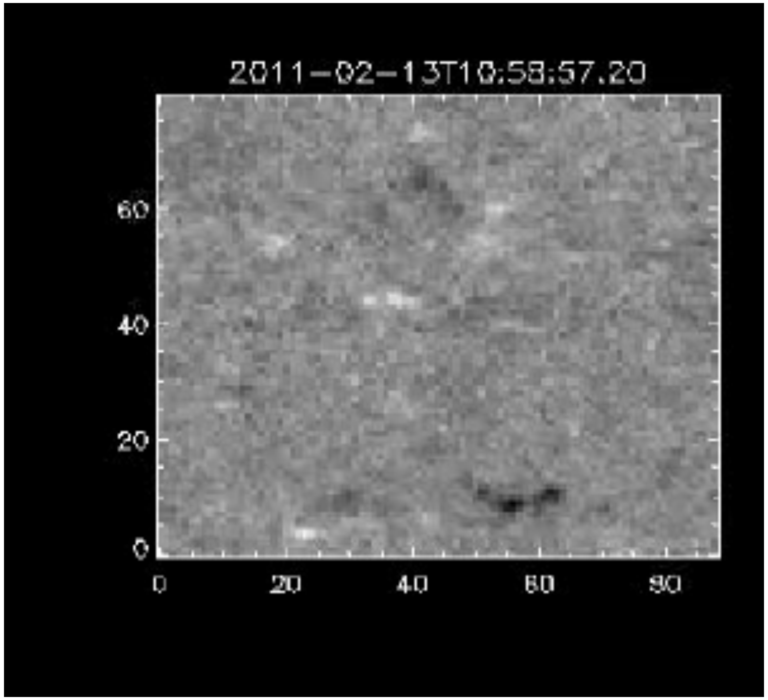


HMI and Potential field extrapolation

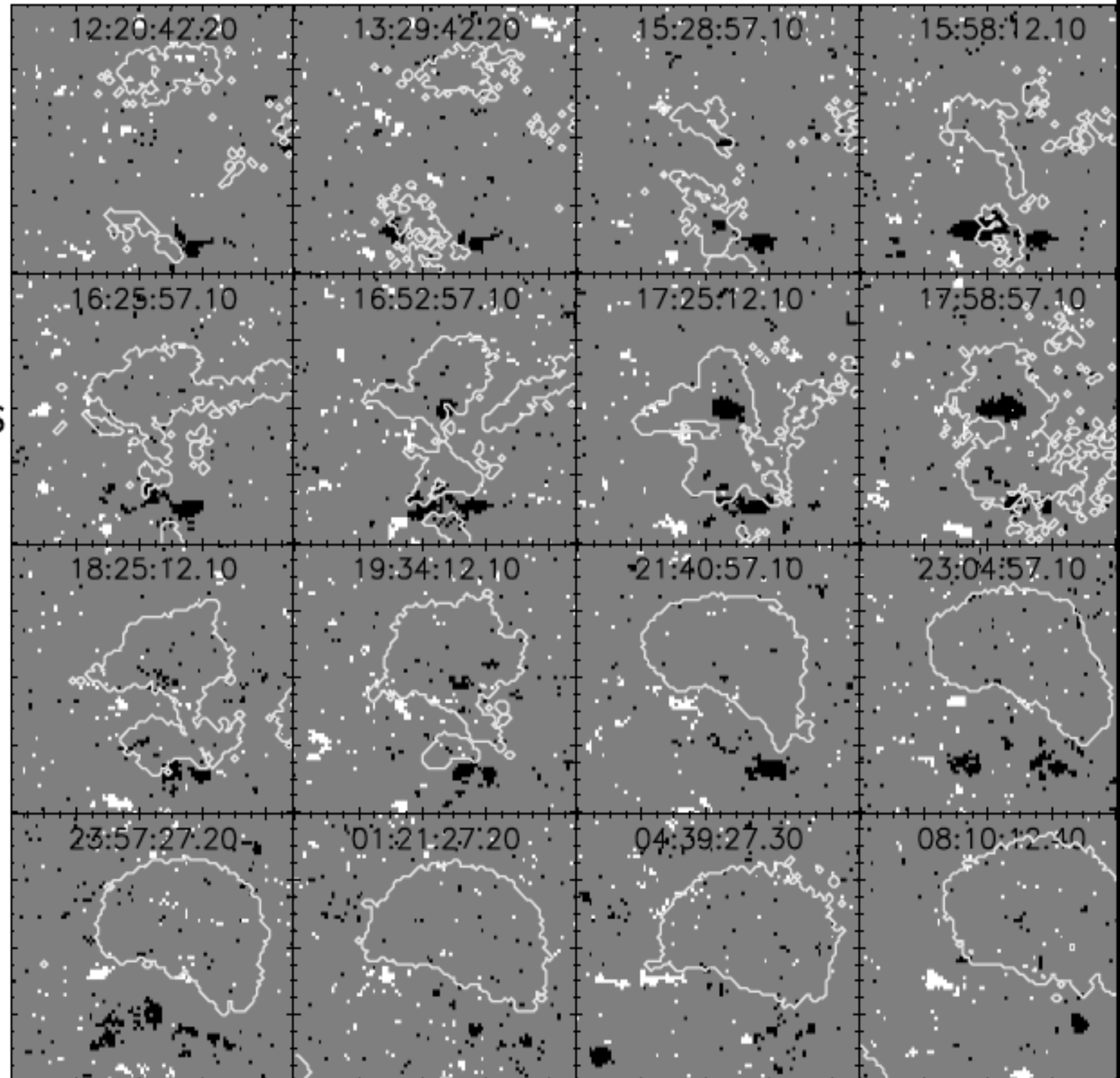


Evolution of the BP1

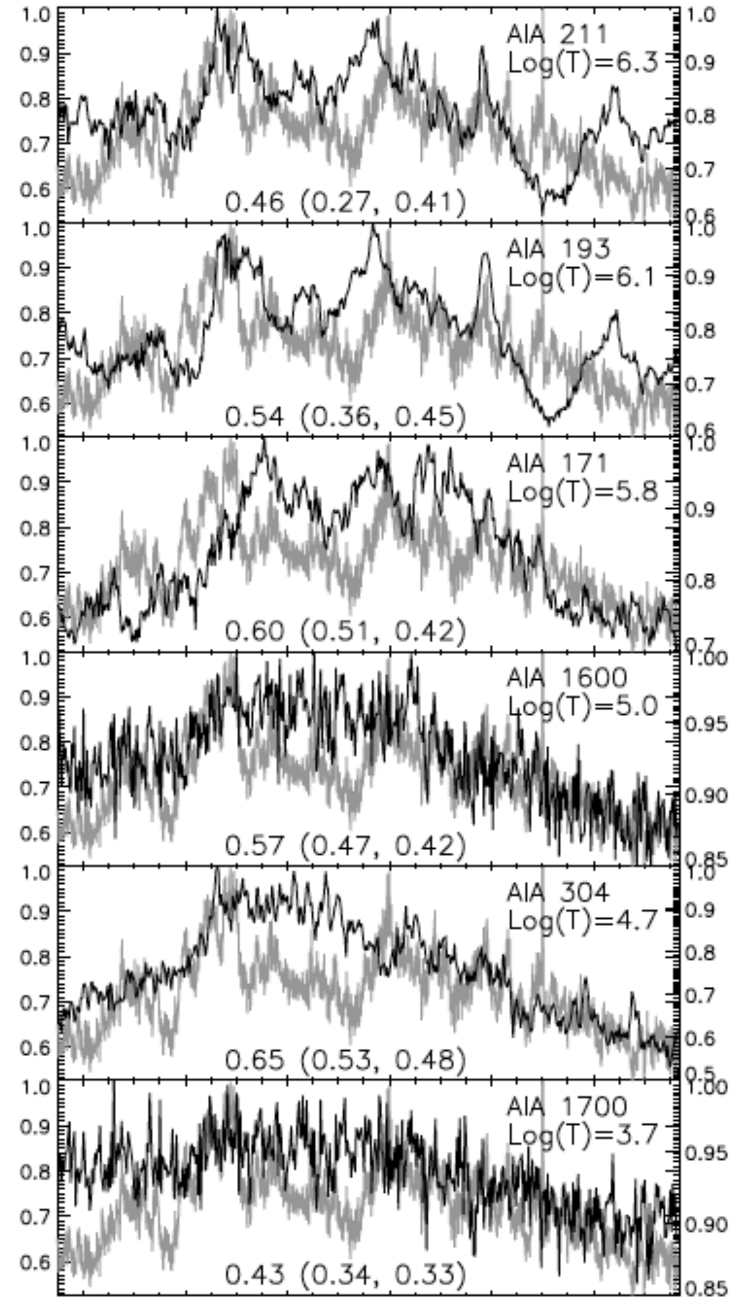




- Synthetic images showing the positive (white) and negative (black) flux regions above ±25 Gauss. Region in grey represents the background below this threshold. In each image, overplotted contours represent the EUV emission region 1.2 times brighter than the mean value taken in the AIA 193 channel.
- Figure: Summurizes the evolution, we see evolution of bipolar structure from a complex multipolar structure



- Normalized light curves for BP1 in six different AIA channels. These were constructed from the total UV – EUV emission brighter than the mean value. Overplotted in grey, in each panel, is the total unsigned photospheric flux. Scale for magnetic flux is on left and that for UV – EUV emission is on right. Characteristic temperatures of individual channels are also listed in each panel. Values listed at the bottom of each panel, are coefficients of correlation between the unsigned flux and the respective intensities. Similar values in the brackets represent these coefficients when the fluxes from individual polarities (positive, negative) are compared with the emission.



Oscillations of BPs

Several studies in EUV and soft X-ray spectral lines have reported a wide range of periodicities.

- Sheeley and Golub (1979) found that the constituent loops could evolve on a time scale of $\approx$ six minutes. Habbal and Withbroe (1981) and Habbal, Withbroe, and Dowdy (1990), using Skylab, showed that BPs exhibit large variations in the emission of chromospheric, transition region, and coronal lines, and no regular periodicity or obvious correlation between the different temperatures was found.
- It is claimed that acoustic waves, which leak through the magnetic field lines of the solar atmosphere, can be converted into magnetoacoustic waves in the region where the plasma β tends to unity and can reach the upper solar atmosphere (Bogdan(2003); Kuridze(2008); Srivastava and Dwivedi(2010)).
- It is also reported that various intensity oscillations may also be generated by repeated magnetic reconnection (UgarteUrra,

Oscillations in BP

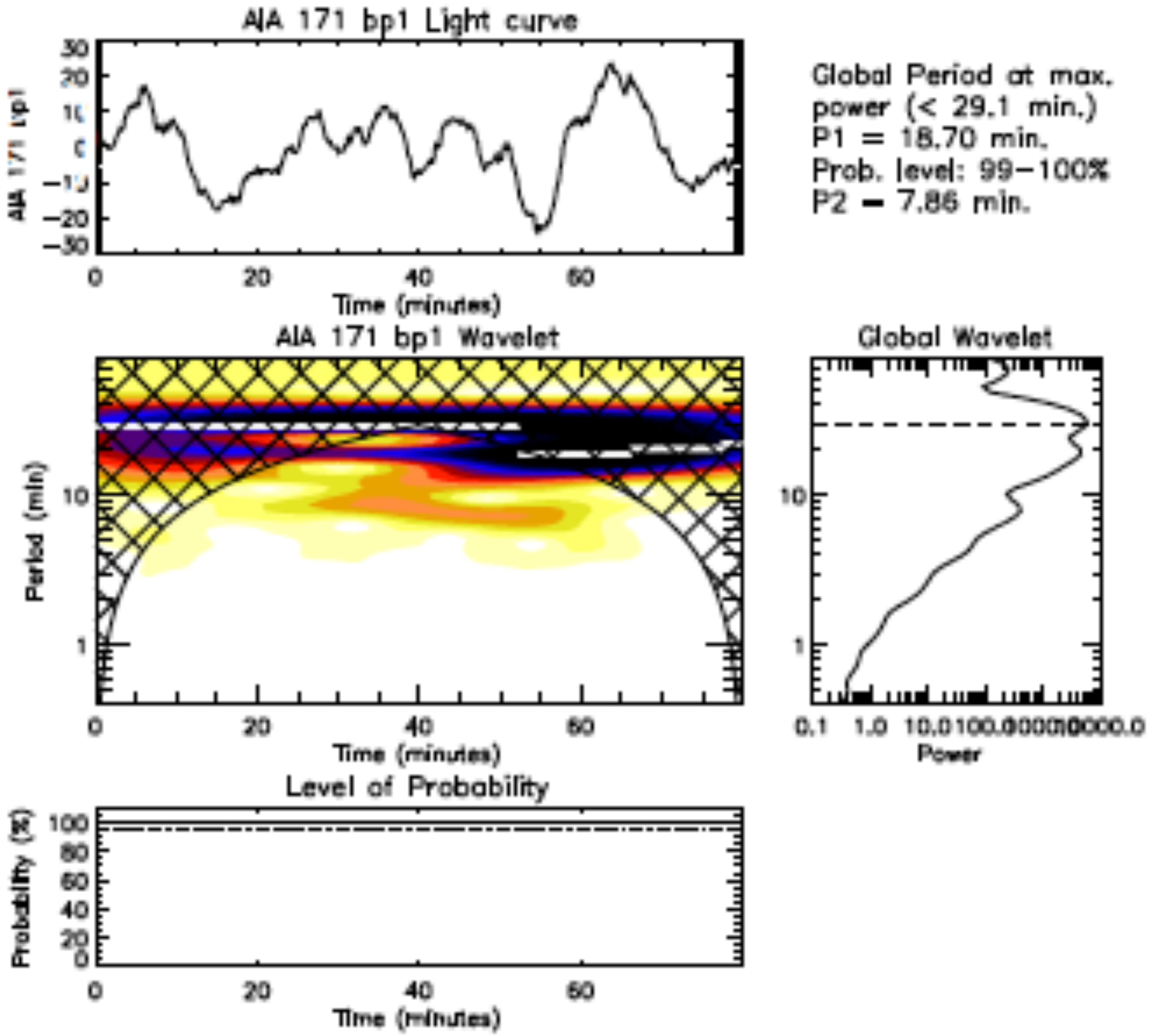
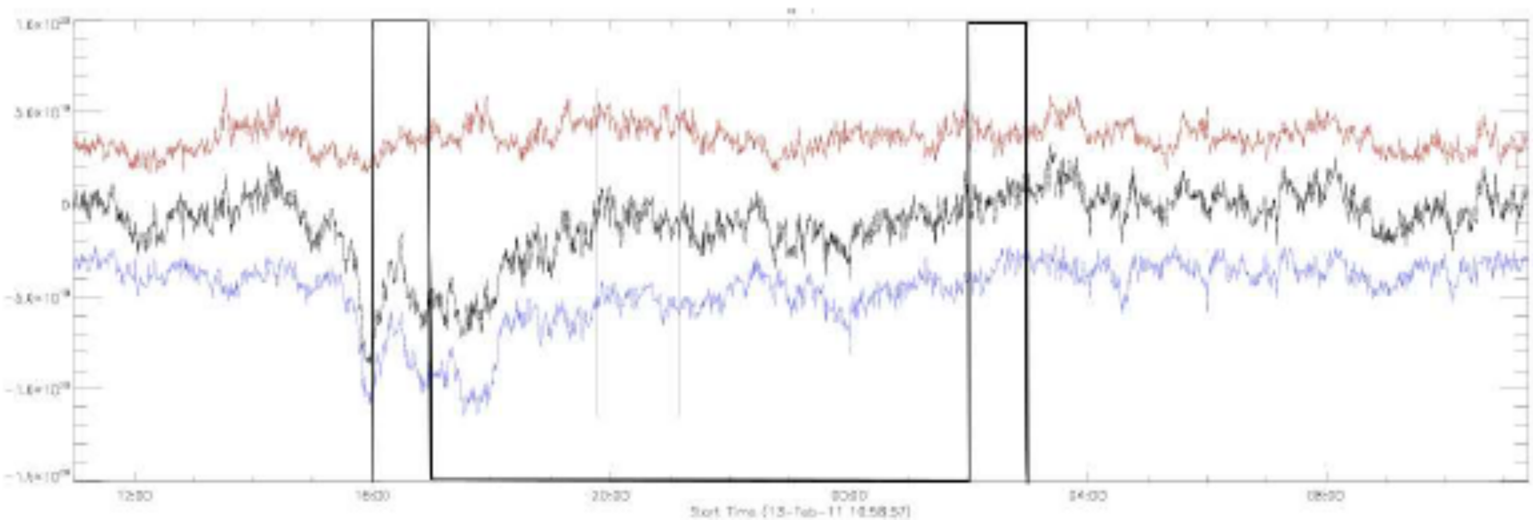


Table: Bright-point oscillation periods as recorded from SWAP and different AIA channels

Inst	SWAP		AIA					
channel	174		171		193		211	
Period	P1	P2	P1	P2	P1	P2	P1	P2
	min	min	min	min	min	min	min	min
bp1	19.5	5.8	18.7	7.9	20.4	14.4	14.4	10.2
bp2			20.4	13.2	18.7	4.7	18.7	10.2
bp3	17.9	8.9	20.4	9.4	26.5	6.6	15.7	24.2
bp4			18.7	8.6	20.4	9.4	20.4	9.4
bp5	19.5	13.8	20.4	7.9	22.2	6.0	22.2	4.7
bp6	23.2	8.9	22.2	8.6	22.2	7.2	22.2	6.6
bp7	23.2	8.2	20.4	11.1	17.1	2.1	18.7	8.6
bp8	25.3	19.5	18.7	6.6	18.7	26.5	18.7	26.5
bp9	25.3	10.6	24.3	4.3	22.2	11.1	12.1	0.5
bp10	13.8	19.5	18.7	9.4	20.4	7.9	20.4	8.6

Periodicities of BP1 observed for times from February 13, 16:00 UT to 17:00 UT (T1) and from February 14, 01:UT to 02:00 UT (T2)



AIA channels	171		193		211	
	T1	T2	T1	T2	T1	T2
P1(min)	13.2	11.12	18.7	17.15	18.7	15.72
P2(min)	6.6	15.72	6.06	10.20	6.06	9.35
(P1/P2)	2.0	0.71	3.08	1.68	3.08	1.68

Conclusions

- Bright points have multiple connectivities, and evolve similar to active regions. They are more likely miniature active regions.
- Intensity oscillations in the Bright Points are excited either due to likage of photospheric power through magnetic filed lines or due to recurrent reconnection.
- Magnetic flux changes may imply repetitive reconnection or divergence of filed change, the P1/P2 ratio may indicate change in oscillation pattren.