

Rapid Changes of Magnetic Fields Associated With Six X-Class Flares and Halo CMEs

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Summary

- For all six events, leading magnetic flux had a rapid increase after flares.
- Following polarity flux either decreased slightly or unchanged.
- Three events showed new sunspot area, predominantly in the form of penumbra. The same three events had increased transverse fields and magnetic shear.
- Explanation: Emergence of sheared, inclined flux rope or expansion of sunspot associated with flares/CMEs.

Introduction

- In general, there has been no detectable changes of magnetic fields after flares (Chen et al., 1994, Hagyard et al., 1999)
- Some studies showed magnetic shear increase after flares (Wang et al, 1994, Ambastha et al., 1993)
- Magnetic transient and sudden decrease of magnetic flux after a flare/CME (Kosovichev and Zharkova, 2001)
- Sudden magnetic flux increase after flares (Wang and Tang, 1993, Spirock et al., 2002)
- In addition to rapid changes, gradual flux emergence, cancellations, shear motion associated with flares/CMEs have been observed for many events (too long to list)

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Observations

- New Digital Vector Magnetograms at BBSO
- MDI magnetograms
- Full disk and high resolution Halpha movies
- Yokoh HXT and GOES Soft X-ray Observations to indicate flare times

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Events

Date	Start Time	Peak Time	AR No.	Size	Location
03/22/91	2230UT	2247UT	6555	X9.0	S23E20
04/02/01	2132UT	2151UT	9393	X20	N19W75
04/06/01	1910UT	1921UT	9415	X5.6	S20E31
08/25/01	1623UT	1645UT	9591	X5.3	S17E34
10/19/01	1613UT	1630UT	9661	X1.6	N15W29
10/22/01	1744UT	1959UT	9672	X1.2	S18E16

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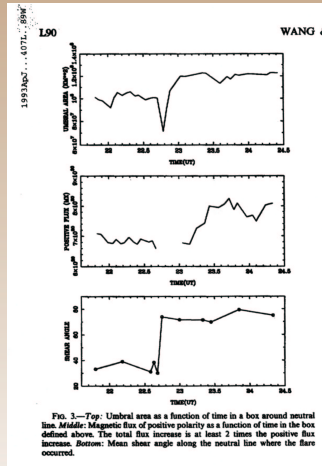
August 27, 1990 Flare (Wang, 1992)

EVOLUTION OF VECTOR MAGNETIC FIELD AND THE AUGUST 27 1990 X-3 FLARE 95

Fig. 9. A comparison of the weighted mean shear angle with the GOES X-ray flux for the area covering two major footpoints. The large increase of the shear at about 21:00 UT coincides with the onset of the flare, as shown by the jump of X-ray flux.

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March 22, 1991 (Wang & Tang, 1993)



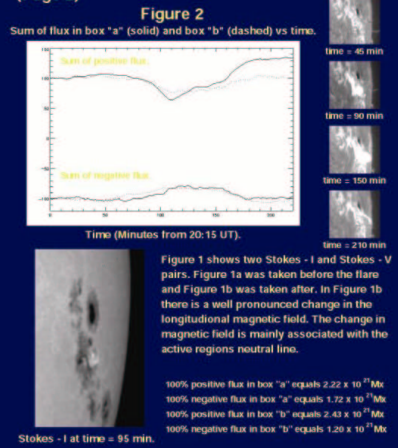
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Spirock et al. (2002)

X17 Flare of April 2, 2001 in NOAA9393 (Page 2)

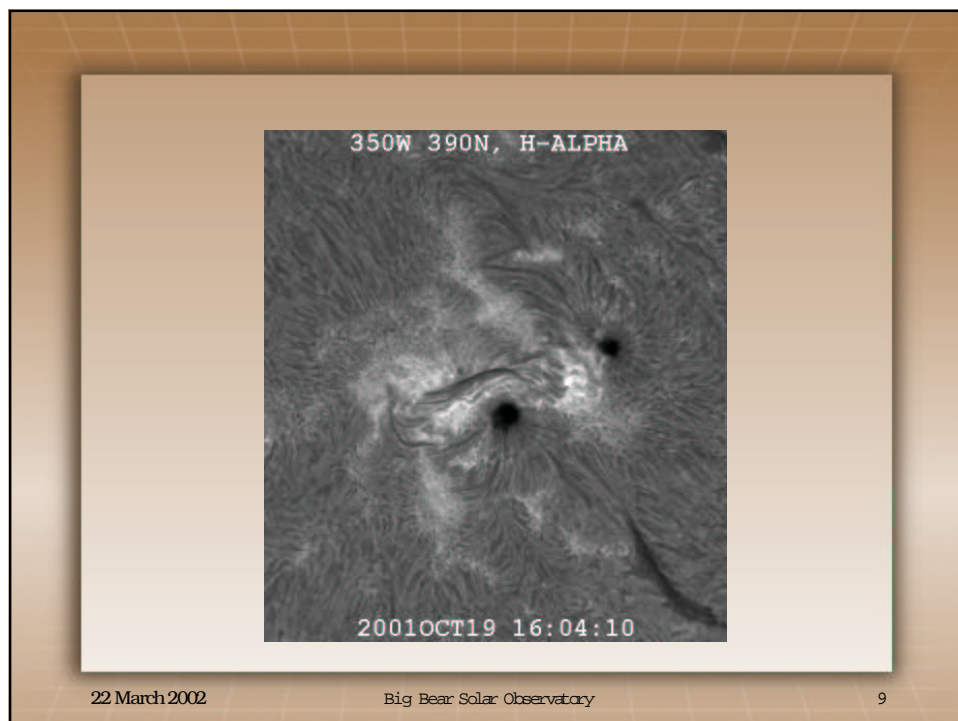
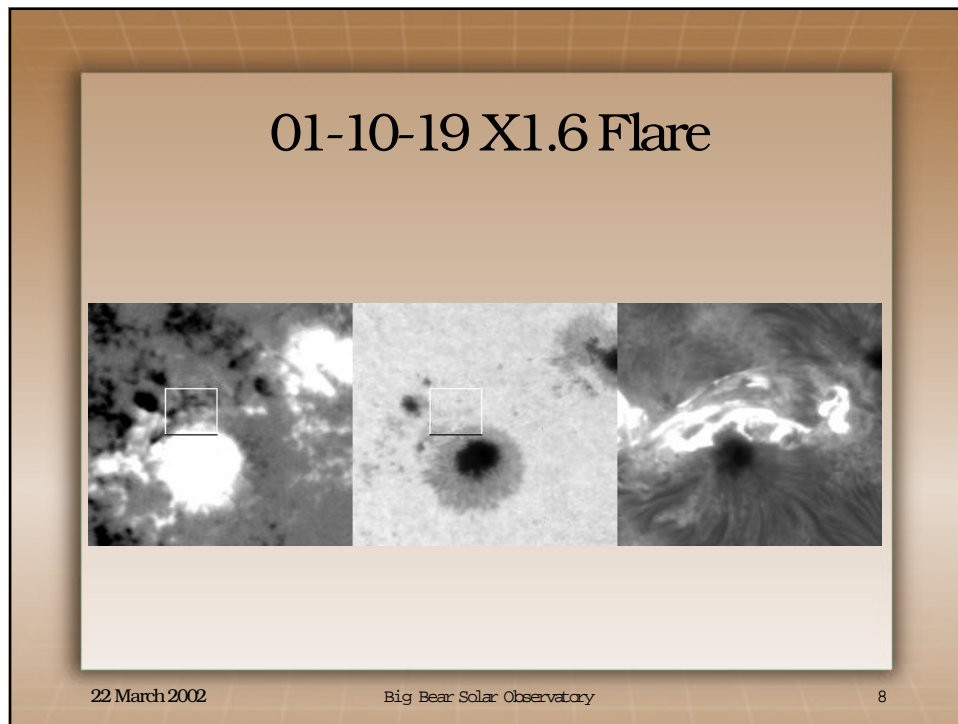


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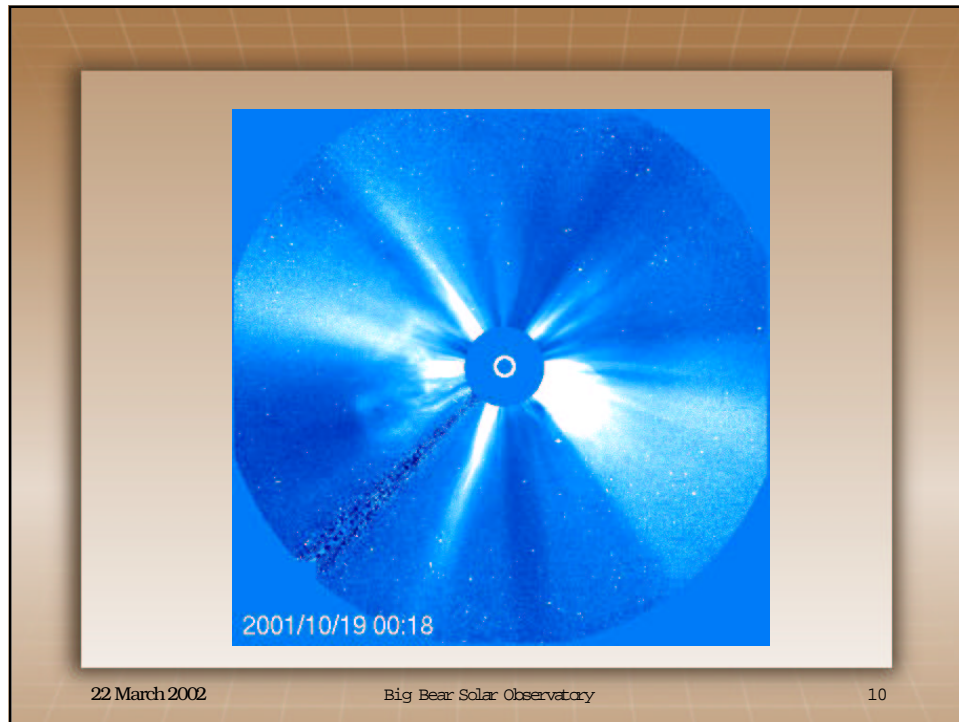
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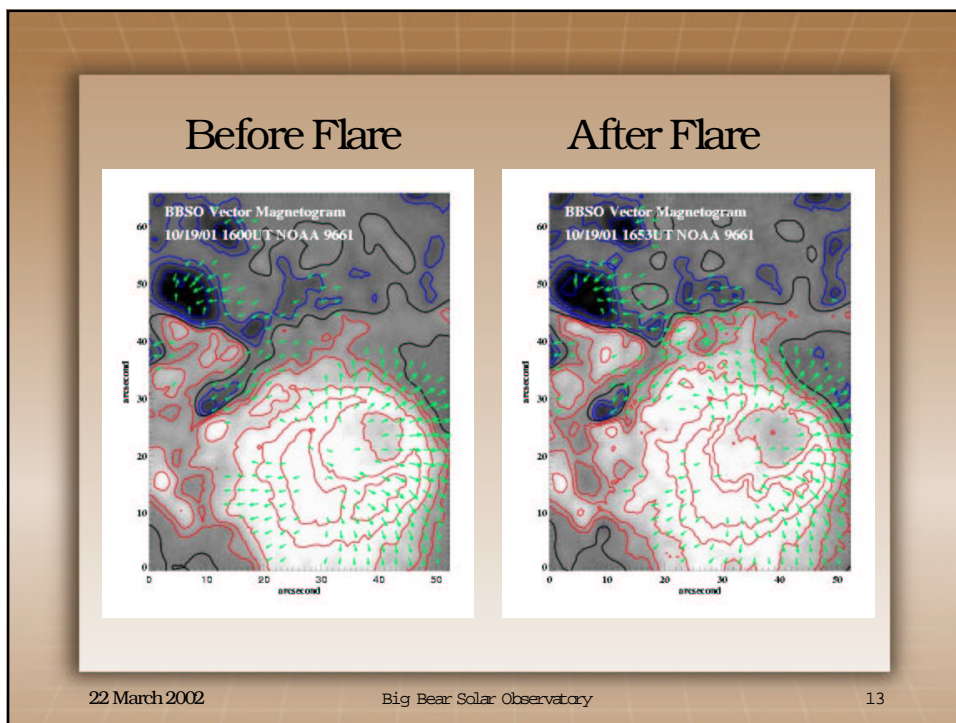
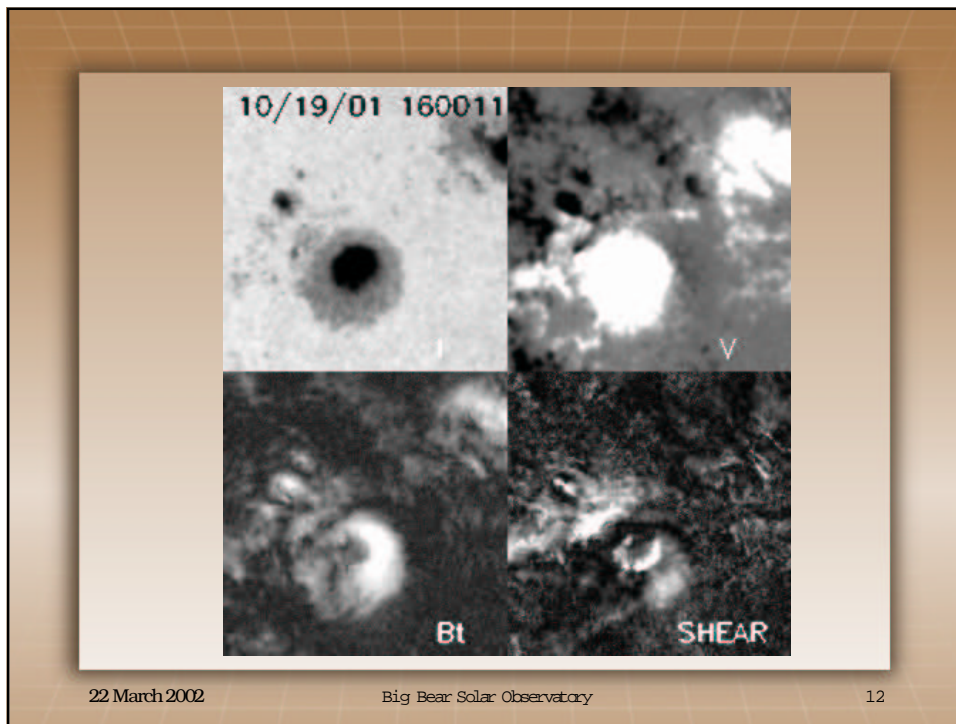
Rapid Changes of Photospheric Magnetic Fields Associated with CMEs and Flares



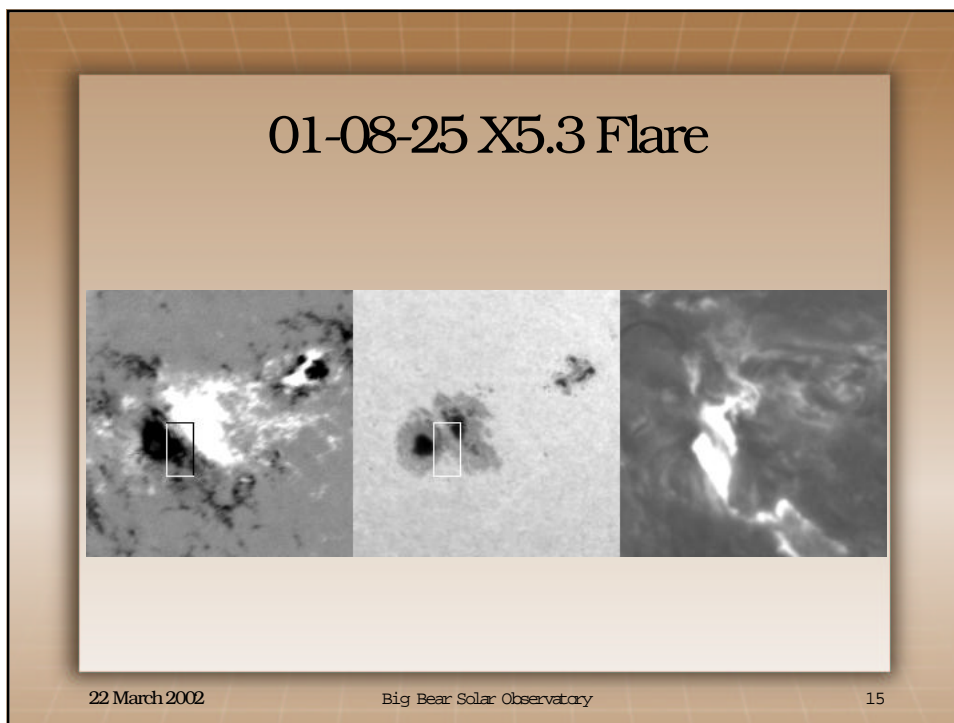
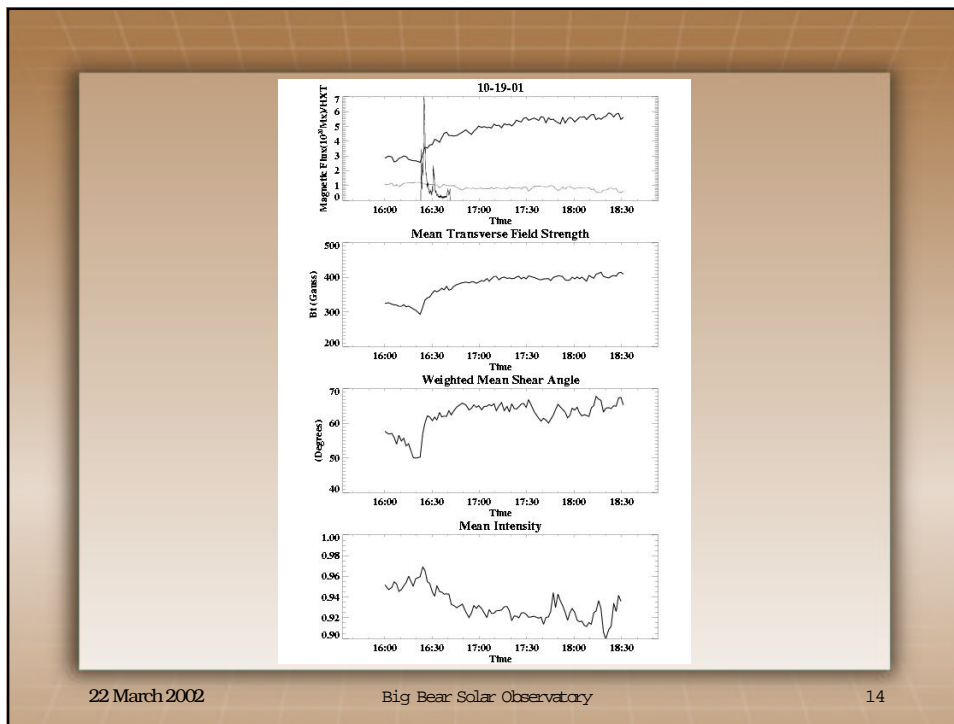
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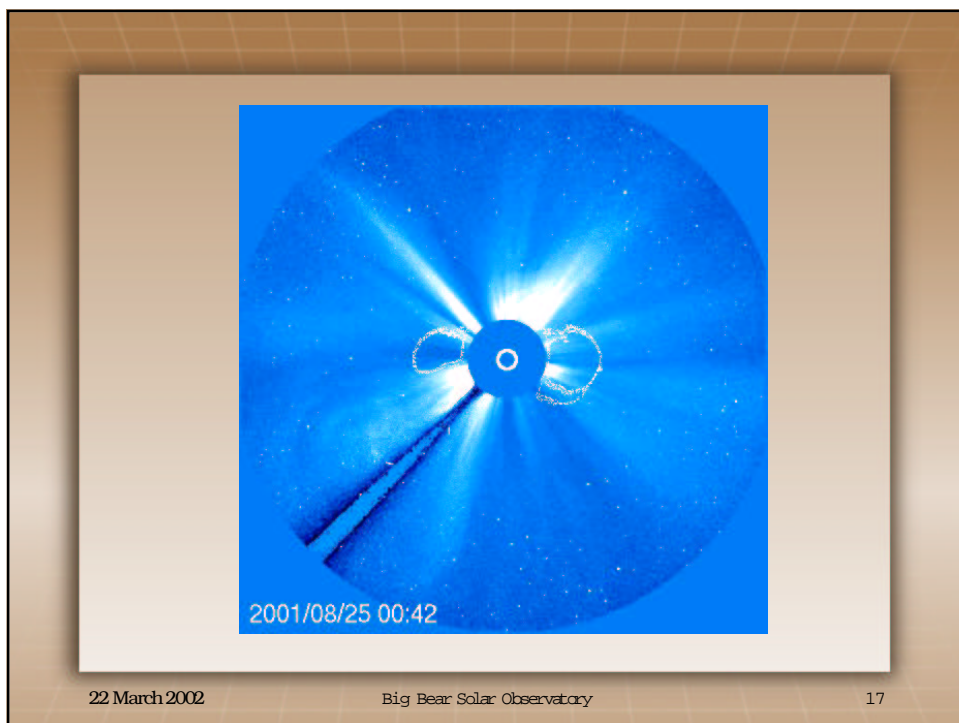
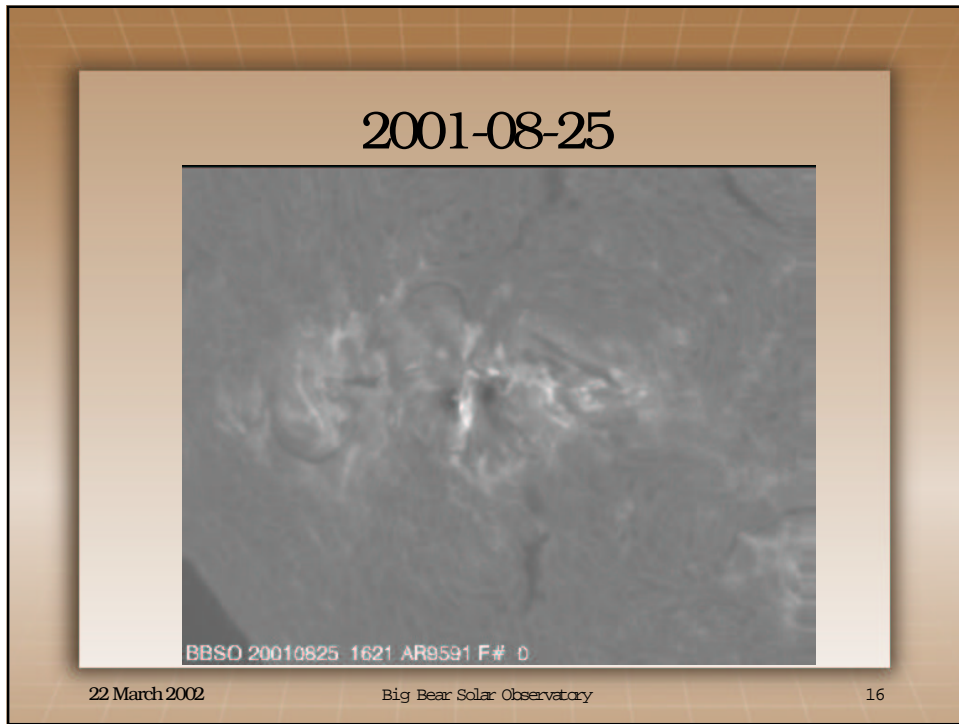
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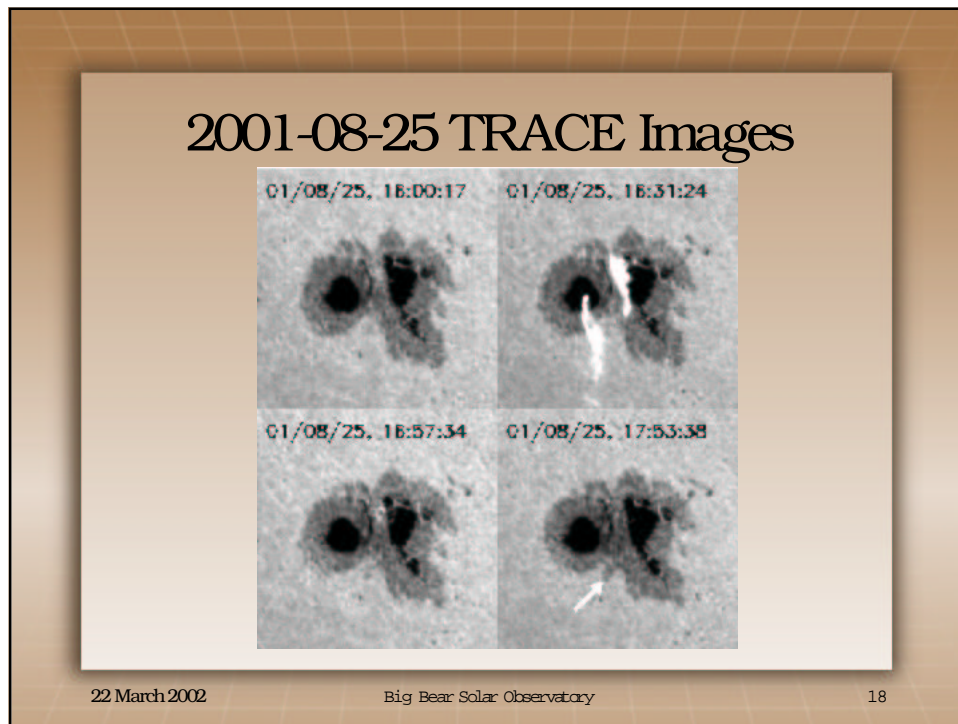
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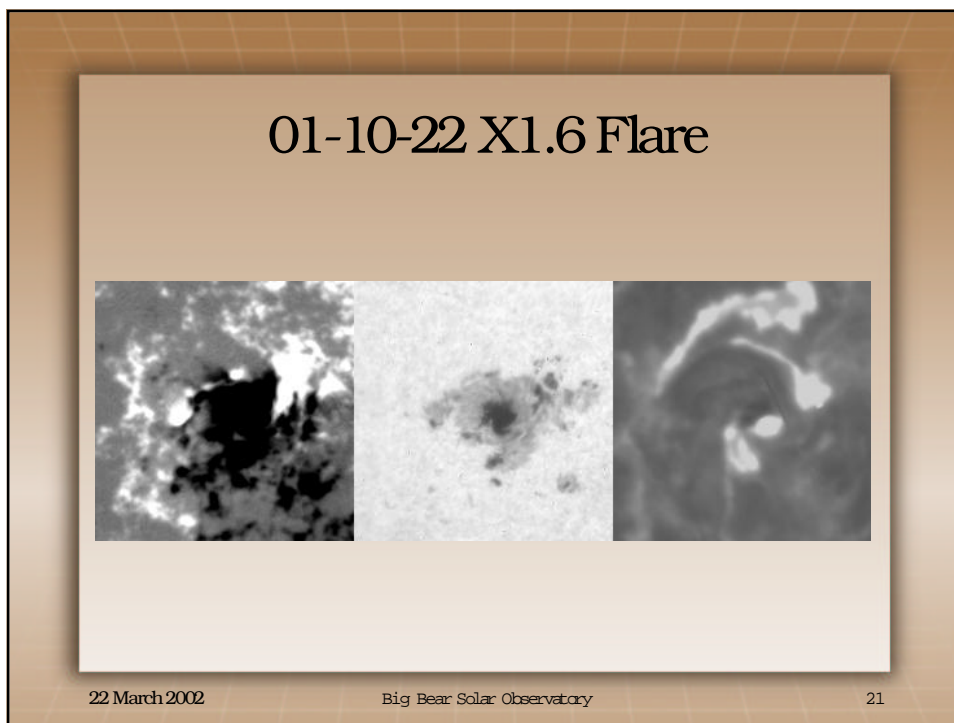
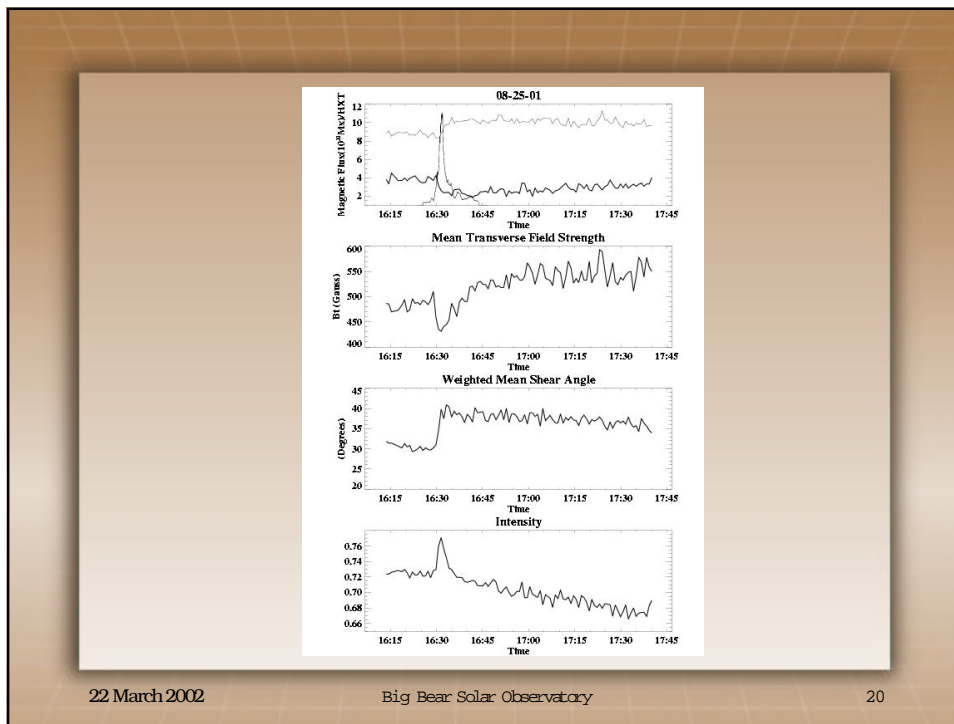
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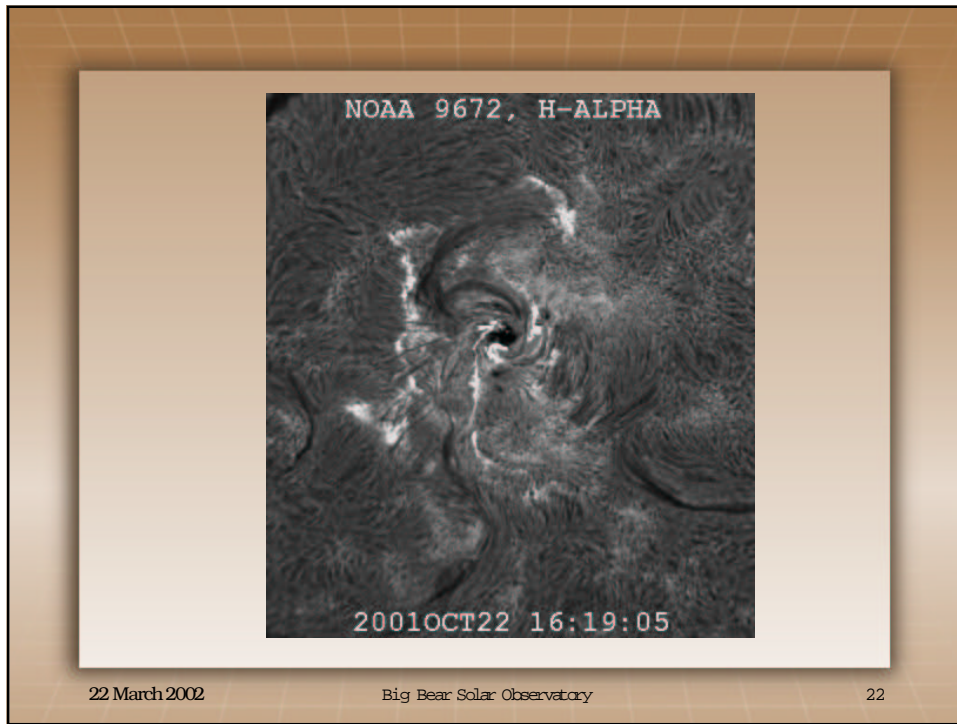
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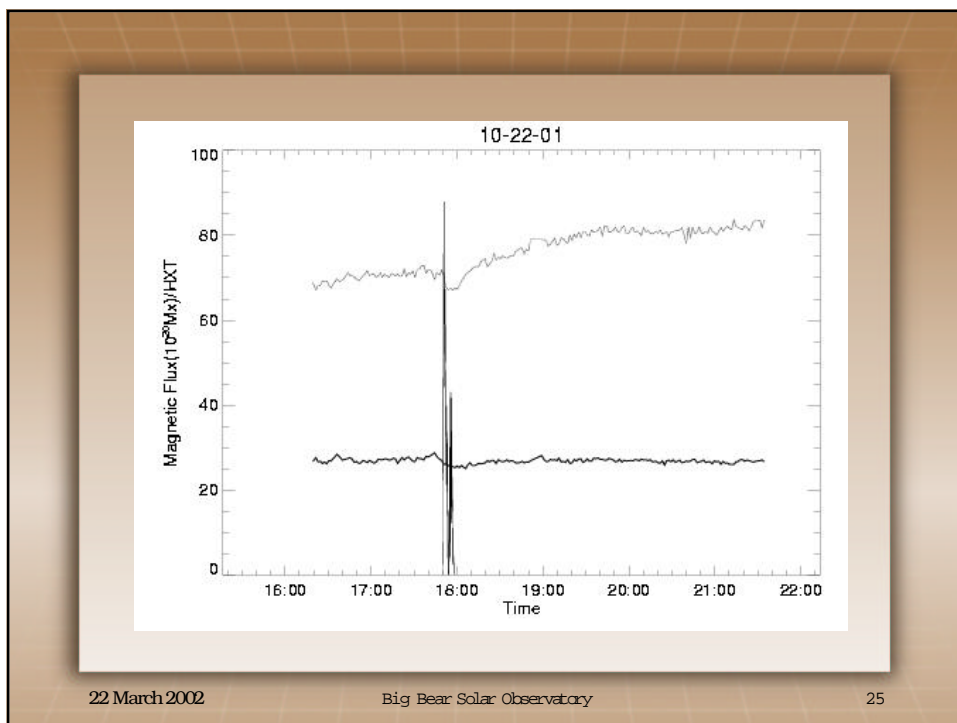
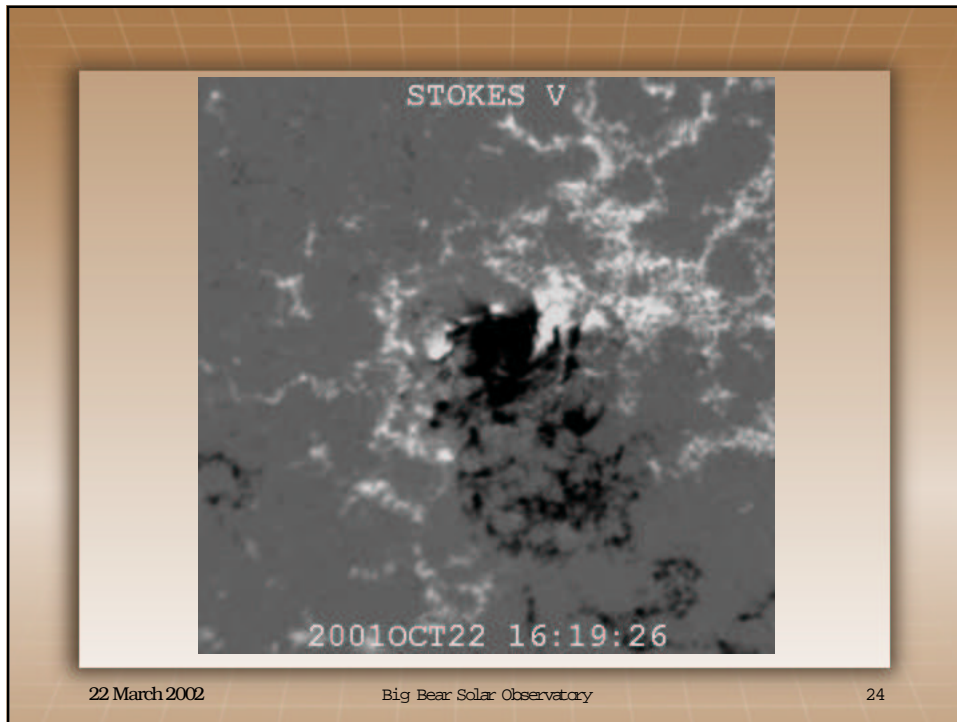
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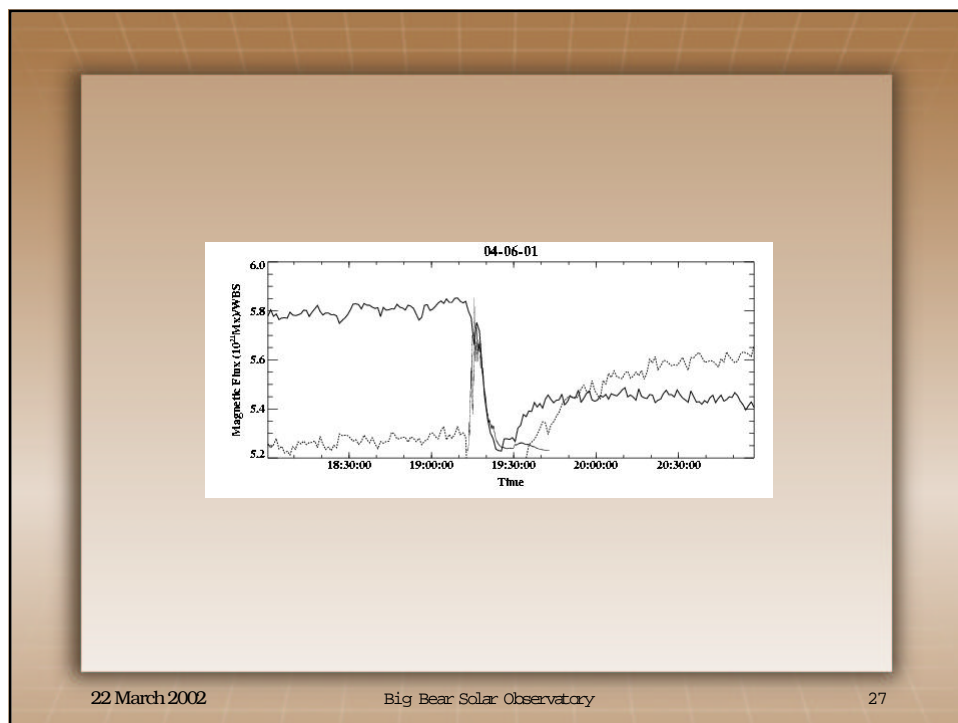
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Rapid Changes of Photospheric Magnetic Fields Associated with CMEs and Flares



Rapid Changes of Photospheric Magnetic Fields Associated with CMEs and Flares



Summary of Results

Date	CME	dT	dP (10^{20}Mx)	dF (10^{20}Mx)
03/22/91	Unknown	50min	+1.0	0
04/02/01	Partial Halo	100min	+6.0	-1.5
04/06/01	Halo	40min	+2.0	-4.0
08/25/01	Halo	10min	+1.8	-0.8
10/19/01	Halo	60min	+3.0	-0.4
10/19/01	Halo	60min	+11	-2.0

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Summary of Results (2)

Date	Magnetic Shear	Transverse Field	New Spot	Explanation
03/22/91	Increase	Increase	Yes	Flux Emergence
04/02/01	No vector Data	No vector Data	No	Flux Emergence
04/06/01	No vector Data	No vector Data	No	Expansion of p-spot
08/25/01	Increase	Increase	Yes	Flux Emergence
10/19/01	Increase	Increase	Yes	Flux Emergence
10/22/01	No change	No change	No	Expansion of p-spot

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Possible Explanations

1. New Flux Emergence

- Sheared
- Inclined
- Cancellation of New P-flux with Existing F-flux

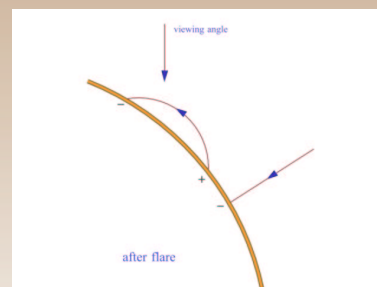
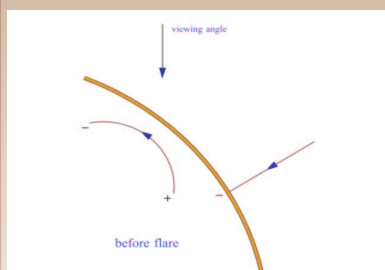
2. Expansion of P spot

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Explanation 1: New Flux Emergence



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**Explanation 2:
Expansion of the sunspot**

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