Four Days of AR09644 Development:

Its magnetic reconnection with AR09640

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Introduction

Magnetic reconnection is a phenomenon which is of particular importance in solar system plasma. Evolution of the photospheric flux has been considered the main cause for solar flares and even for CMEs.

- In this paper we analyze the 3D magnetic field of two neighbor active regions observed in October 2001.
- These active regions are situated at South of a polar huge filament which had a complex dynamics that we suppose is linked to the active regions evolution.
- The AR09640 is a well developed region.
- In its neighborhood emerged the young AR09644 that produced few flares.
- Our study reveals the 3D magnetic reconnections in all the area.

H_α

Observational data

- magnetograms from MDI (Michelson Doppler Imager) for the period between 30 September and 5 October 2001.
- *H alpha* images from BBSO (Big Bear Solar Observatory) and Meudon Observatory.
- WDCA (http://cdaw.gsfc.nasa.gov)

- An IDL program to reconstruct the magnetic field in 3D, based on a dipolar model principle.

Brief description of the method

The dipolar model method:

The positions of the dipole are obtained from the magnetogram. This generation is performed using the magnetic flux density components derived from the magnetic dipole equations with the dipole at the origin. The derived magnetic flux density components are:

$$B_x = B_o \frac{3xz}{r^5},$$

$$B_y = B_o \frac{3yz}{r^5},$$

$$B_z = -B_o \frac{\left(1 - 3\frac{z^2}{r^2}\right)}{r^3}$$

Where *x*, *y* and *z* are the Cartesian components of the position vectors of the field lines, *r* is the magnitude of the position vector,

$$r = \sqrt{(x^2 + y^2 + z^2)}$$

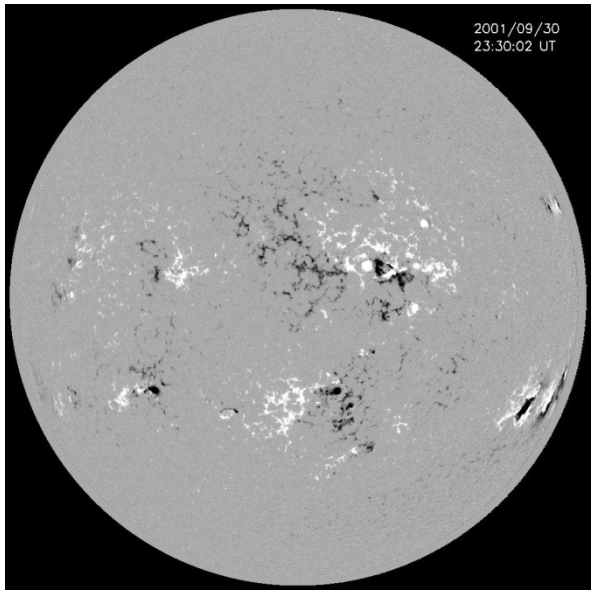
B_0 is the magnetic force constant

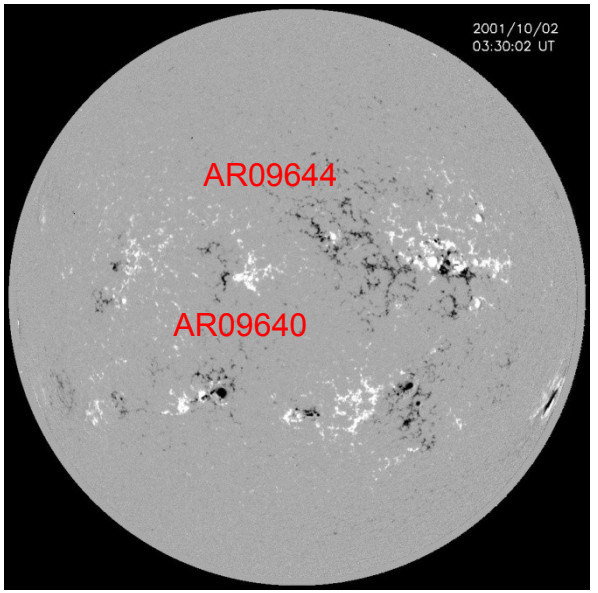
Jong Kwan Jake Lee - *Coronal Loop Identification (http://www.uah.edu/KSA/jake/OC/coronal_loop_detection.html)*

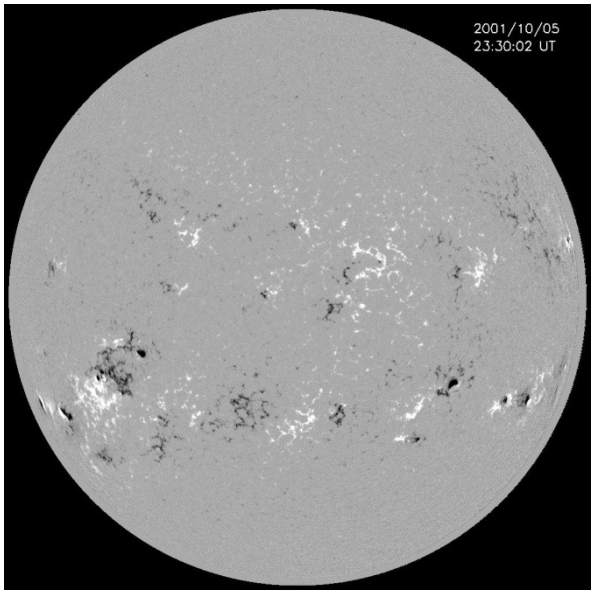
Analysis

The data analyzed are from 30 September 2001 (one day before 09644 active region was counted on the MDI magnetograms) until 5 October 2001 when both, 09640 and 09644 disappeared.

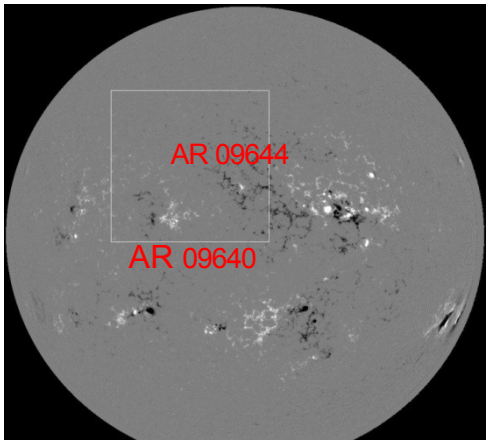
The 09640 active region appears before 30 September, but in its evolution until the appearance of 09644 has no major influence in the neighborhood, being isolated from other active regions in its vicinity.

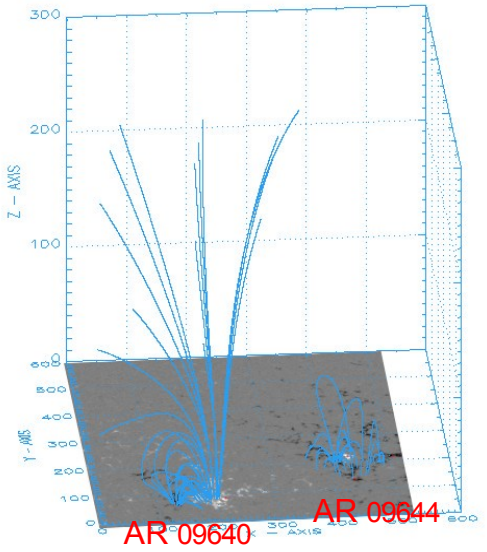






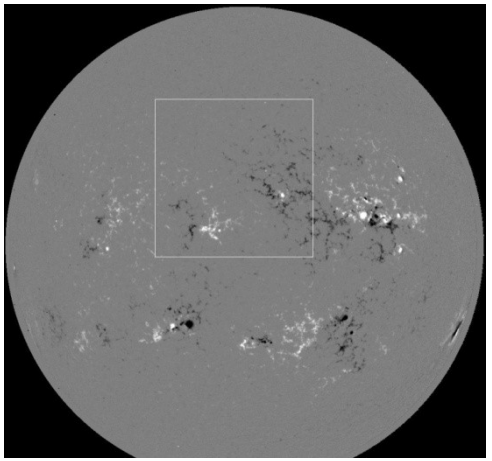
01.10.2001 – 12.00 UT

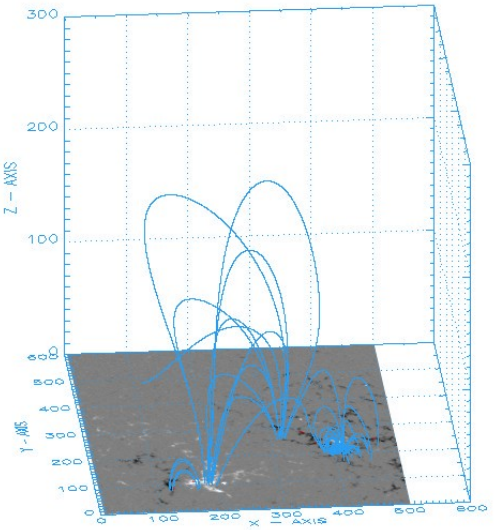




- emergence of 09644 active region near AR09640 – a well developed region
- there is no connectivity between these two regions at this time

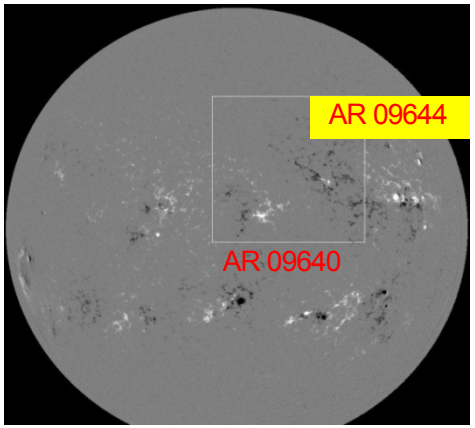
02.10.2001 – 07.00 UT

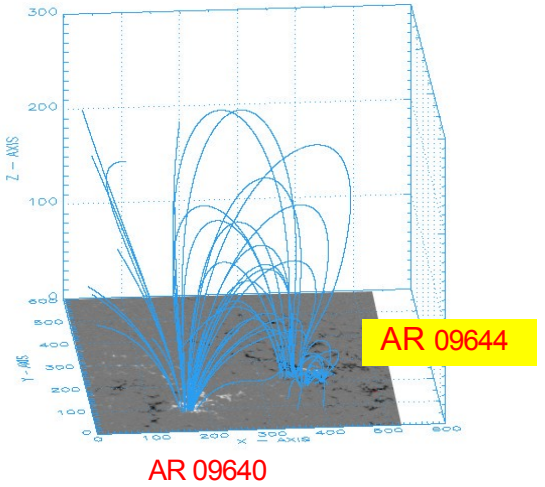




- AR0944 development increases and the magnetic field within this region grows stronger
- the two regions start to connect with each other

03.10.2001 – 10.41 UT





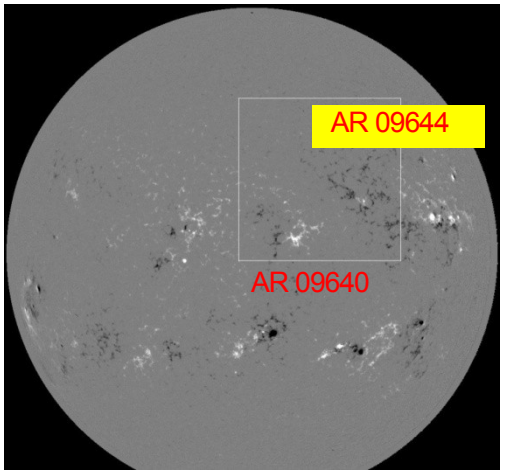
Before 1st flare

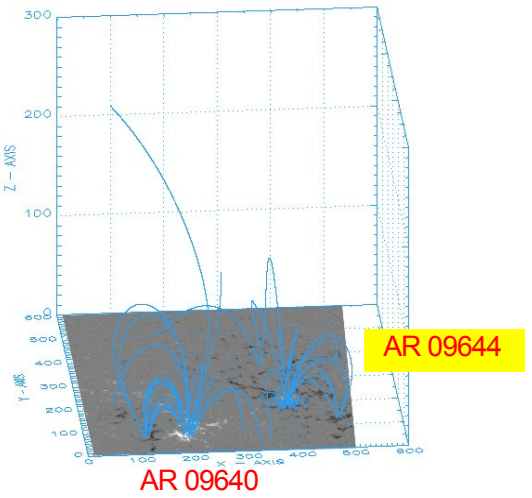
- both regions are still connected
- the magnetic field in the two regions develops a strong connection between them

H alpha flare from AR09644

occurred at 14:30 UT, with maximum at 14:34 UT, ended at 14:41 UT (www.solarmonitor.org)

03.10.2001 – 18.07 UT



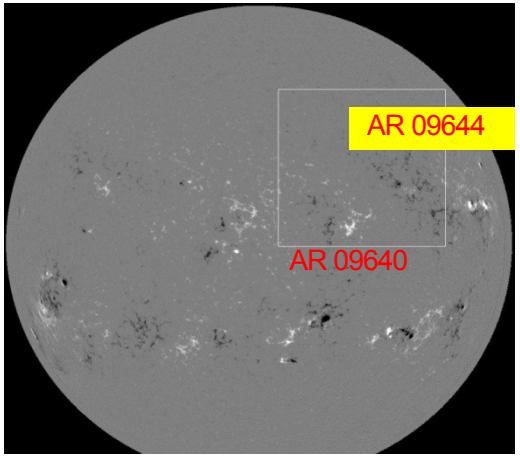


After 1st flare

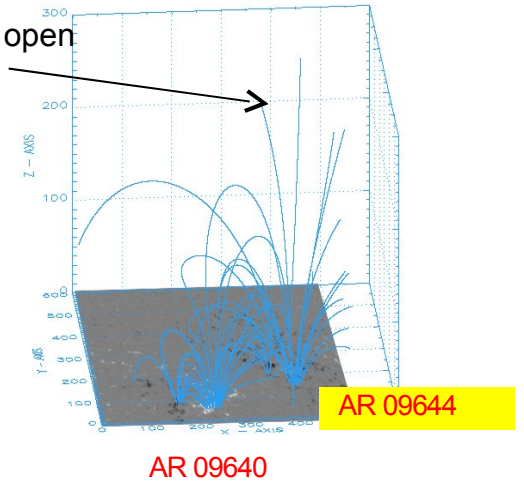
- we observe reconnections of the magnetic fields lines between these two regions and a decrease of the magnetic field intensity
- part of lines open at the H alpha flare

04.10.2001 – 14.01 UT

Before 2nd flare



part of lines open



AR 09640

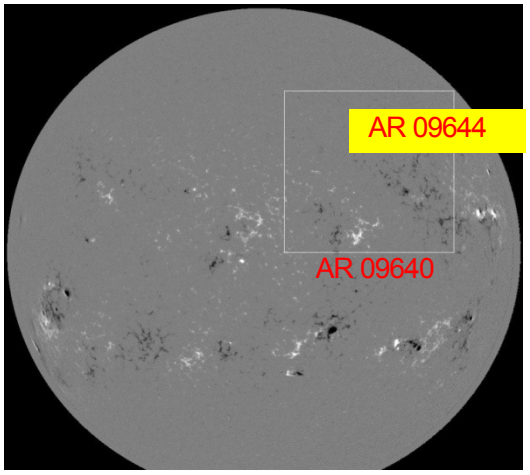
- the active regions reconnect – magnetic field lines are linked to both ARs
- increasing of the magnetic field intensity

X ray flare from AR09644 – second flare

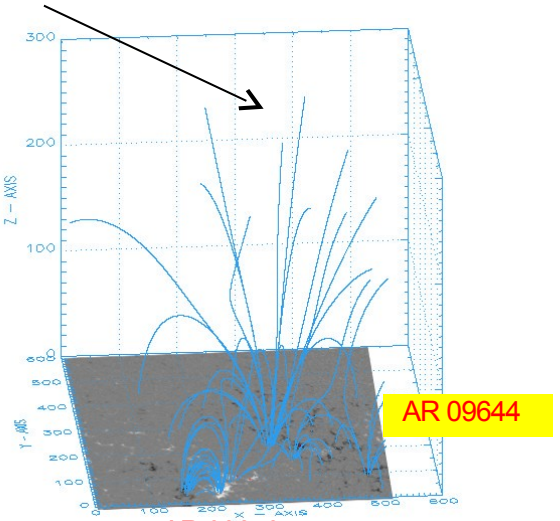
occurred at 14:16 UT, with maximum at 14:19 UT, ended at 14:26 UT (www.solarmonitor.org)

04.10.2001 – 14.28 UT

After 2nd flare



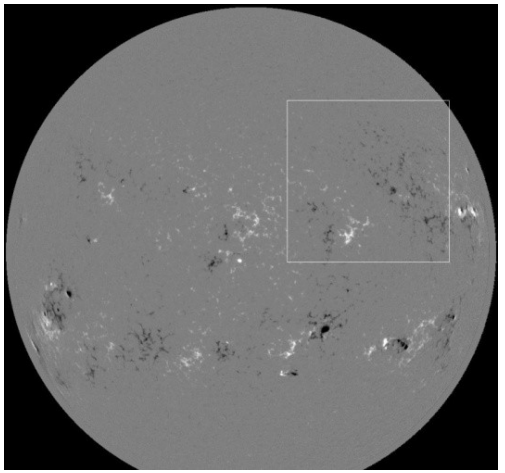
magnetic field lines open

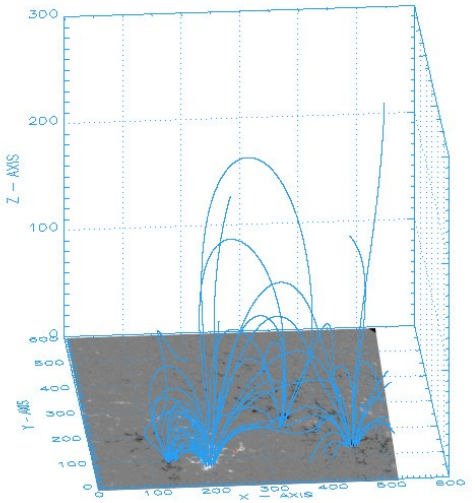


AR 09640

- the magnetic field lines open in AR09644 and disconnect from the AR09640
- the AR09640 keeps its topology, it seems unchanged by the flare

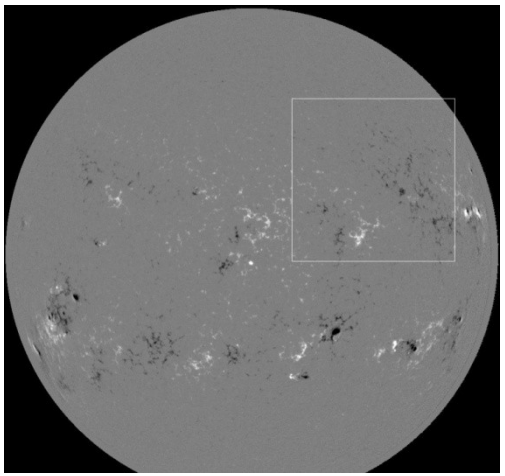
04.10.2001 – 18.30 UT

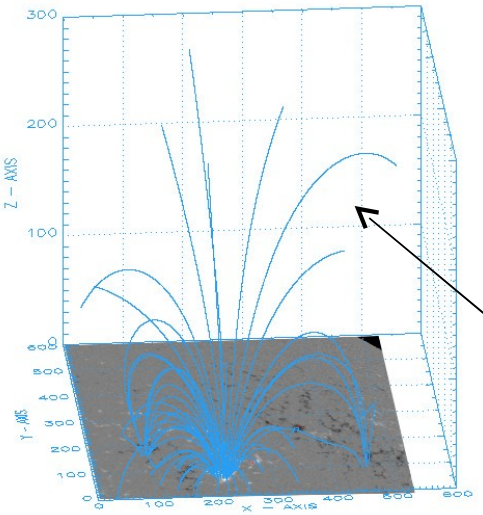




- again, both region reconnect
- the AR09644 seems to connect with other regions too

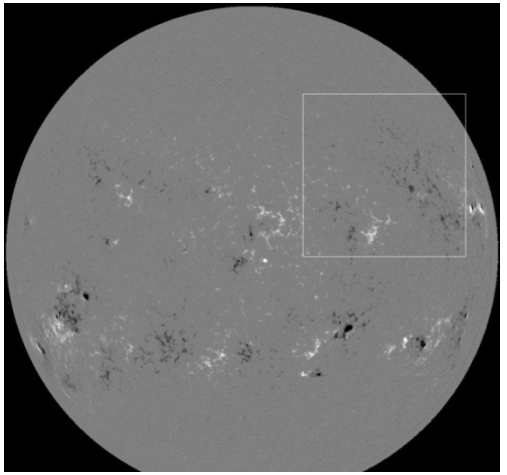
04.10.2001 – 23.00 UT

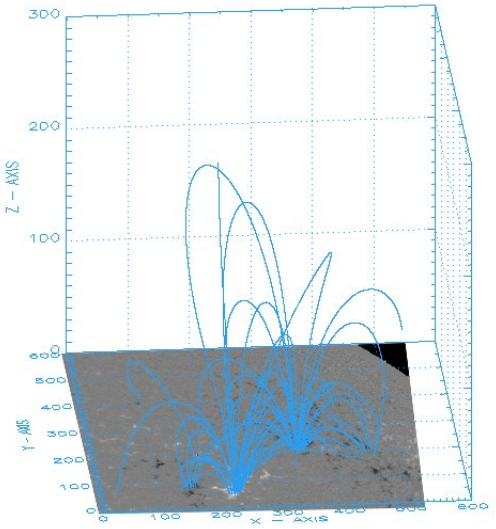




- the magnetic field of the AR09644 decreases in intensity
- the AR09640 ’s magnetic field display open lines similarly to the topology observed after a flare – no flare was reported in region

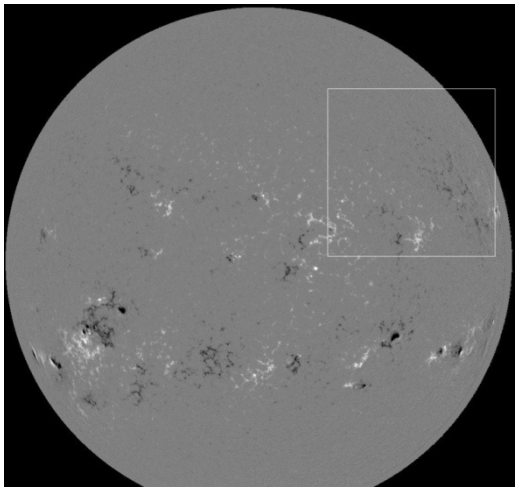
05.10.2001 – 05.00 UT

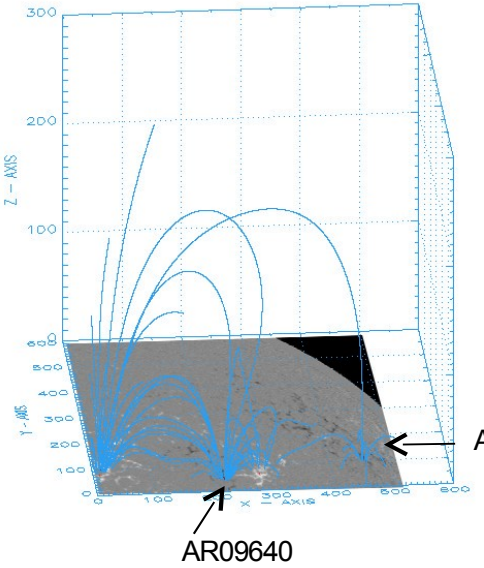




- both regions are reconnected and they are linked also to other active regions in the vicinity

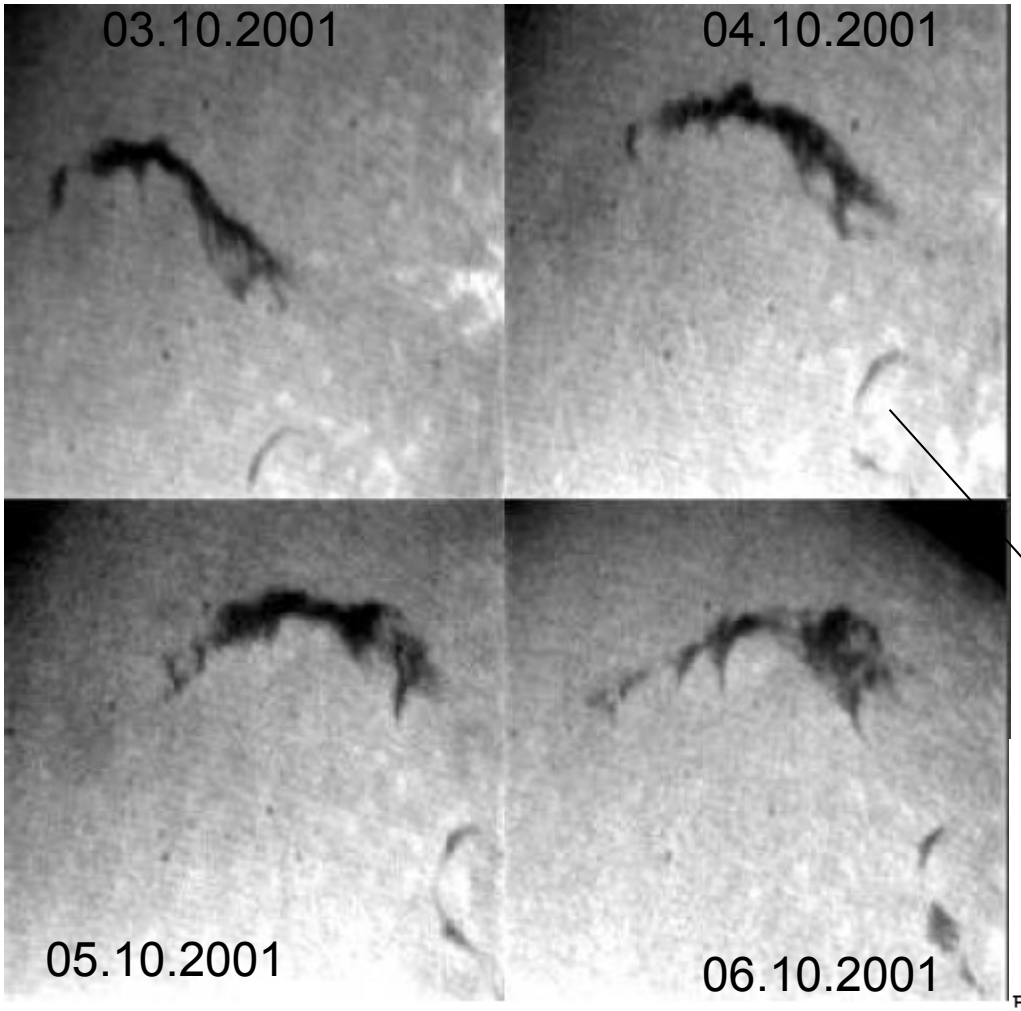
05.10.2001 - 23.30 UT



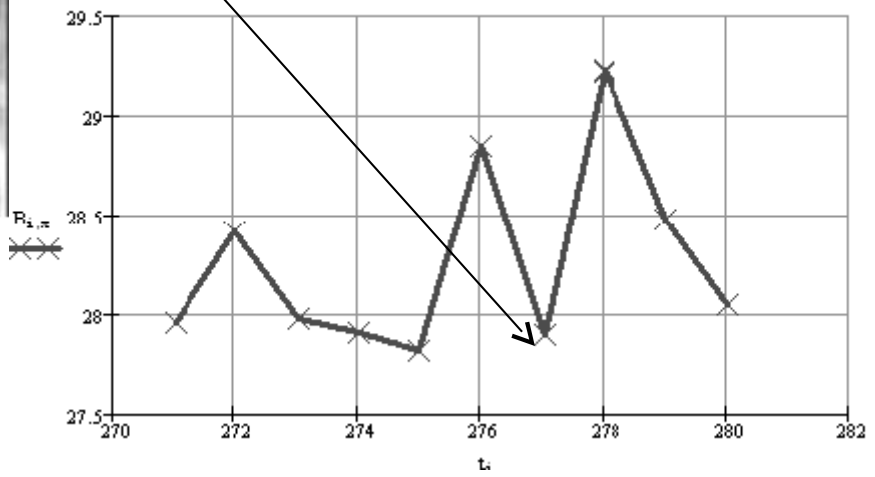


- the magnetic field intensity of the AR09644 decreases

- AR09640 is still linked to AR09644 but it has a stronger connection with another active region from neighborhood



- A huge filament situated in the Northern hemisphere near AR09644 has an interesting dynamics.
- The Southern part of the filament appears had cut off from the main body and enlarged later
- On 5 October the filament length became minimum while the tilt angle and magnetic field became maximum
- We suspect that the eruption observed on 04.10.2001 had a major influence in the filament evolution



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Conclusions

- ✓ We have investigated the 3D topology of the magnetic field joining two active regions: one well developed region (AR09640) and AR09644 new emerged one.
- ✓ The young AR09644 gave two flares (one observed in H alpha and another observed in X-ray) – facts revealed by the opening of the magnetic field lines and magnetic reconnections
- ✓ These flares seemed to play a driven role in a neighbor Northern filament dynamics.
- ✓ Our method of investigation revealed also an opening of the magnetic field lines in AR09640, where no flare observation was reported.