



A DKIST observation of magnetic structures from solar photosphere to corona

Philip Judge, visitor U. Bern, High Altitude Observatory



High Altitude Observatory



Outline

- Universal electrodynamic coupling
- How is the solar atmosphere controlled by magnetic fields?
 - observational approach *strongly guided by theory (MHD...)*
 - *Novel DKIST work (ViSP instrument, Early June 2022)*
 - energy injection (only, not transport, dissipation)
- This work: chromospheric magnetism, motions, Poynting flux
 - relation to plasma structure & heating

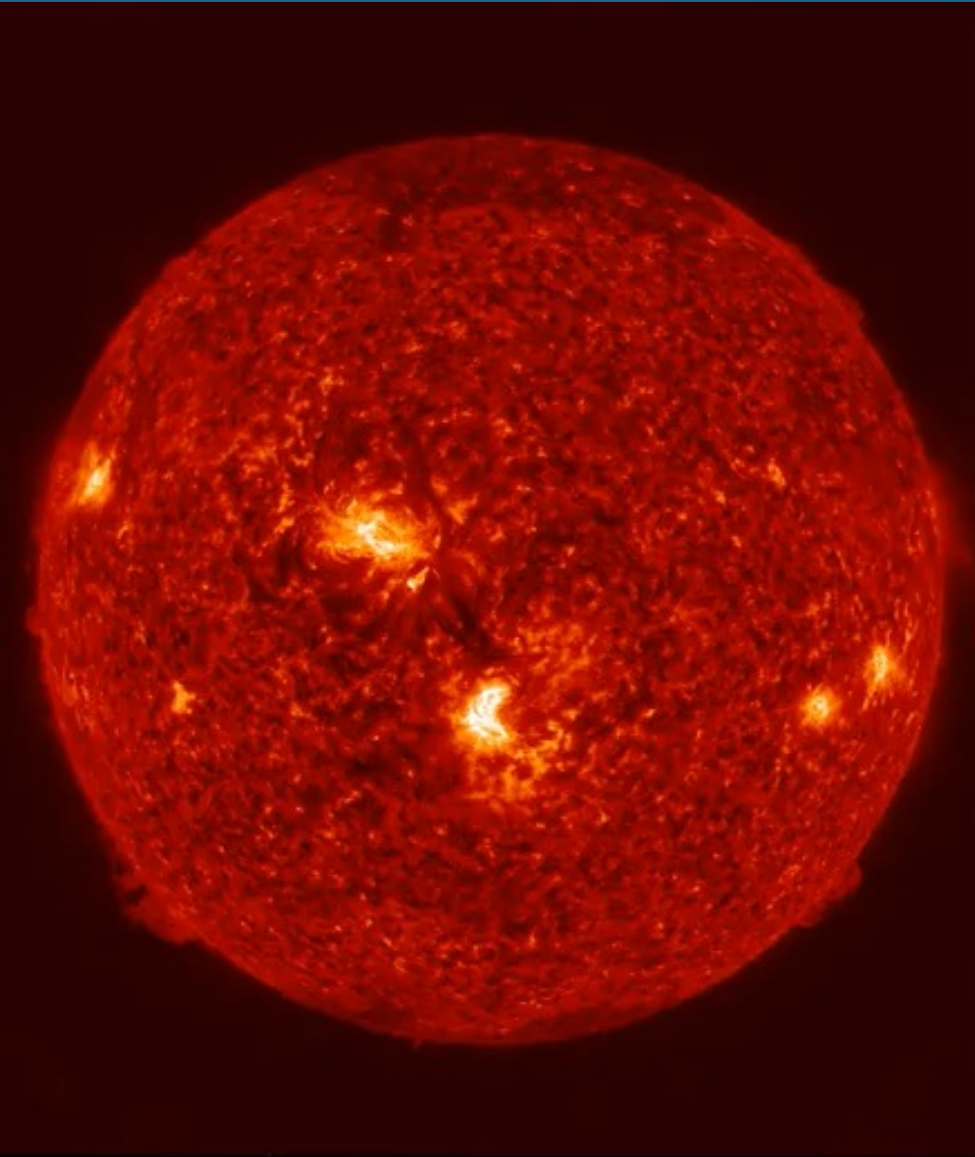


Radio galaxy Hercules A

1 ½ million light years long ~
distance to Andromeda Galaxy M31

Credit: NRAO

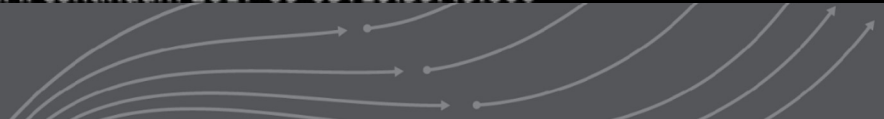
Today's Sun and magnetism

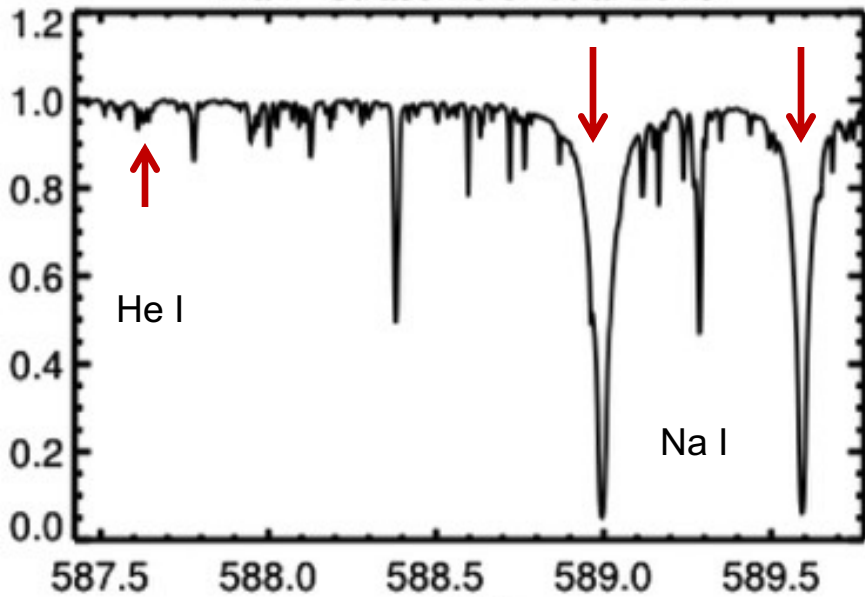


AIA 304 2017-09-03T19:59:29.130



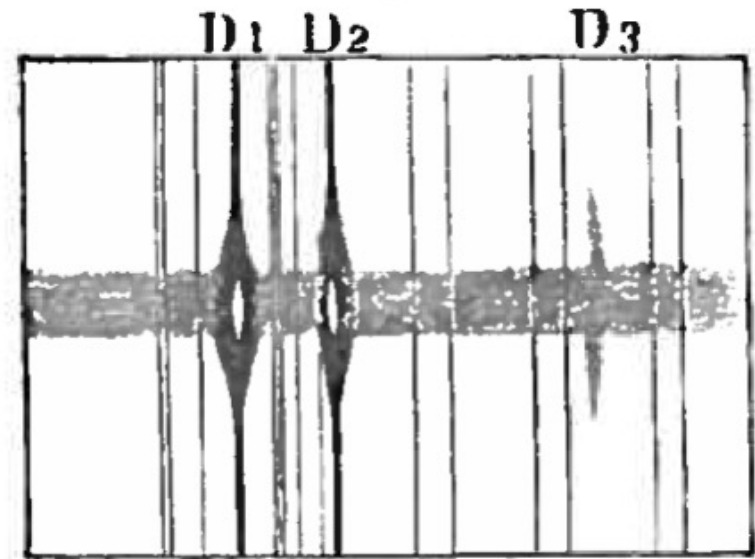
HMI continuum 2017-09-03T19:59:49.600





Young 1883, observations
observation reported in 1870

FIG. 36.



REVERSAL OF THE D-LINES.



from 2014 The Guardian

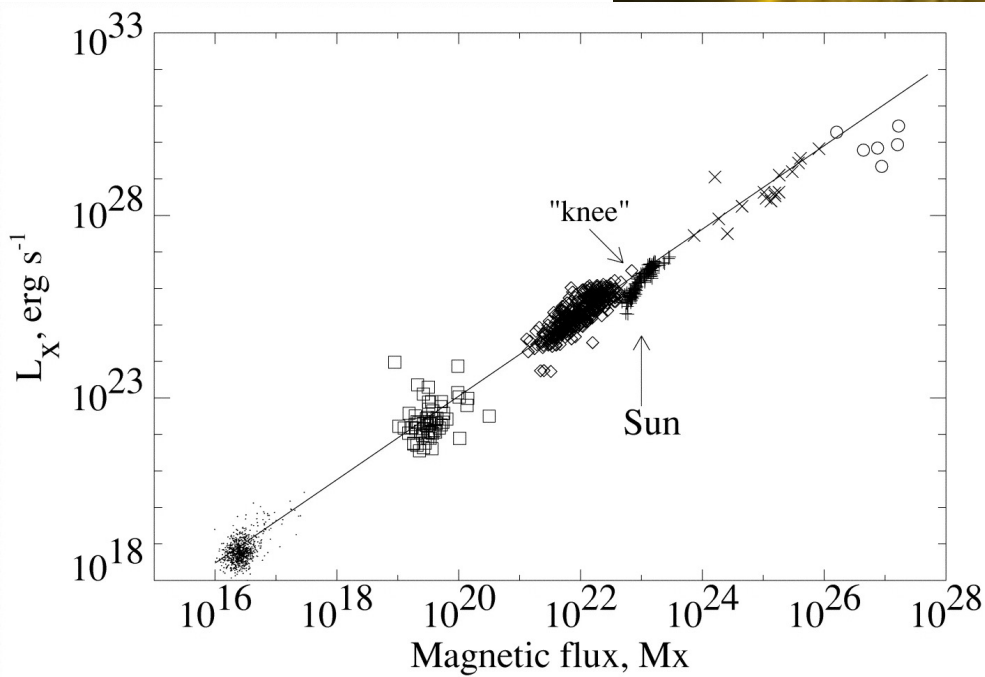
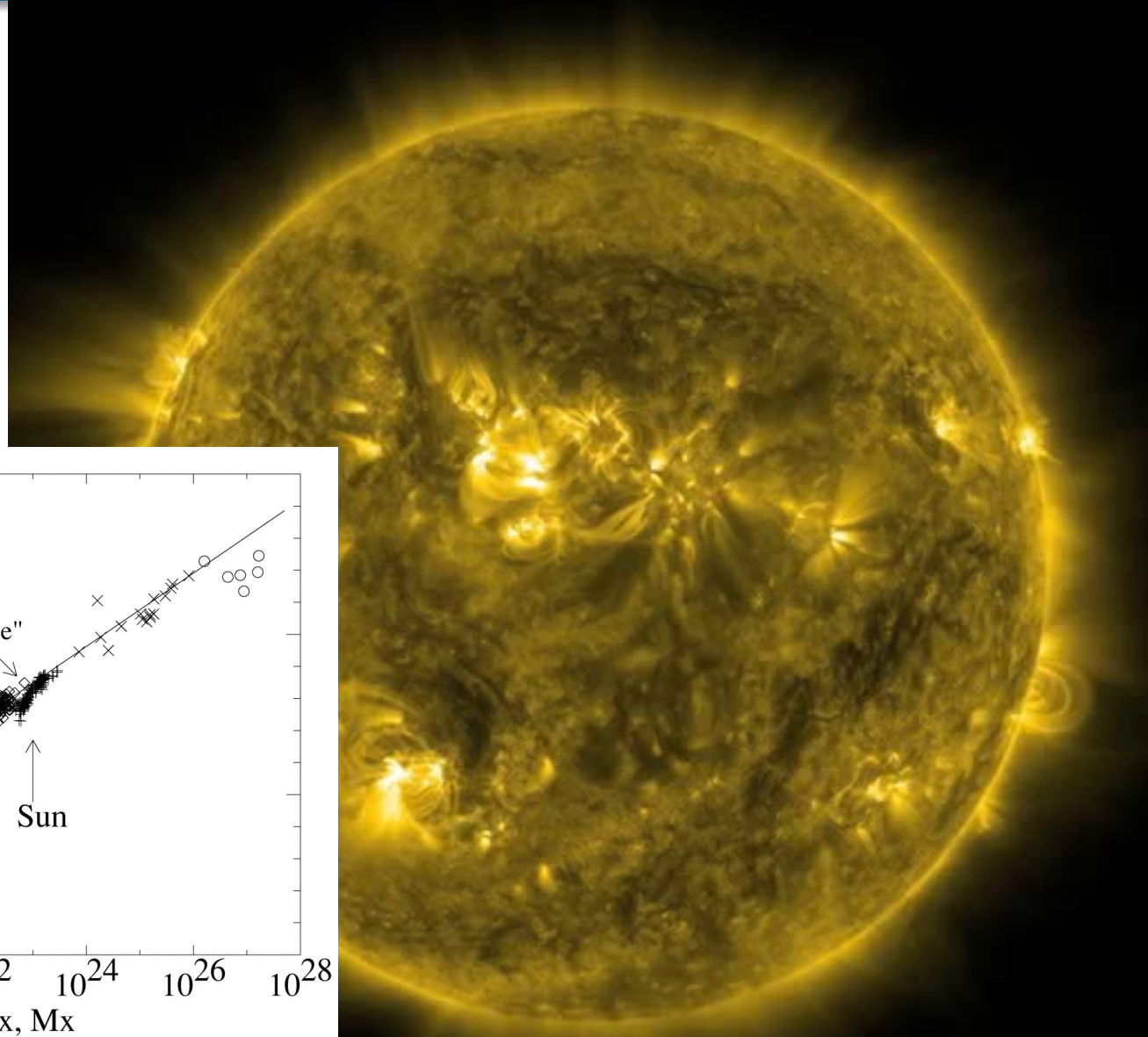
Zeeman effect was observed on the Sun decades before it was identified in the lab

Sunspots = strong magnetism

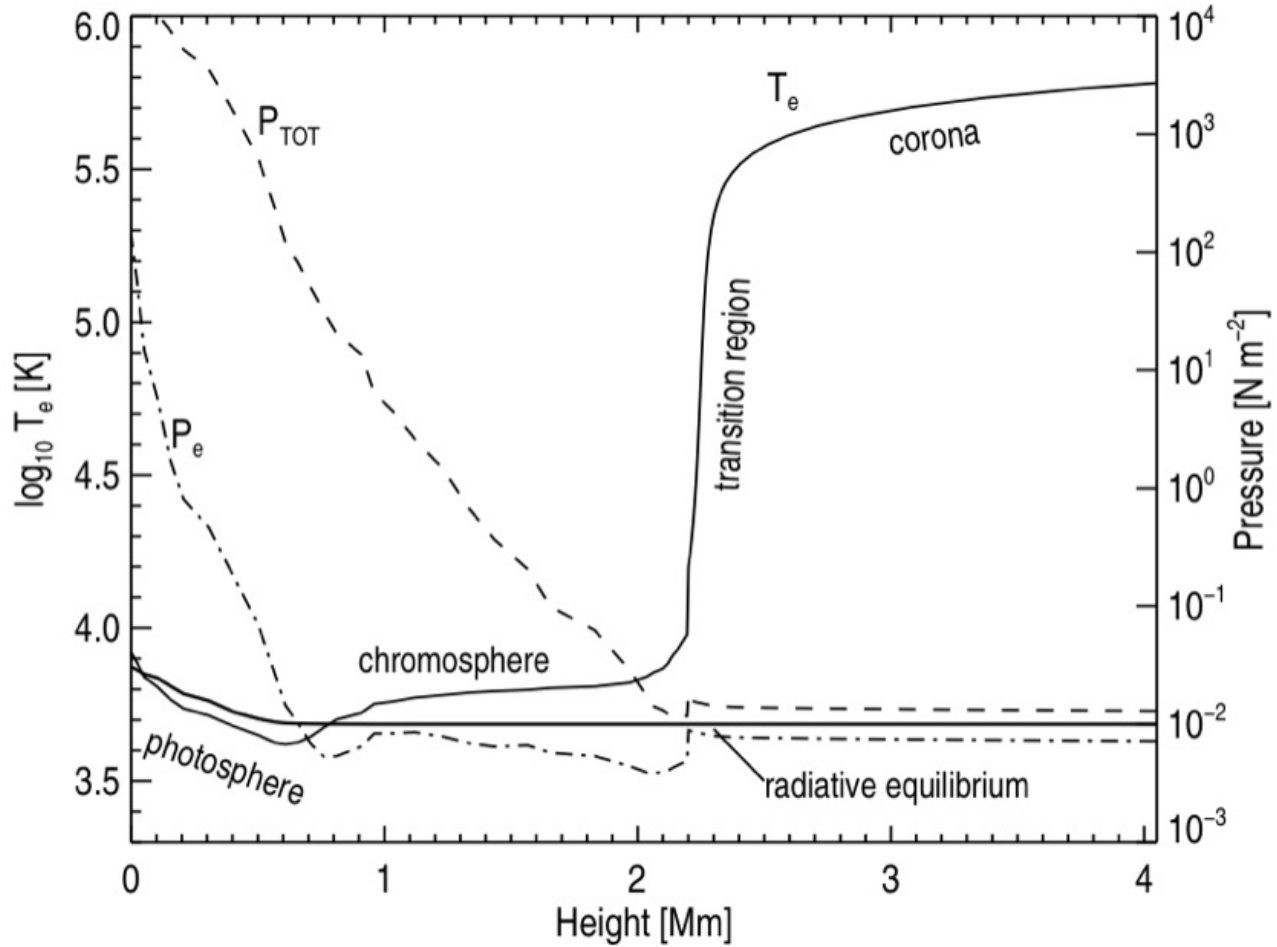
Accepted wisdom: magnetic fields & heating

Magnetism (spots) threads and controls the outer layers of the Sun

An example of cosmic *electrodynamical coupling*



Average sun (does not actually exist)



Gabriel 1976

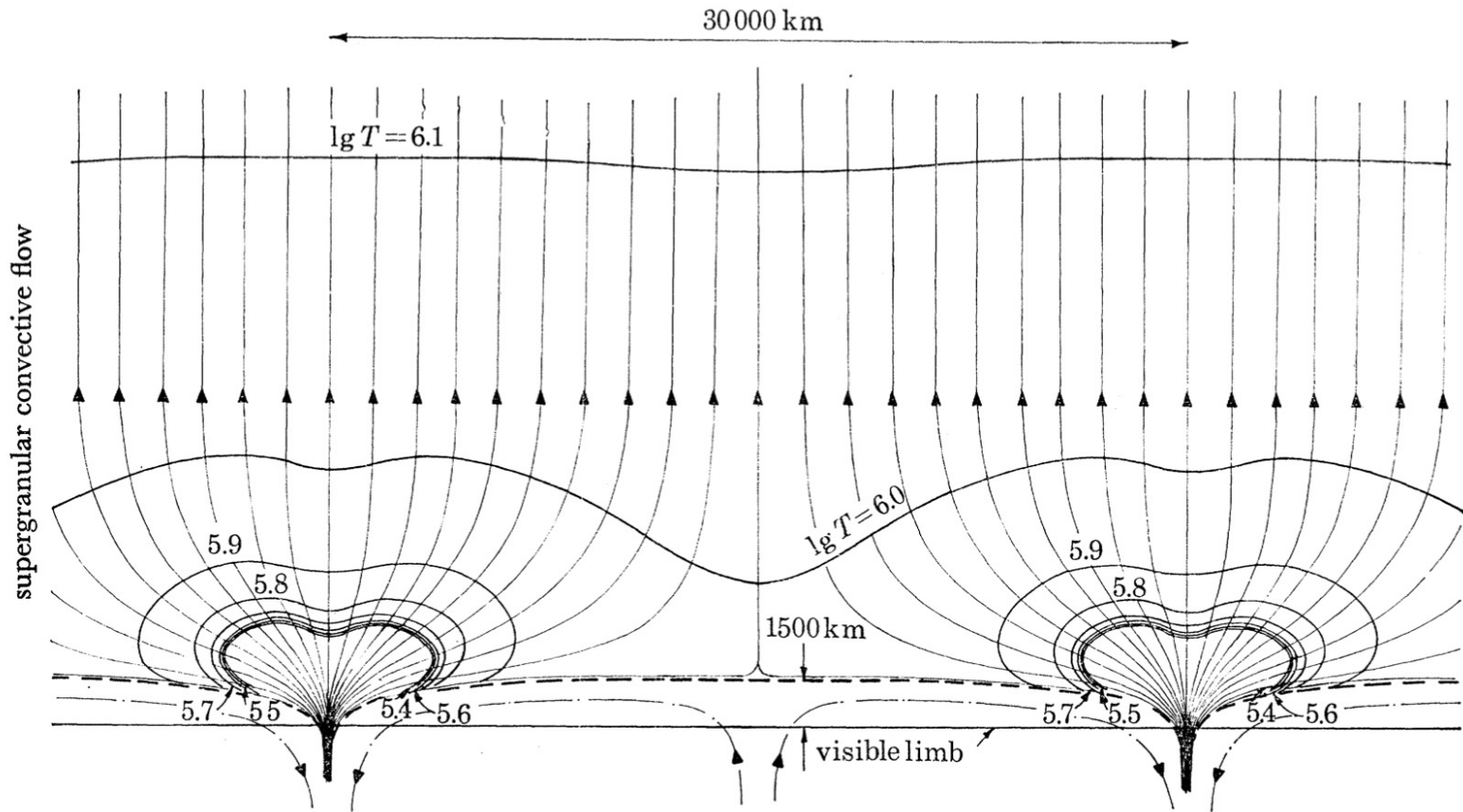


FIGURE 5. The proposed structure of the network model based upon energy balance (model C), showing the convection cell, magnetic field lines and contours of constant temperature. The primary transition region is indicated by the converging contours of temperature. The secondary transition region is shown by the dashed line.

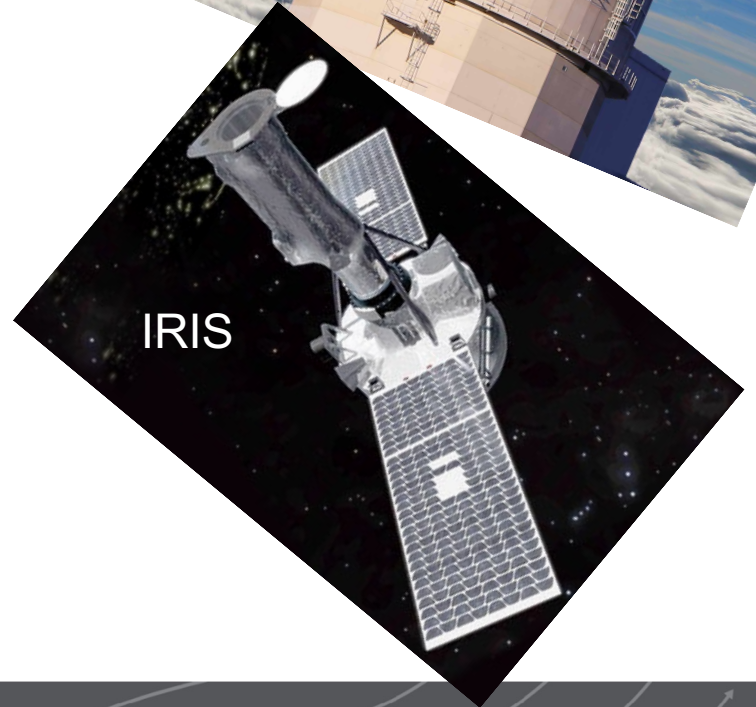
June 2022



(Parker Solar Probe)



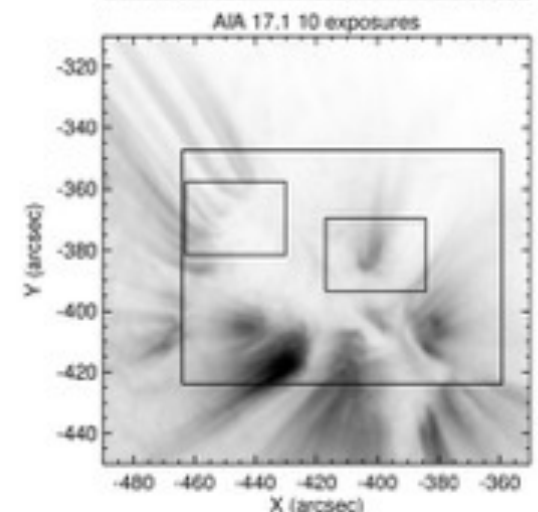
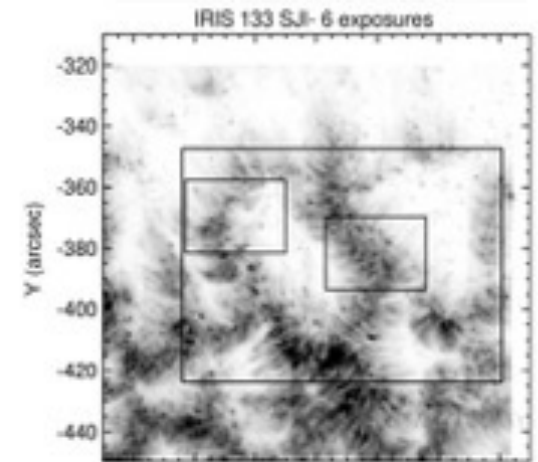
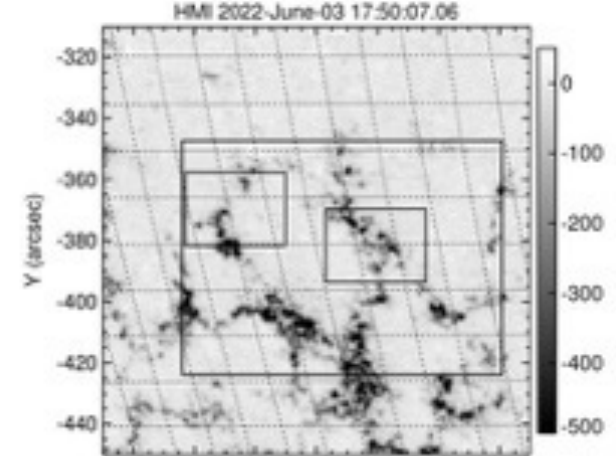
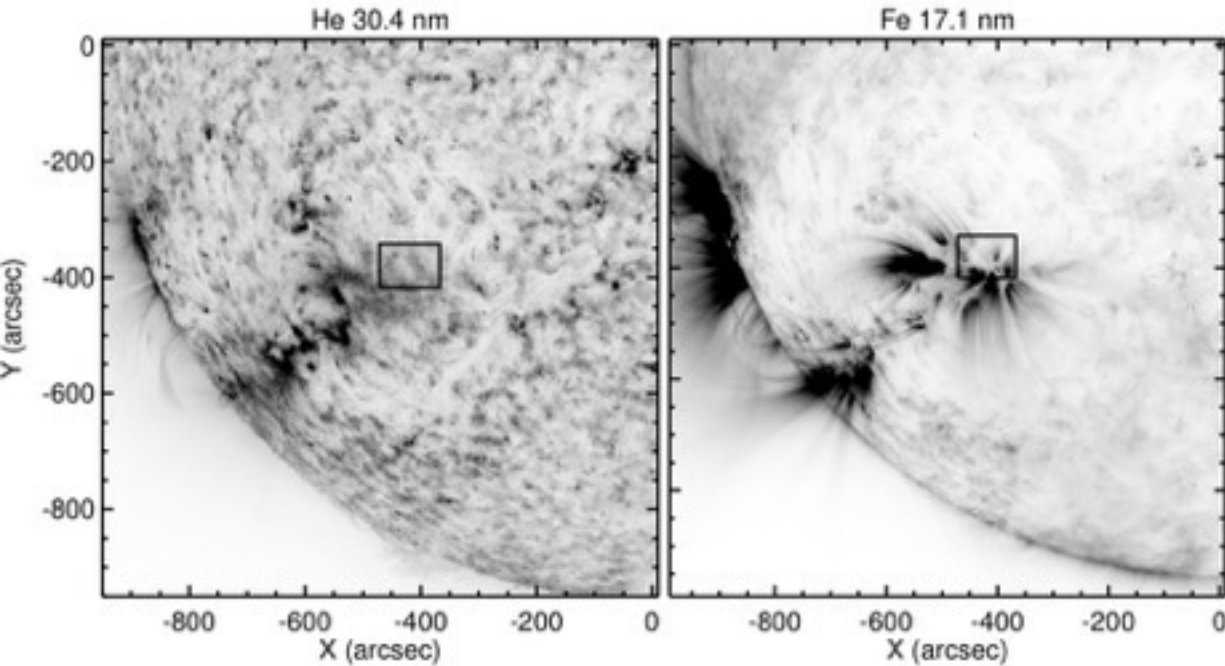
SDO
Solar Dynamics Observatory




IRIS



22 June 2022



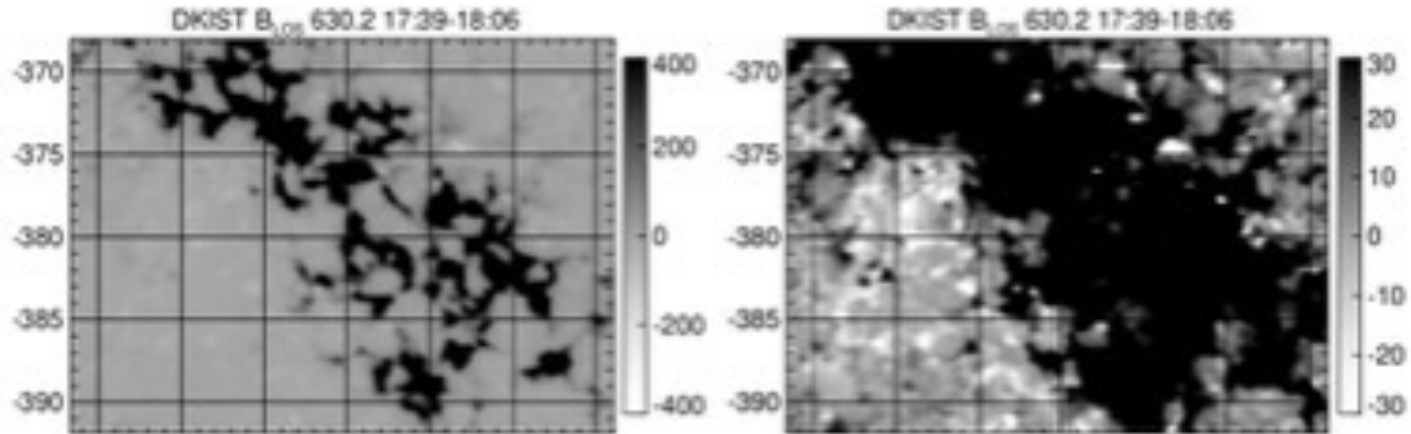
DSO and IRIS. - Photosphere
transition region
corona

DKIST =  Magnetism just beneath the corona
“Low” resolution mode of ViSP
instrument. (0.213”), Sens. 20 Mx/cm²

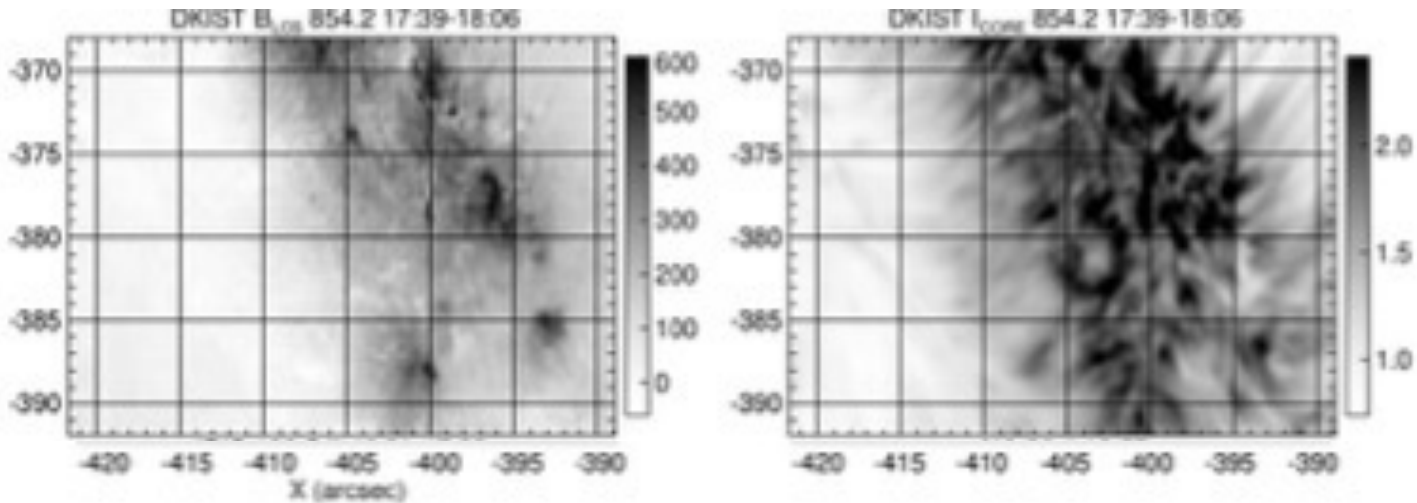
Zeeman effect DKIST wfa

DKIST

photosphere



chromosphere
(1-2 scale heights
beneath the corona)

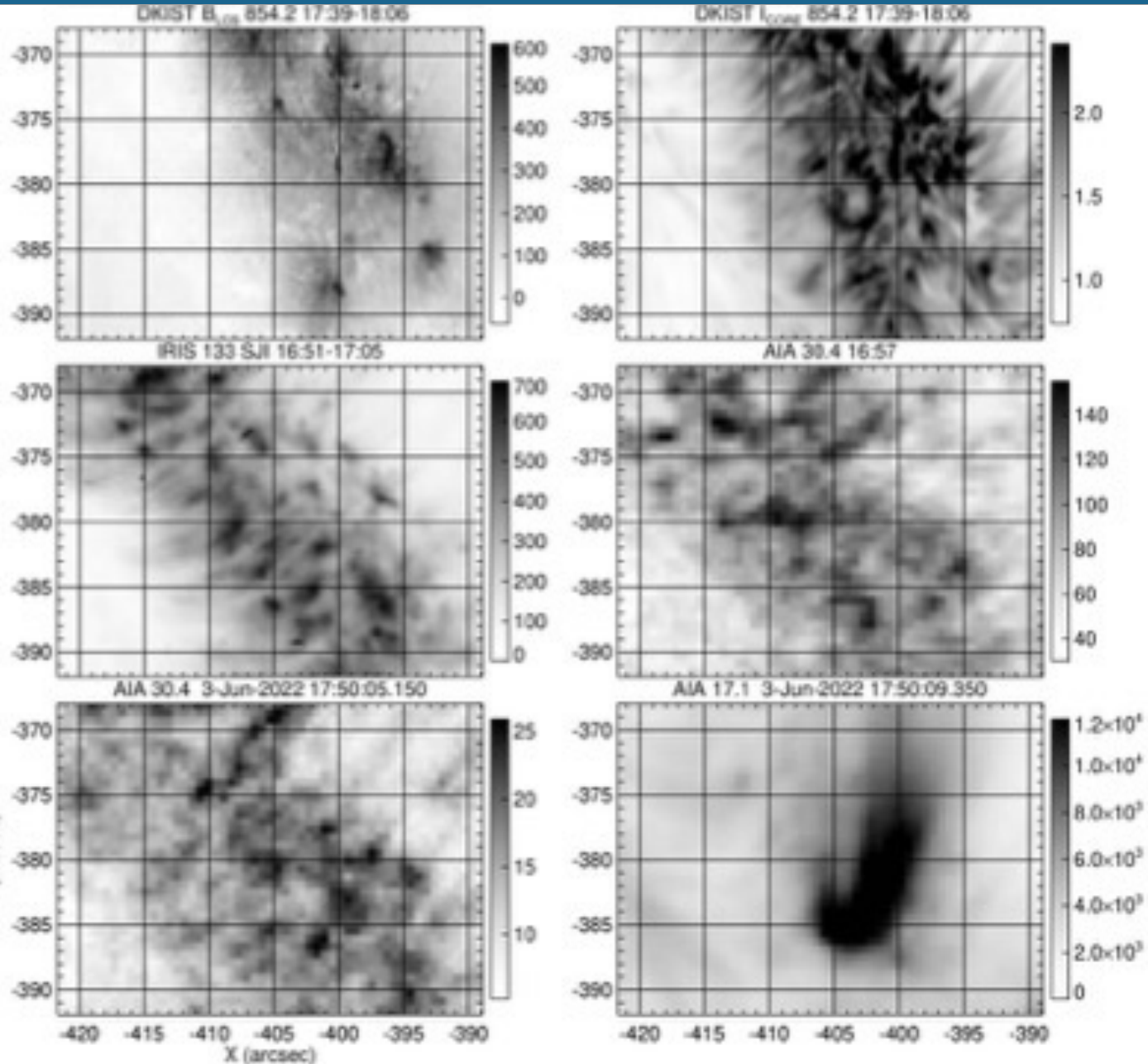


Magnetic energy and plasma

DKIST, IRIS, SDO

No relations of chromospheric \mathbf{B} to overlying plasmas.

consequences for plasma heating on the Sun and in astrophysics.



Magnetism energy injection and plasma

Poynting flux
up from chromosphere

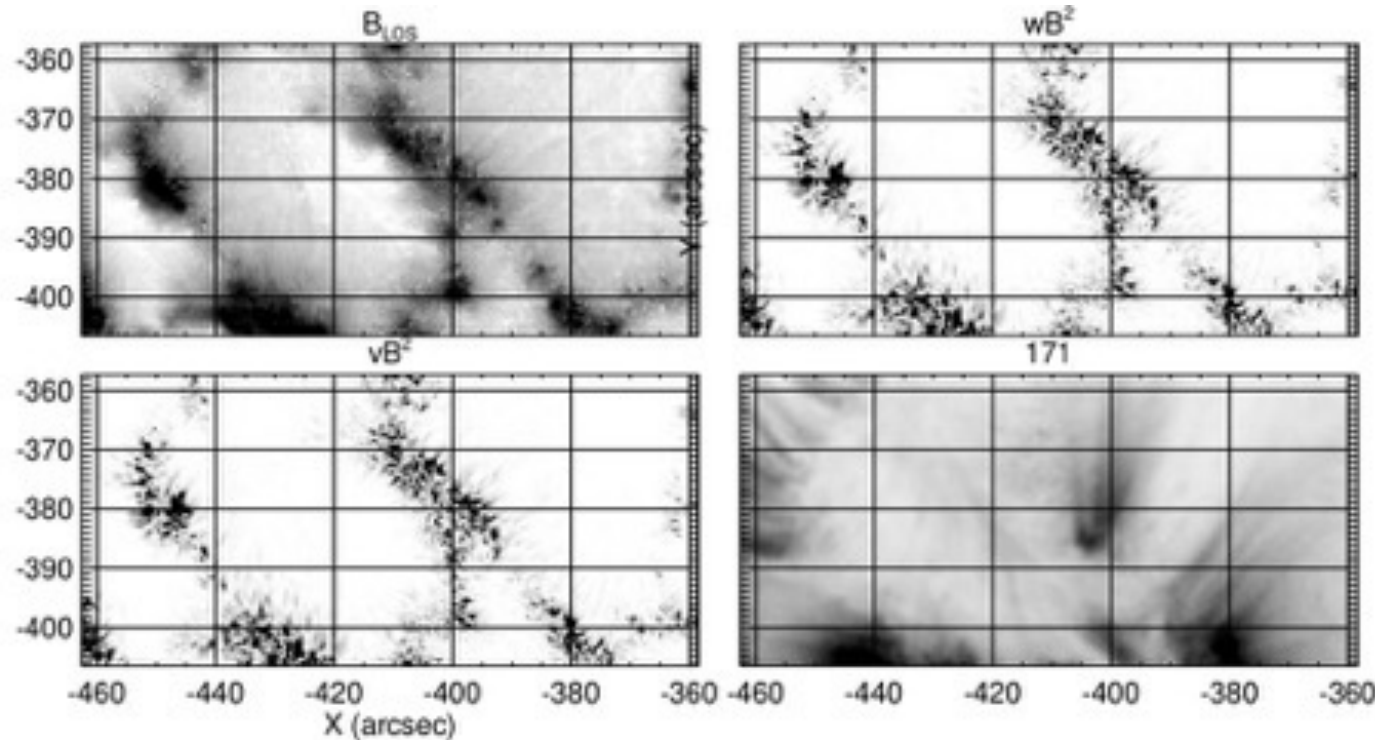
$$\mathbf{S} = \mathbf{E} \times \mathbf{B} / \mu_0$$

$$\sim v \mathbf{B}^2 / \mu_0$$

No relations of
chromospheric \mathbf{B} to
coronal plasmas.

Overwhelming
consequences
for plasma heating
on the Sun and in
astrophysics.

Back to the
drawing board



Magnetism energy injection and plasma

Poynting flux
up from chromosphere

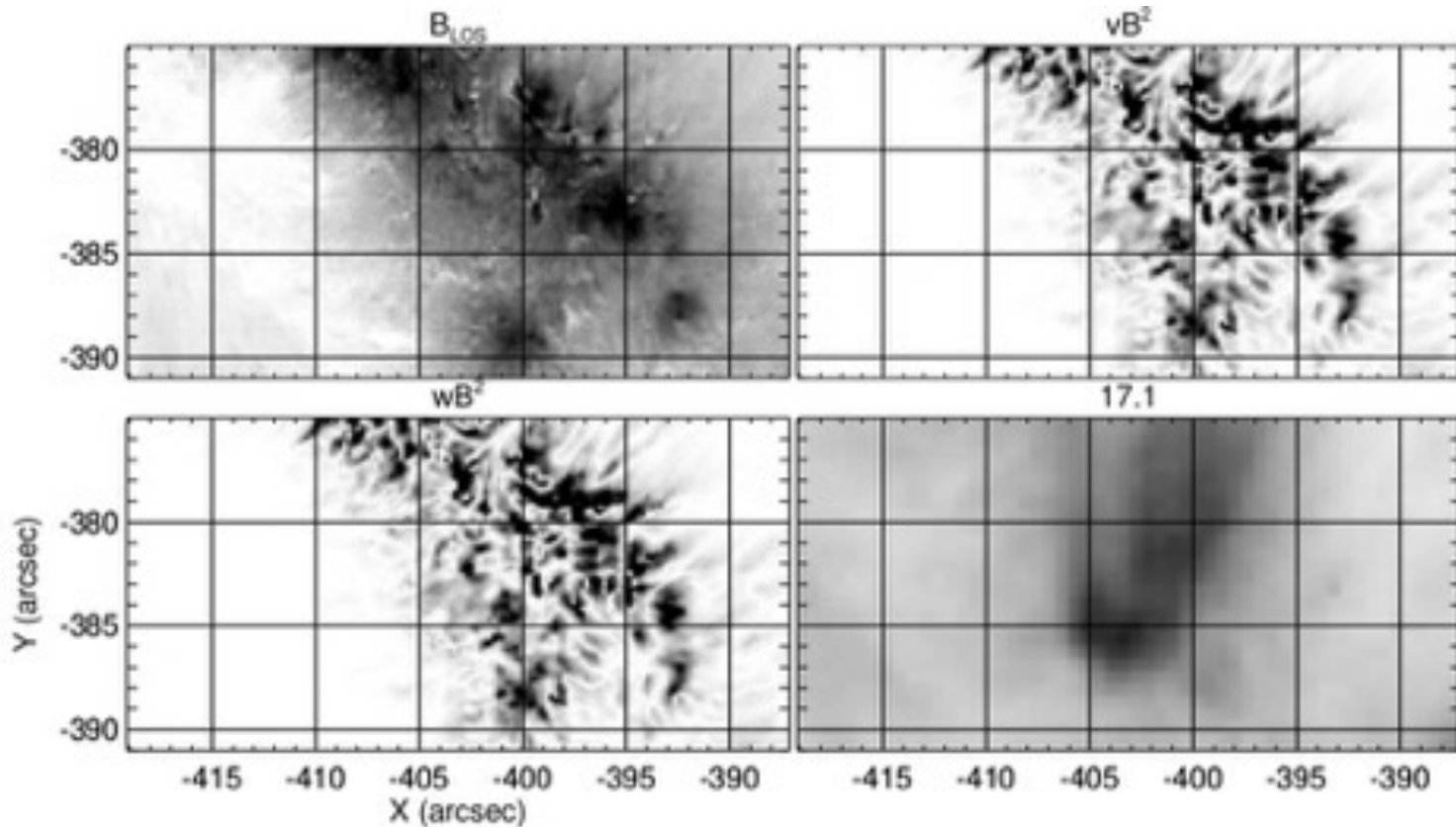
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Magnetism energy injection and plasma

Poynting flux
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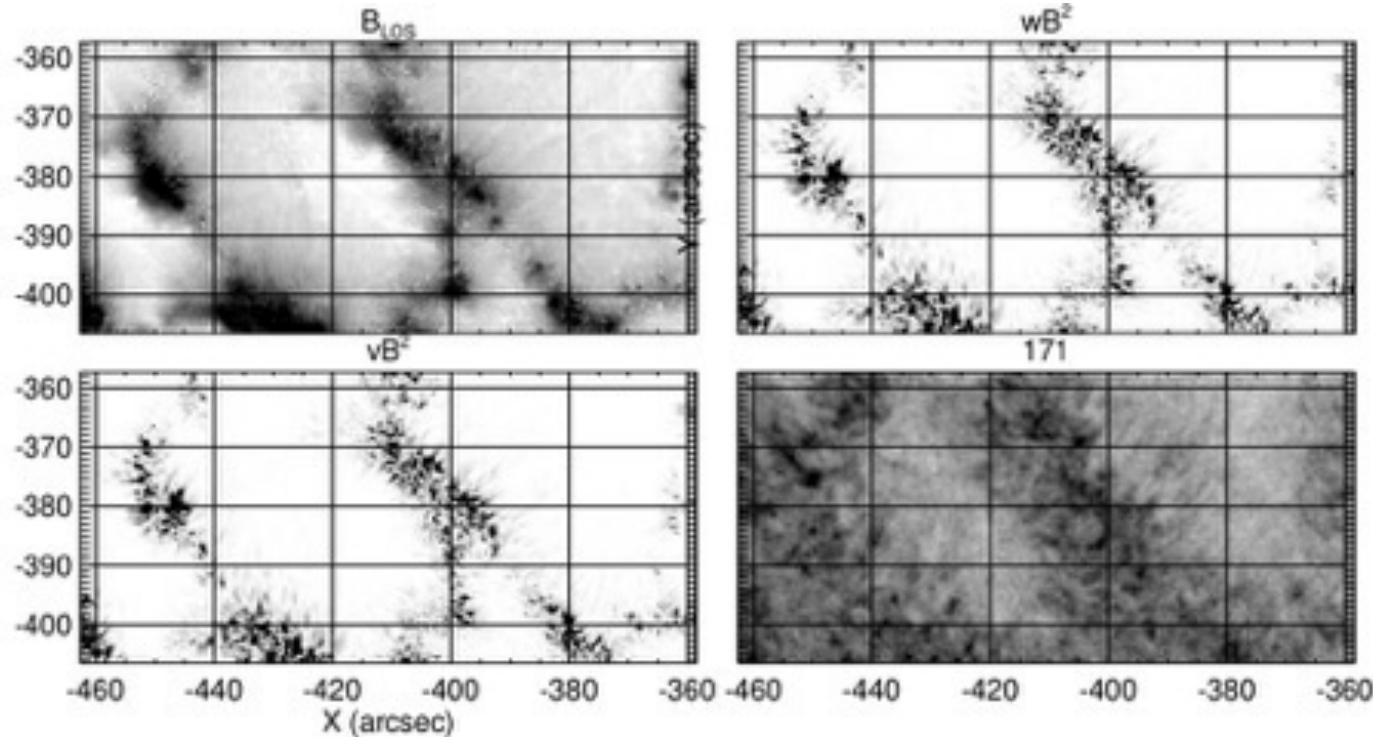
$$\sim v \mathbf{B}^2 / \mu_0$$

No relations of
chromospheric \mathbf{B} to
transition reg plasmas.

Overwhelming
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astrophysics.

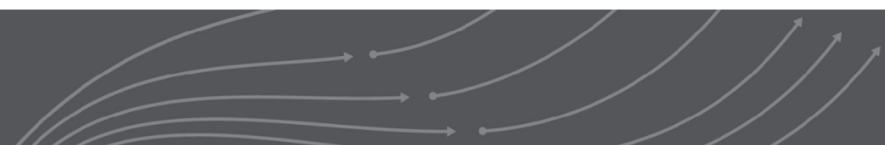
Back to the
drawing board

measured \mathbf{B} is only
a small part of the
story



Measured j_z also insufficient (chromosphere only,
Socas-Navarro 2005)

A reminder



More?

The Problem of Coronal Heating **A Rosetta Stone for Electrodynamic Coupling in Cosmic Plasmas**

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Under final review by Springer, May 2023

EXTRA SLIDES



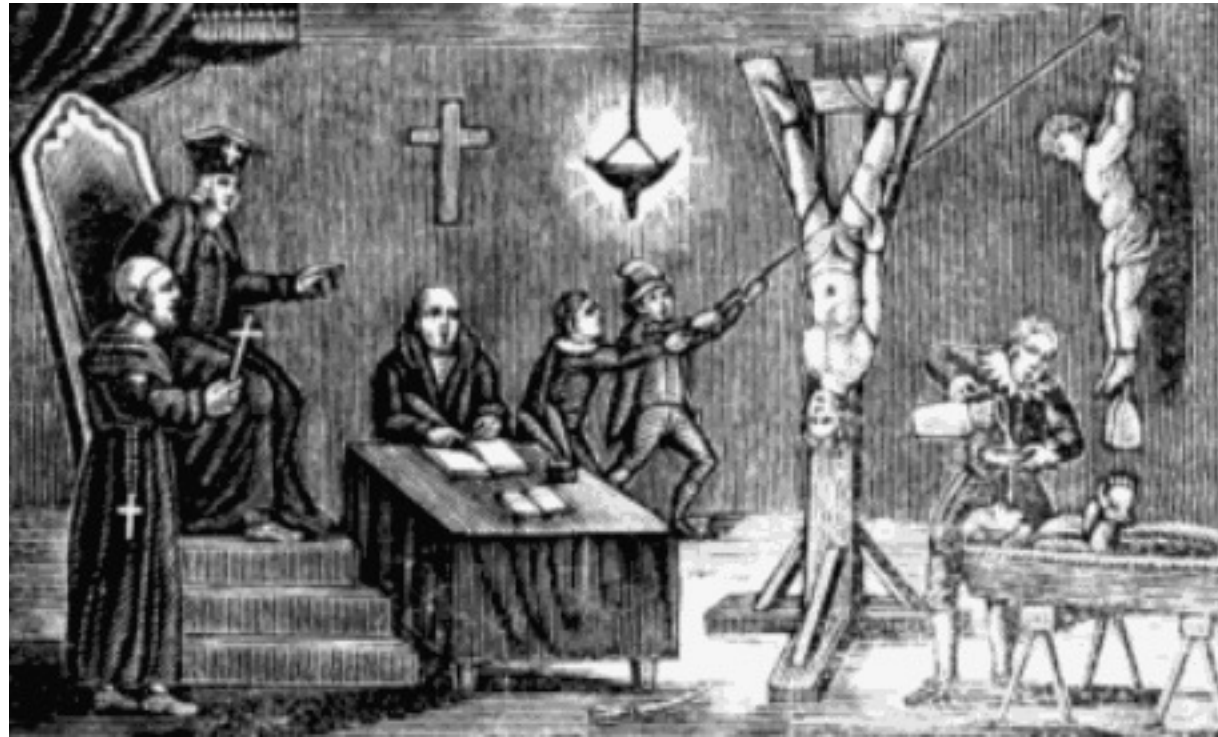
EXTRA SLIDES

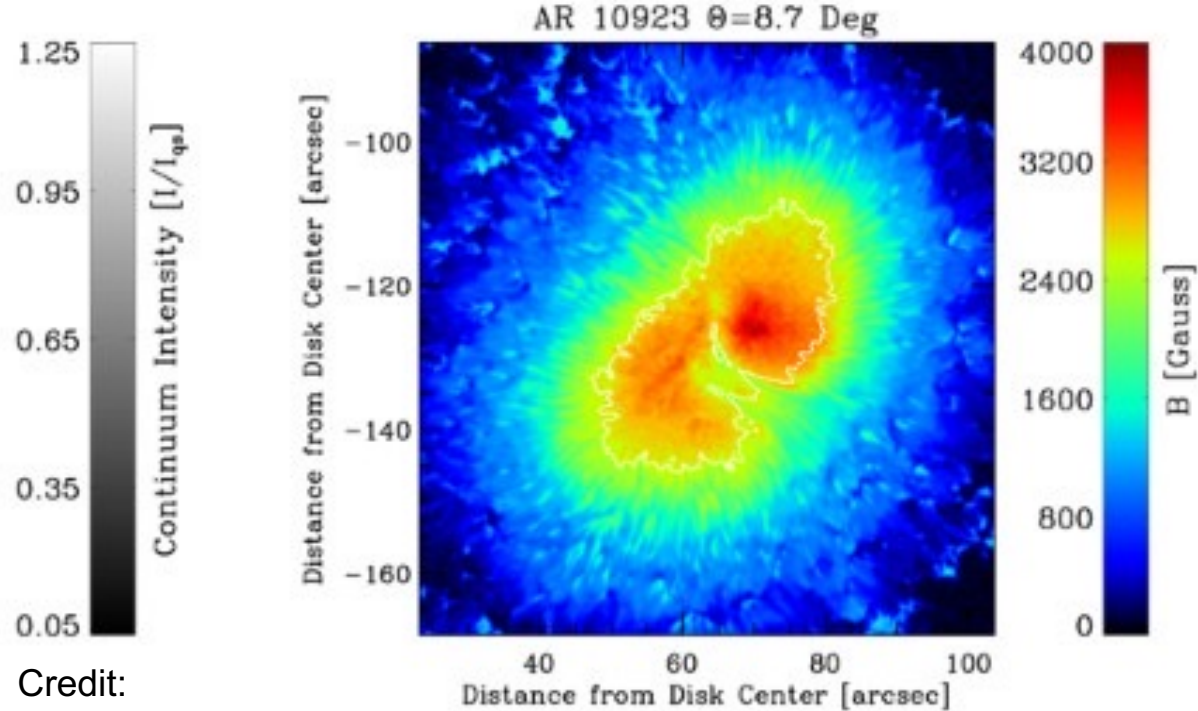
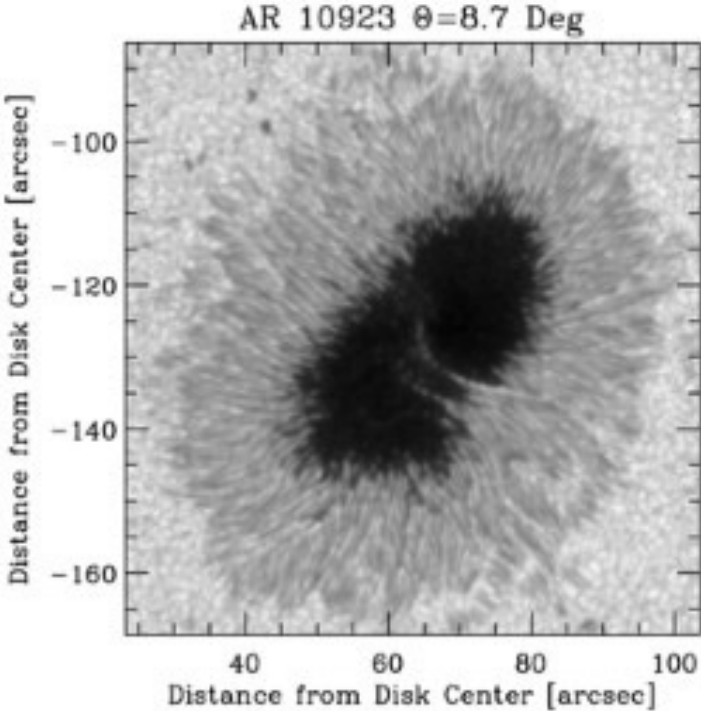


Preliminary conclusions of recent work in Bern

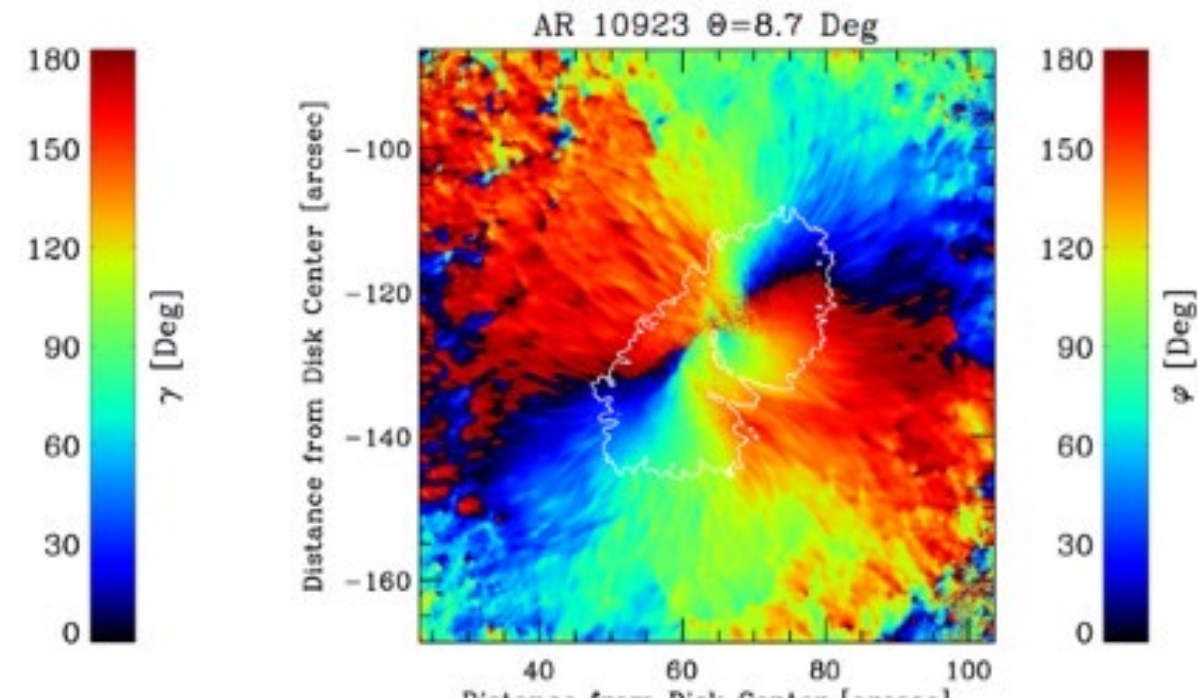
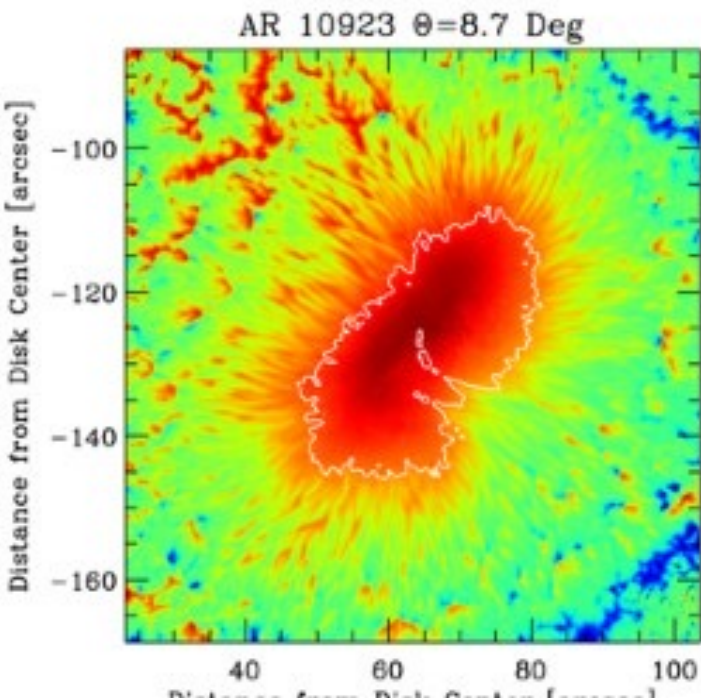
- Heating and B_0 appear independent
- Heating occurs in locally unipolar regions
- Mixed polarity fields have little to do with heating

All of these conclusions are **HERETICAL** !





Credit:
Borrero+Ichimoto 2011



DKIST 2022-

