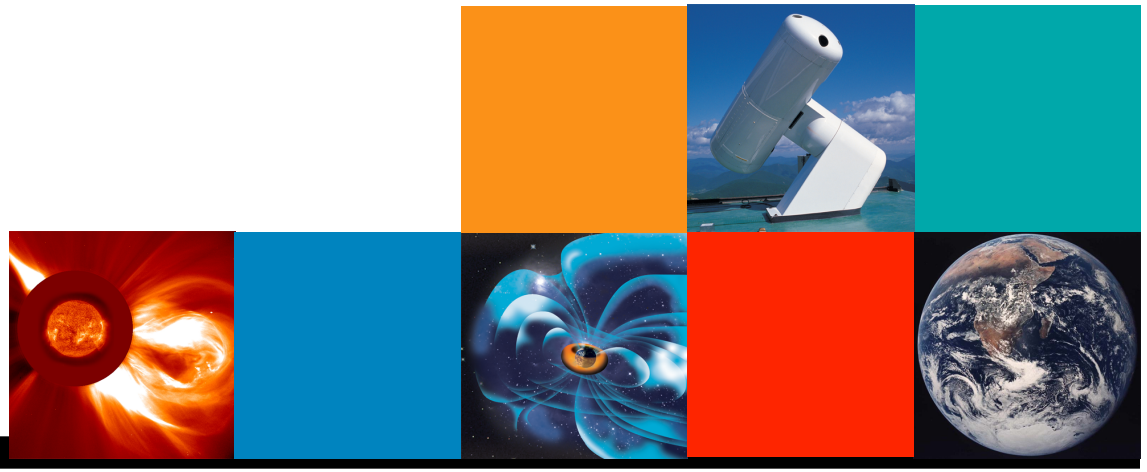
The 3rd Asia-Pacific Solar Physics Meeting
APSPM 2015
3~6 November, 2015
Seoul National University, Seoul, Rep. of Korea



KASI 한국천문연구원
Korea Astronomy & Space Science Institute

Motion of Plasma in Pores and their atmosph eres

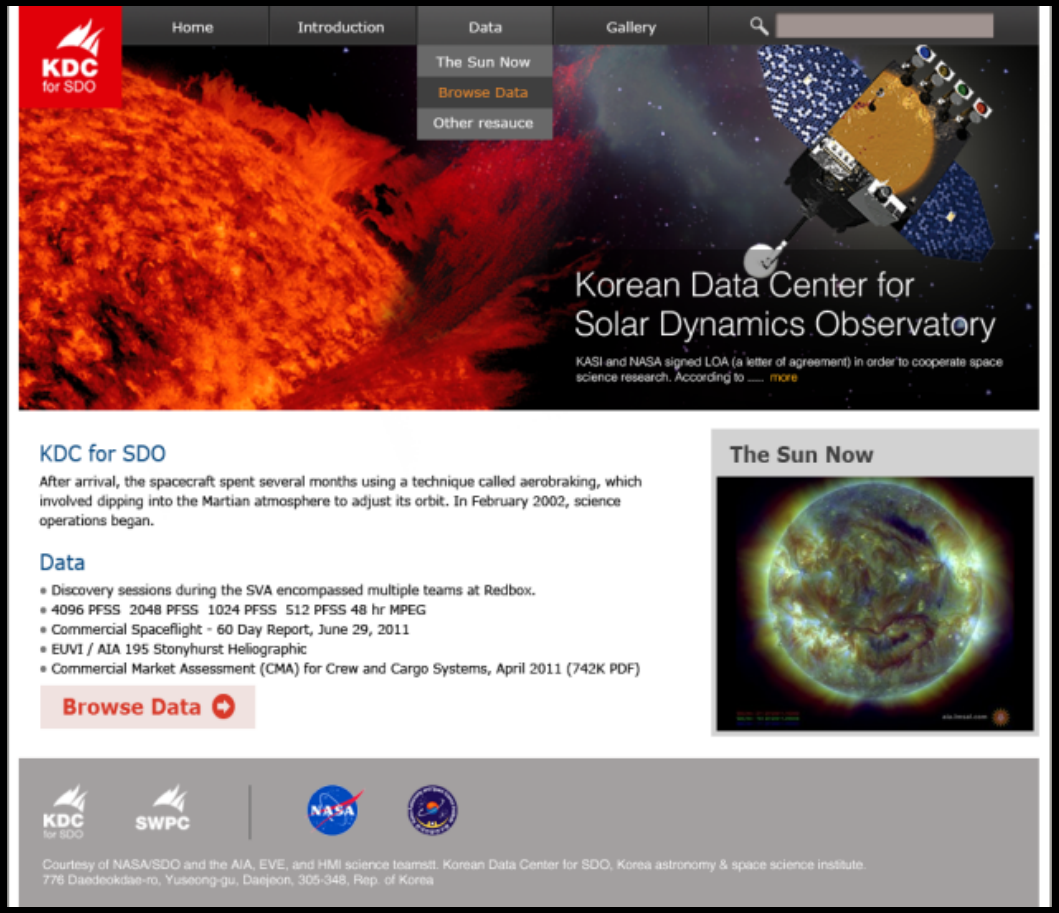
Kyung-Suk Cho (趙京錫)

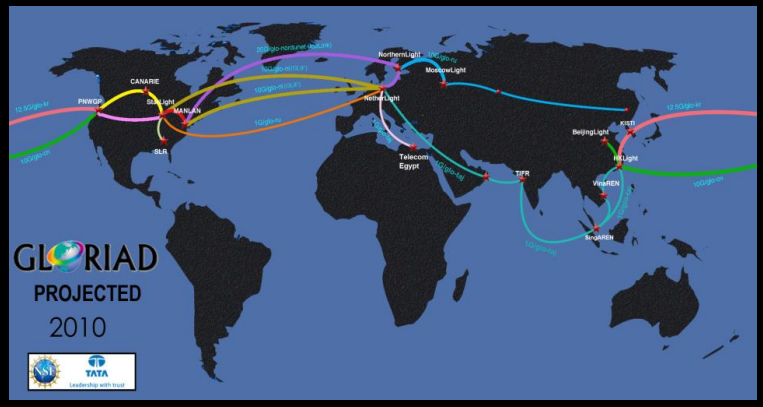
Collaboration with S.-C. Bong , E.-K. Lim, I.-H. Cho, Y.-H. Kim, Y.-D. Park, (KASI), H.-S. Yang, H.-M. Park and J.C. Chae (SNU)♪

Content

(1) Statistical comparison between Pores & sunspots by using SDO/HMI (PC-02)

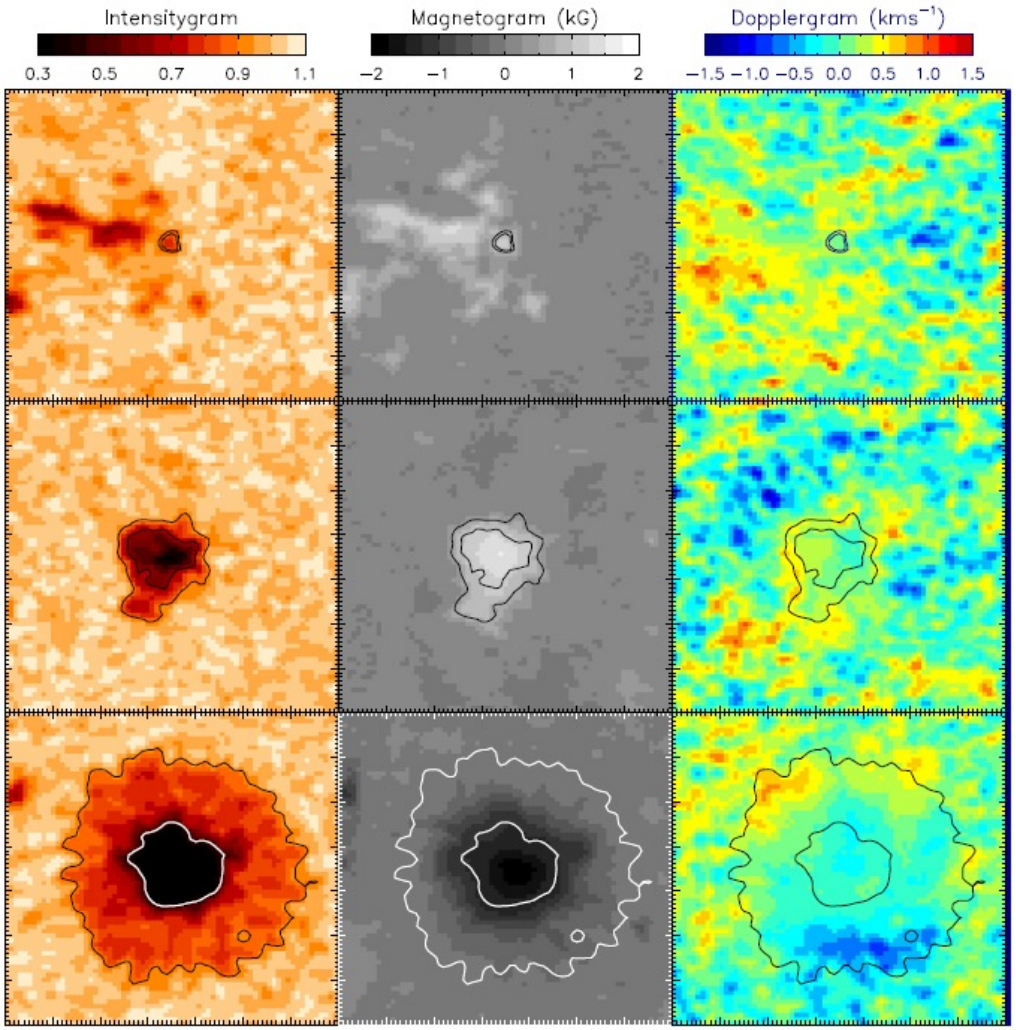
KASI SDO Data Center (http://sdo.kasi.re.kr)





2010. 5 ~ 2015. 5, 2.5PB (1.5TB/day)
SDO/AIA, SDO/HMI)

Data Set (2010. 5 – 2015.2)



24,214 datasets of

$\mathbf{I_{inner}}$ $\mathbf{A_{inner}}$ $\mathbf{B_{inner}}$ $\mathbf{V_{inner}}$

A_{outer} > 2 MSH: 9881

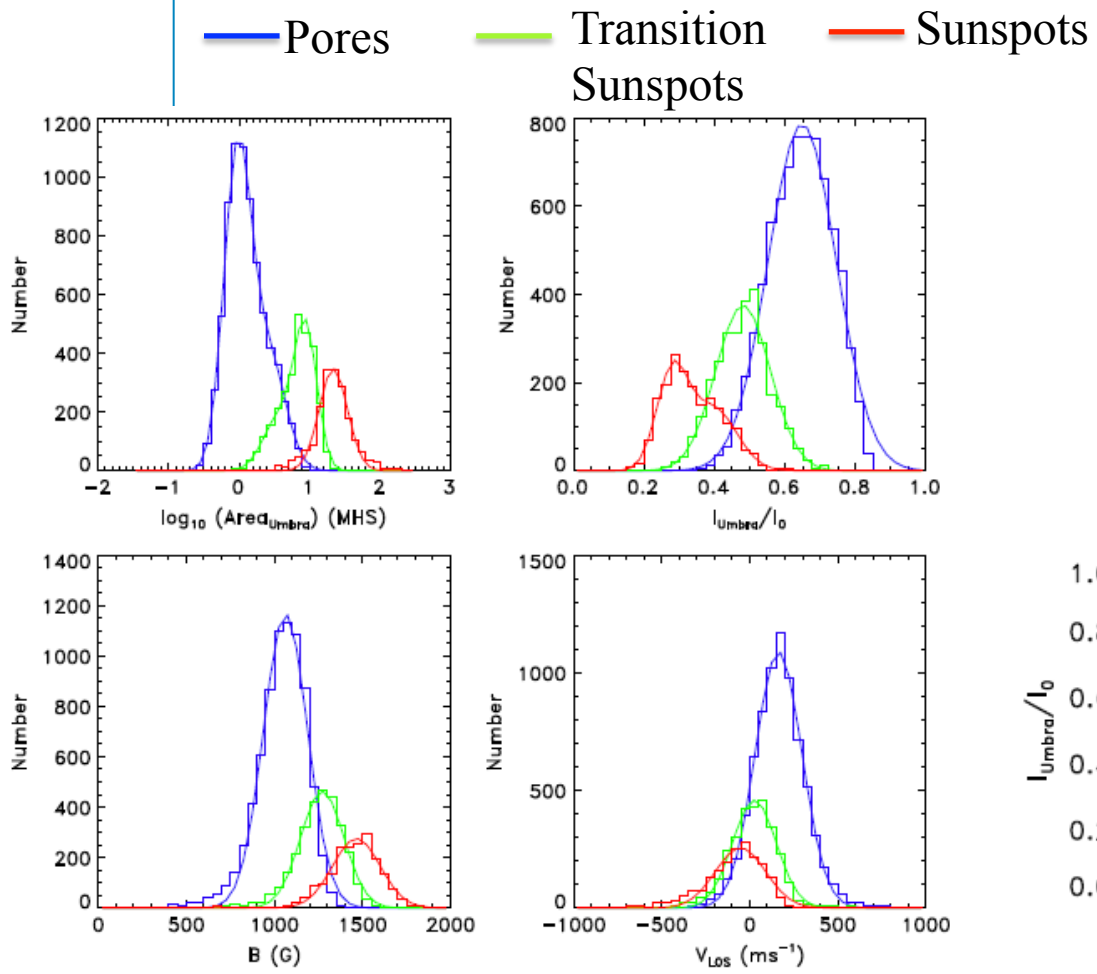
Pores: 7464

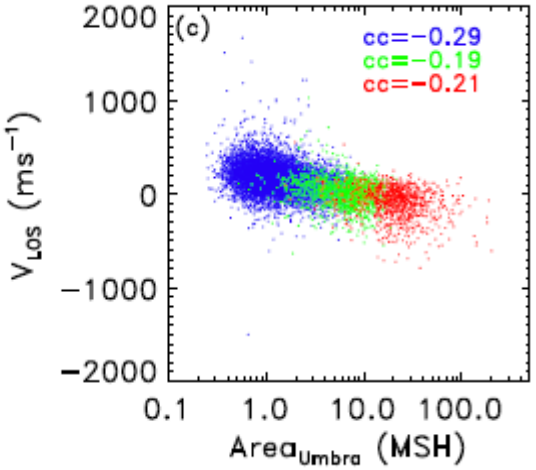
Sunspots: 2417

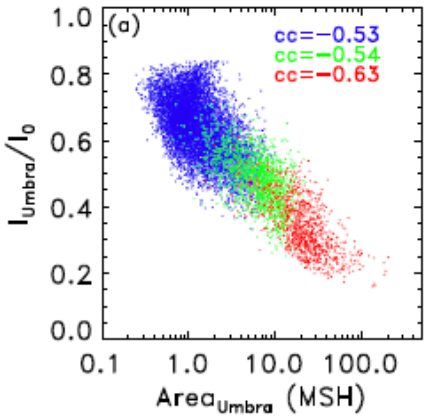
MSH: **M**illionth of the **S**olar **H**emisphere

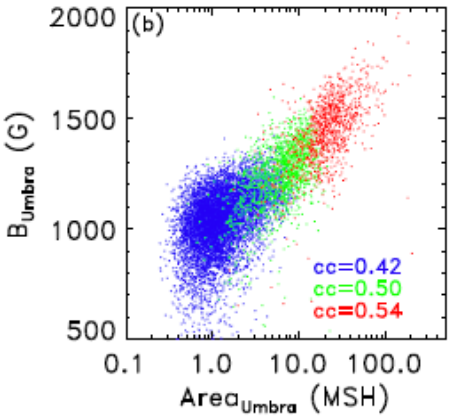
(Cho et al. 2015)

Results







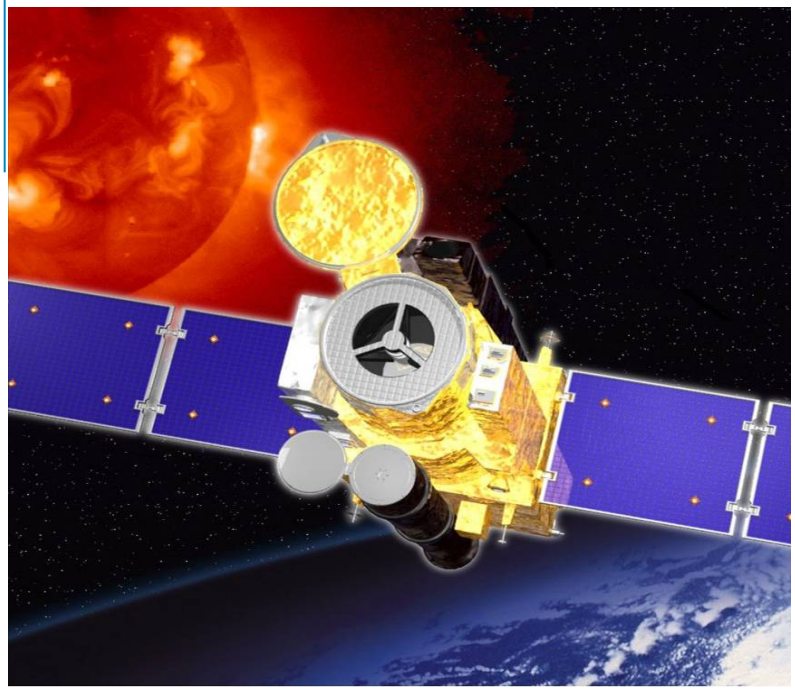


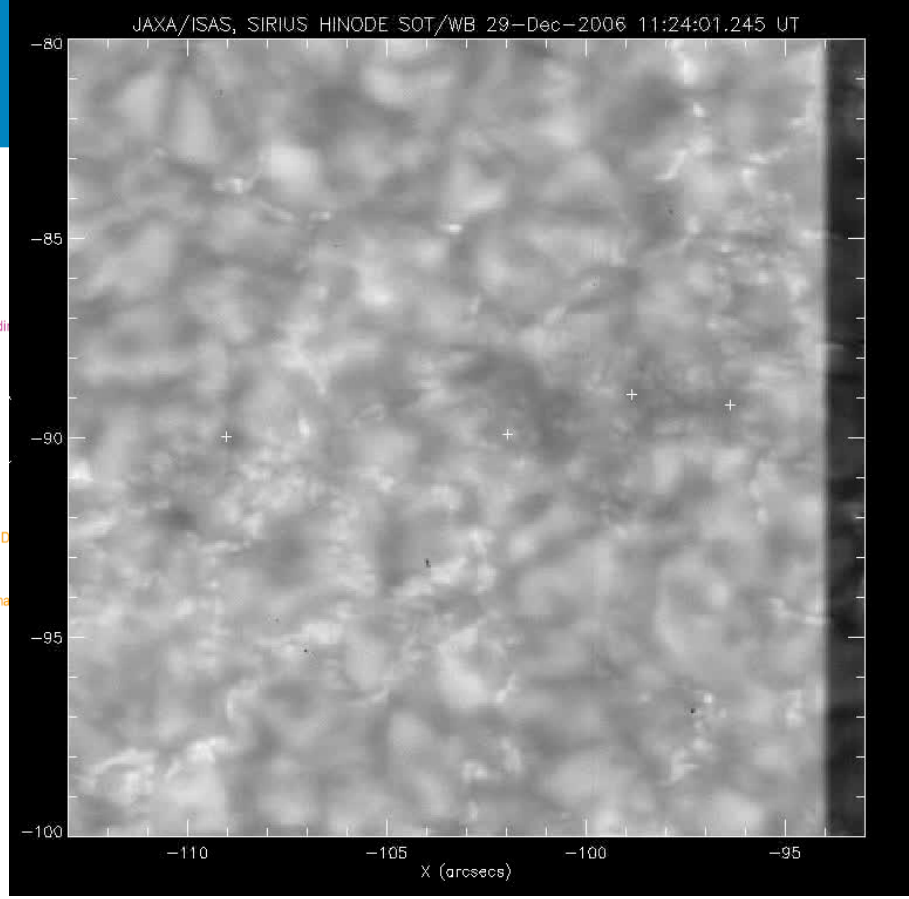
Bimodal distributions of I, B, Vlos

Pores: red-shifted
Sunspots: blue-shifted

(2) Photosphere Observation using HINODE/SOT (Cho et al. 2010)

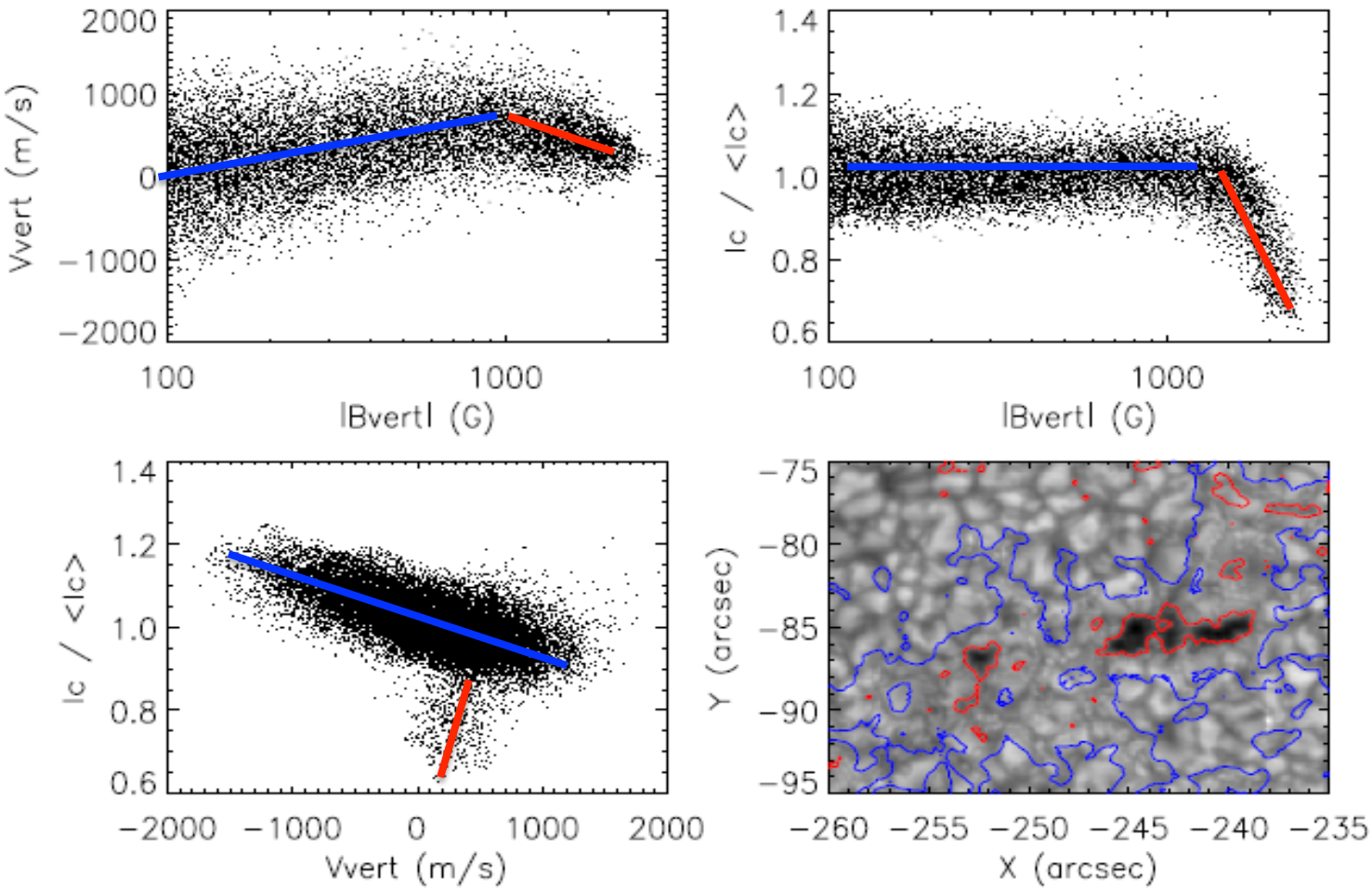
Hinode/SOT





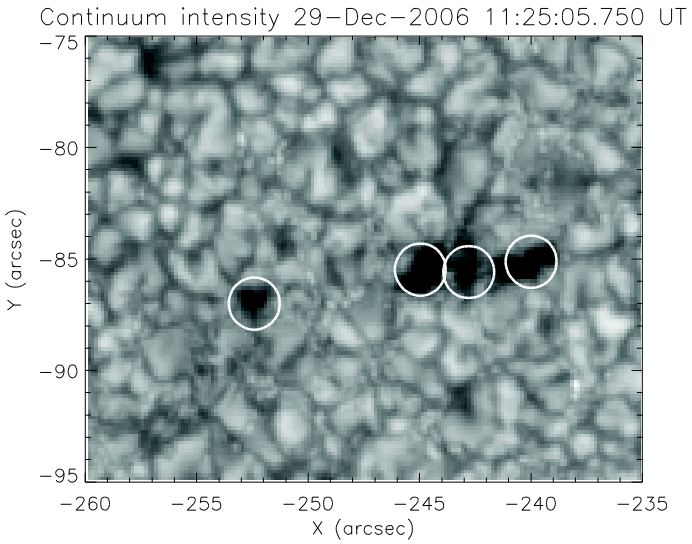
- **Optical Telescope Assembly (OTA)**
  - **Optics type: Gregorian with heat dump mirror**
  - **Primary mirror: 50 cm, Diffraction limit: 0.2” – 0.3”**
- **Focal Plane Package (FPP)**
  - **Broadband Filter Imager(BFI)**
  - **Spectropolarimeter(SP)**

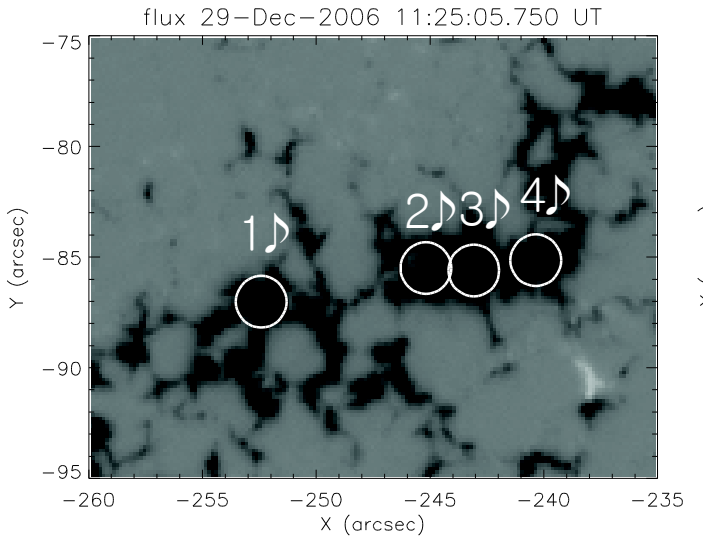
Characteristics of Pores

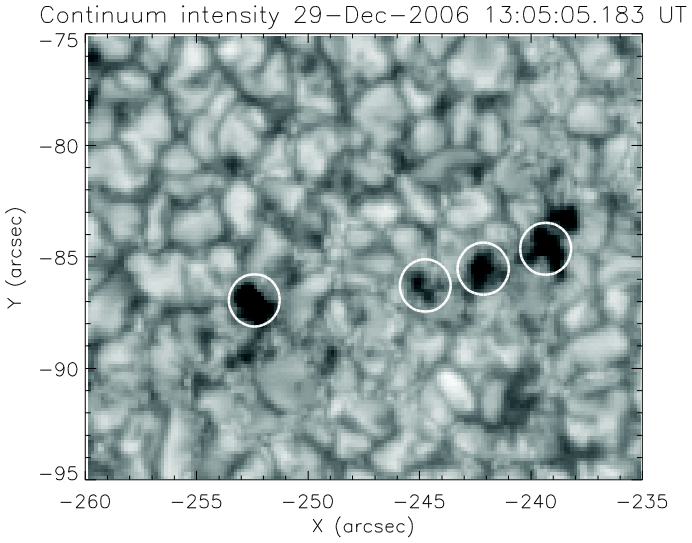


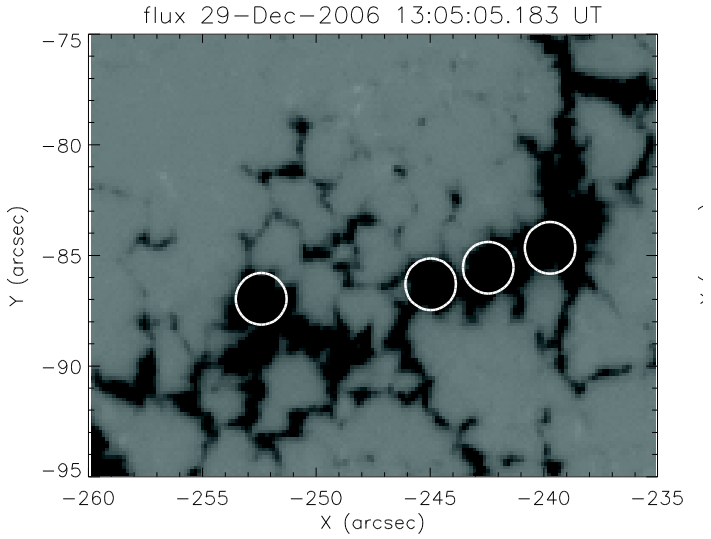
- Doppler velocity is negatively correlated with field strength.♪
- Darkness of the pores increases with their field strength.♪
- Pores have strong magnetic field and downward motions.♪

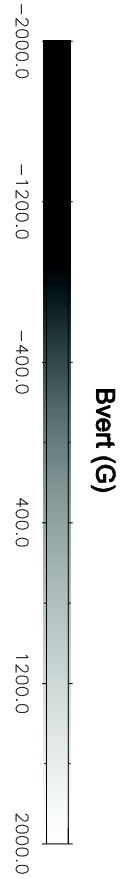
Stokes I & LOS magnetic flux density♪



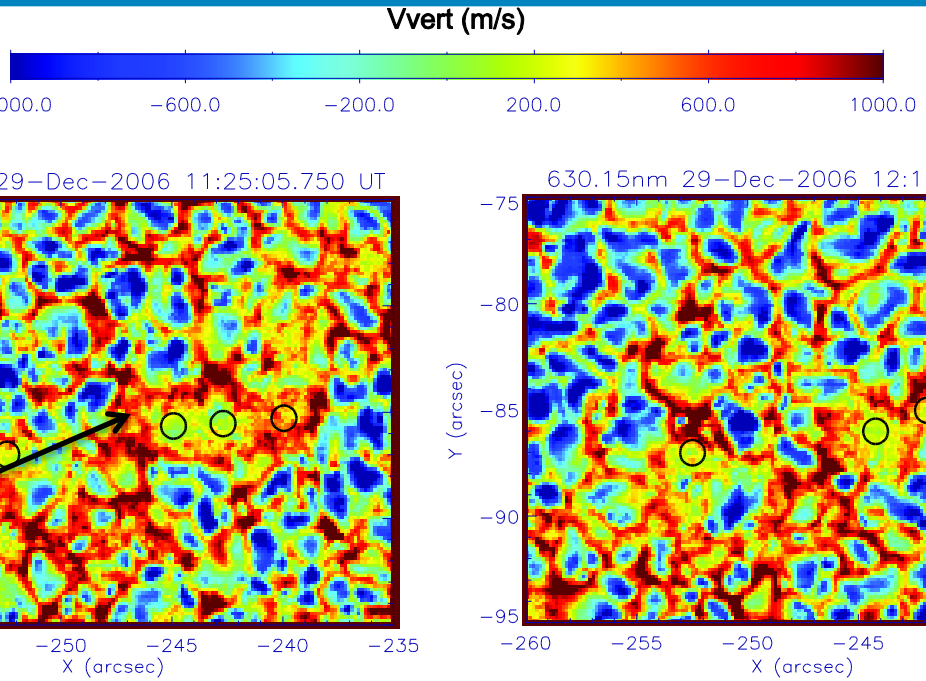








Doppler velocity map♪

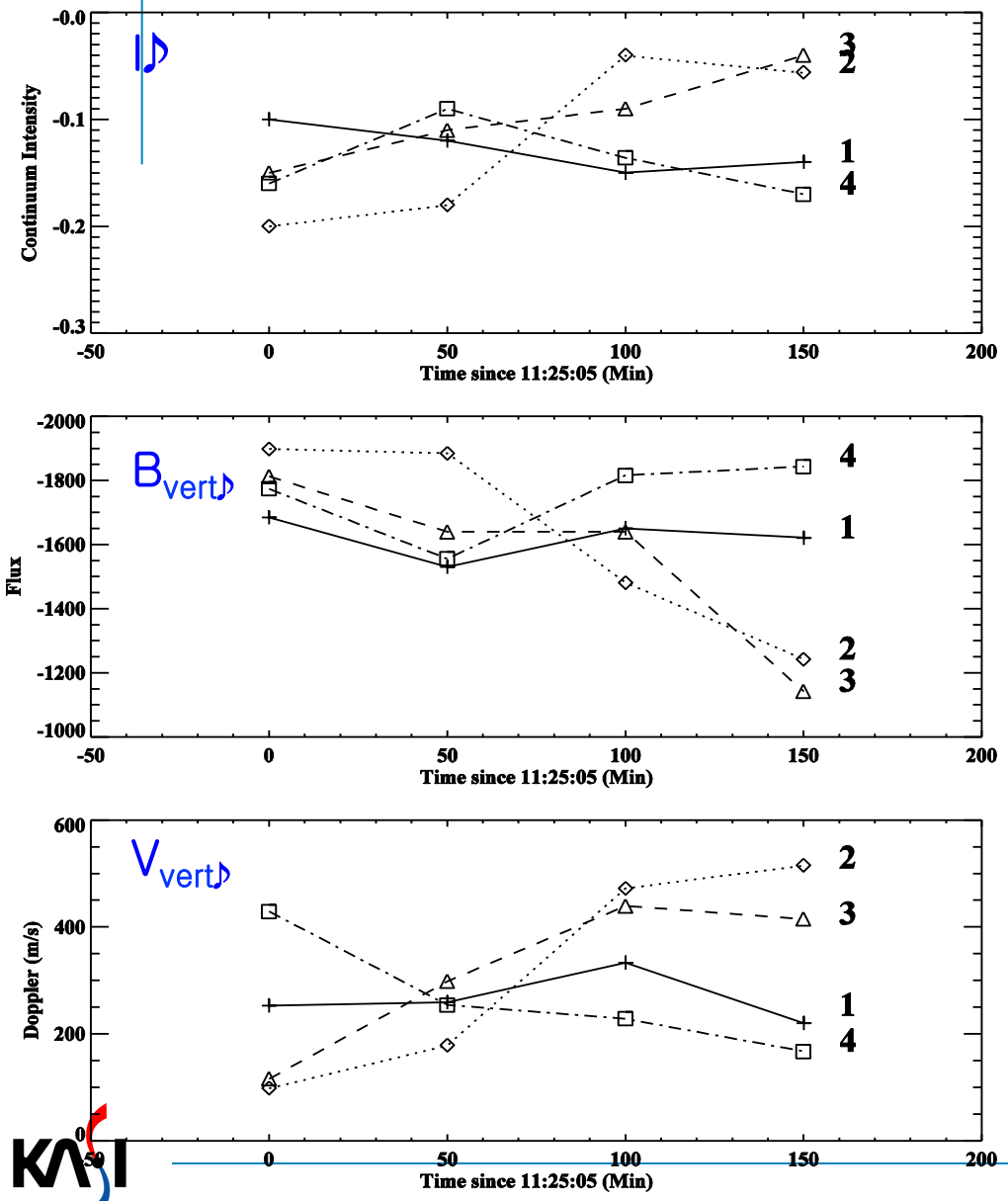


Convection ♪ motion♪

Strong ♪ downflow ♪ channels ♪

Weak ♪ Down−flow♪ Motion ♪

Temporal variation of the Pores

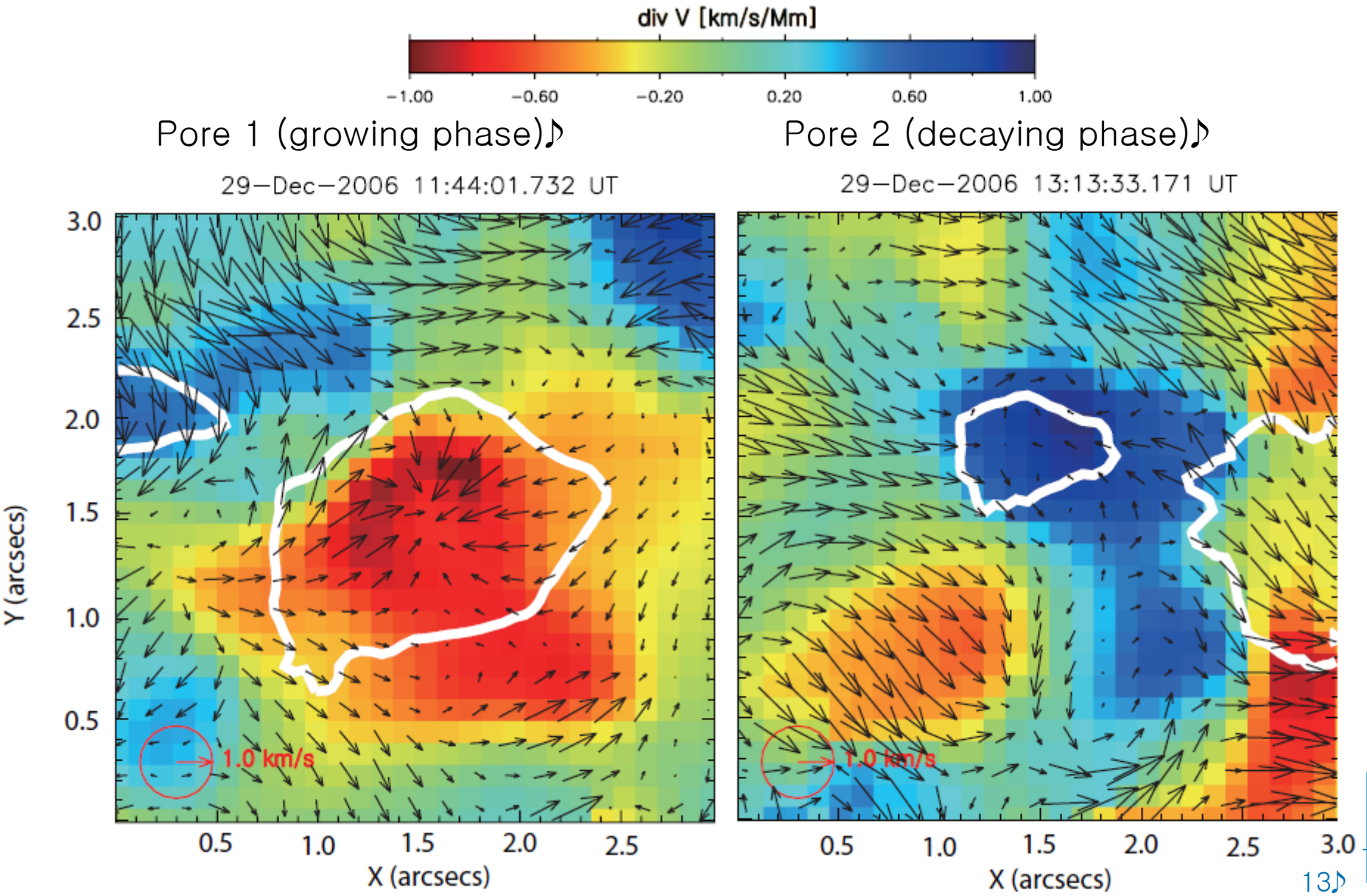


- Pores 1 and 4 are getting darker and bigger whereas pores 2 and 3 are decaying as time goes.

- Field strengths of the decaying pores (2, 3) are decreasing while those of growing pores (1, 4) are increasing or maintaining.

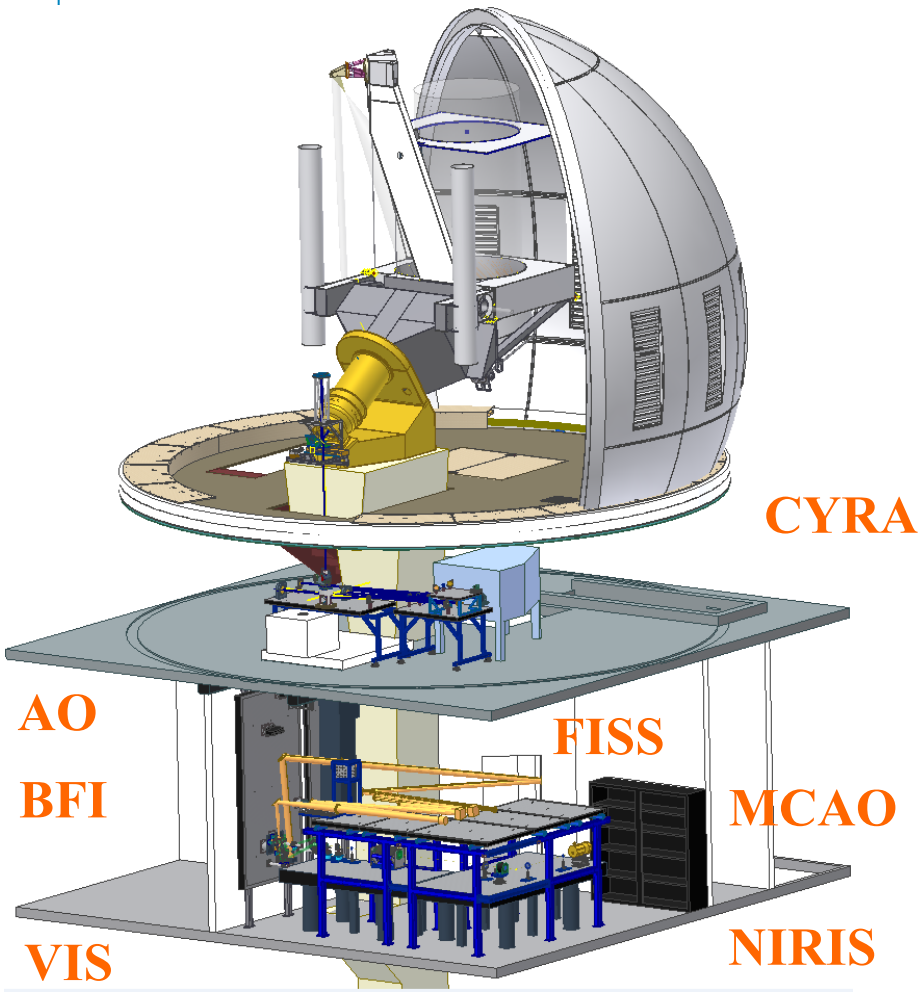
- Downward motion becomes faster in case of the decaying pores (2, 3)♪

Flows around pores

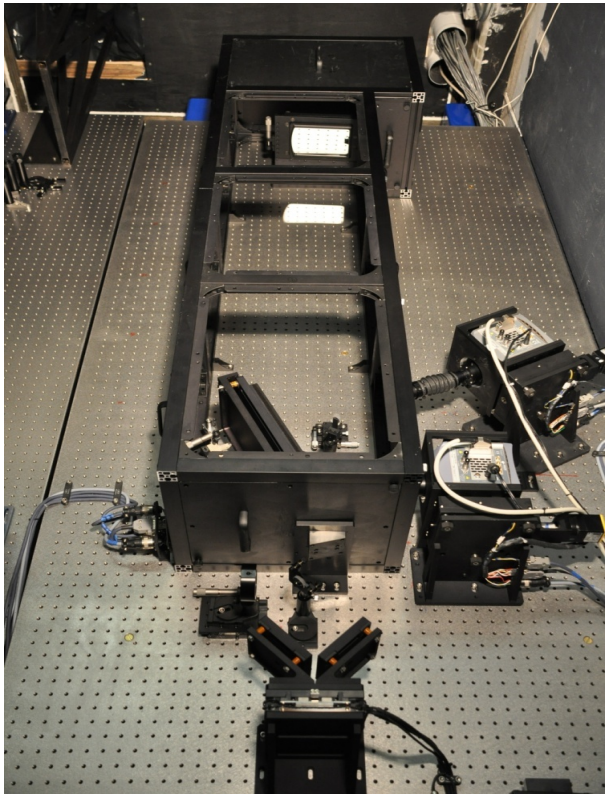


(3) Upper Photosphere Observation using NST/ FISS (Cho et al. 2013)

NST/FISS @ BBSO

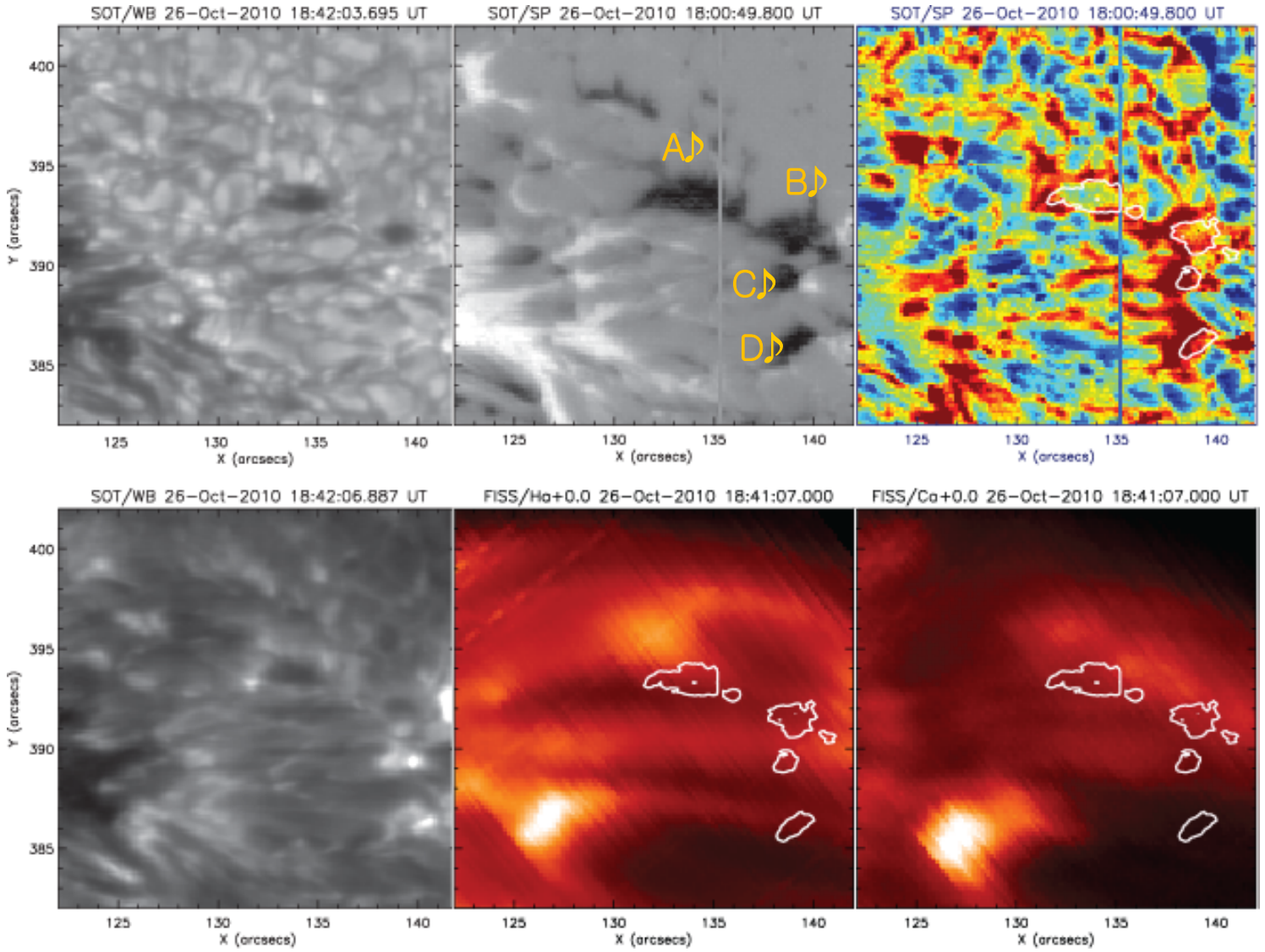


Fast Imaging Solar Spectrograph (FISS)♪



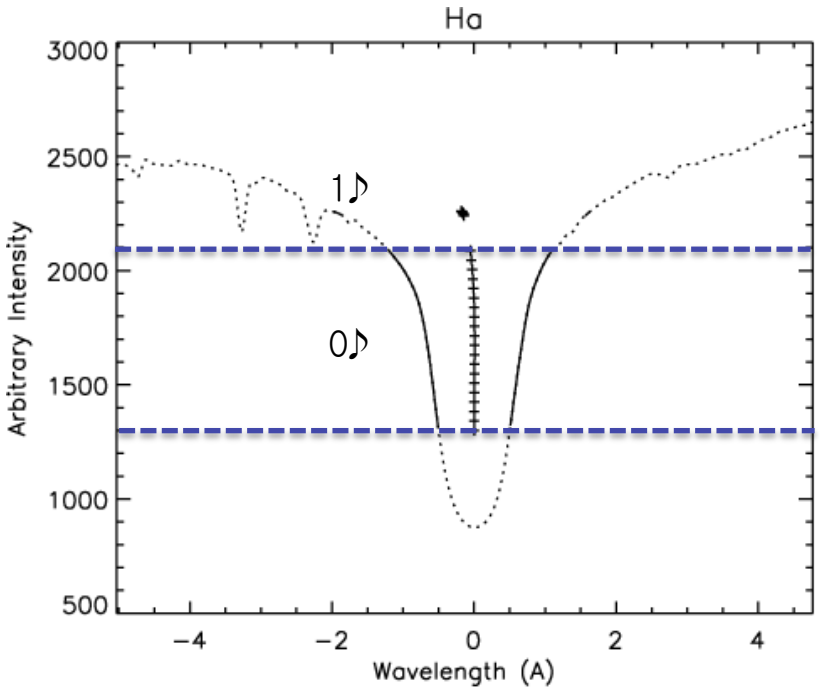
FISS is a unique system that can do imaging of H-alpha and Ca II 8542 band simultaneously, which is quite suitable for st udying of dynamics of chromosphere.

Hinode & FISS Observation♪



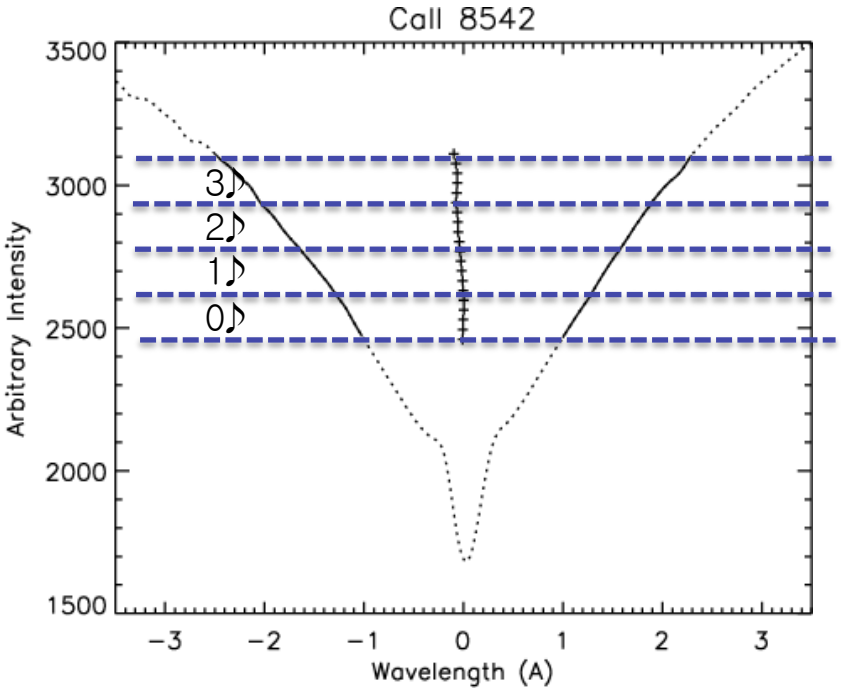
Telluric line remove & apply Bisector method♪

Hα♪
(6562.817 Å)♪



[±1.9 Å] & [−1.2 ~ 0.5 Å] ♪

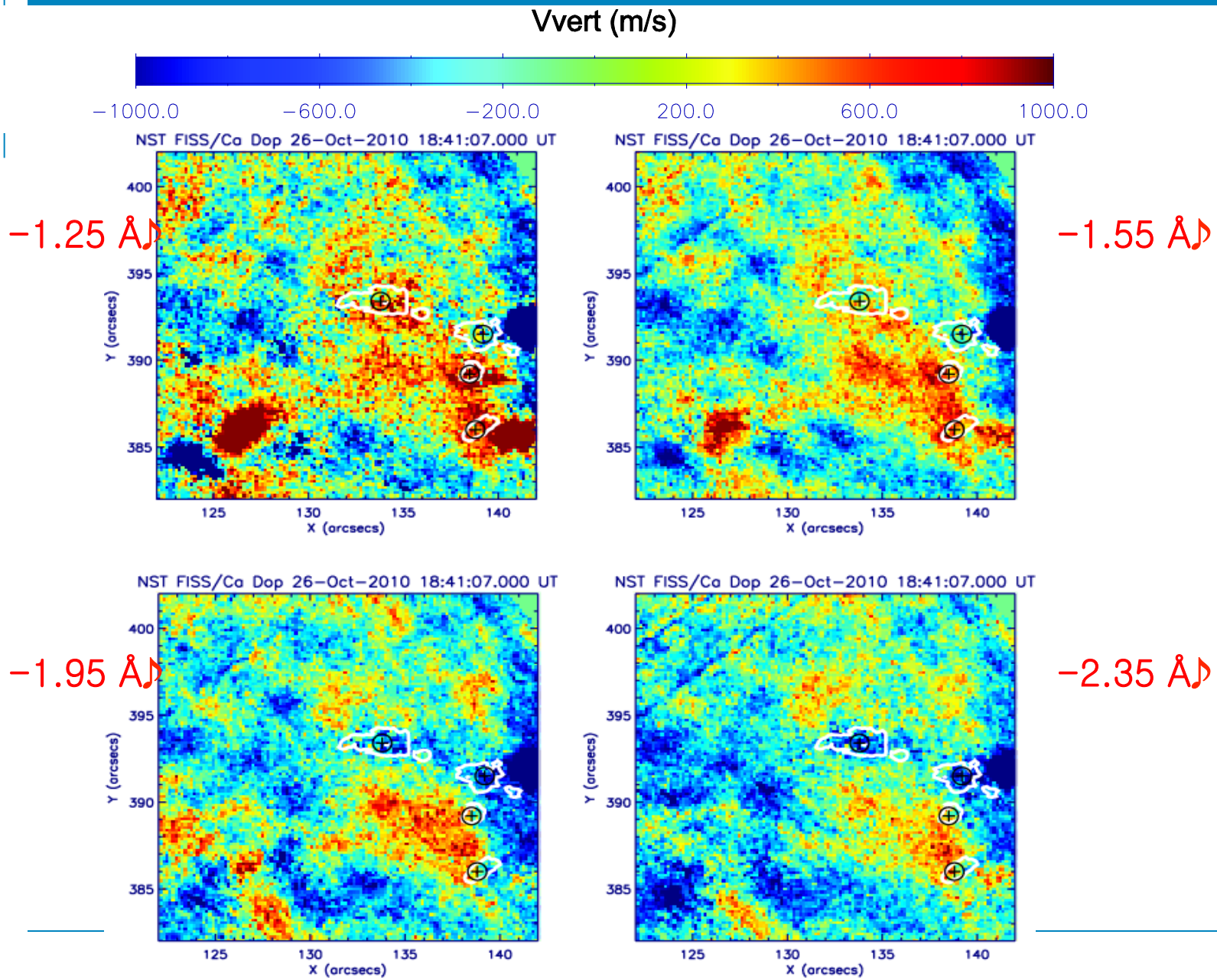
CaII ♪
(8542.206 Å)♪



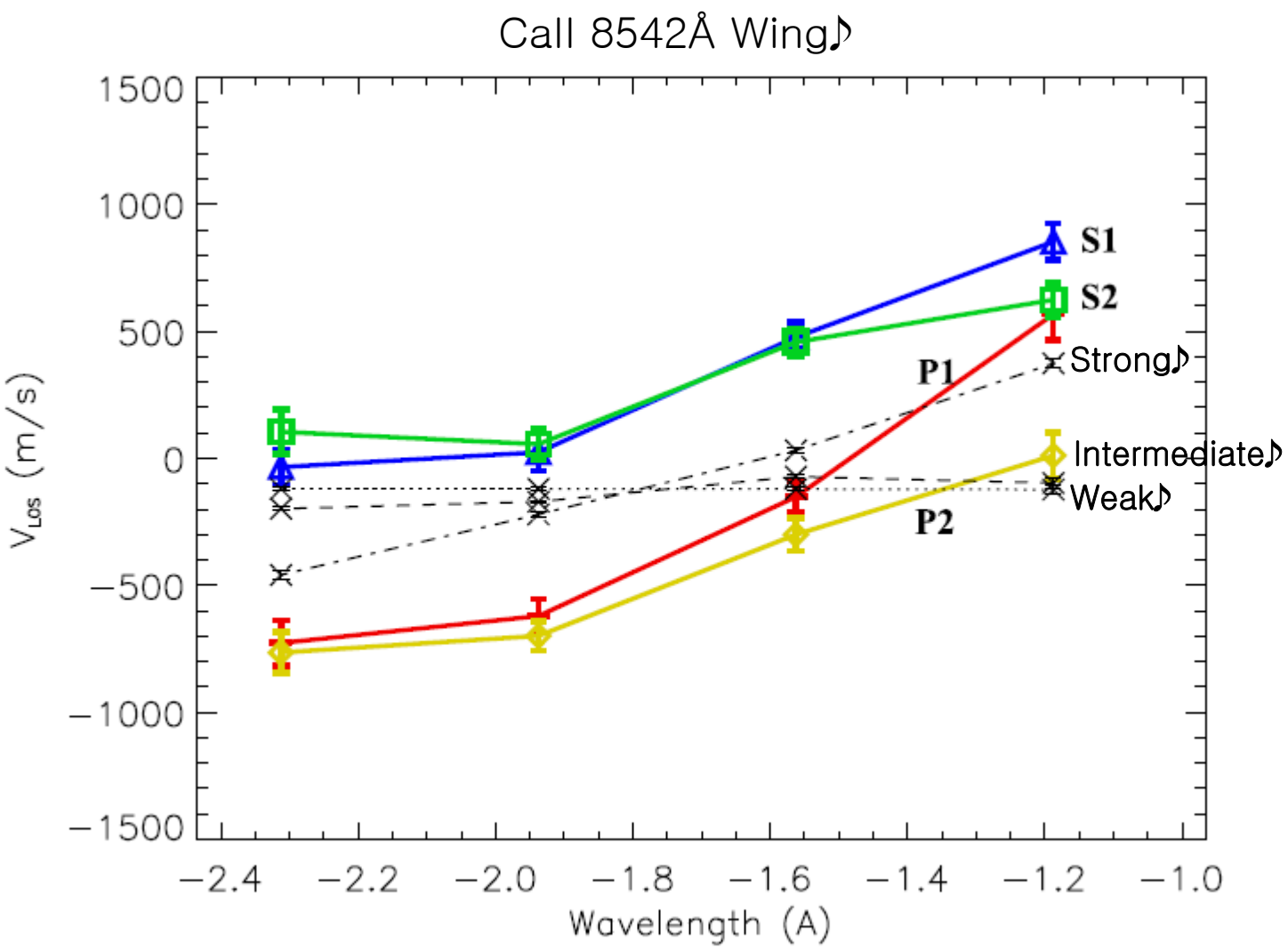
[−2.5 ~ −1.0 Å] ♪

The Hα line is formed either in chromospheric fibrils or in deep photosphere whereas the CaII 8542 Å samples the layers in between the fibrils and the photosphere (Cauzzi et al., 2008, 2009).♪

Line-of-sight Velocities♪

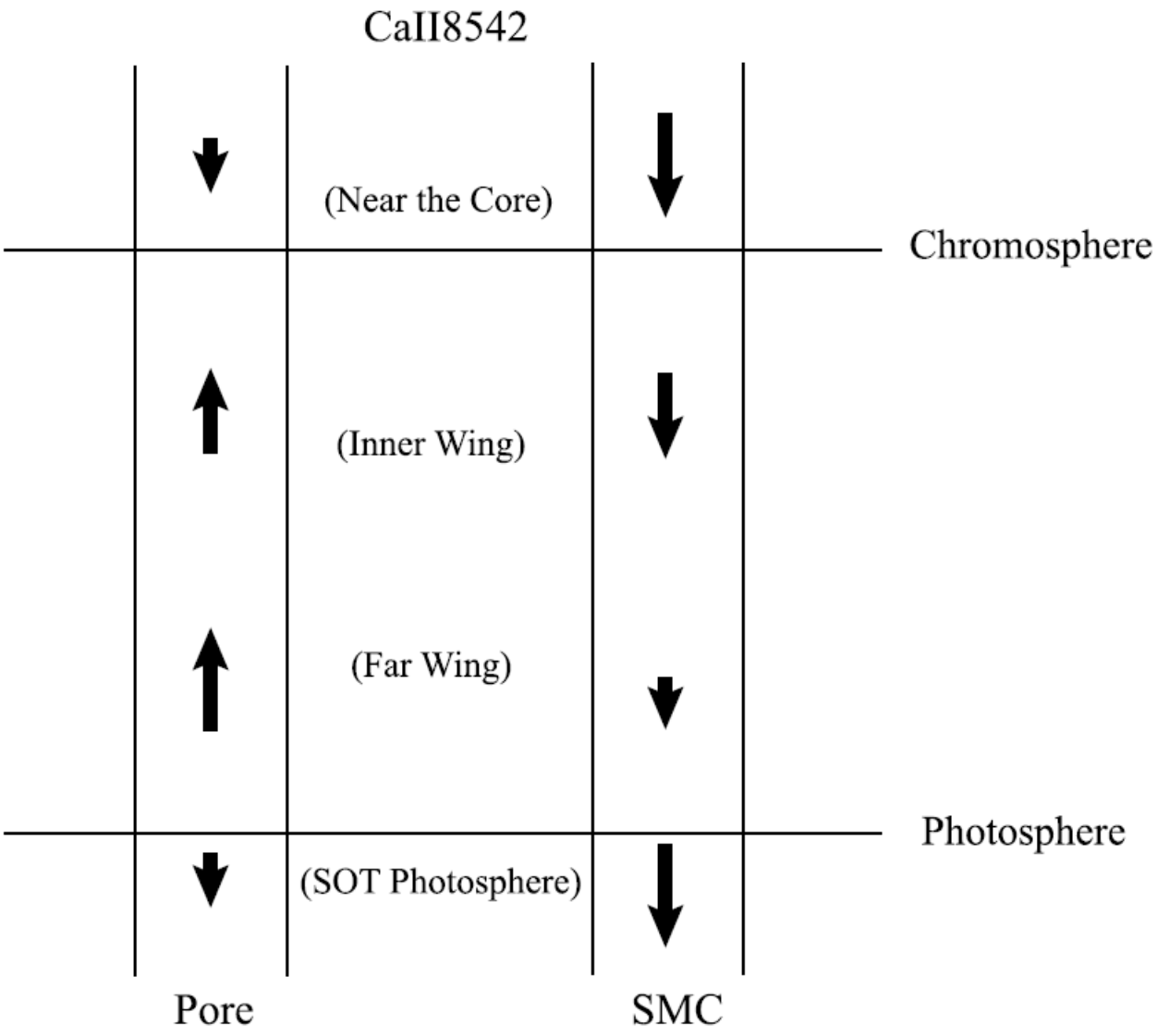


Variation of V_{LOS} in pores at various wavelength♪



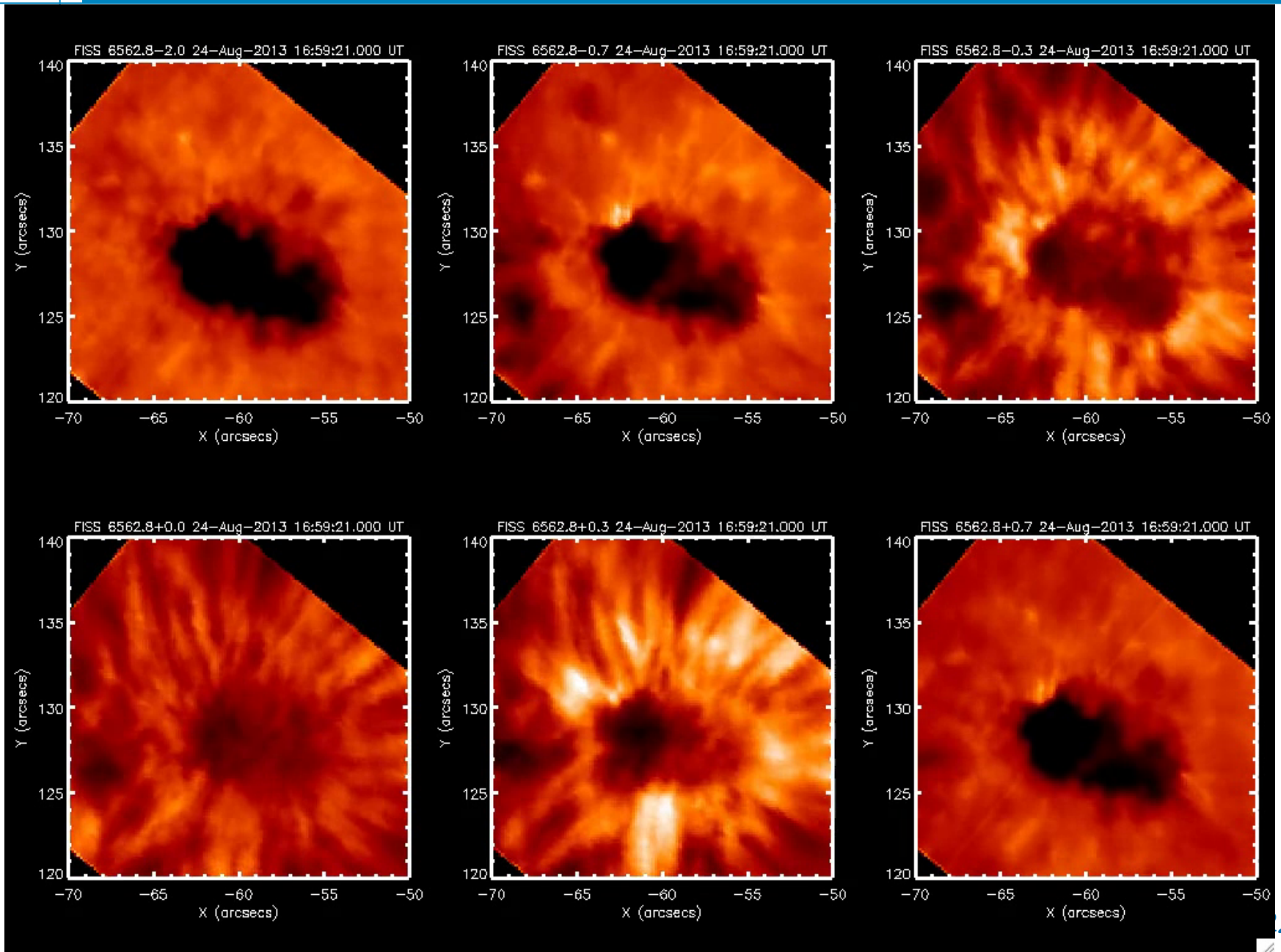
Uncertainty in the mean velocity was estimated from the velocity fluct uation inside the averaged region.♪

Vertical motion of plasma in the pore♪

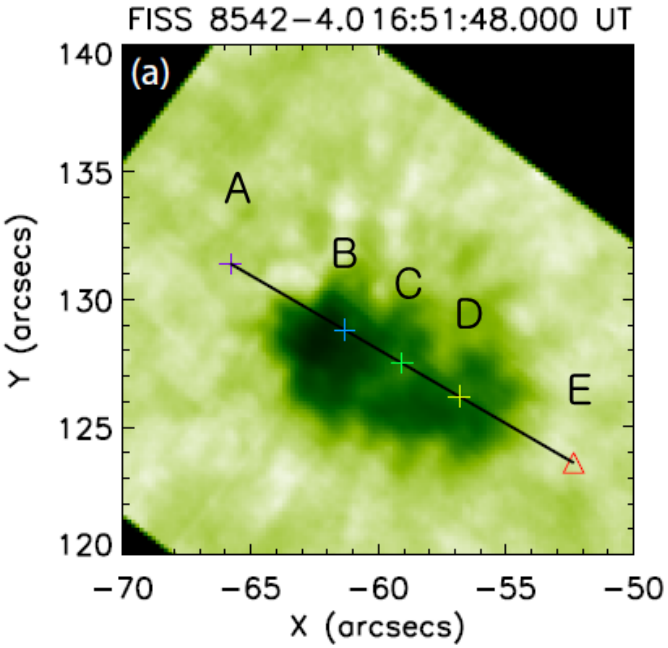


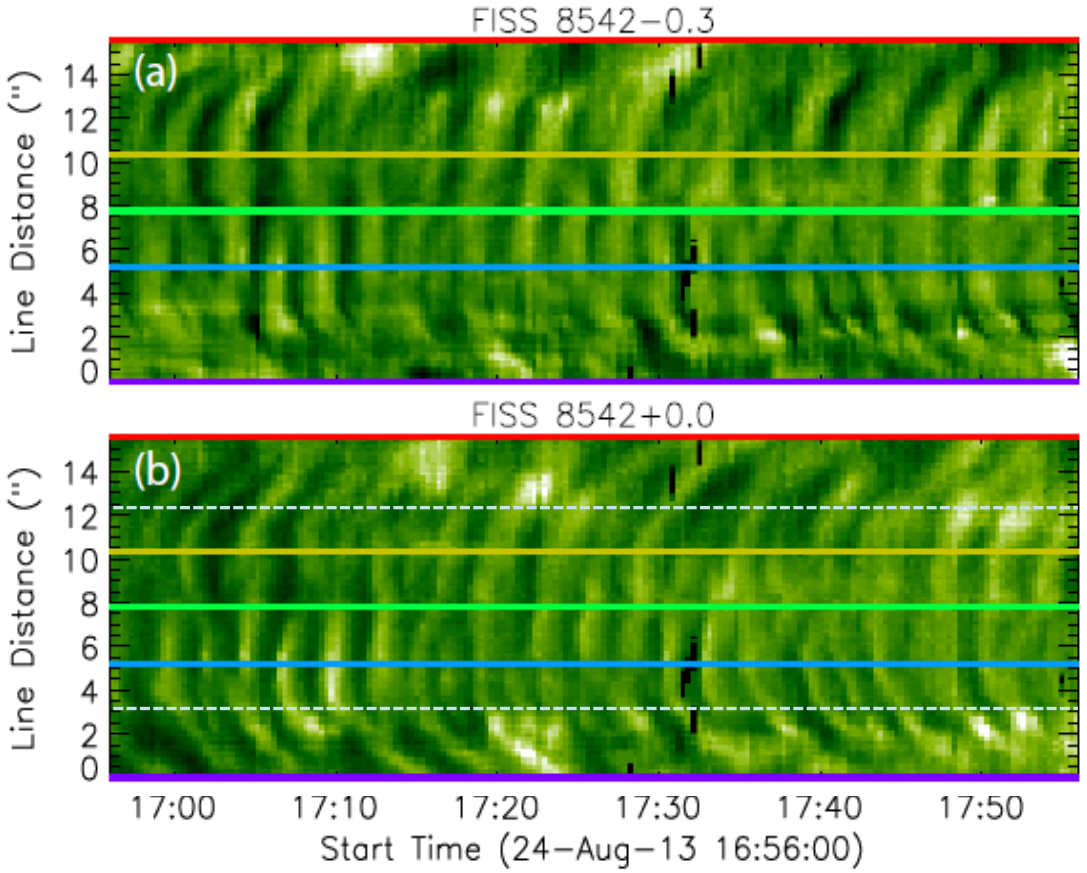
(4) Intensity and Doppler Oscillations in Pore Atmosphere (Cho et al. 2015)

FISS Ha Intensity



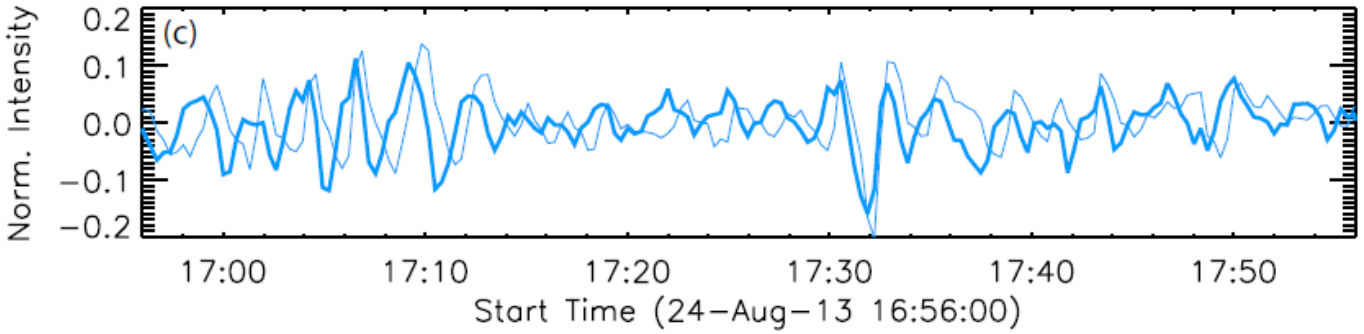
Wave source and propagation in CaII



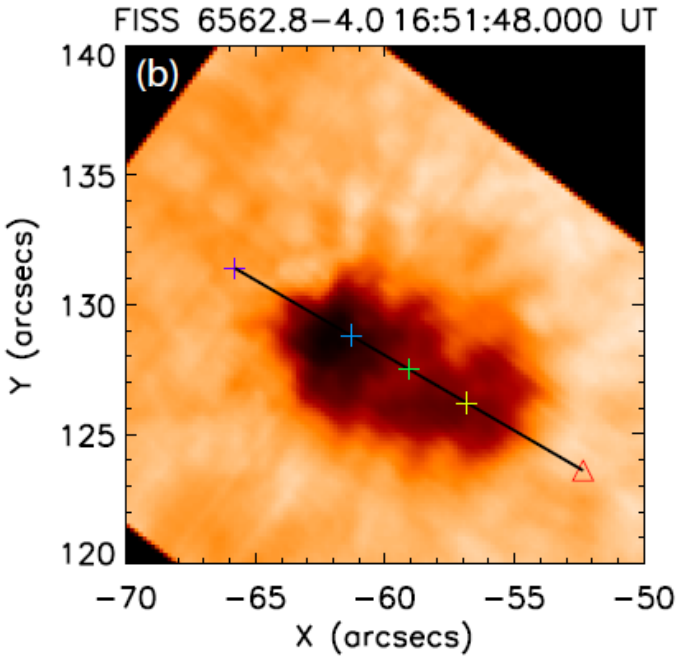


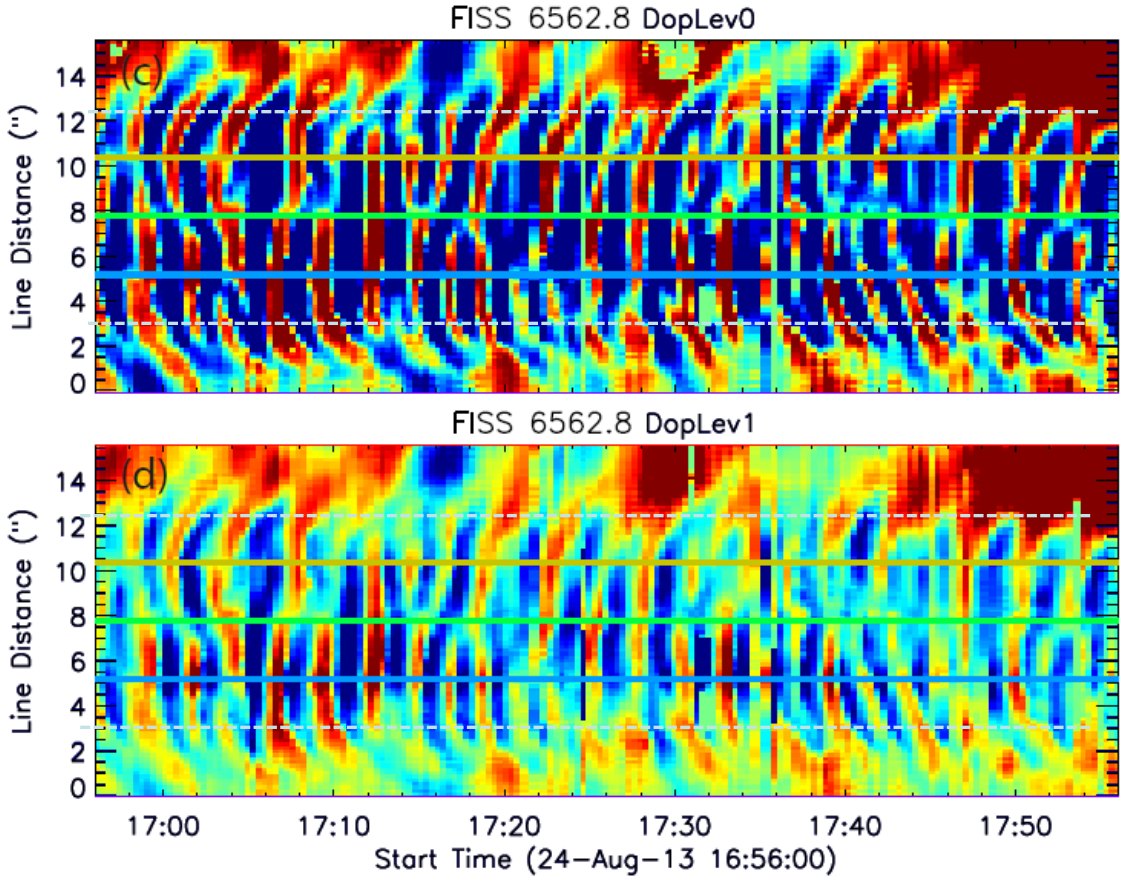
Thick line♪
: −0.3Å♪

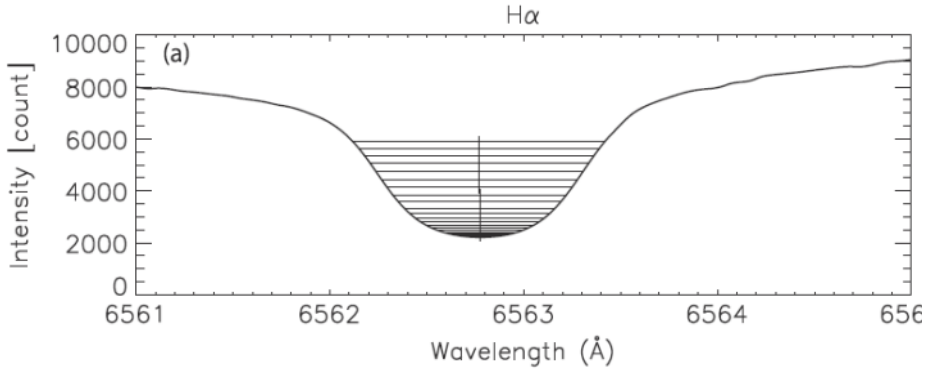
Thin line♪
: −0.0Å♪

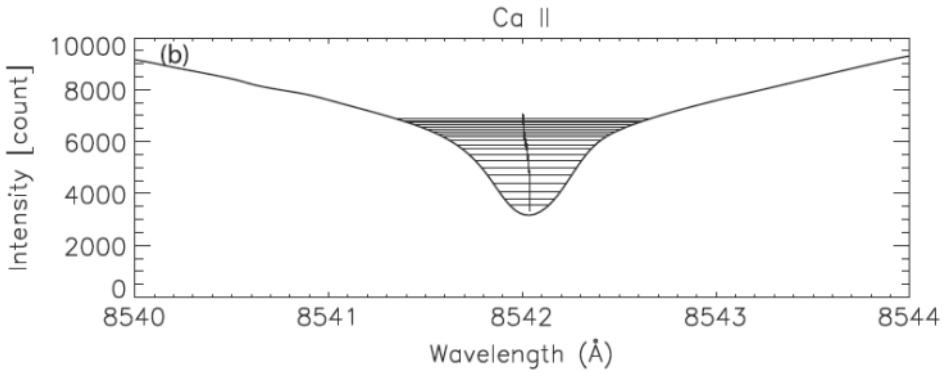


Wave source and propagation in Ha

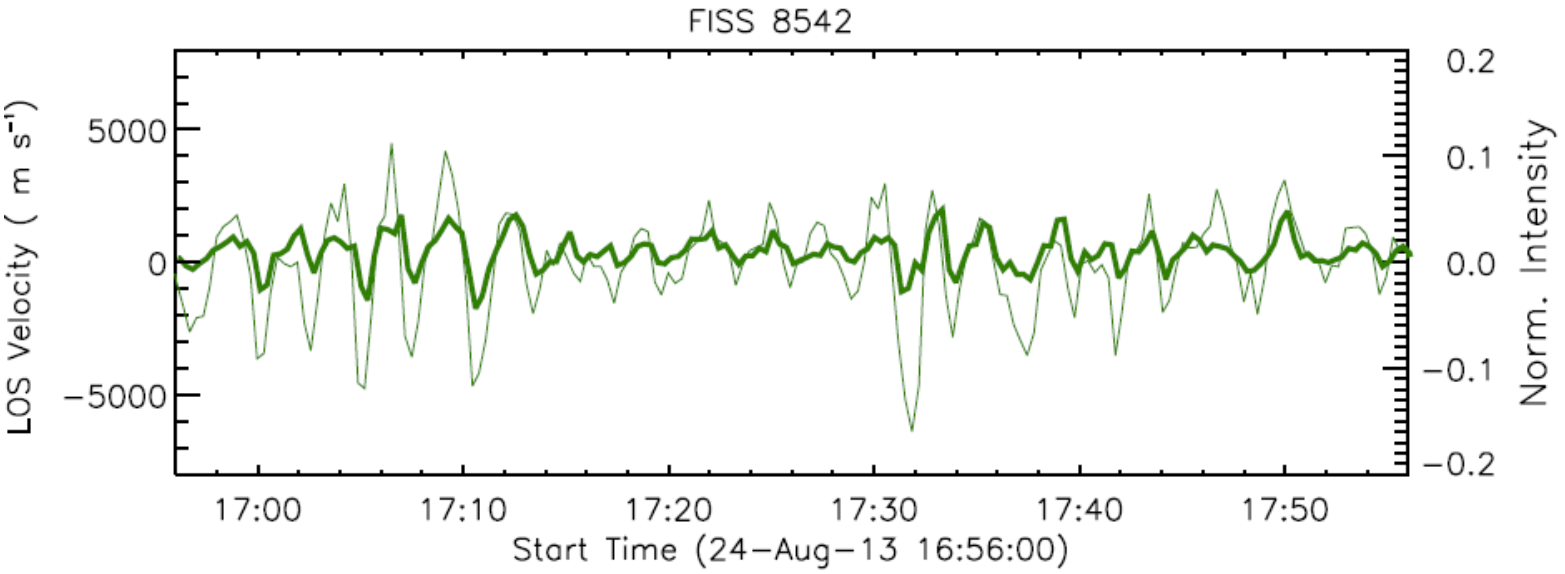






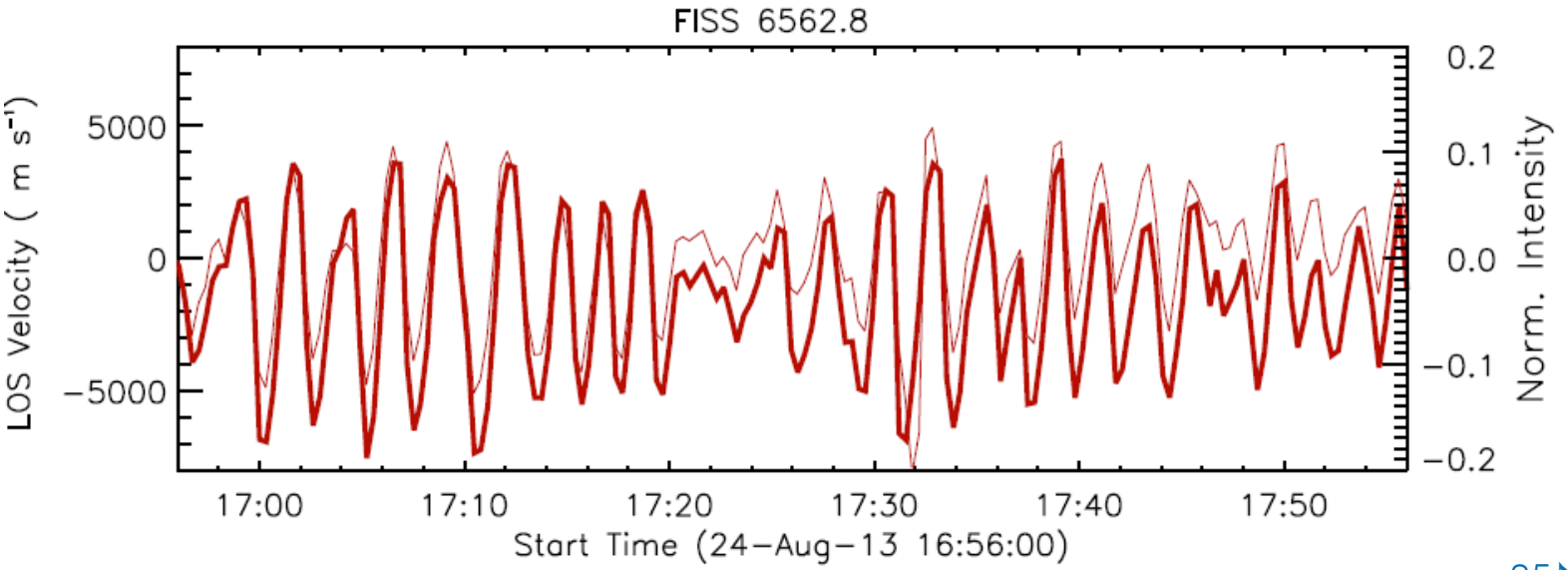


LOS speed and Intensity comparison at Ha (-0.3Å) and CaII (-0.3Å)

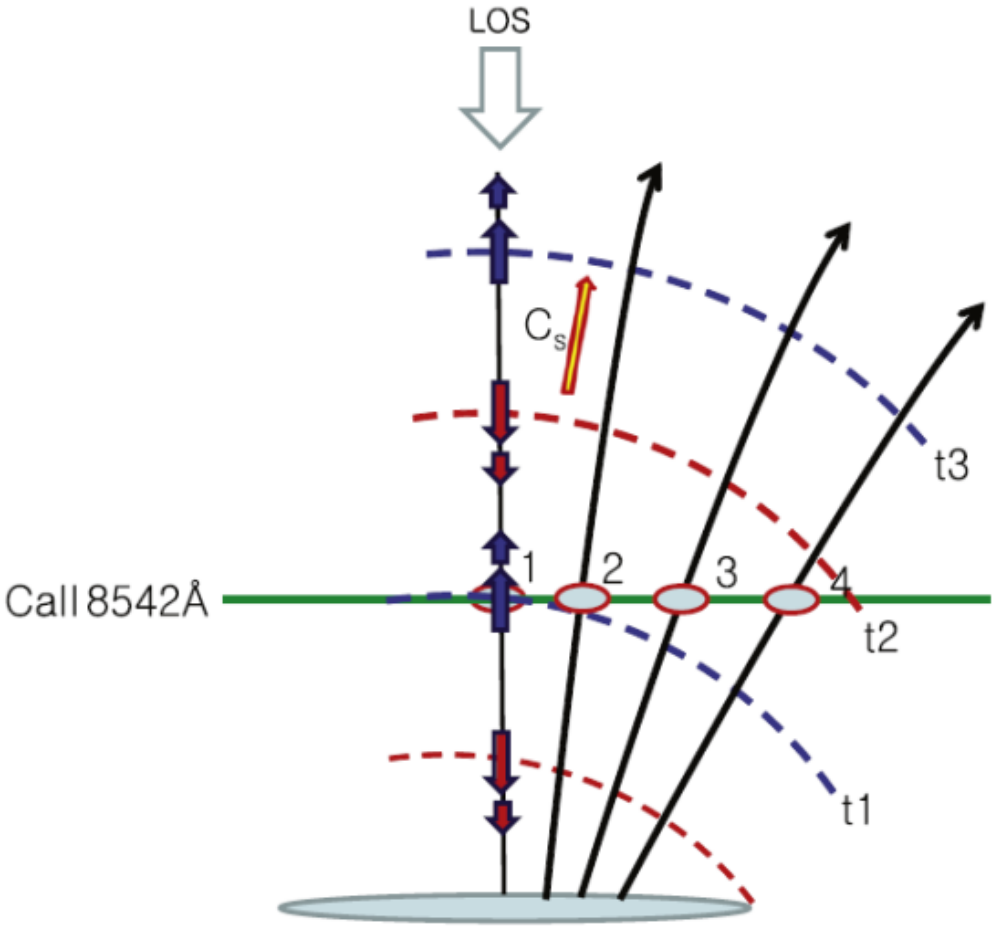


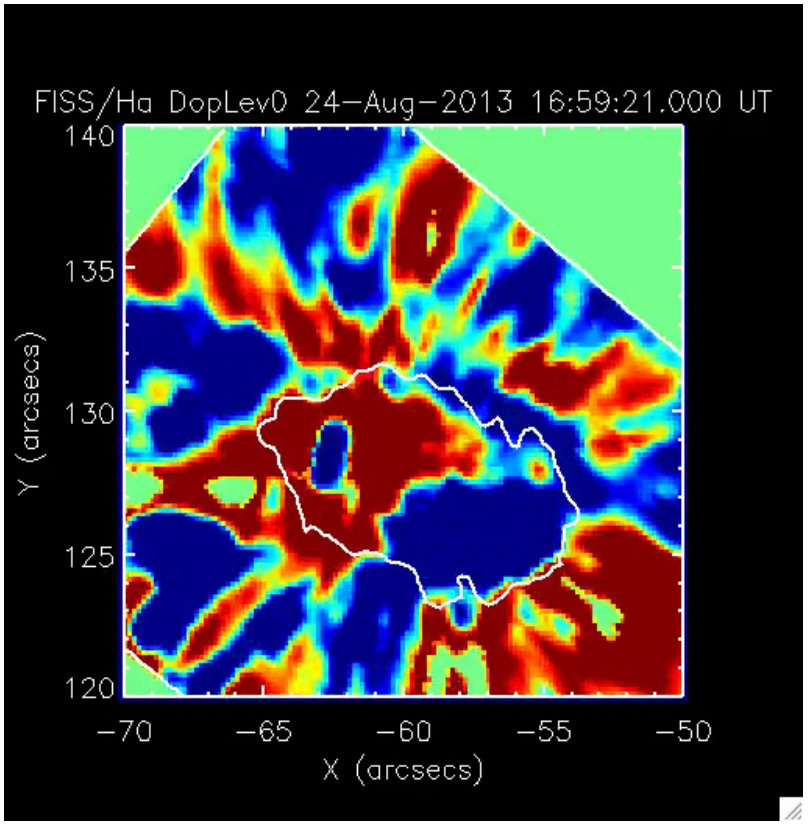
Thick line♪
: Doppler speed♪

Thin line♪
: Intensity♪



Conclusion





Sudden decrease of its speed beyond th e pores can be explained by the projecti on effect caused by inclination of the m agnetic field with a canopy structure.

Slow ♪
Magnetoacostic ♪
Wave♪

Summary

(1) Three groups of pores, transition sunspots, and mature sunspots have different characteristics in their area, intensity, magnetic field, and LOS velocity as well in their relationships.

(2) A pore grows as the magnetic flux density increases due to the convergence of ambient mass flow and it decays with the decrease of the flux density due to the diverging mass flow.

(3) The plasma flows upwards inside the pores and the upflow slows down with height and turns into downflow in the upper chromosphere.

(4) The observed wave is a slow magnetoacoustic wave propagating along the magnetic field lines in the pores.

Thank you
for your attention