Magnetic and electric field inference in a surge using spectropolarimetric observations in HI Paschen lines

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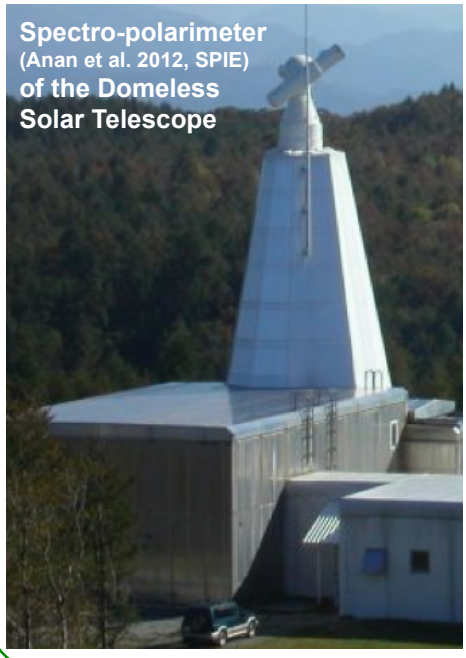
We present magnetic field measurements in a surge, a first estimation of upper limit of motional electric fields and the corresponding limit to plasma velocities across the magnetic field lines.

Observation at Hida observ.

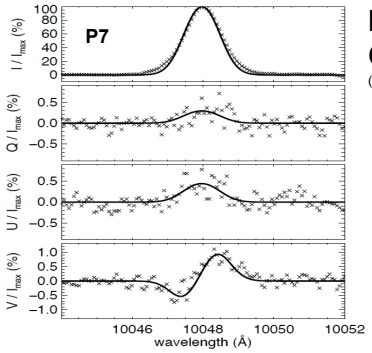


Spectral line
Paschen series of HI
P7(n:7=>3), P9, P10, P11, ,
[Effective polarization process in the lines & field]
- Stark effect - **E** field
- Zeeman effect - **B** field
- Resonance scattering - radiation field
- Hanle effect - **B & E** field
- Alignment to orientation - **B** & **E** field

Achromatic modulator

on focal plane

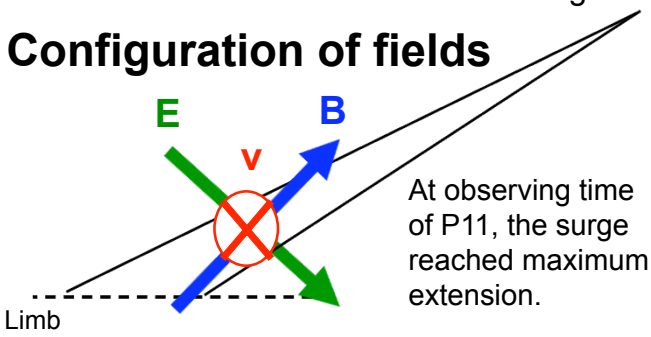
Integration time : 50 sec
photon noise ~2×10^{-3}



Inversion by Principal Component Analysis
(López Ariste & Casini 2002)

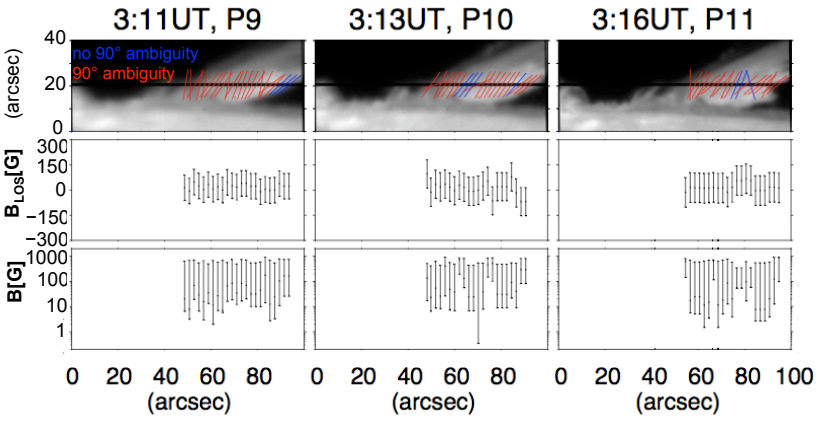
Most of the observed Stokes profiles are fitted satisfactory by the inversion taking into account only with B field.
E field is too small to detect. Thus we derive upper limit of E field.

Configuration of fields



At observing time of P11, the surge reached maximum extension.

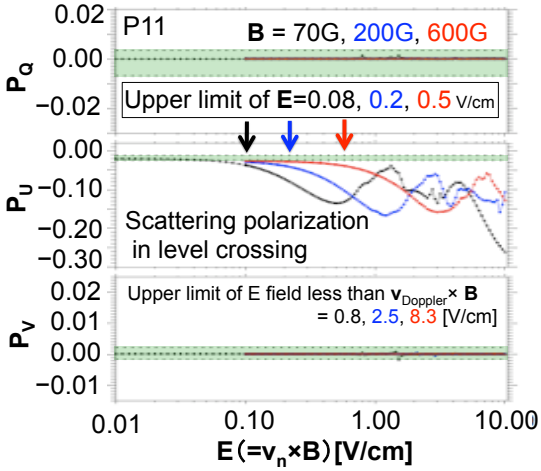
Magnetic field of surge



The direction of B field on the plane of sky is approximately aligned to the surge. |B| = 10G ~ 640G.

Upper limit of Electric field

Observation vs. theoretical net pol. (Casini 2005)



$\mathbf{E}\ (=\mathbf{v}_n\times\mathbf{B}) < \mathbf{v}_{Doppler}\times\mathbf{B}$ for B = 70, 200, 600G
➡ $\mathbf{v}_n$ across the B field < $\mathbf{v}_{Doppler}$ (~12km/s)

Conclusion : The B field (10G – 640G) approximately aligns to the surge on the plane of the sky. Because of no definitive evidence of the effects of E fields in the observed profile, we estimated an upper bound of E (=v×B) of 0.08, 0.2, and 0.5 V/cm, using B of 70, 200, 600G, respectively. The corresponding limit to plasma velocities across the B field lines is 1 km/s (< Dopplear vel. 12 km/s). *Hence the neutral atoms must be highly frozen to the B field in the surge.*