Topology and dynamics of solar prominences (Option B)

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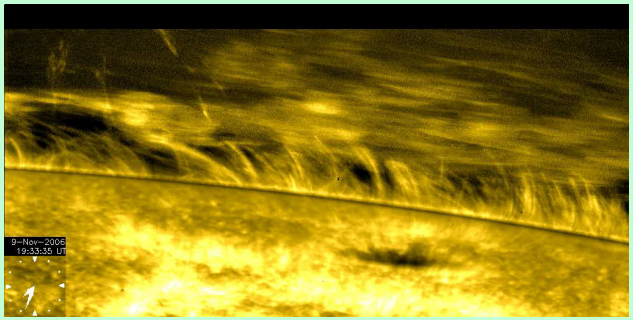
- Recent Hinode observations have shown “dynamic” activities in fine structures of prominences.
- Active motions of fine structures provide various information

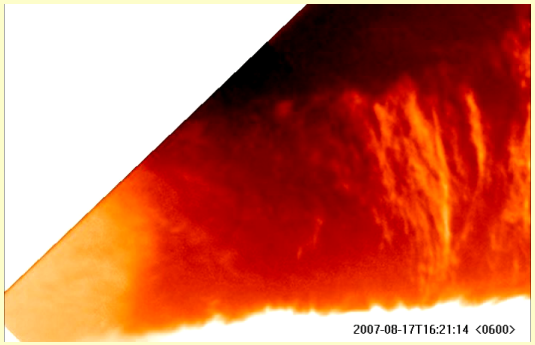
lateral motion
(Alfvenic wave)



(Okamoto et al. 2007)

strength of mag. fields

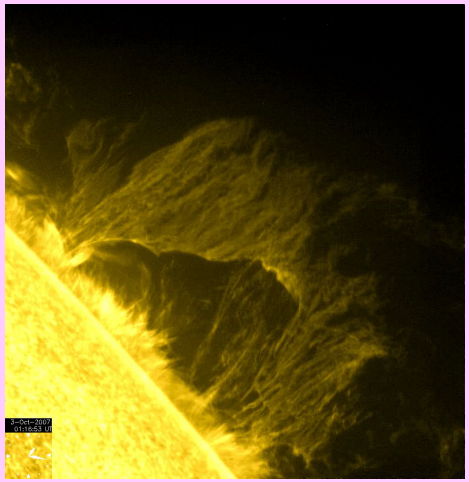
horizontal flow
in vertical structure



(Chae et al. 2008)

structure of mag. fields

vertical motion (large
bubble, small plume)



(see Berger et al. 2008, 2010)

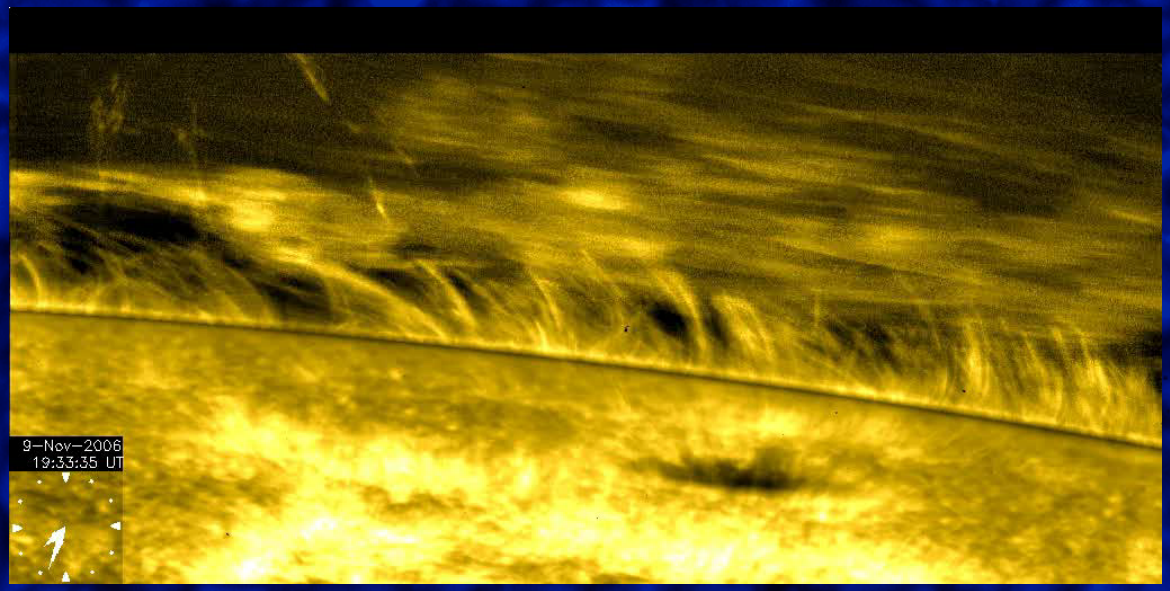
density and temperature of plasma

Impact of prominence

- Visualization of coronal field and information about density of plasma are useful for investigations of
  - magnetic configuration in the corona
  - energy transfer by MHD waves
  - triggering mechanism of flares and CMEs
- Necessary to clarify
  - fine structures
  - formation and evolution process
  - dynamical phenomena (bubble etc.)

Fine structures

- width < 0.3” by SST observations (Lin et al. 2005)
- mag. field strength, plasma density of each thread ?
  - important to understand the property of mag. field from the photosphere to the corona
- What is located in between threads ?

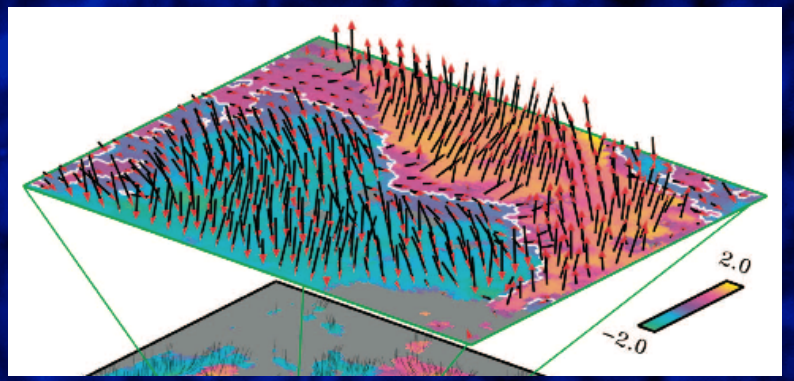


Not so strong request to achieve 0.1” resolution
（0.2” is enough ?）

High-res. obs. without physical quantity cannot provide useful information

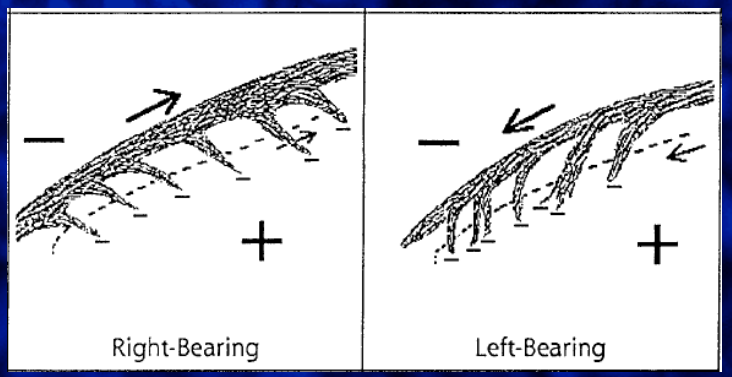
Magnetic configuration is helical ?

- Yes
  - flux rope in the corona (e.g., Gibson & Fan 2006)
  - speculation from photospheric mag. fields (Lites 2005)
  - magnetic dips support cool mass



Lites (2005)

- No
  - magnetic shear and minority polarity patches
  - flows along threads maintain mass (Zirker et al. 1998, Karpen et al. 2001)



Martin (1998)

Magnetic configuration

vector mag. field

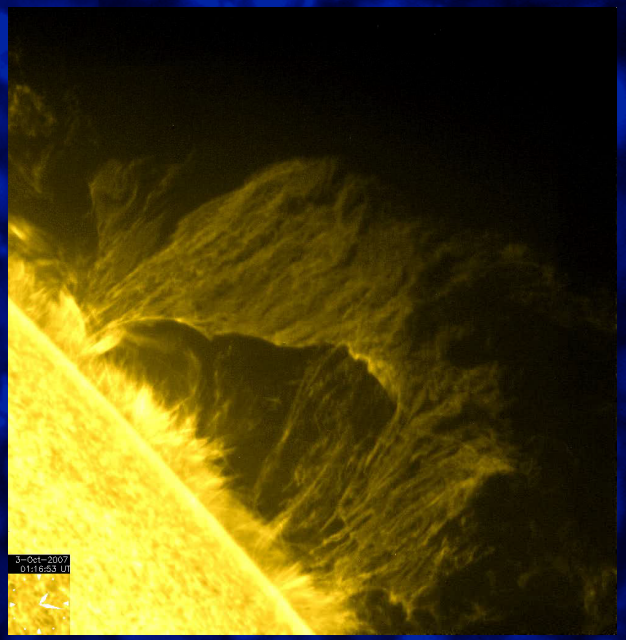
vector velocity

simultaneously

→ 3D configuration along magnetic field

- 200”x 100”
- 0.3” (slitscan 0.15”)
- limb observation is better
  (easier to get information about height)

impossible from ground with considerations of dynamic prominence & AO does not work at the limb
→ space obs. is required

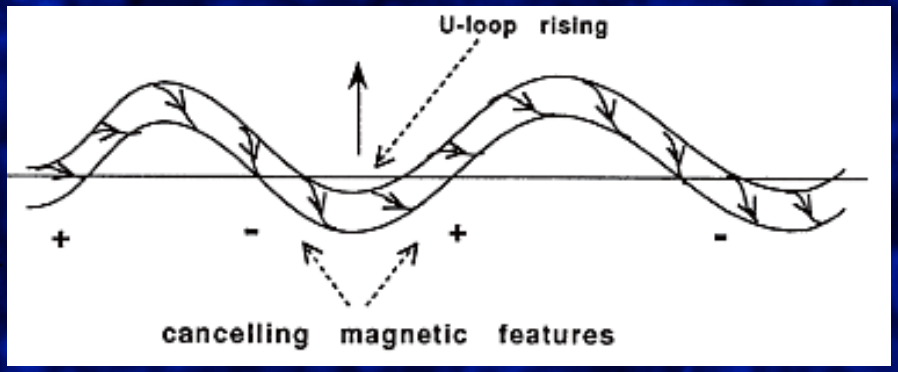


Formation of mag. field

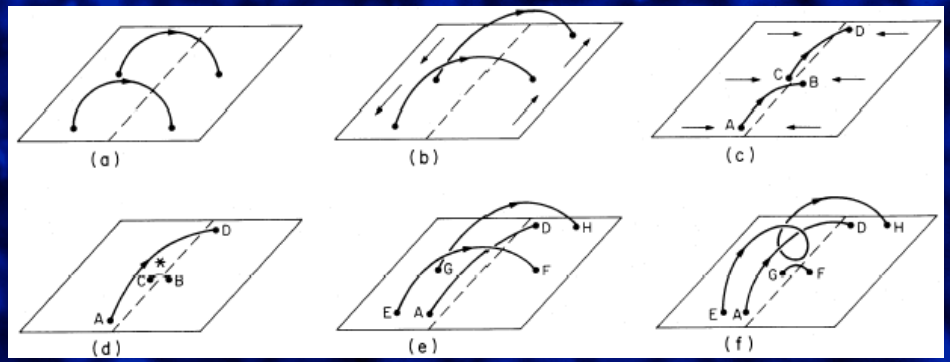
About helical field

- flux rope model
  originally-twisted flux emerges from below the photosphere

- sheared-arcade model
  by photospheric shear and converging motions, and reconnection in the corona



Rust & Kumar (1994)

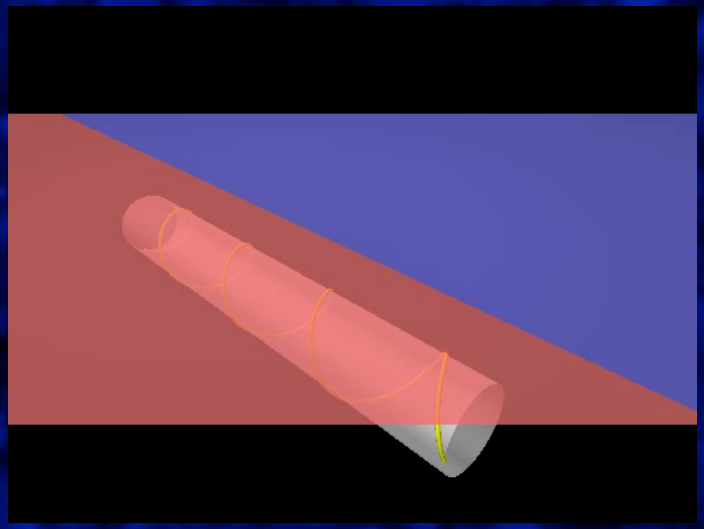


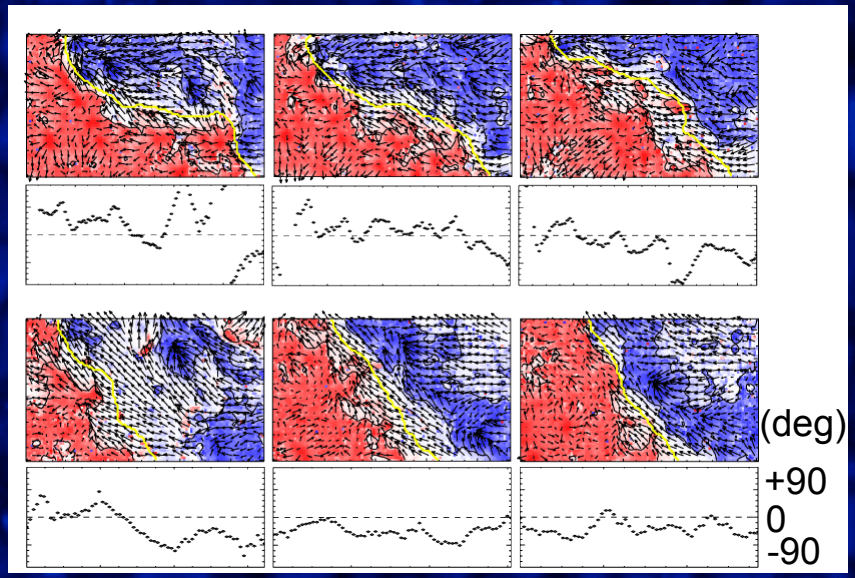
van Ballegooijen & Martens (1989)

Formation of mag. field

- good example of helical flux emergence under prominence
- question : this flux emergence contributed formation of prominence ?

Okamoto et al. (2008)

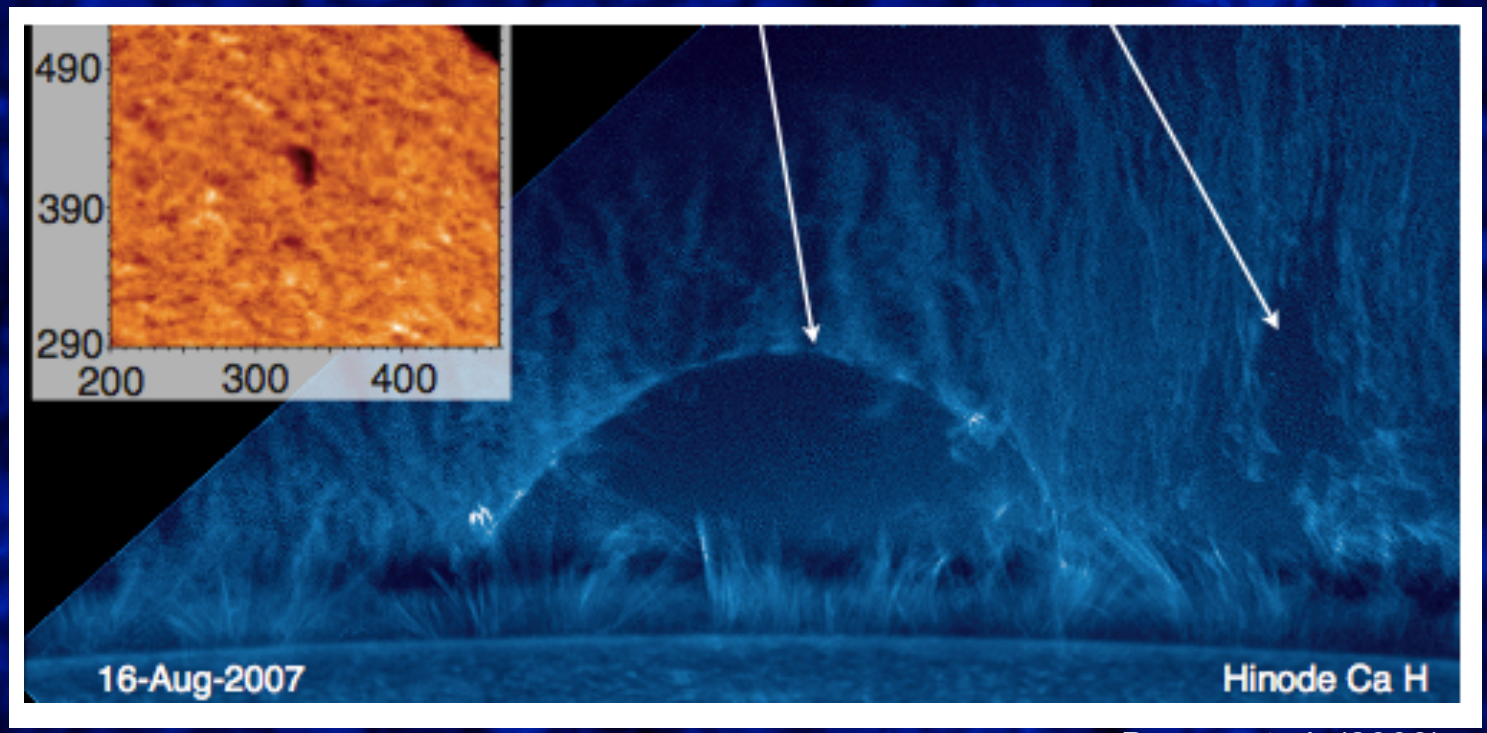




To know the behavior of the emerging flux in the chromosphere and corona, simultaneous observation of chromospheric fields is important in addition to photospheric vector fields.

Plumes and bubbles

Hinode/SOT discovered dynamic phenomena in prominence.

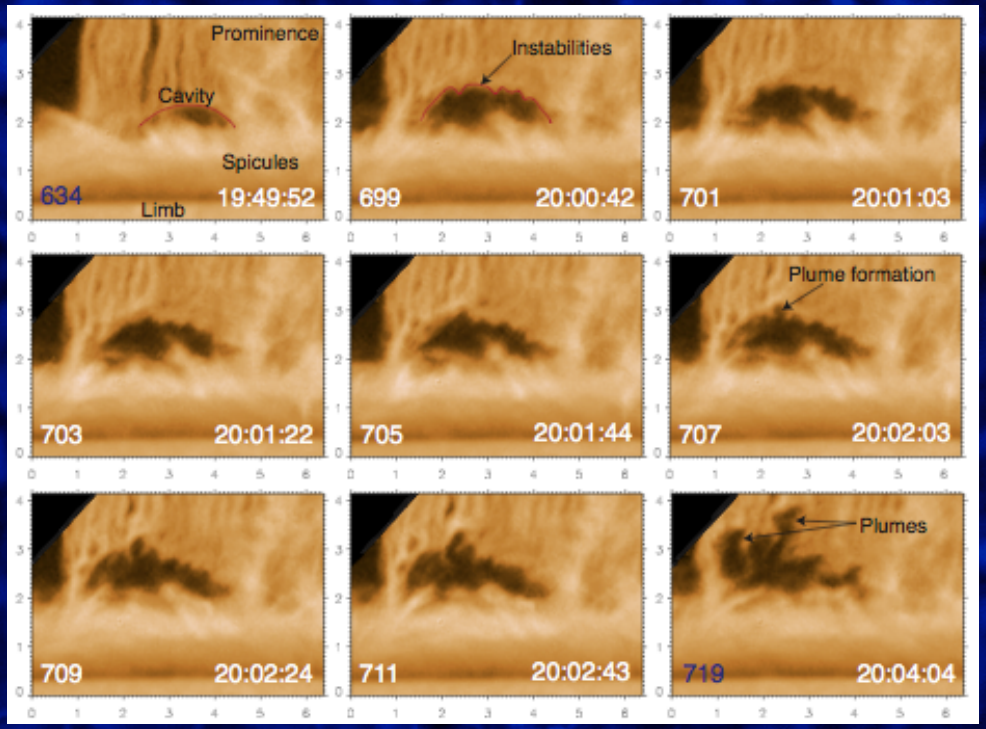


Berger et al. (2008)

Plumes and bubbles

- What are these ?
  - flux emergence ?
  - hot component ?

The true identity remains unknown.



Berger et al. (2010)

spectrometric observation is required for the dynamics
→ information about time evolution of density and velocity

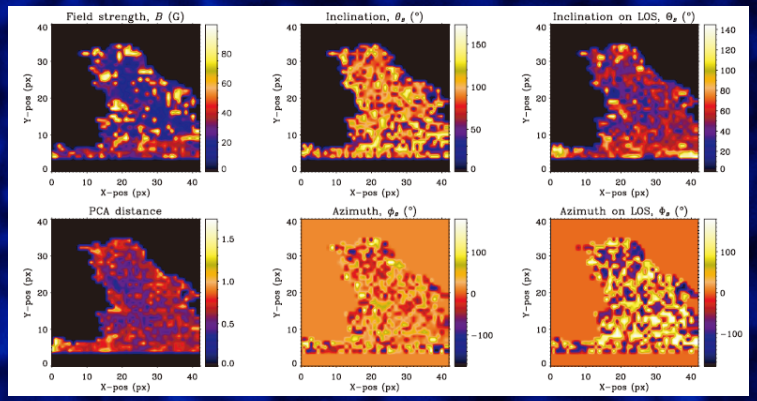
Prominence observations

- Most of the prominence studies (as chromospheric material) with Hinode are performed only with “filtergraph”.
- For accurate and quantitative studies, we need to observe density, LOS velocity, mag. field of fine structures wit
  - spectrometer
  - spectro-polarimeter
  - in addition to photospheric vecto

- High-cadence observations are required in any cases of prominence studies.

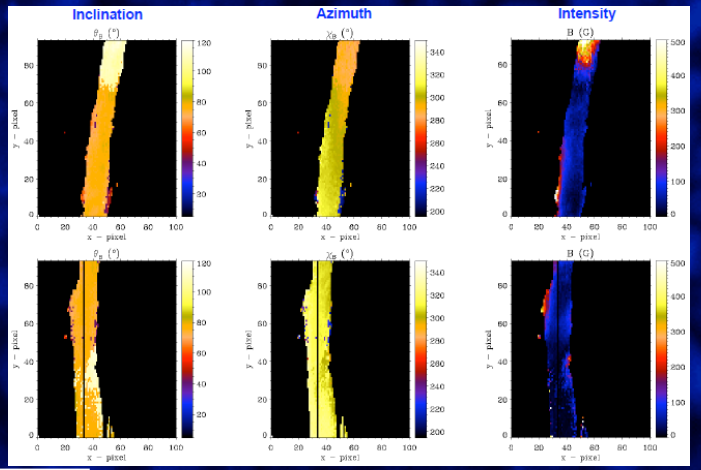
Measurement of mag. field in prominence

- long-integration time is required for measurement (accuracy : 10^{-3} ~ $^{-4}$)
  - due to seeing
  - 20~50-min average for spicule (Centeno et al. 2009)
  - 100-s integration for prominence (Merenda et al. 2006)
  - 2~3" res. to achieve the accuray



Casini et al. (2003)

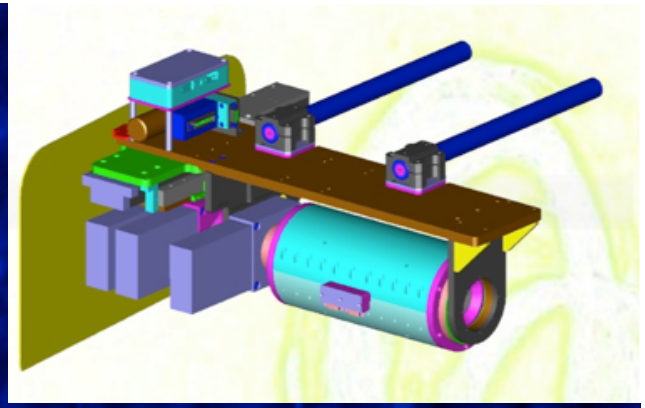
- acceptable for "dynamic" chromosphere ?
  - assumed that material moves along stationary mag. fields



Merenda et al. (2006)

Large advantage of space observation

HAO ProMag



- Prominence Magnetometer
  - Sac Peak, 40-cm aperture
  - res. 2~3”, FOV >100”
  - 2 wavelengths, simultaneously（5876 or 6563 + 10830）

Important issue :
Measurement of prominence fields “actually” provide useful information without difficulty to analyze ?

→ guideline for Option-B (as is also IRIS)

Summary

- Observation of chromospheric mag. fields from space has a significant advantage to investigate prominences itself and the surrounding environment.
- Note that prominence is a part of overall magnetic structures. We have to observe not only cool material but also photospheric fields and its coronal cavity, simultaneously.
- Chromosphere including prominence is so dynamic that high telemetry is essential for the studies. (Option B)

request to Option-B

- spatial resolution ~< 0.2” (100 cm @ 10,000 A)
- FOV 200”x 200” (~SOT/FG)
- cadence : 8 s (0.2” displacement with 20 km/s)
- long-duration observation is also important

- spectrometry： Mg ？ Na D ？ He I ？ H I ？
- spectro-polarimetry： < 0.05% (see ProMag）