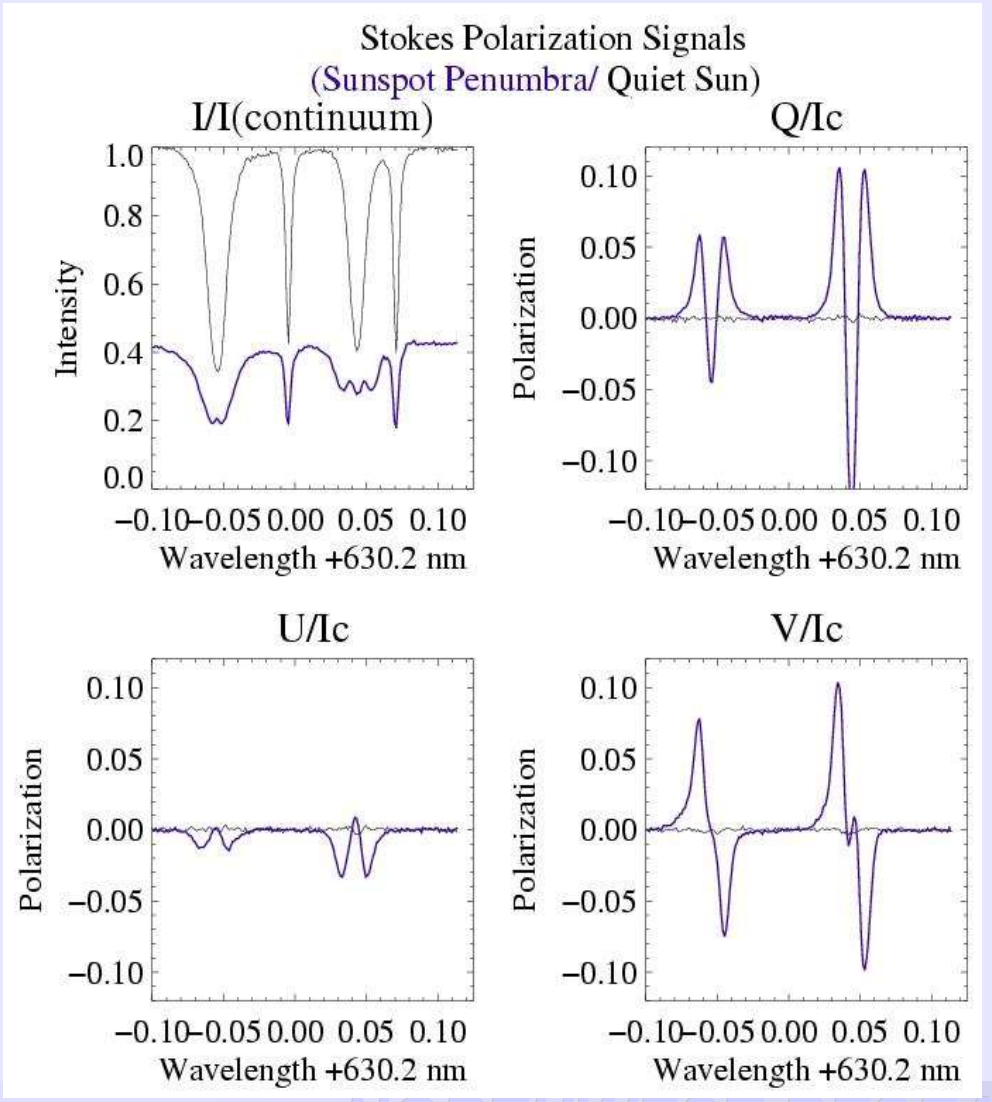
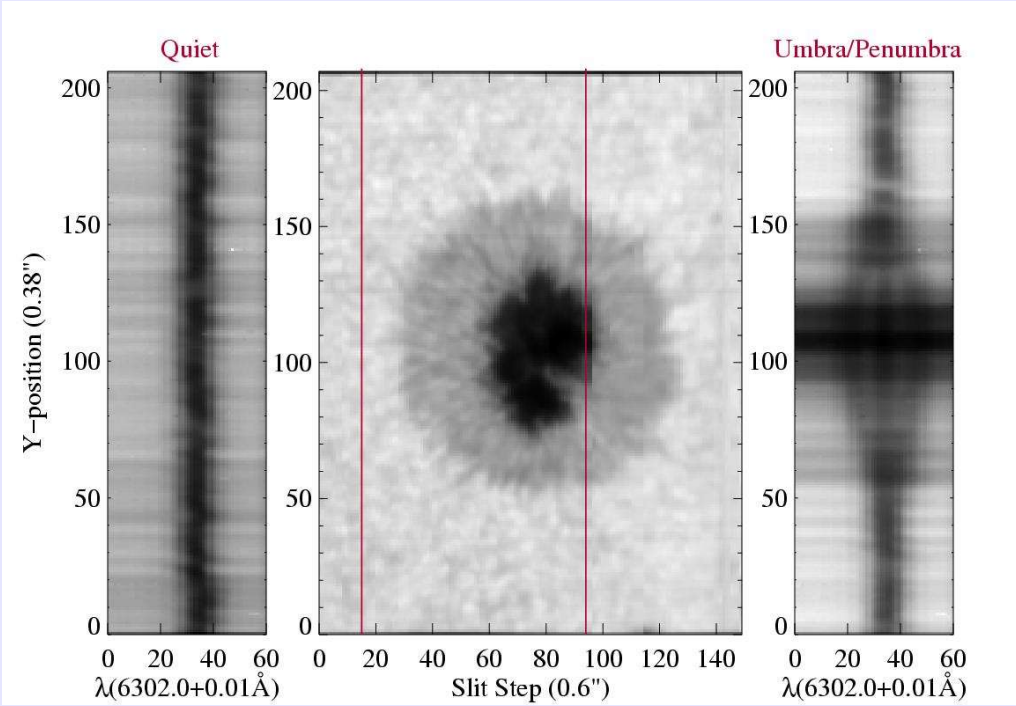
Upcoming synoptic vector field data sources:

- SOLIS (NSO)
  - line-of-sight available now, replaces old KPNO 'grams.
  - 1" sampling.
  - Vector available soon (any day now ... really).
  - Pros:
    - Full disk, benchmark 3/day.
    - Spectrograph-based with full M.E. Inversion: very quantitatively reliable and robust (caveat below).
  - Cons:
    - Ground-based, so seeing-influenced results.
    - single-station (for now): low temporal sampling.
- Solar-B (NASA/Japan)
  - Launch scheduled for 2006.
  - Pros:
    - Space-based: no seeing influences.
  - Cons:
    - Small FOV instrument w/ very high resolution spectrograph instrument that uses a small FOV, *plus* a filter-based instrument. Max 2.5' square.
    - Data access/availability TBD
    - Unclear observing sequence/cadence with larger-FOV instrument.
    - Unclear how quantitative the filter-based data will be.
- SDO/HMI (NASA)
  - Launch scheduled for 2008
  - 1" sampling.
  - Pros:
    - Full disk every 90 seconds, space-based.
    - Fully accessible data.
  - Cons:
    - Not available until 2008, possibly early 2009.

Measuring the photospheric magnetic field: **Stokes spectropolarimetry:**

- Zeeman effect: magnetic field induces both energy-level splitting and polarization to emergent light of magnetically sensitive lines.





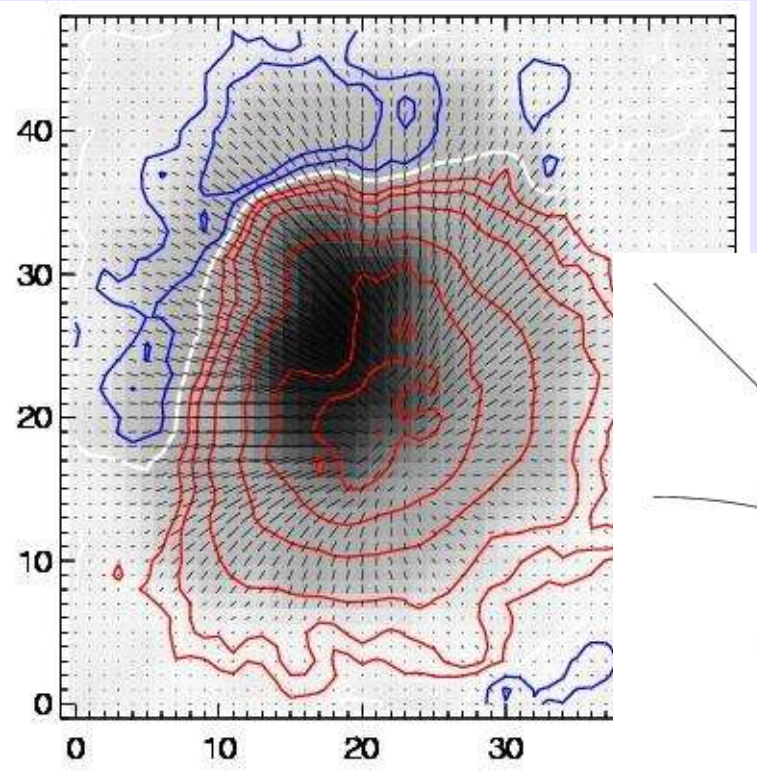
- Shape of polarization spectra and degree of polarization due to: strength, direction of magnetic field, thermodynamics of plasma, spatial and spectral resolution.

Measuring the photospheric magnetic field cont'd:

- Inversion procedure: I, Q, U, V spectra → B_{los}, B_{trans}, ϕ
  - Myriad methods exist, each with strengths and weaknesses
  - Inversion based on Milne-Eddington atmosphere, accounting for Faraday rotation, thermodynamics, magnetic fill-fraction.
- 180° Ambiguity in B_{trans} inherent in Zeeman-polarization observations
  - Myriad methods exist, each with strengths and weaknesses
  - Minimize divergence and current simutaneously
  - Results transformed to heliographic ***B***

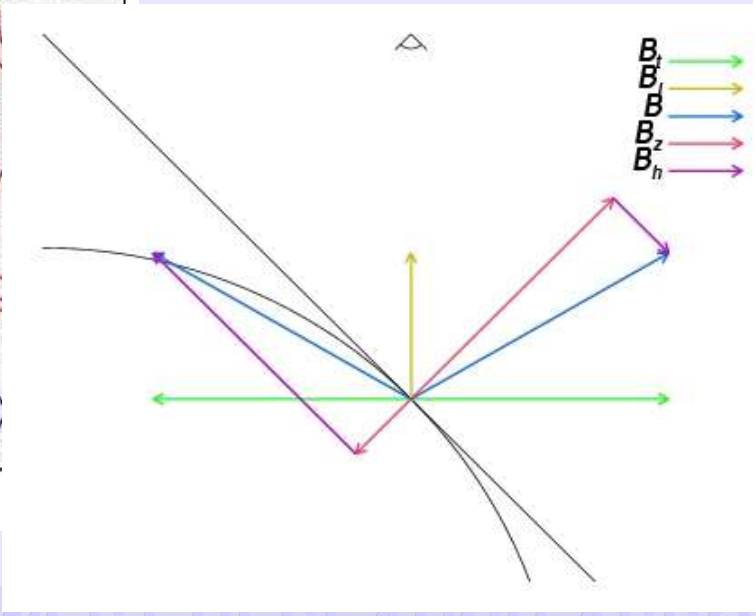
Heliographic *B* results.

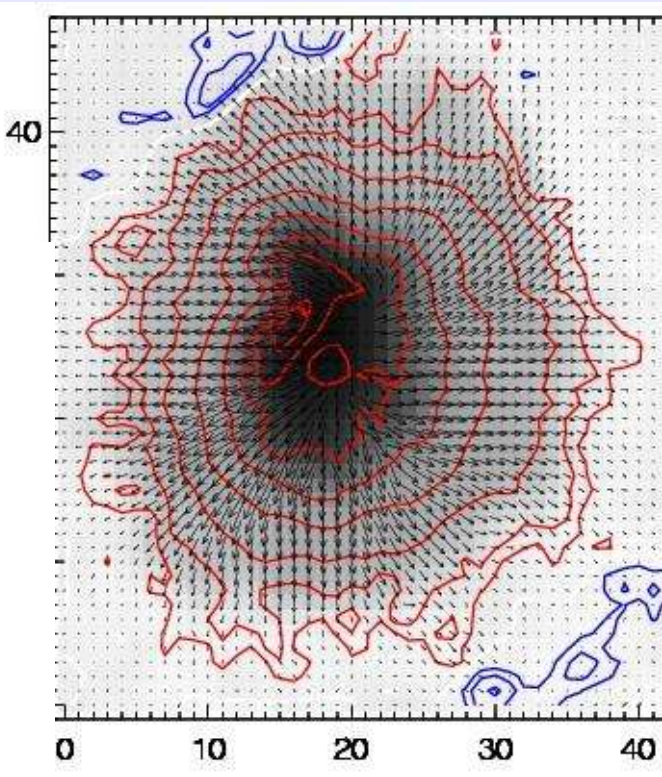
↓ (note shift in neutral line)



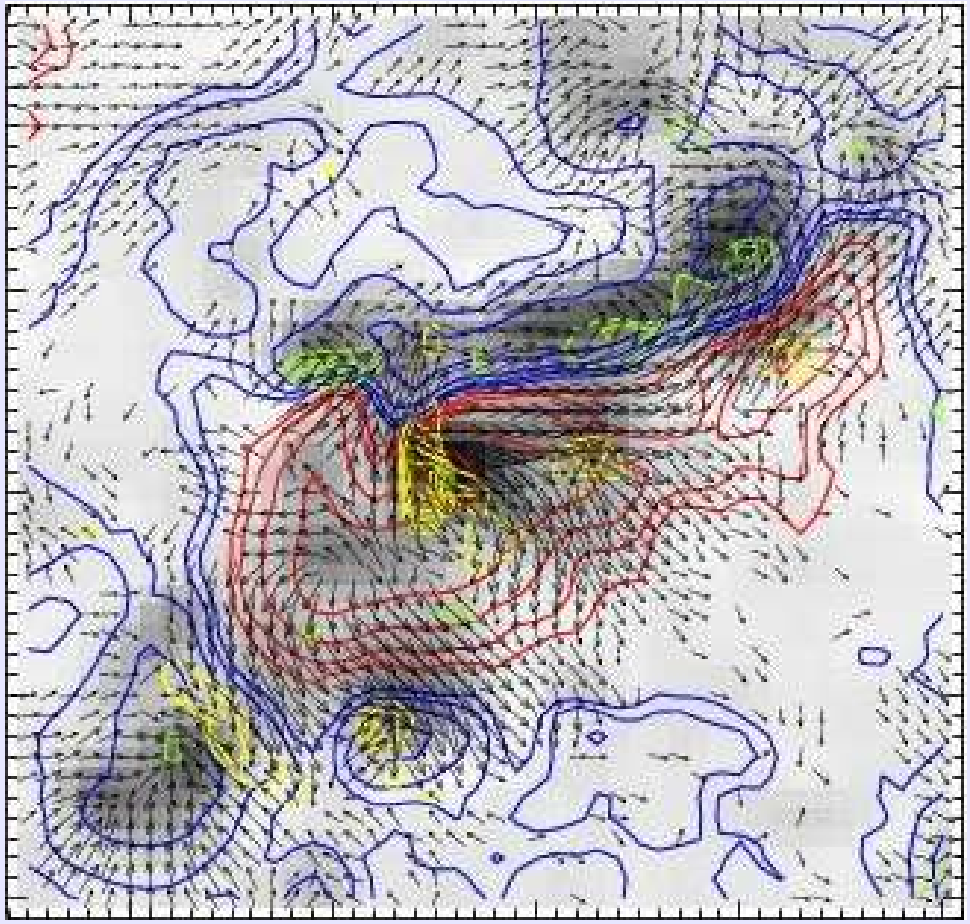
← Observed B_{los}, B_{trans}, ϕ

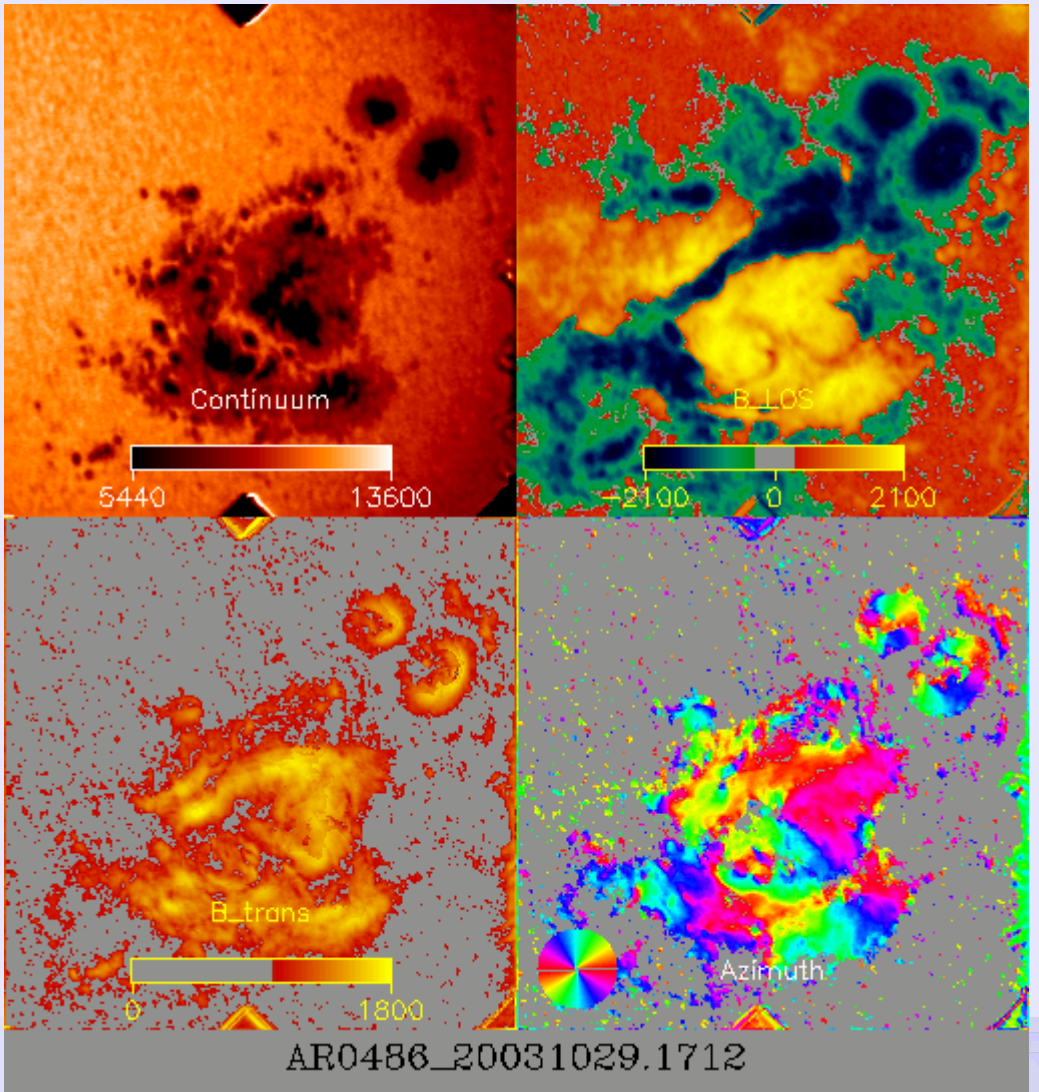
↓ B_{trans} direction is chosen.





Visualization:

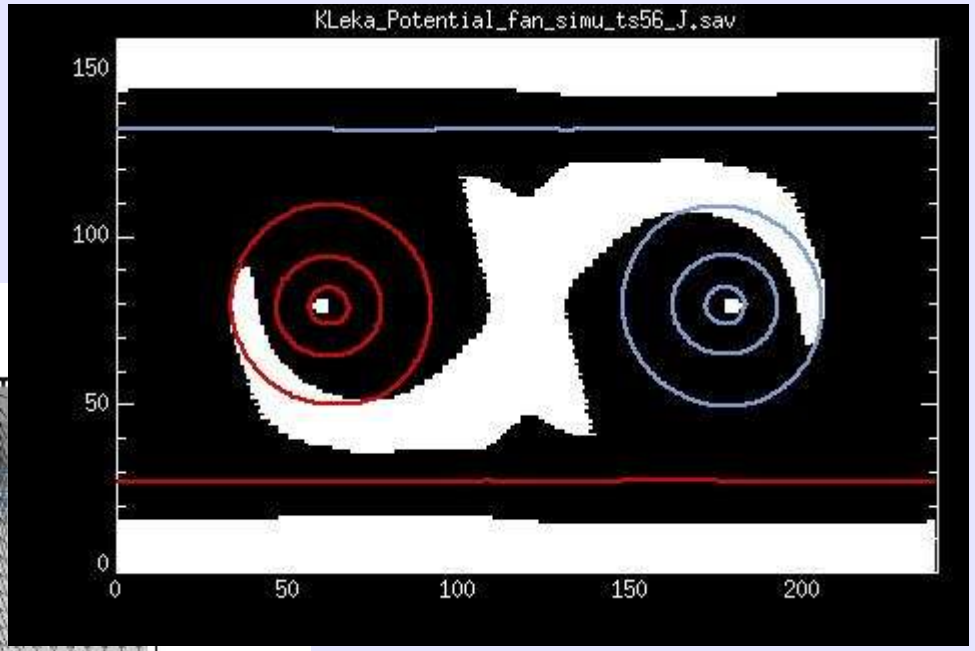


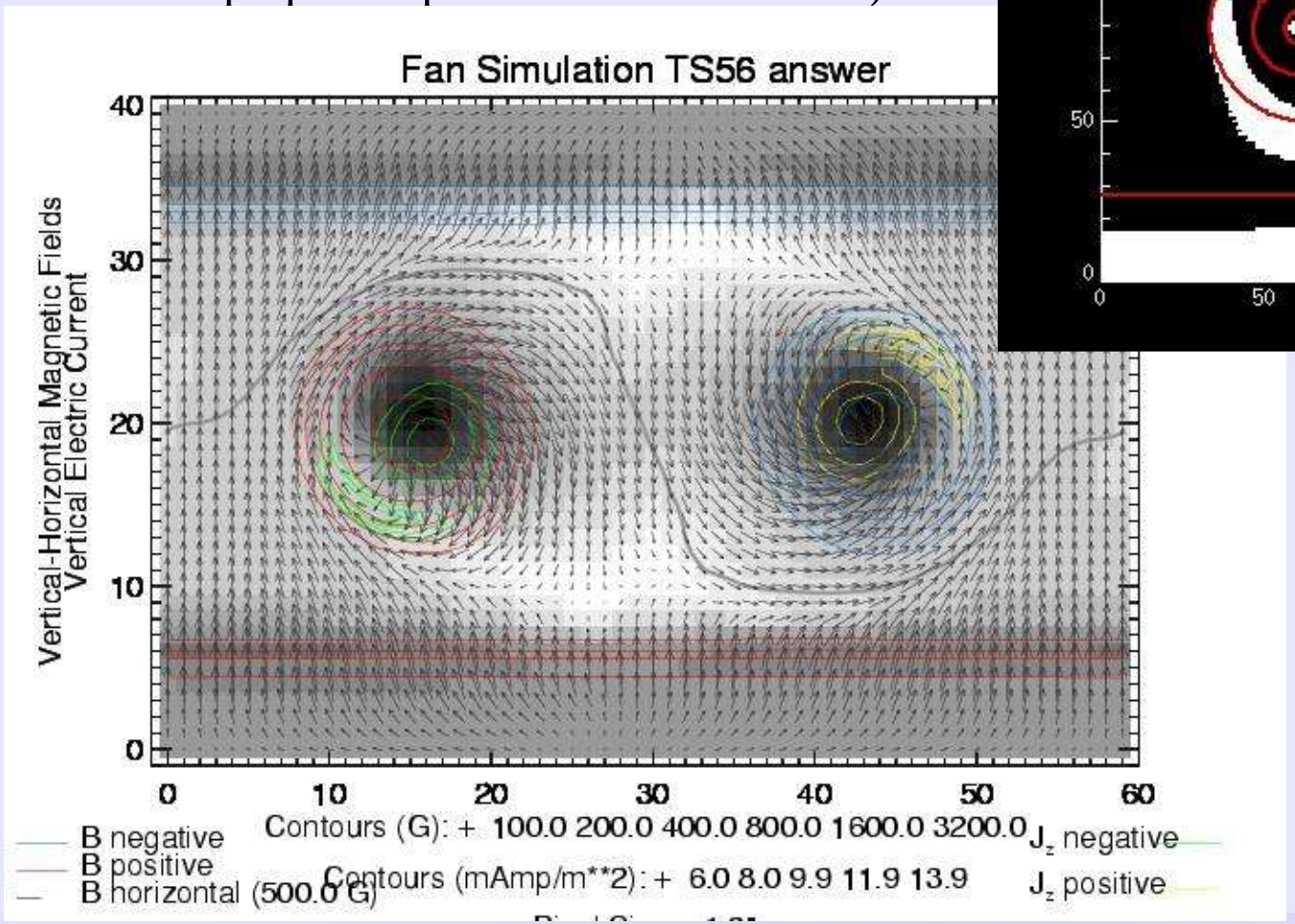


Ambiguity Resolution: recent workshop approach and example results.

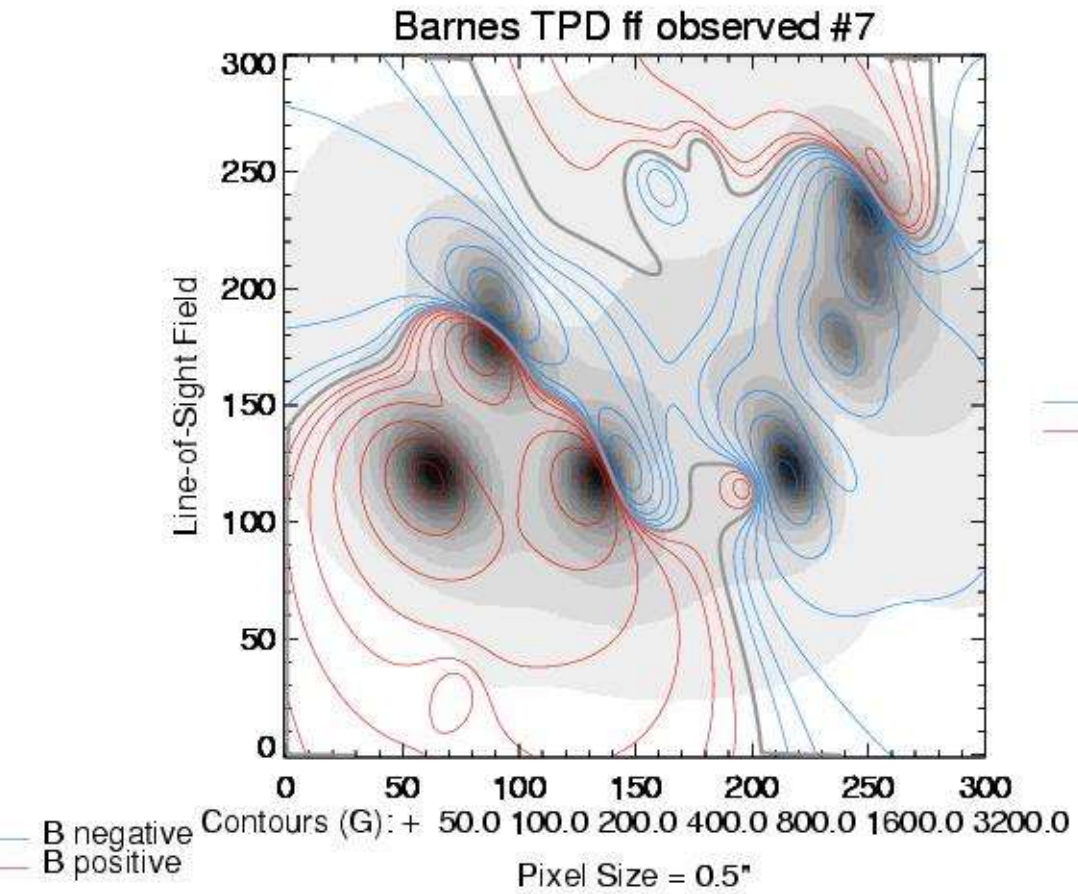
Y. Fan numerical simulation used to construct a "photospheric magnetogram".
Solar-appropriate in many ways.
Challenge: a bald-patch, plus widely varying twist-parameter "α" (twisted fluxrope plus a potential-field arcade).

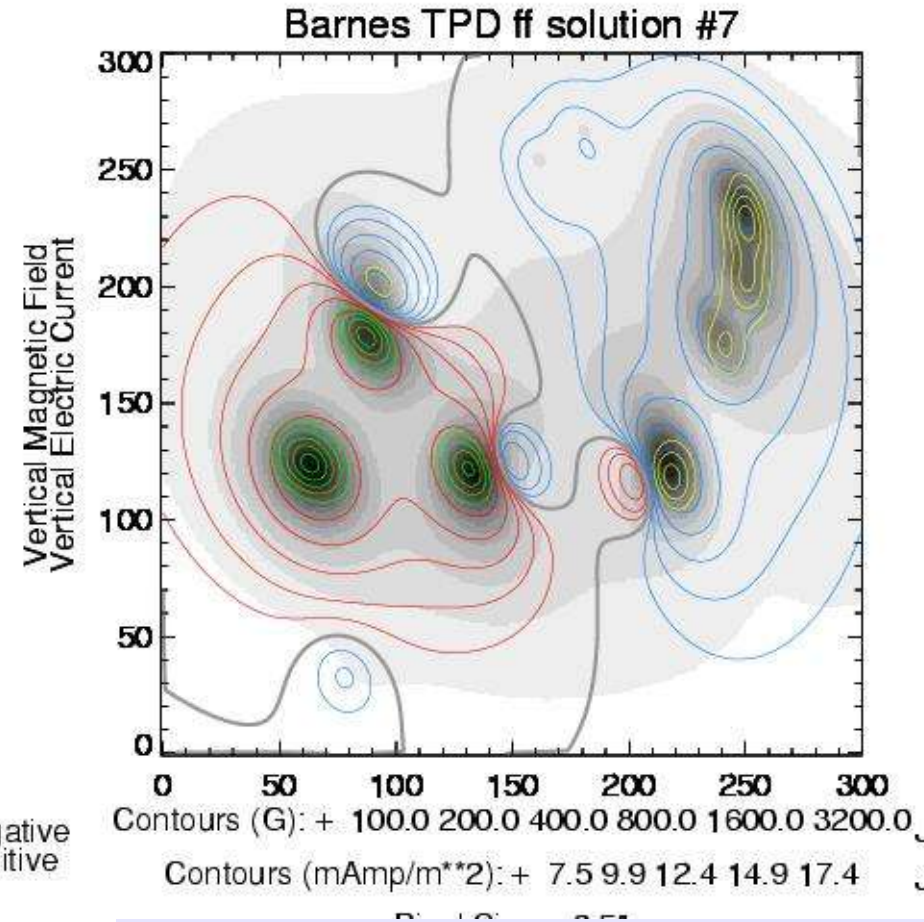
Results using a potential field to guide the disambiguations:



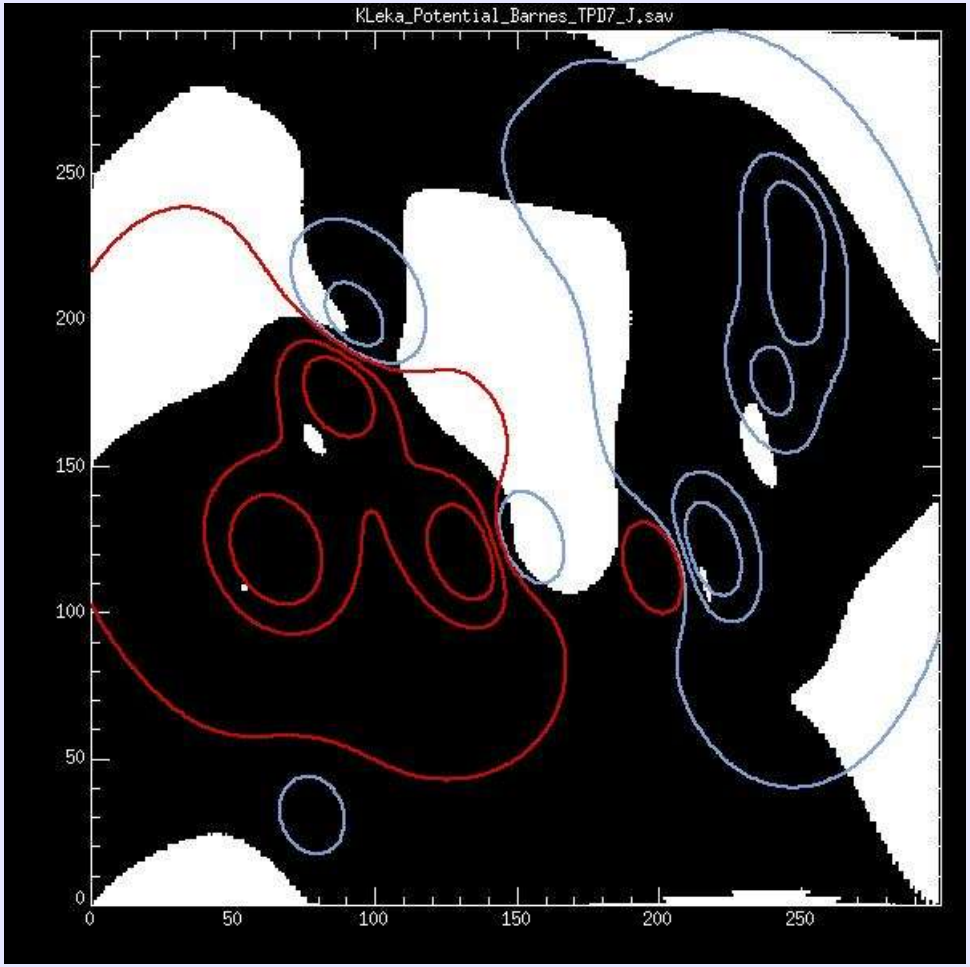


Barnes used approach of Chou & Low to construct a force-free model and placed it at 45 deg west, 20 deg north.
Multiple bald-patches, but constant-α.
We were afraid this was going to be too easy.





Nope. Results using a potential-field to guide the disambiguation:



Metrics were devised to compare how algorithms performed, based on % area correct, % flux correct, and comparison of vertical currents (where it got it correct *plus* a penalty for extra currents introduced)

Bad news: some algorithms did worse than simply using a potential-field solution.

Good news: a few algorithms that are almost completely autonomous performed very well, scoring > 99% for flux/area metrics, and < 0.1 for the Jz-comparison metric.

Why does anyone care? Need disambiguation algorithm to interpret ***B*** in a meaningful way; need it automatic for synoptic data such as the HMI firehose.

Discussion Topics:

- Sensitivity: where there is information (active regions), and where there is *not* (under filaments/coronal holes, *etc*)
- Image-coordinates vs. Heliographic coordinates and what that means for vector magnetic field data.
  - "fake" neutral lines and other systematic errors, how it differs w/ vector data vs. MDI-type 'grams.
  - Beware the fine print in research papers.
- How to best present vector ***B*** data for forecasters
  - Map of a gazillion arrows probably not useful.
  - Parameterizations, quantitative reports for each active region.
  - Tools need to be in place soon. SOLIS data will be available soon and will be a good "prep" for HMI-type data.