

プランク偏光データに見る分子雲周辺の 磁場及び塵粒子の特性: L1689フィラメント

B-field and dust grains around molecular clouds
revealed by Planck polarization data: the L1689
filament

松村雅文 & BISTRO-Jチーム

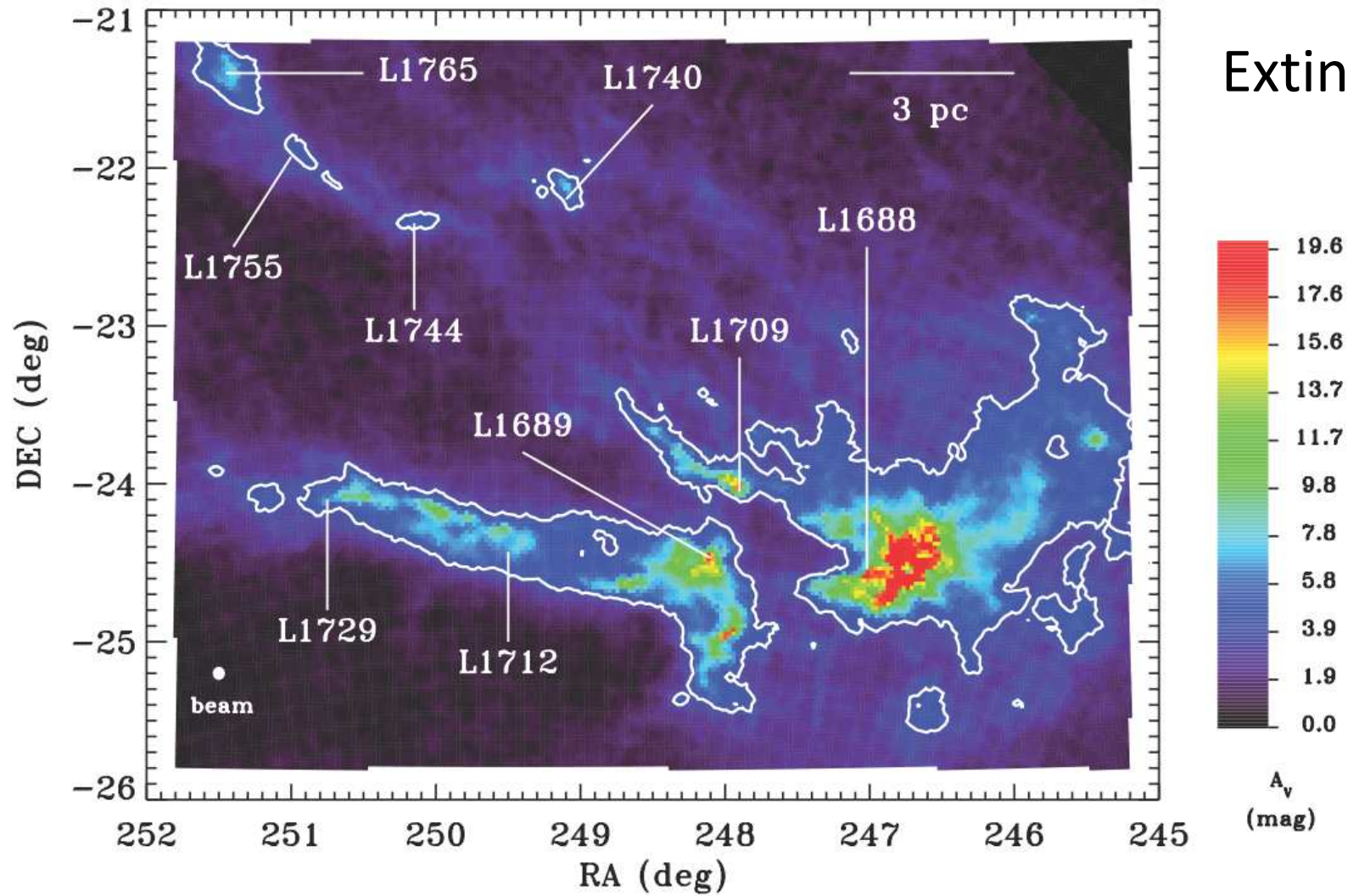
Masafumi Matsumura & BISTRO-J team

Introduction (1)

- BISTRO: B-fields In Star-forming Region Observations
 - Use Polarimeter POL-2 in submm region, with SCUBA-2 on JCMT,
 - To trace the magnetic field in star-forming regions in the Gould Belt.
 - PIs: Derek Ward-Thompson (UK); Pierre Bastien (Canada); Ray Furuya (Japan); Woojin Kwon (Korea); Di Li (China); Shih-Ping Lai (Taiwan) .
 - Co-Is: many from Canada, China, EAO, Japan, Korea, Taiwan, & UK
- Regions to study in BISTRO:
Auriga, IC5146, Ophiuchus (3 fields), L1689B, Orion A, Orion B, Perseus B1, NGC1333 (2 fields), Serpens (2 fields), Taurus B211/213 (2 fields) , & L1495
- Now it is on progress...
 - Furuya-san & Kwon-san's talks for details.

Introduction (2)

- Observation by BISTRO
 - Sensitive and high-spatial resolution, but not very wide areas.
- This study
 - investigates the B-field and grains, around the mapping regions by BISTRO,
 - expects to obtain better understanding of the BISTRO data,
 - with using available data:
 - Planck v.202: flux and polarization data
 - Low resolution: FWHM=4.9' @HFI 353GHz (Planck Collaboration, 2016, A&A 594, A8)
 - But sensitive ($3 \times 10^{-5} \text{ K}_{\text{CMB}} = 2.5 \text{ kJy/sr}$), homogeneous all sky map
 - optical polarization data. etc.
- This talk considers a filament in L1689 of Oph region.
 - This filament contains L1689, L1712, and L1729.



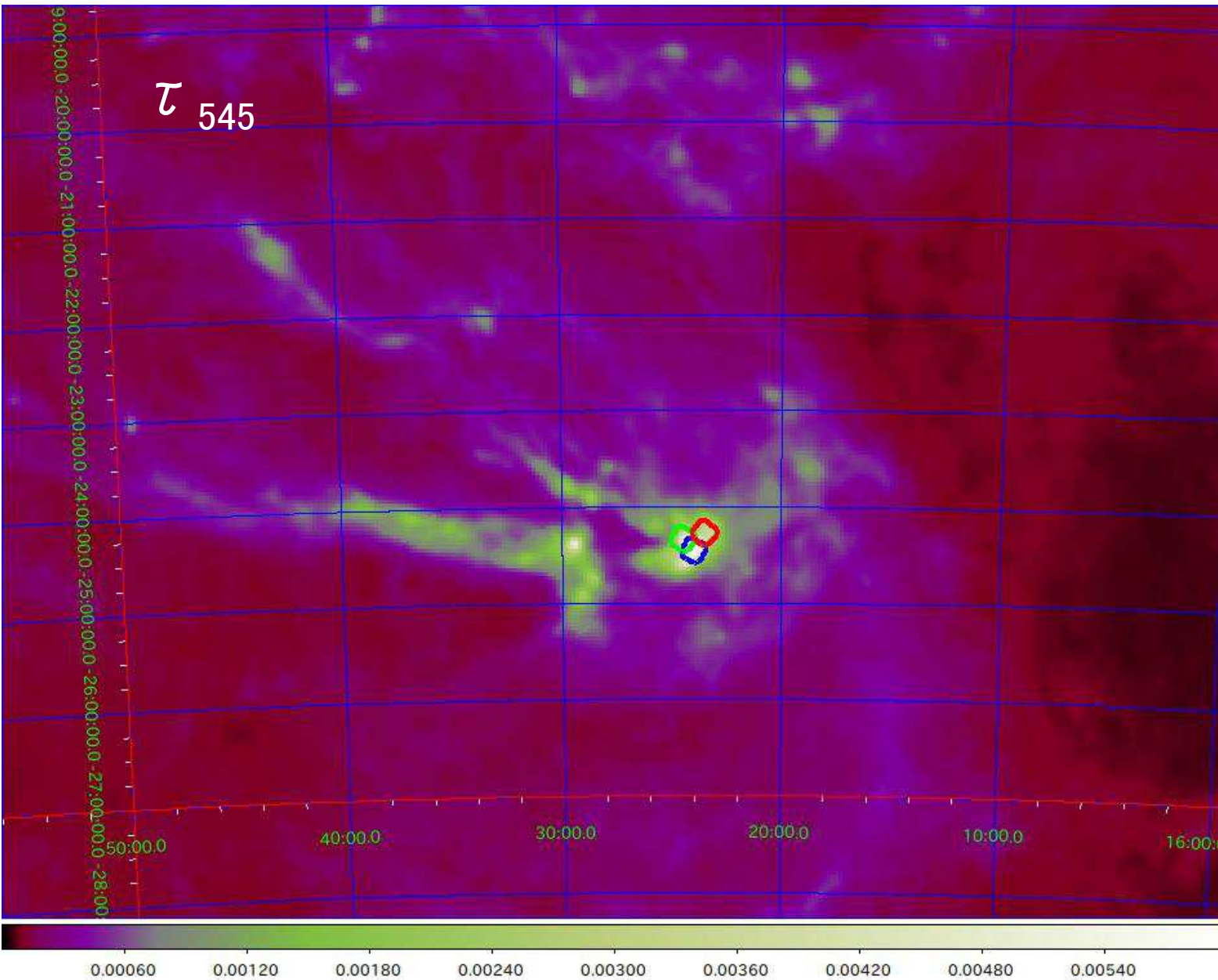
Extinction Map

FIG. 3.—Map of extinction in Ophiuchus derived using 2MASS NICER. The contour indicates an A_V of 3 mag and is repeated in subsequent figures for orientation. Note that the small “hole” at the center of the L1688 cluster is an artifact due to the high extinction at that position.

Ridge + 2006 AJ 131, 2921

Data used in this study:

- Planck data: version 2.02 (released in 2015)
 - 353GHz all sky map: HFI_SkyMap_353_2048_R2.02_full.fits
 - CO 3 → 2 line subtraction:
 - Planck Collaboration, 2014, AA571, A13
 - “Type 3” method “Multi-line approach”
 - data: COM_CompMap_CO21-commander_2048_R2.00.fits
 - CMB subtraction:
 - data: COM_CMB_IQU-commander-field-Int_2048_R2.01_full.fits
- Optical polarimetry:
 - Vrba et al. 1976, AJ 81, 958 (also Vrba et al. 1993, AJ 105, 1010)
- Dust model: “2 component model” ... it uses 2 black (grey) bodies.
 - Meisner & Finkbeiner 2015, ApJ 798, 88

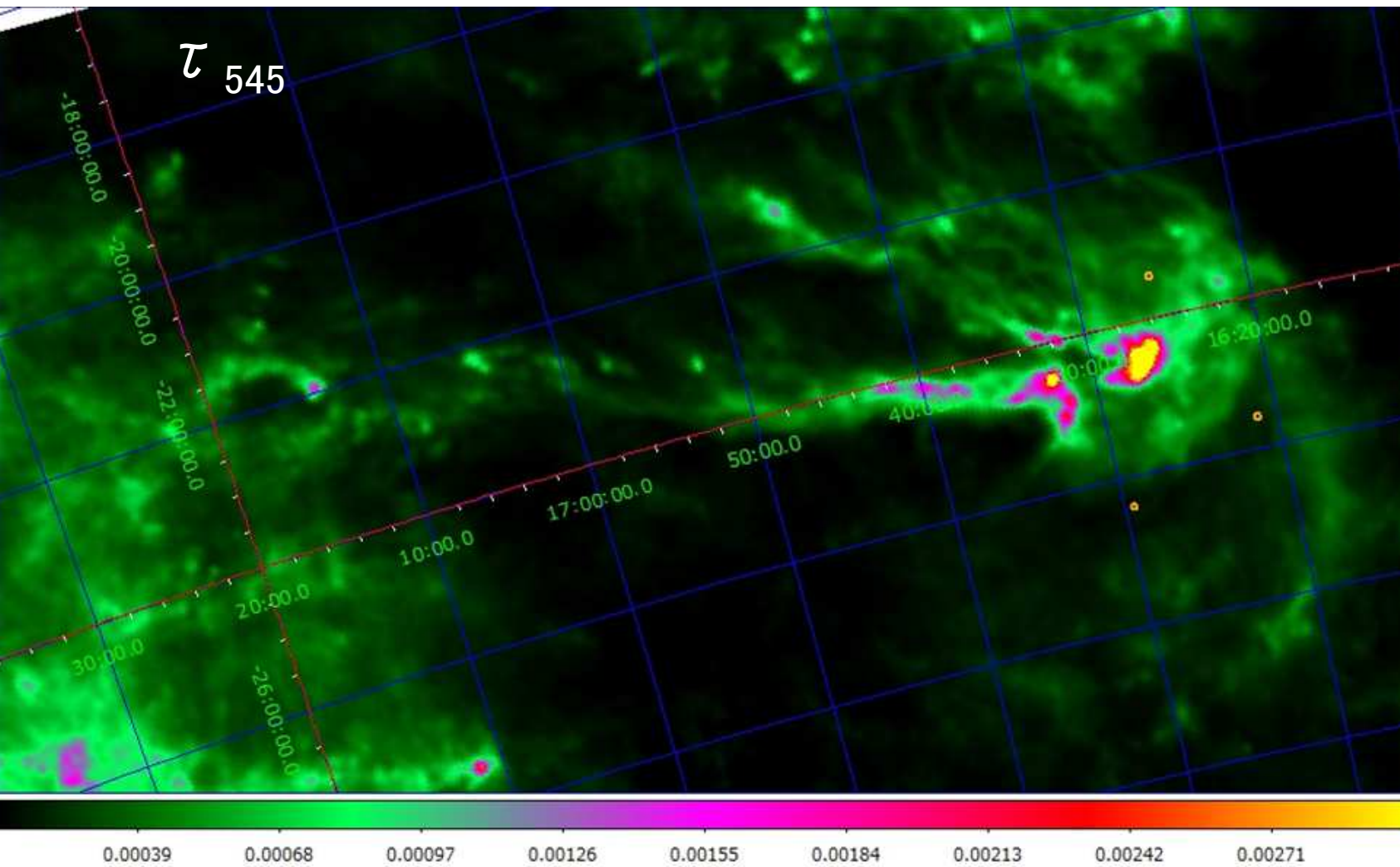


τ_{545} of 2comp-
model

Meisner & Finkbeiner
2015

$$A_V = 8 \times 10^3 \tau_{545}$$

Regions of L1688
observed by BISTRO are
also indicated.

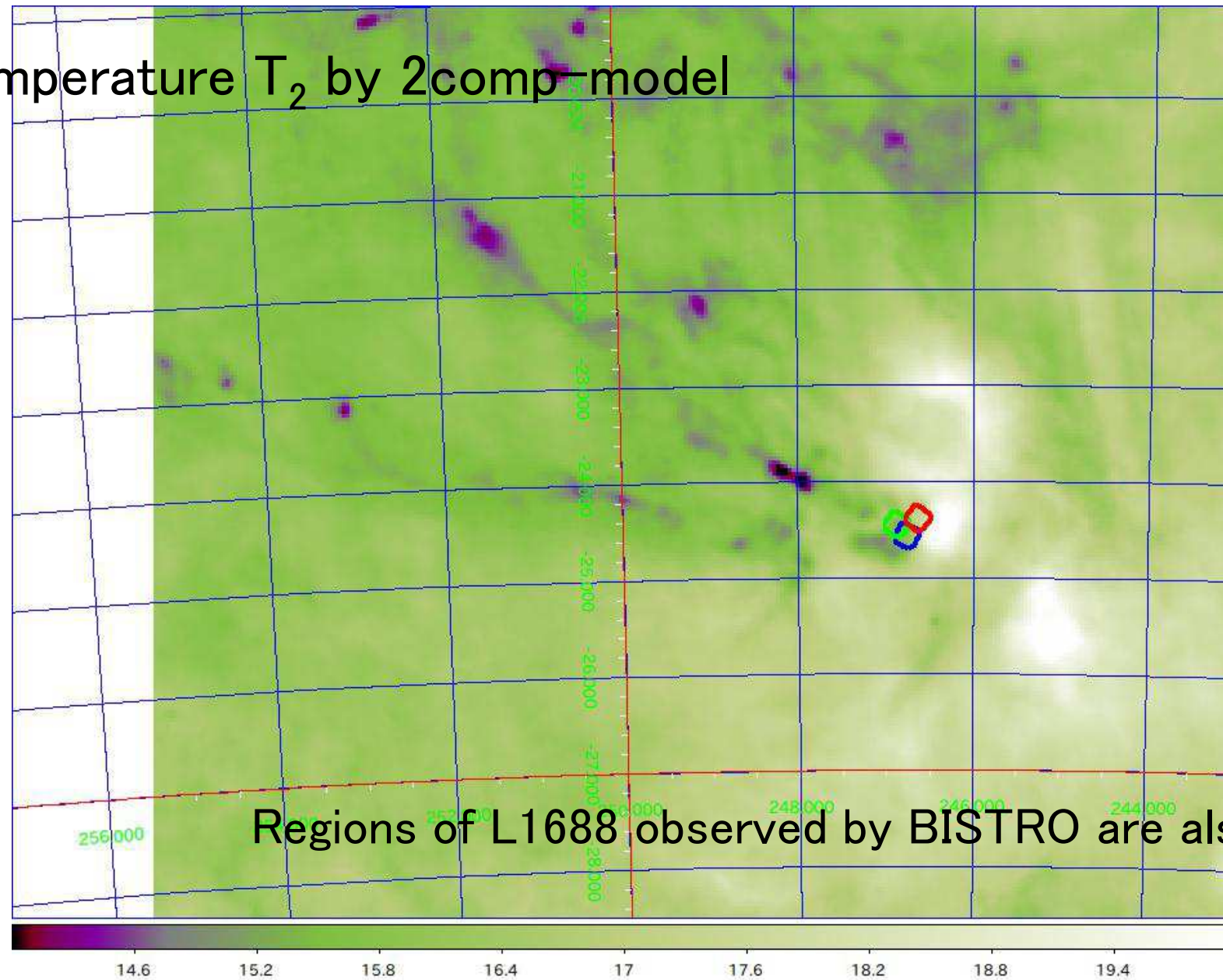


τ_{545} of
2comp-model

Meisner &
Finkbeiner 2015

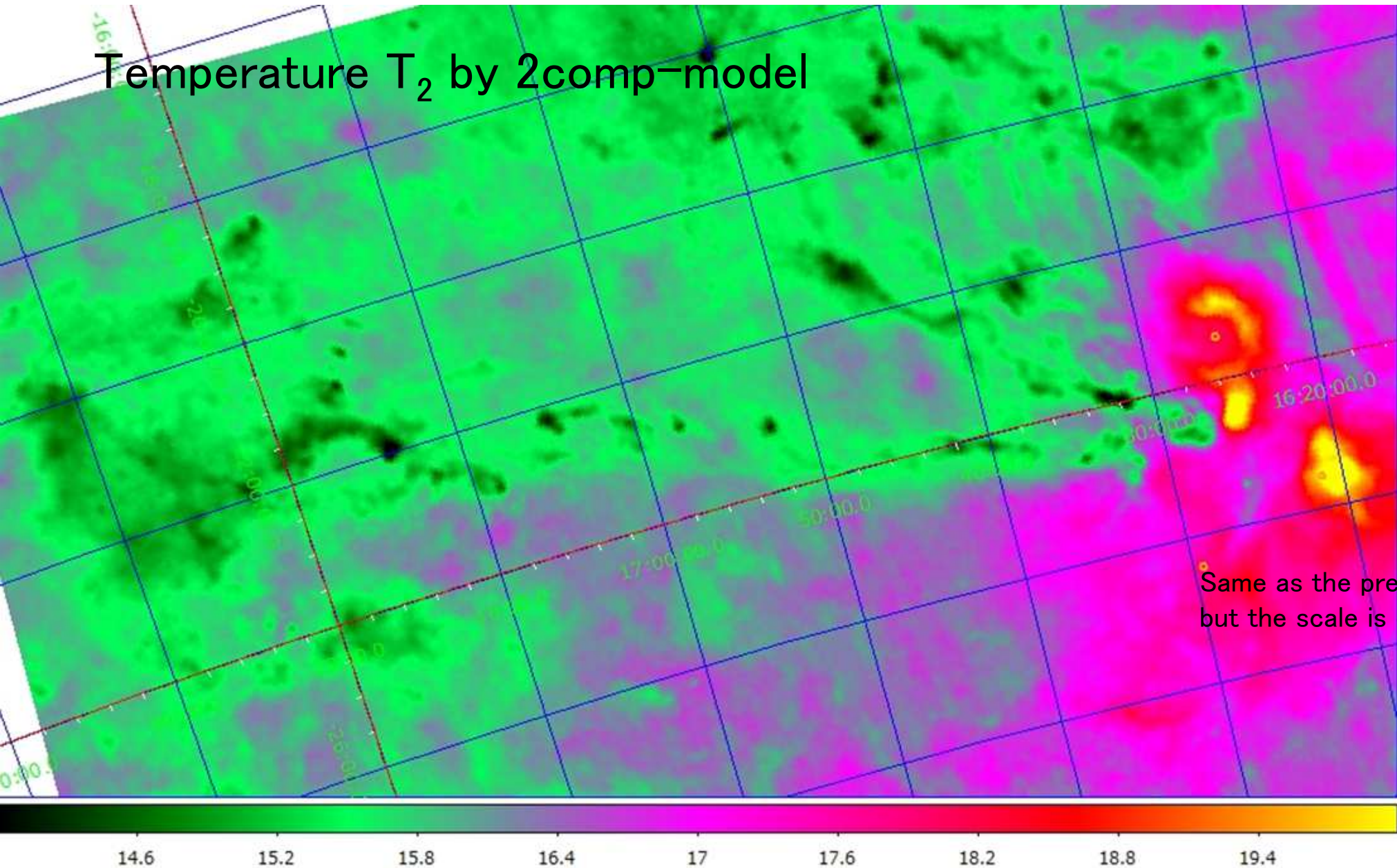
Same as the
previous slide, but
the scale is different.

Temperature T_2 by 2comp-model

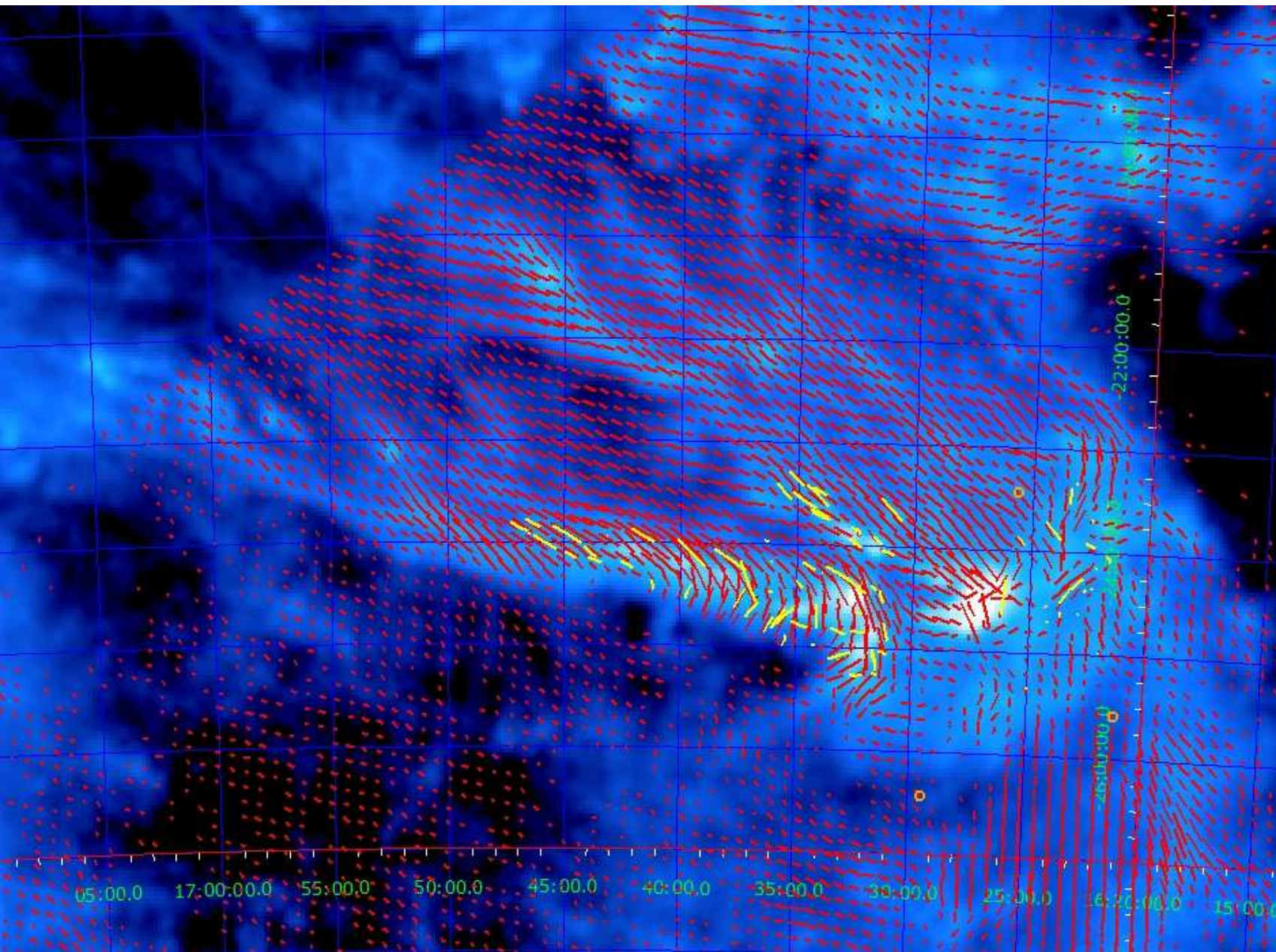


Regions of L1688 observed by BISTRO are also indicated.

Temperature T_2 by 2comp-model

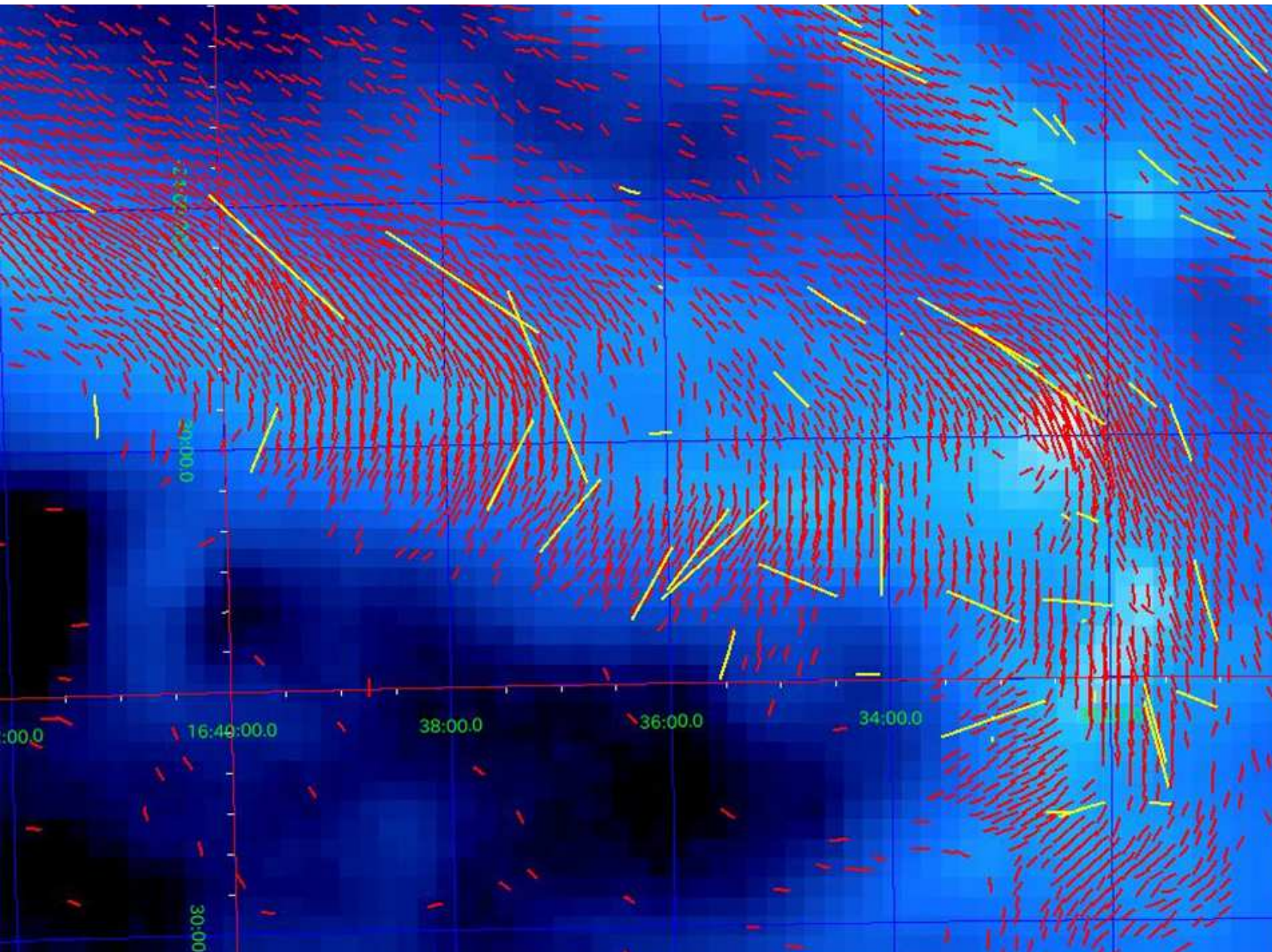


Same as the previous slide,
but the scale is different.



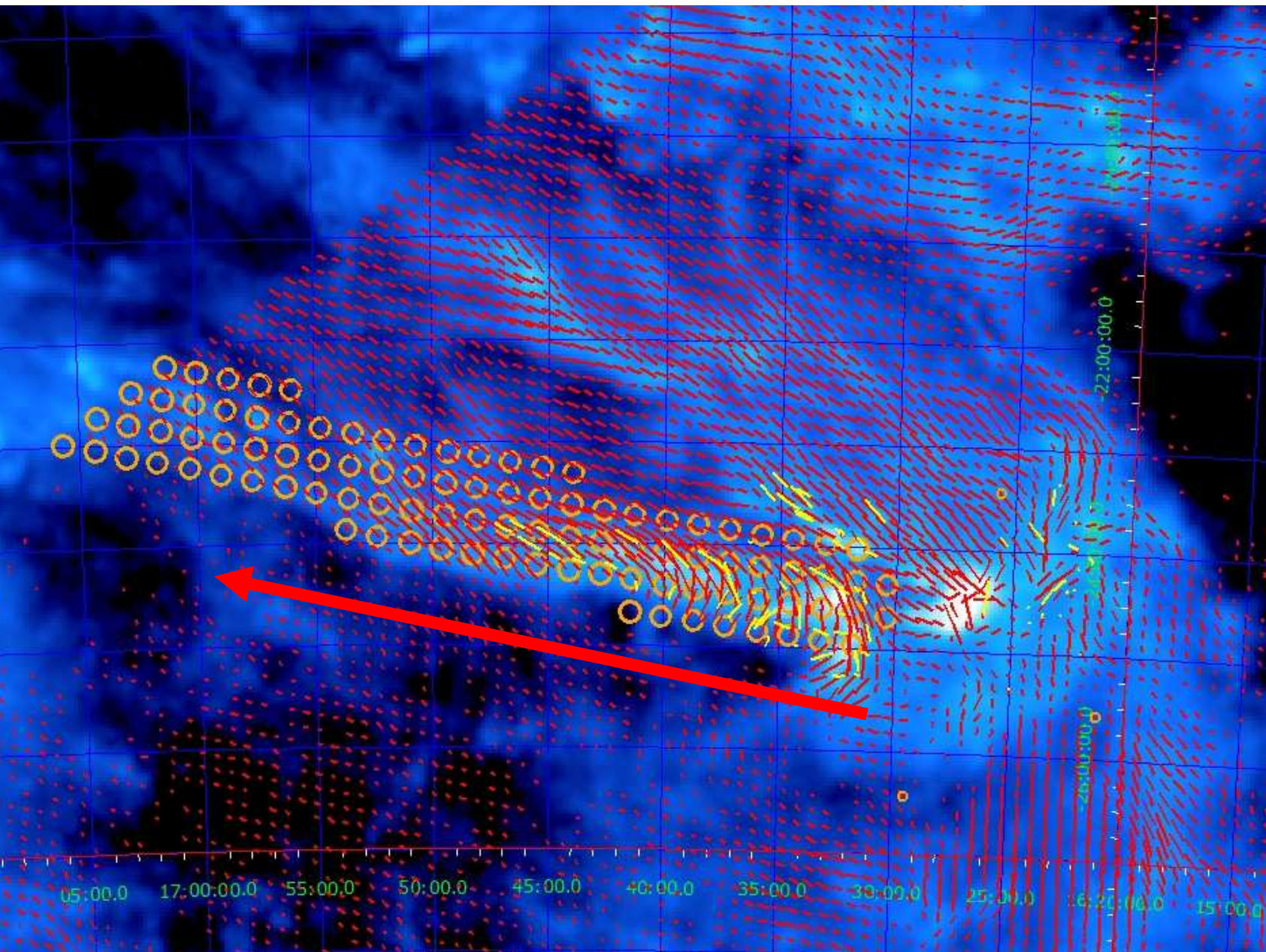
Polarization

- The directions are the B-field.
- Red: Planck 353GHz submm polarized flux
 - binning: $8.5' \times 8.5'$
- Yellow: Optical polarization by Vrba + 1976



Polarization around L1689 (enlarged)

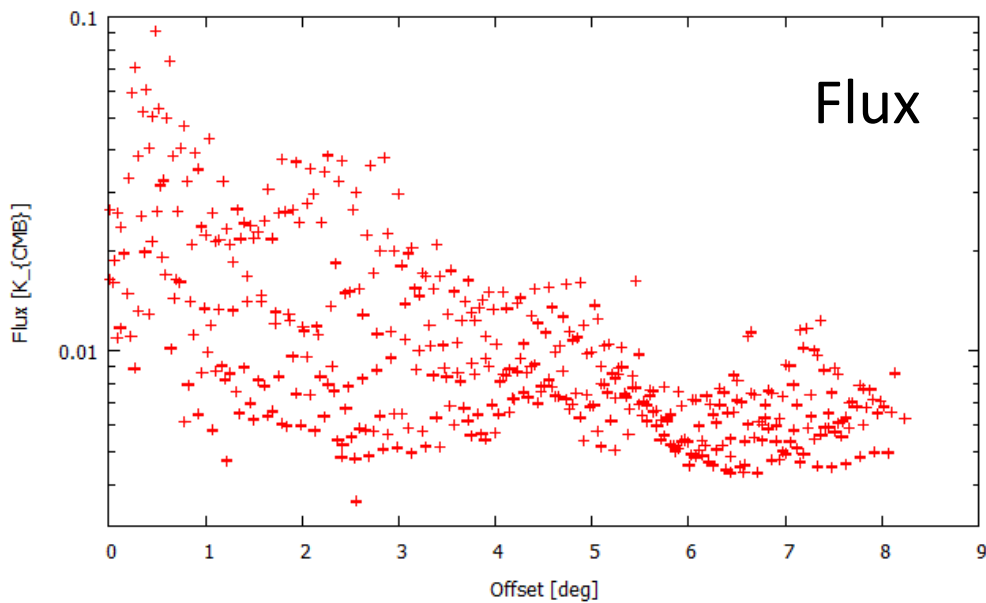
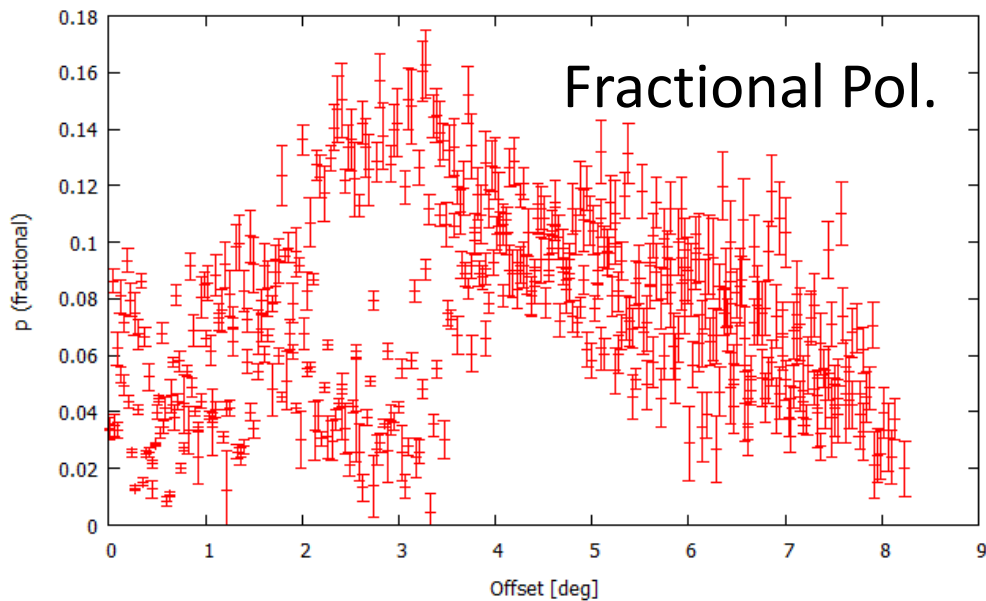
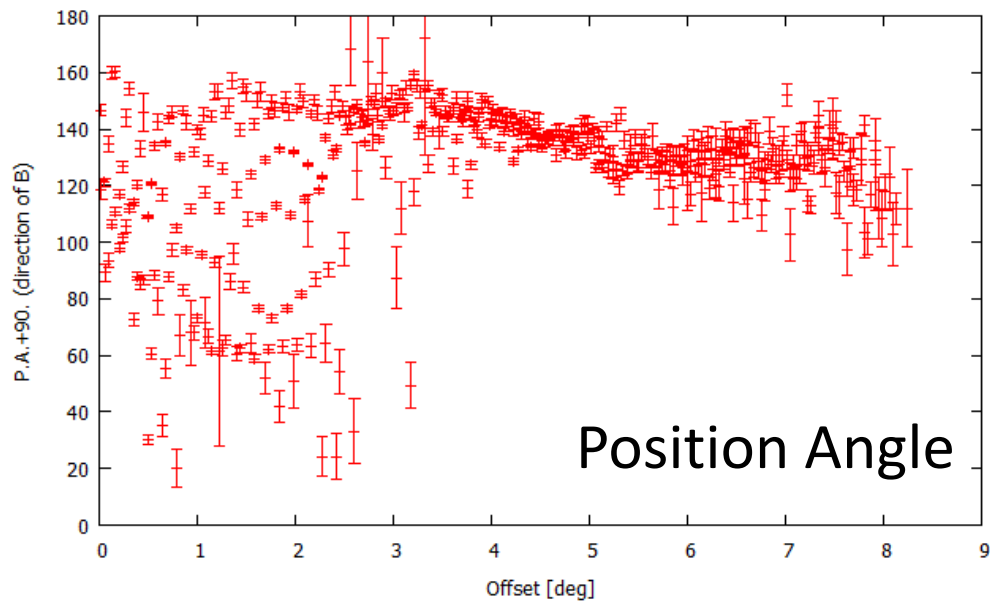
- Red: Planck 353GHz submm polarized flux
 - no binning
 $1.7' \times 1.7'$
- Yellow: Optical polarization by Vrba + 1976



Investigated region
of L1689 filament:

From $(\alpha_0, \delta_0) =$
 $(353.43, 16.05)$
In the direction of
P.A.=72deg.

Width: ± 0.6 deg.
Length: ~ 8 deg.

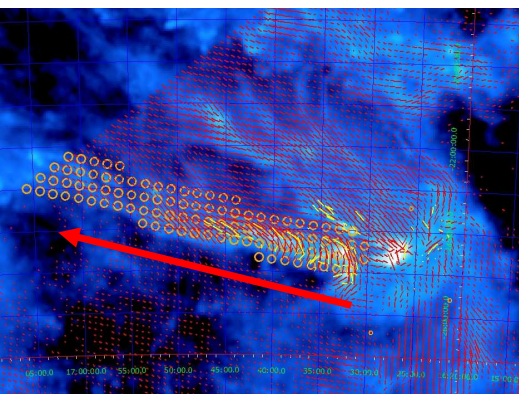


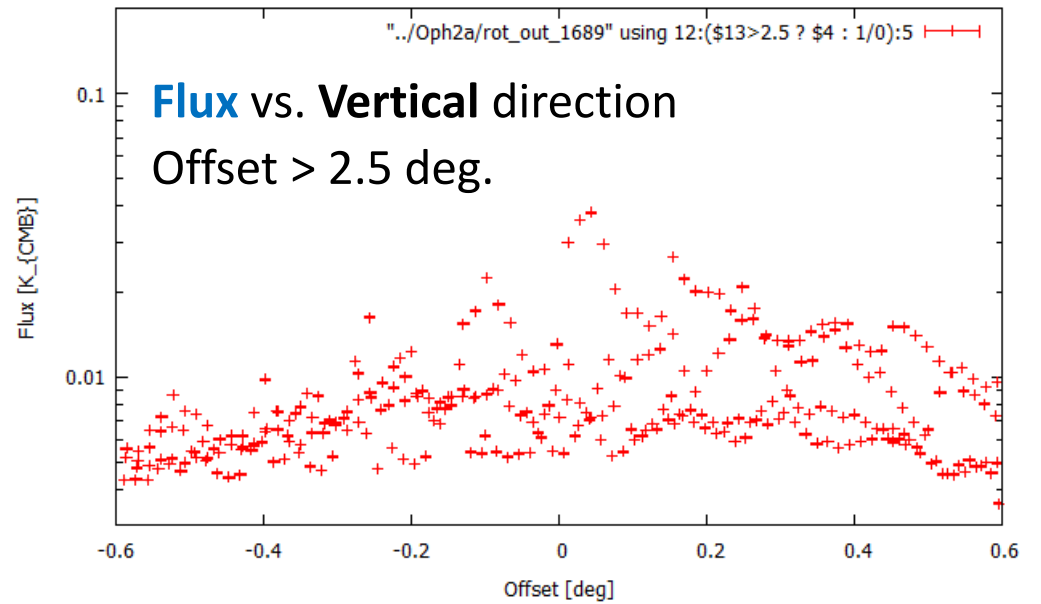
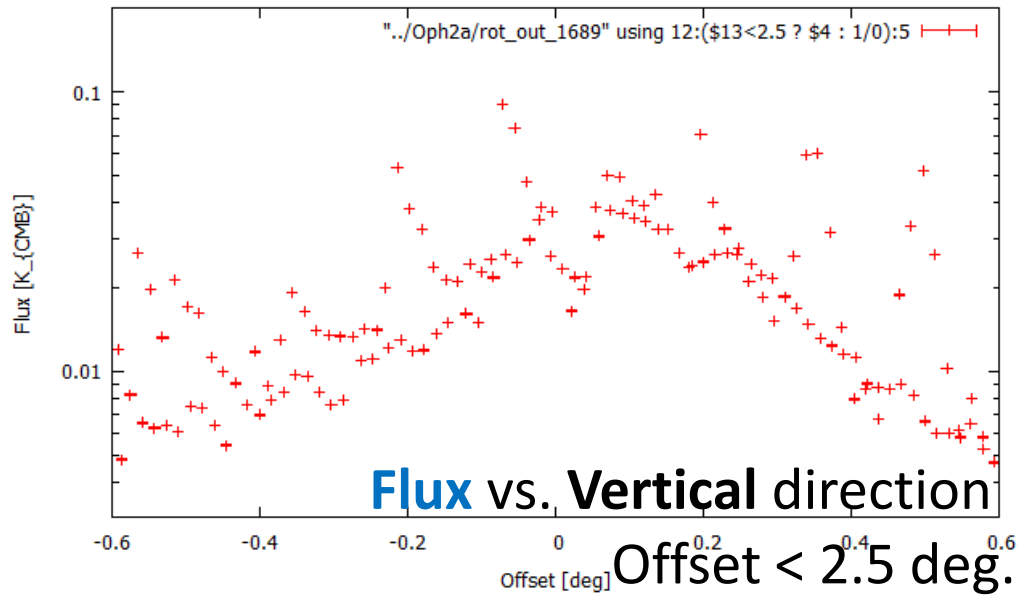
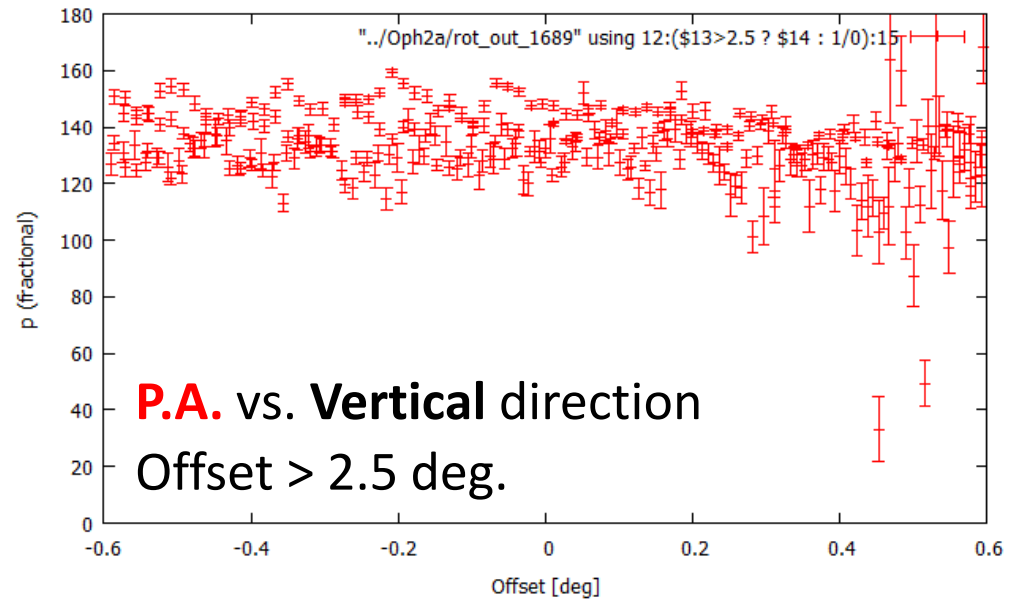
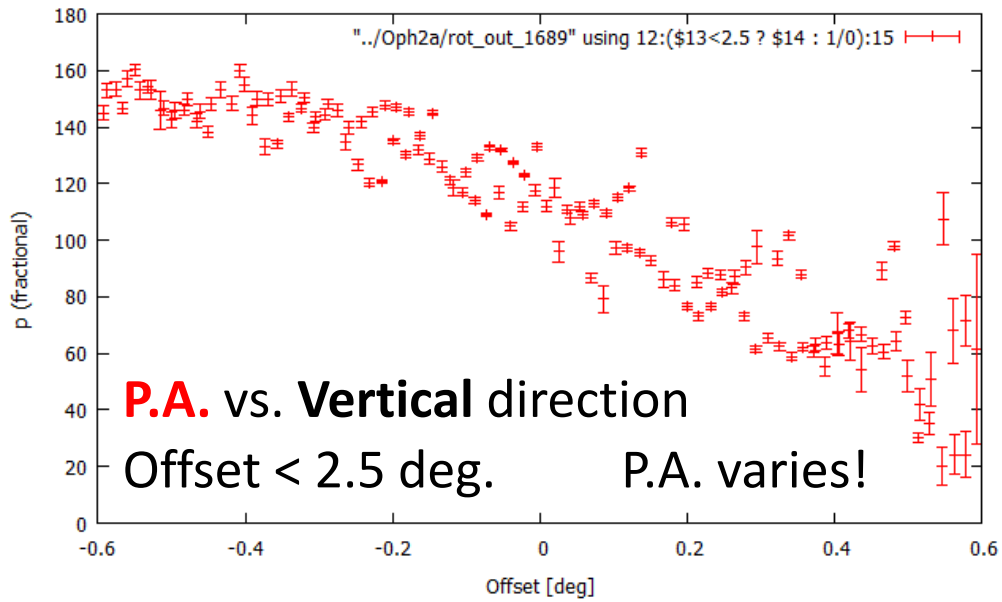
• L1689 filament: $(\alpha_0, \delta_0) = (353.43, 16.05)$

P.A. of cutting: 162d.

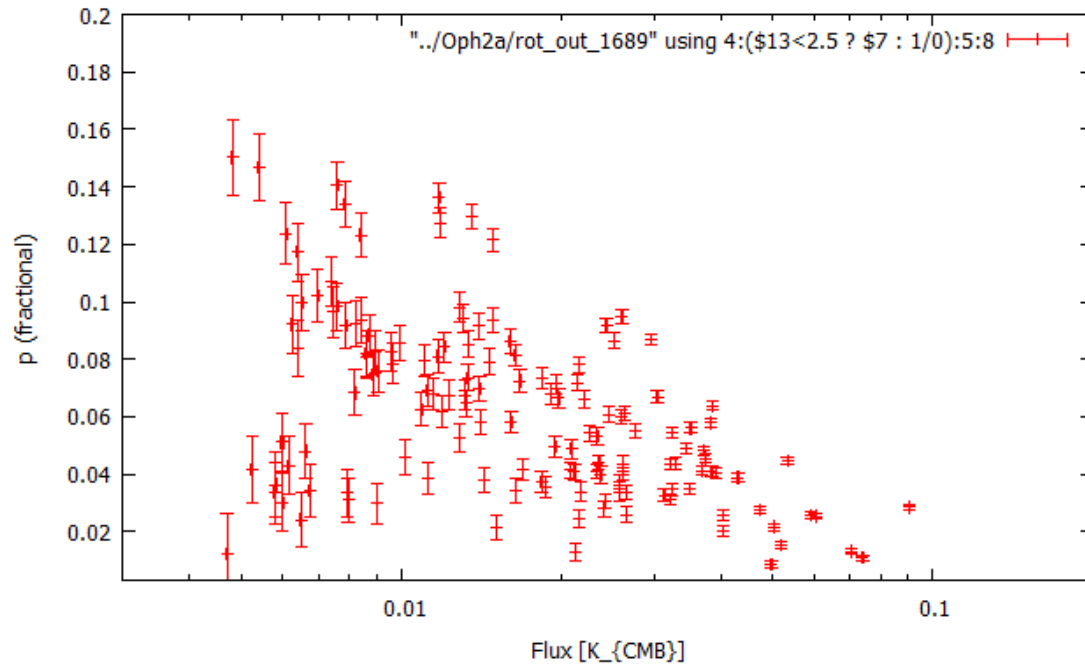
162 deg. \neq 140 deg.

Binning: $8.5' \times 8.5'$

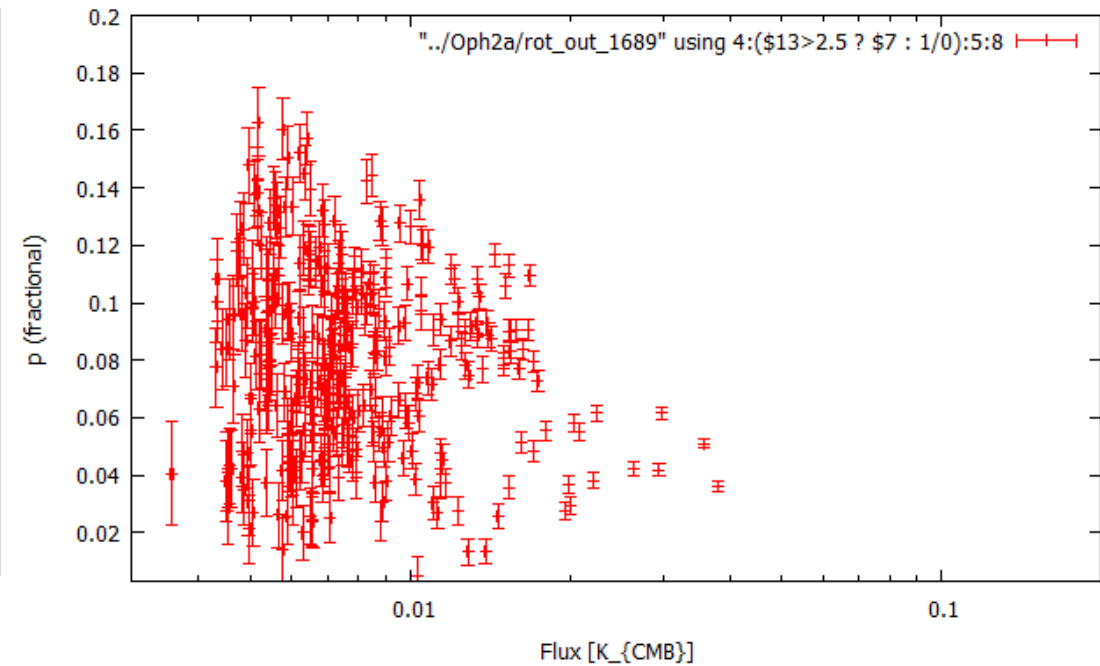




Flux vs. fractional pol in L1689 filament

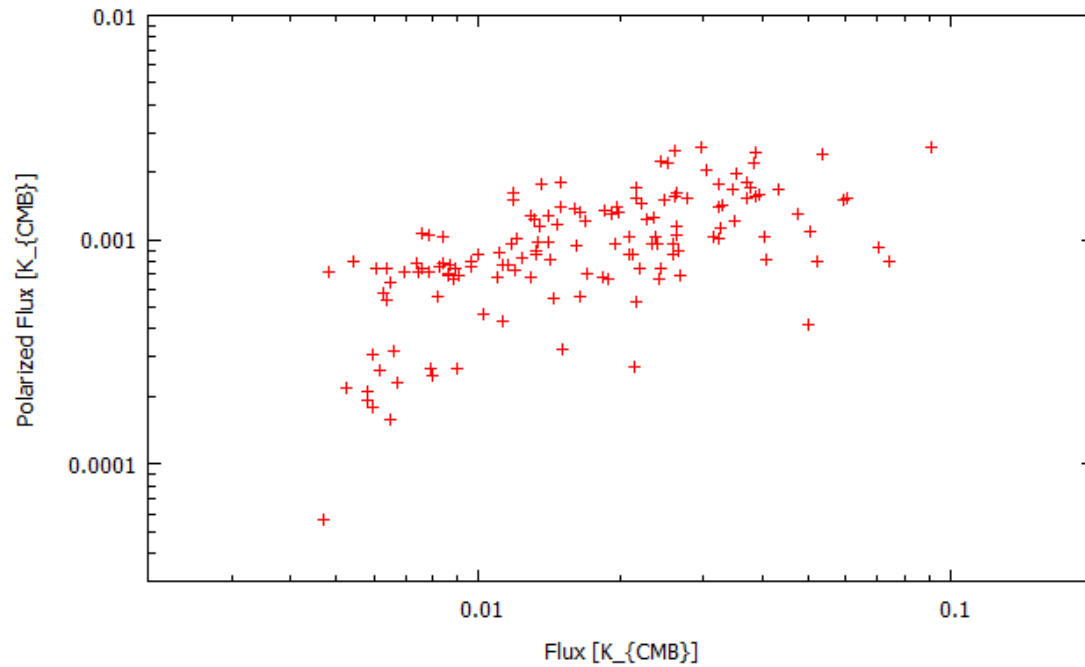


Offset < 2.5 deg.

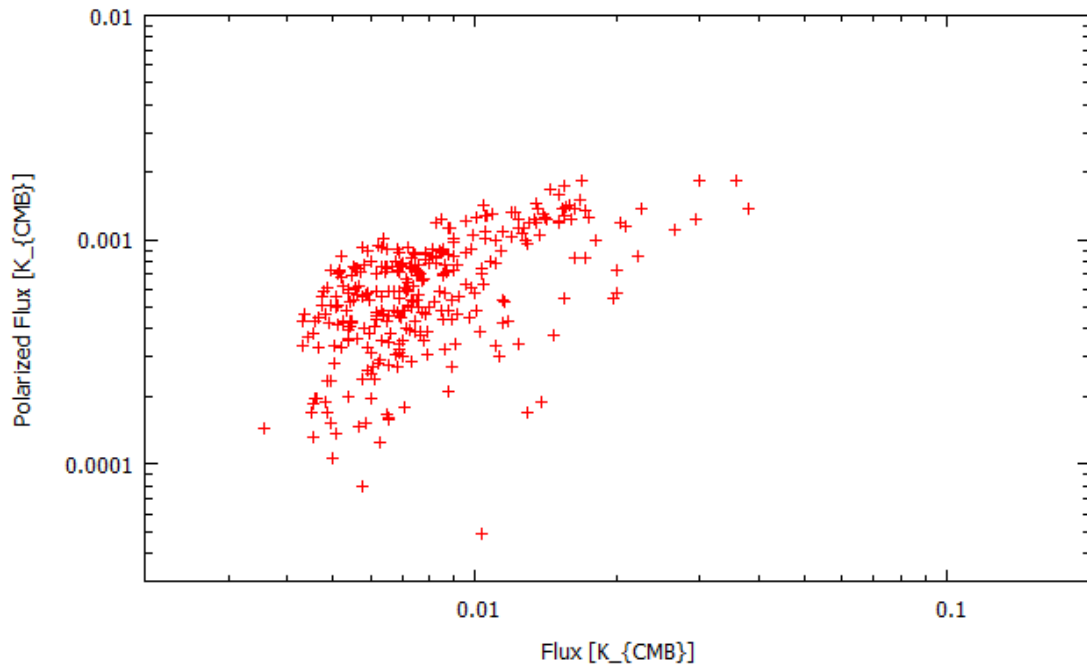


Offset > 2.5 deg.

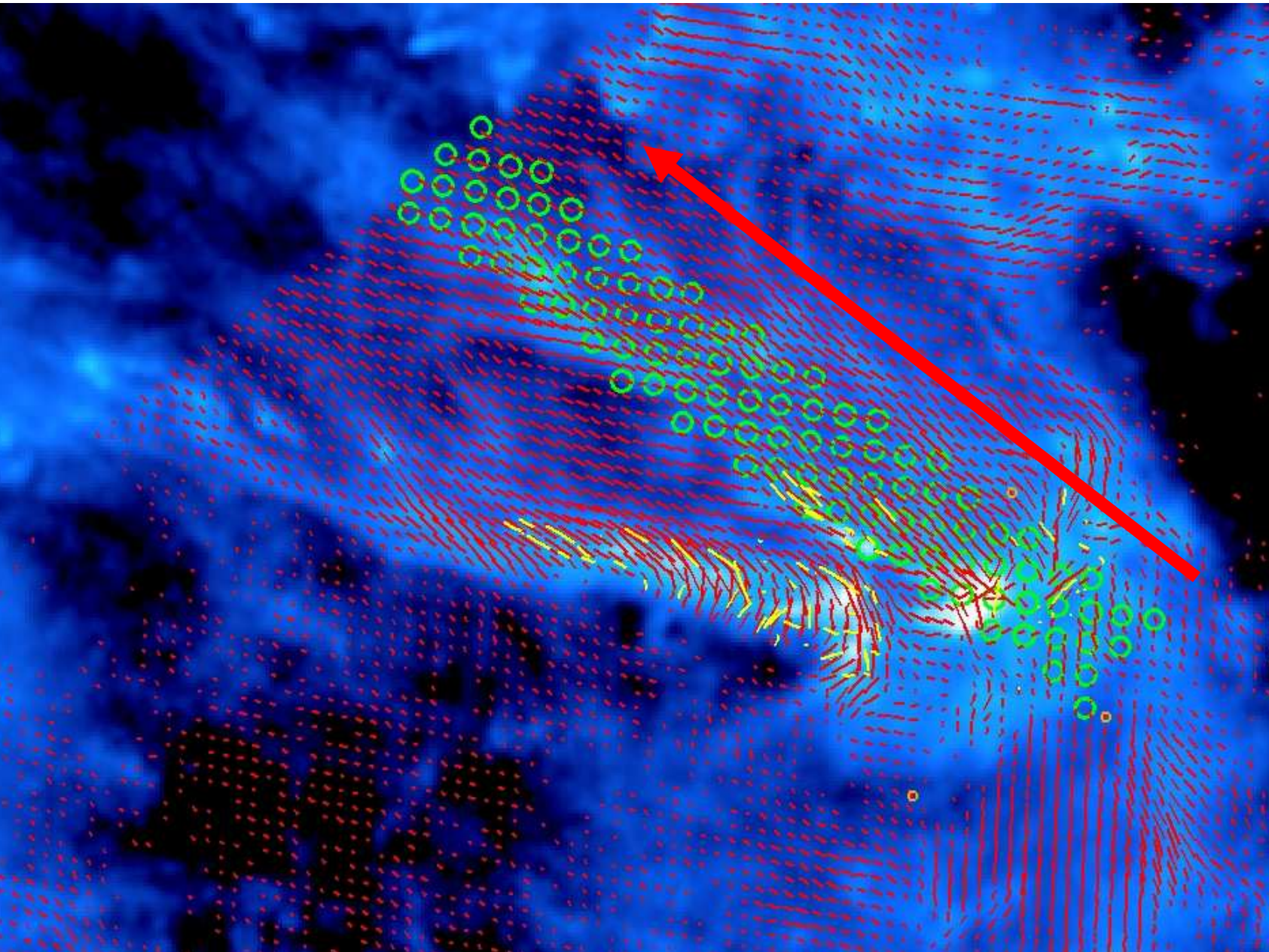
Flux vs. Polarized Flux in L1689 filament



Offset < 2.5 deg.



Offset > 2.5 deg.



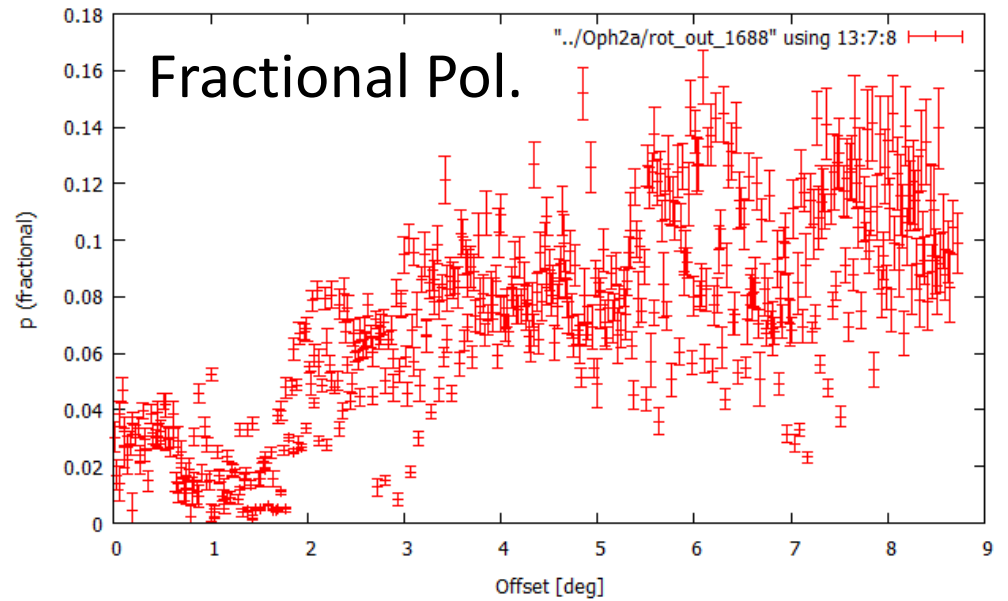
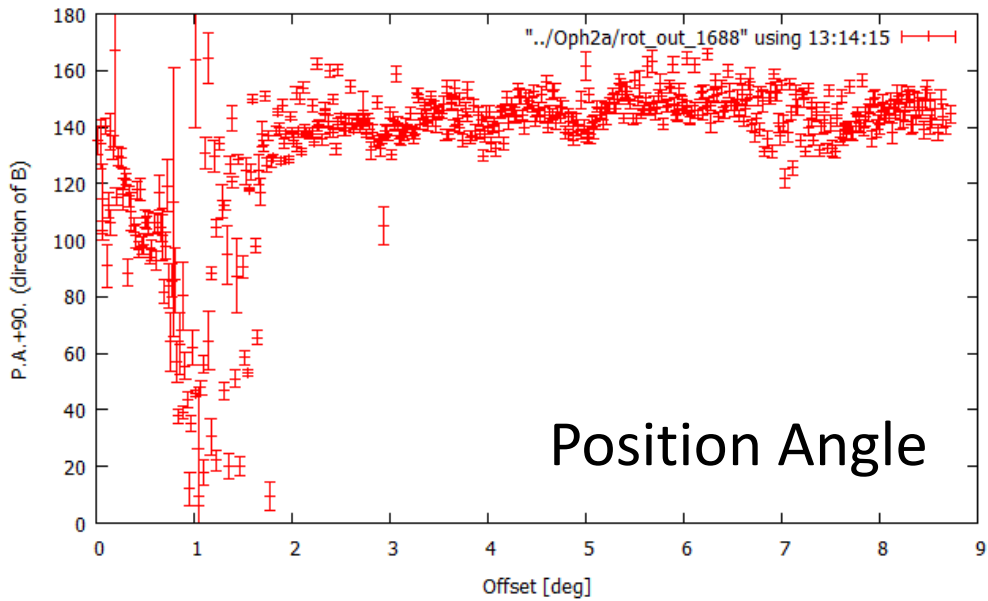
Investigated region
of L1688 filament:

From $(\alpha_0, \delta_0) =$
 $(351.61, 17.48)$

In the direction of
P.A.=52deg.

Width: ± 0.6 deg.

Length: ~ 9 deg.

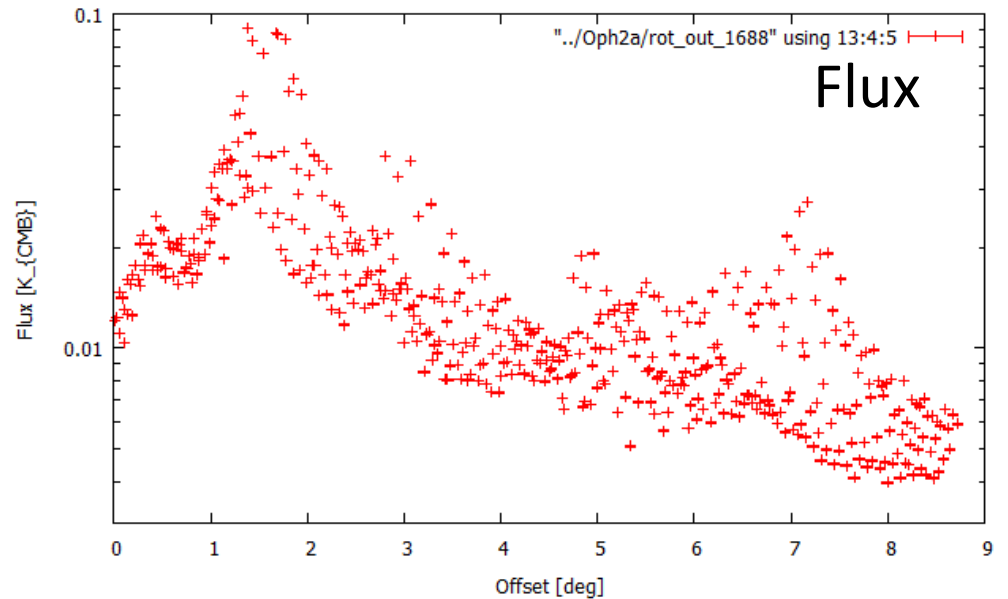
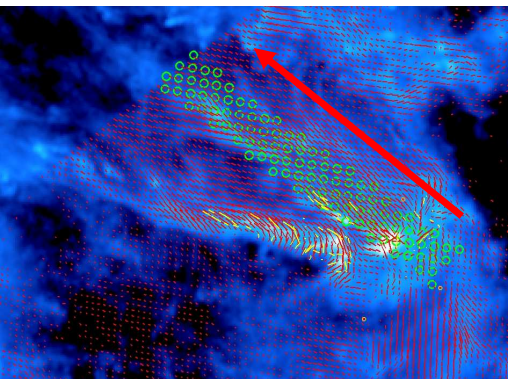


- L1688 filament: $(\alpha_0, \delta_0) = (351.61, 17.48)$

P.A. of cutting: 142 deg.

It coincides with P.A.

Binning: $8.5' \times 8.5'$



Summary

- L1689–L1712–L1729 filament: warped magnetic field?
 - We found that P.A. varies 120 deg. in the NS direction.
 - This variation continues along 2.5° (or 5.7 pc in projected linear distance) along the EW direction.
 - P.A. is almost constant ~ 140 deg. in the eastern region.
 - But P.A. is NOT exactly the same as the filament direction ~ 160 deg.
- What is it? Can stellar wind from σ Sco and/or other stars explain it?
- Clumps are present in the L1689 filament.
 - In the pol-vector map, those clumps seem not to be affected by the B-field.
 - The B-field may be too complicated to resolve, so the appearance of pol-vectors does not change?

Thank you! Merci!