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# MAGNETIC FIELDS AND TURBULENCE IN THE DIFFUSE ISM AND ON GALACTIC SCALES

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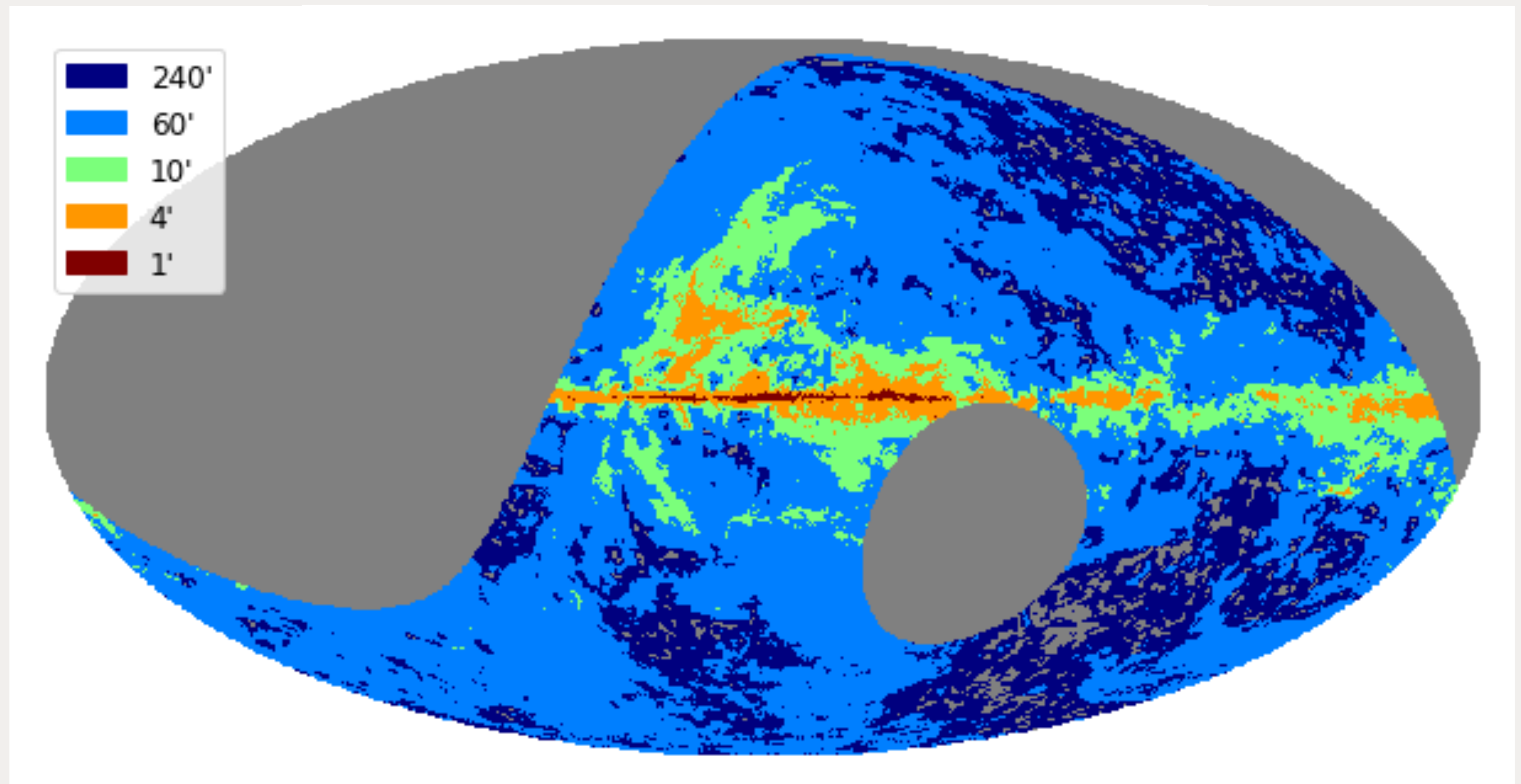
# Big-Picture Science Questions

- How do magnetic fields affect structure formation and evolution in the diffuse ISM?
- Are magnetic fields in molecular clouds connected to galactic-scale magnetic fields?
- What is the composition of interstellar dust?
- What is the nature of magnetohydrodynamic turbulence in the ISM?
- How does turbulence dissipate in the diffuse ISM?

# Mapping magnetic fields in the diffuse ISM

- What dust polarization maps can be made “for free”, considering nominal large-area sky survey?
- CMB-S4 high-cadence uniform coverage strategy
- 4000 hours, uniform coverage over DEC +18 to -64,  $\sim 25000 \text{ deg}^2$
- 850 GHz

What resolution is needed for 3 sigma polarization detections?

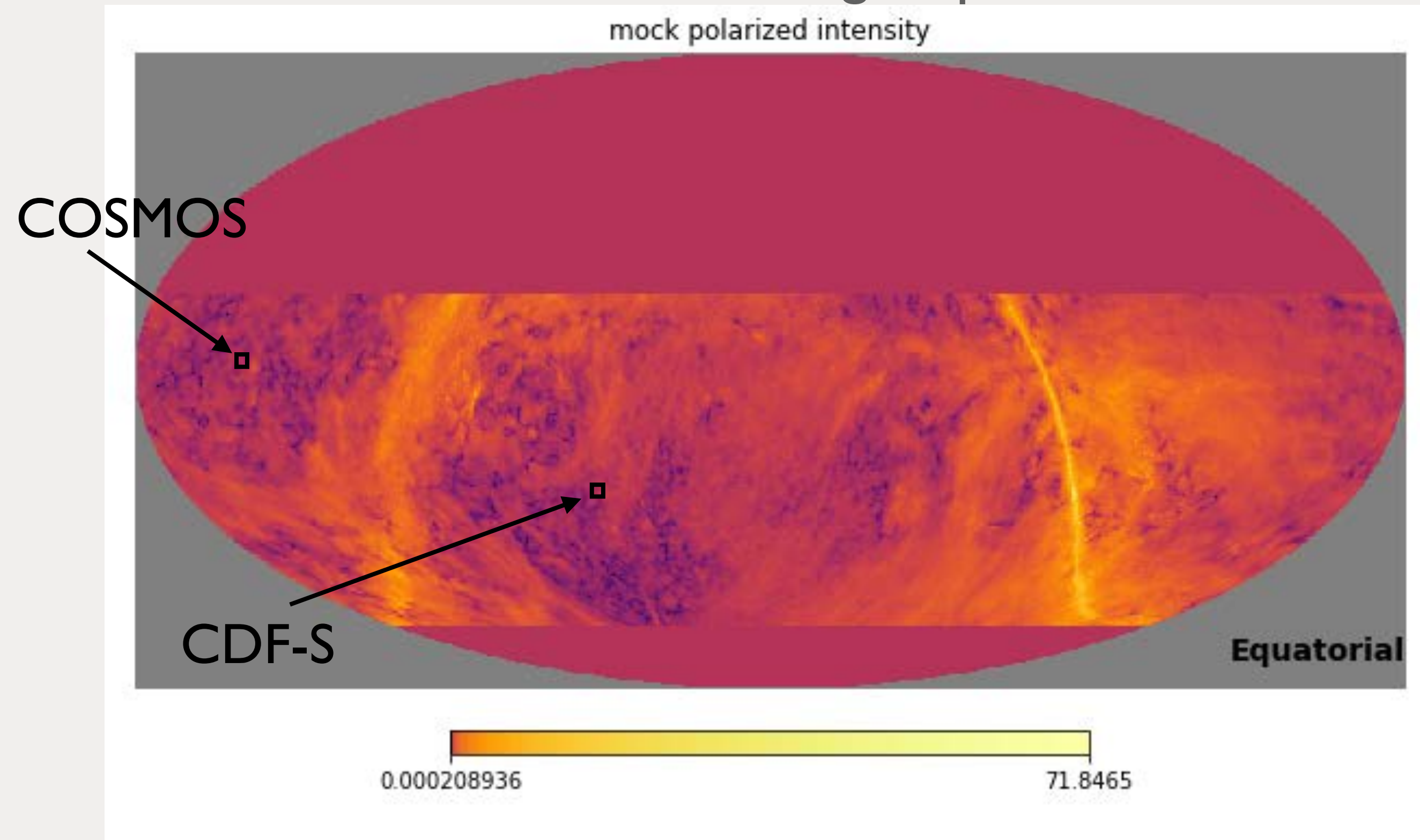


Based on *Planck* 857 GHz intensity + 353 GHz polarization fraction

# Mapping magnetic fields in the diffuse ISM

- What dust polarization maps can be made “for free”, considering nominal deep survey regions?
- CDF-S and COSMOS fields, following Choi+ 2020
- 2000 hours, uniform coverage over  $8 \text{ deg}^2$
- 850 GHz

What resolution is needed for 3 sigma polarization detections?



Based on *Planck* 857 GHz intensity + 353 GHz polarization fraction

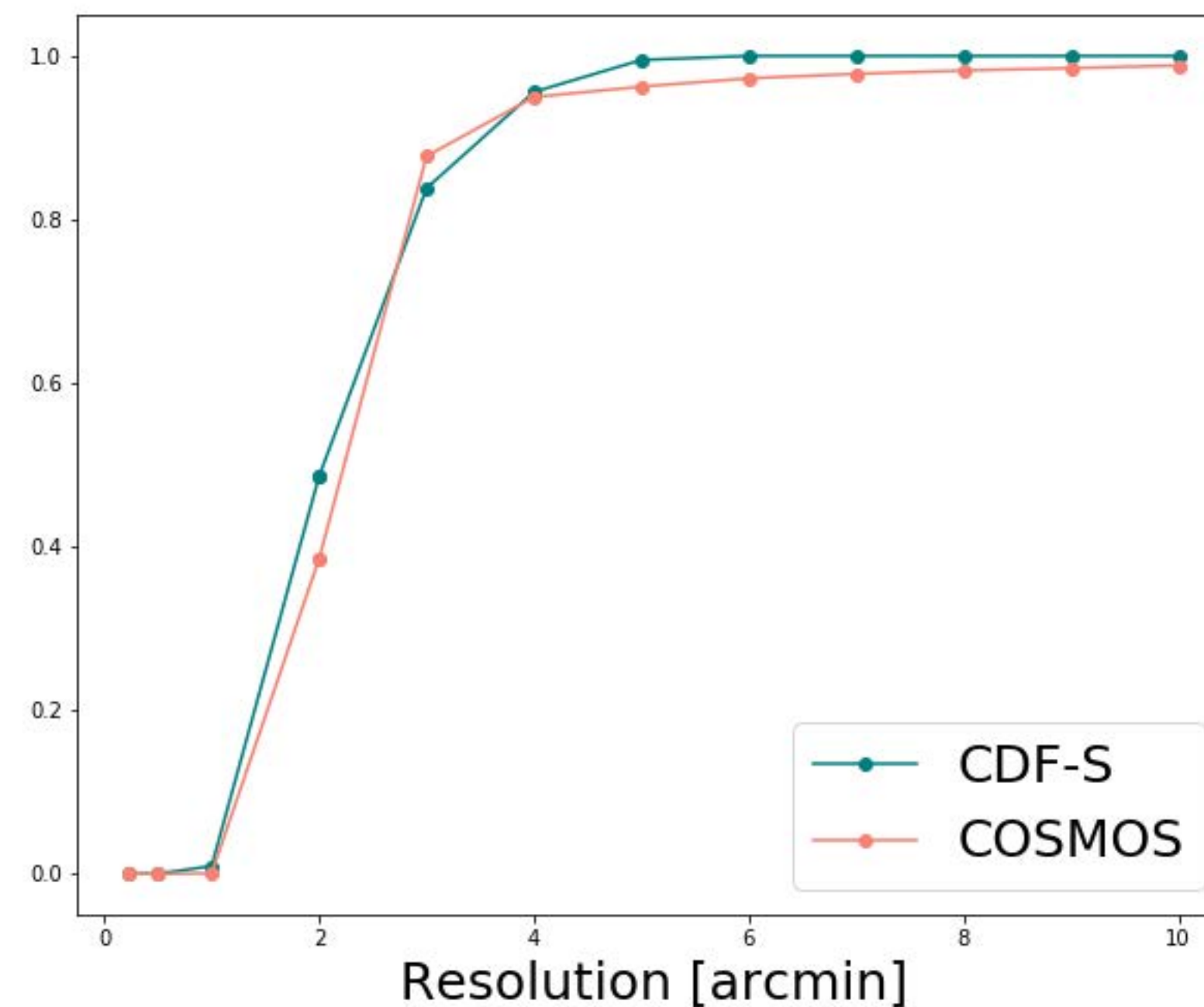


# Mapping magnetic fields in the diffuse ISM

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Fraction of field with 3 sigma polarization

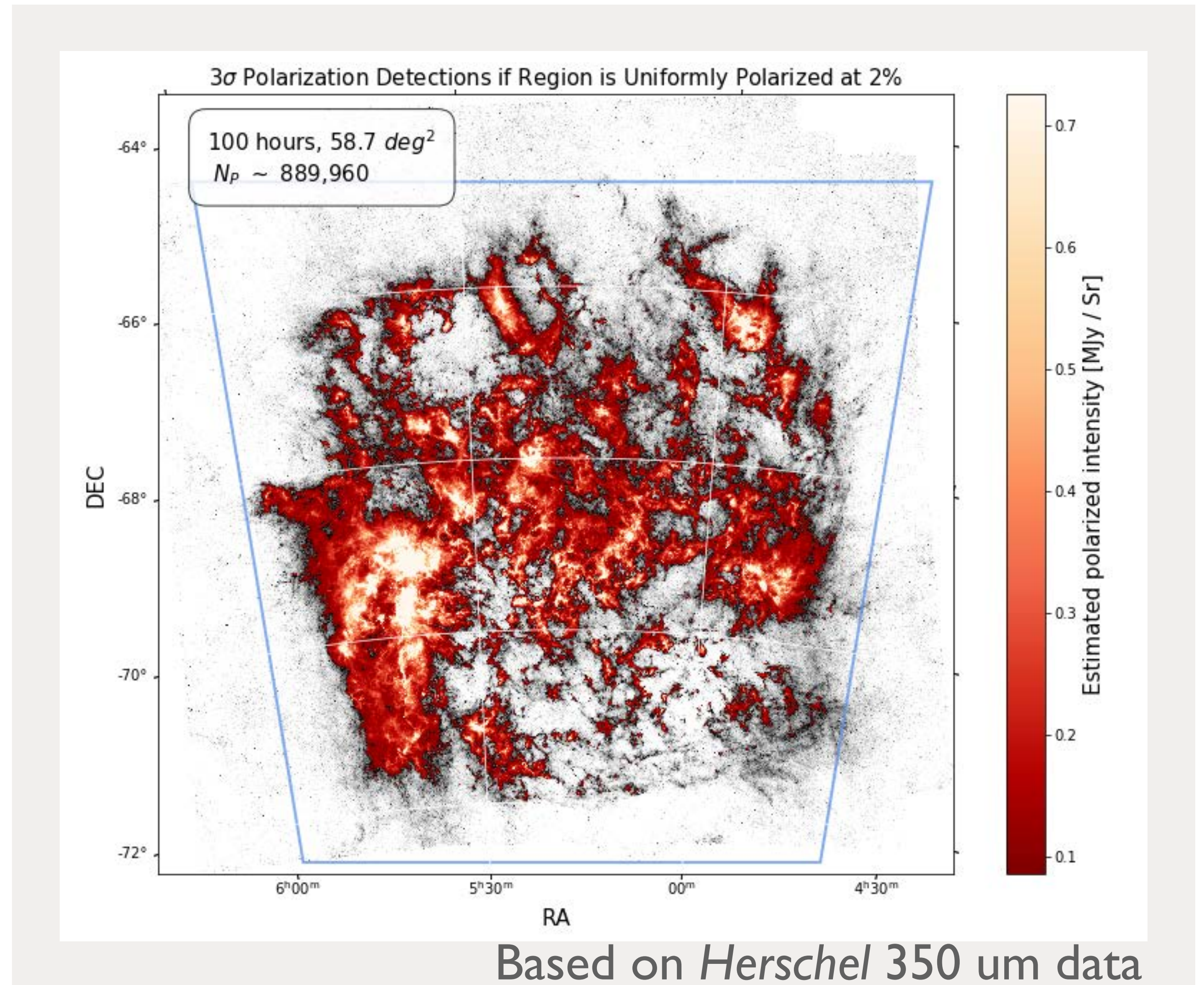


Based on *Planck* 857 GHz intensity + 353 GHz polarization fraction



# Mapping magnetic fields in the LMC

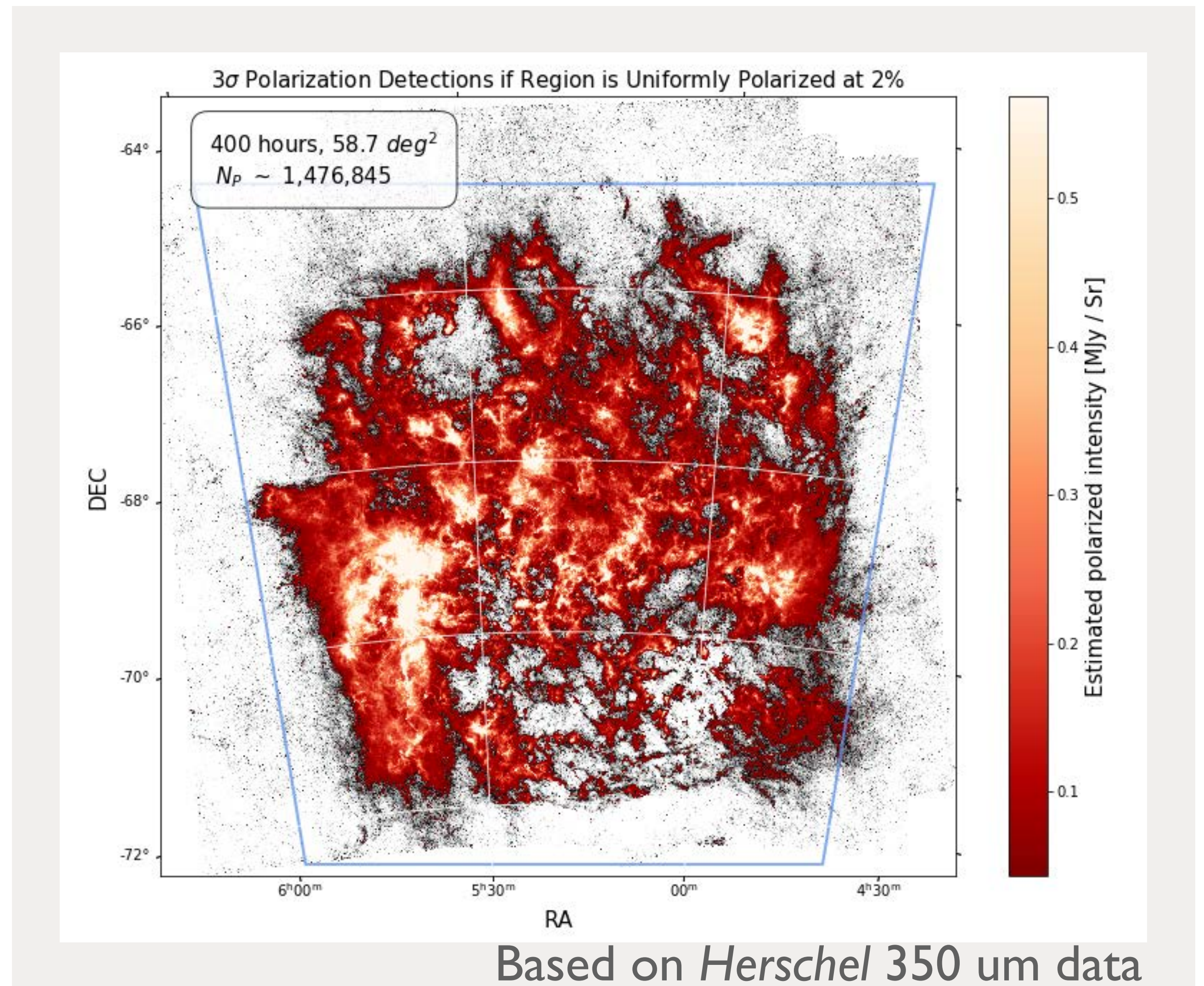
- A dedicated map of the LMC would place measurements of molecular cloud magnetic fields in a galactic context
- Assume uniform 2% polarization. This is a conservative estimate, because diffuse regions are more strongly polarized.
- 100 hours, uniform coverage over  $\sim 59 \text{ deg}^2$
- 850 GHz at full resolution
- Red colorbar shows estimated 3sigma polarization measurements.





# Mapping magnetic fields in the LMC

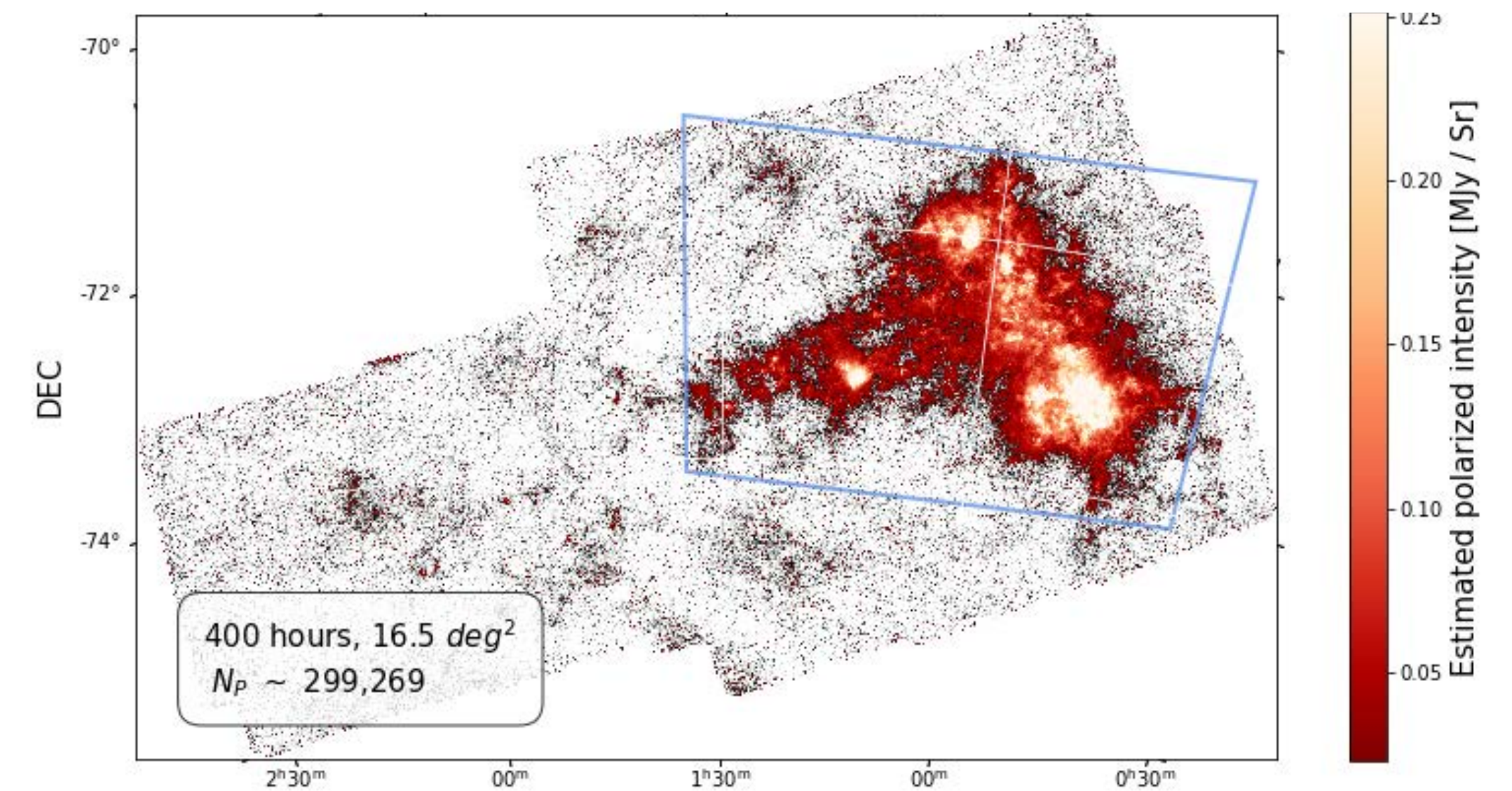
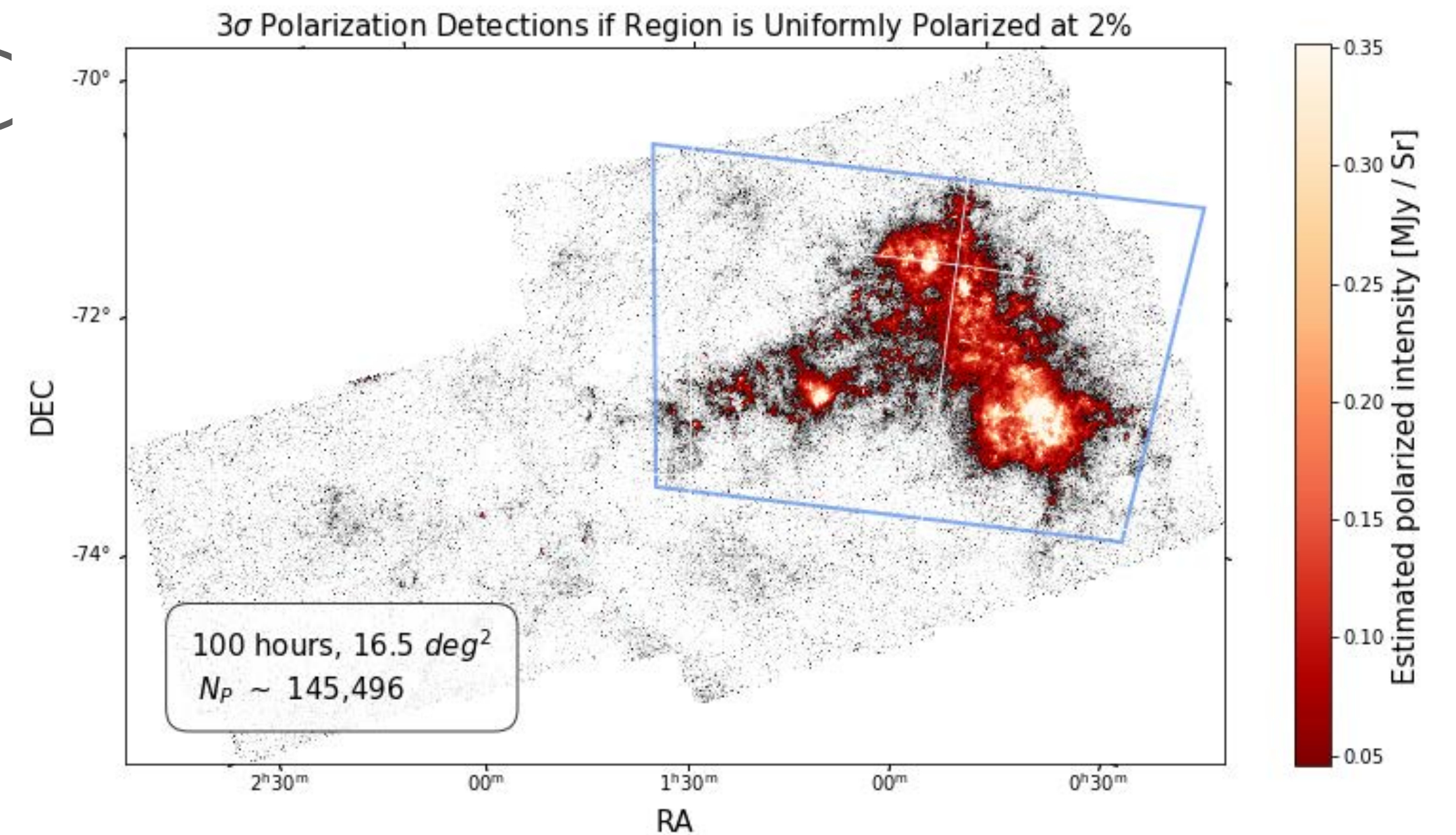
- A dedicated map of the LMC would place measurements of molecular cloud magnetic fields in a galactic context
- Assume uniform 2% polarization. This is a conservative estimate, because diffuse regions are more strongly polarized.
- 400 hours, uniform coverage over  $\sim 59 \text{ deg}^2$
- 850 GHz at full resolution
- Red colorbar shows estimated 3sigma polarization measurements.





# Mapping magnetic fields in the SMC

- A dedicated map of the SMC would place measurements of molecular cloud magnetic fields in a galactic context
- Assume uniform 2% polarization. This is a conservative estimate, because diffuse regions are more strongly polarized.
- 400 hours, uniform coverage over  $\sim 16.5 \text{ deg}^2$
- 850 GHz at full resolution
- Red colorbar shows estimated 3sigma polarization measurements.

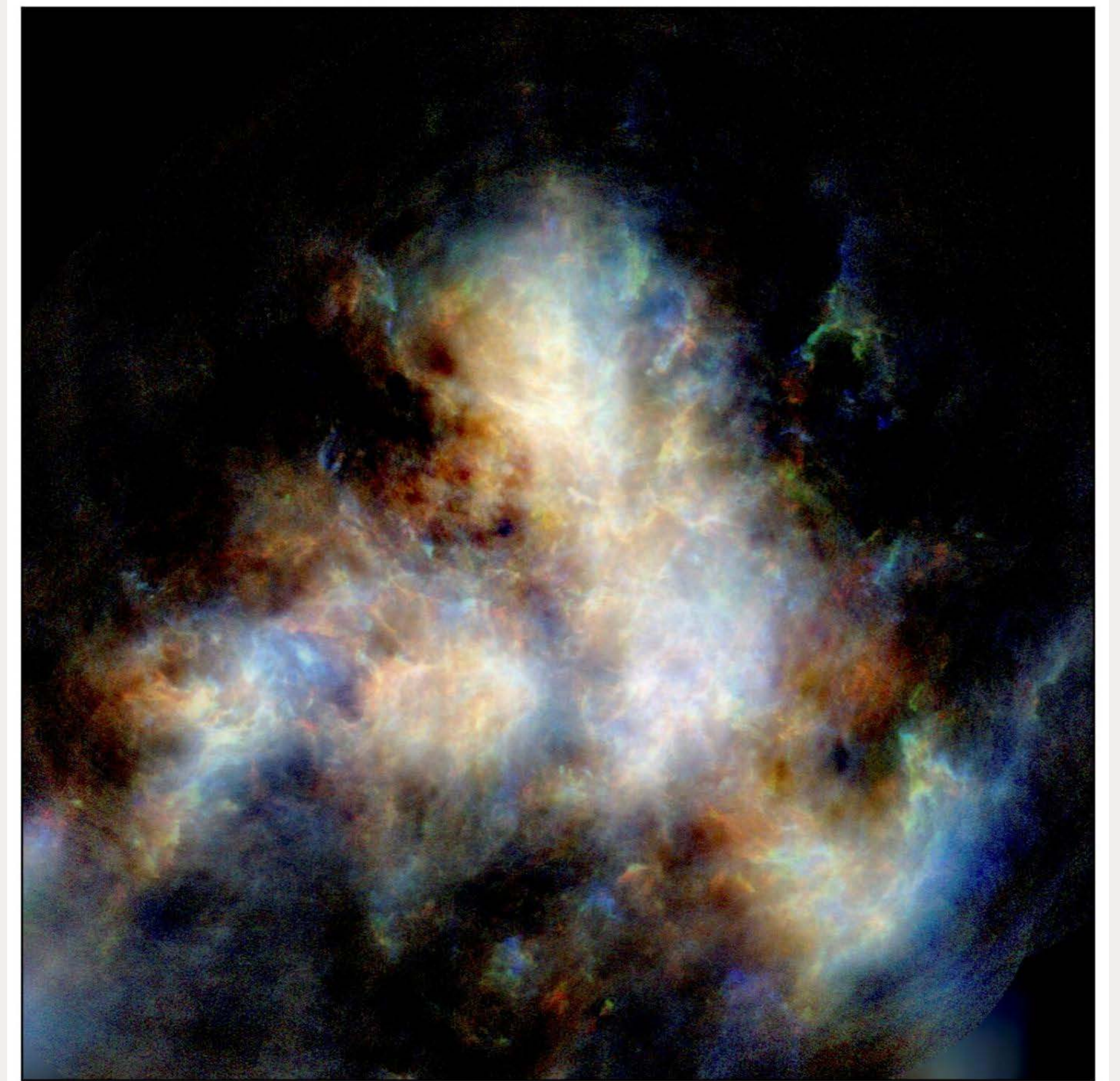


Based on *Herschel* 350  $\mu\text{m}$  data



# Mapping magnetic fields in the LMC and SMC

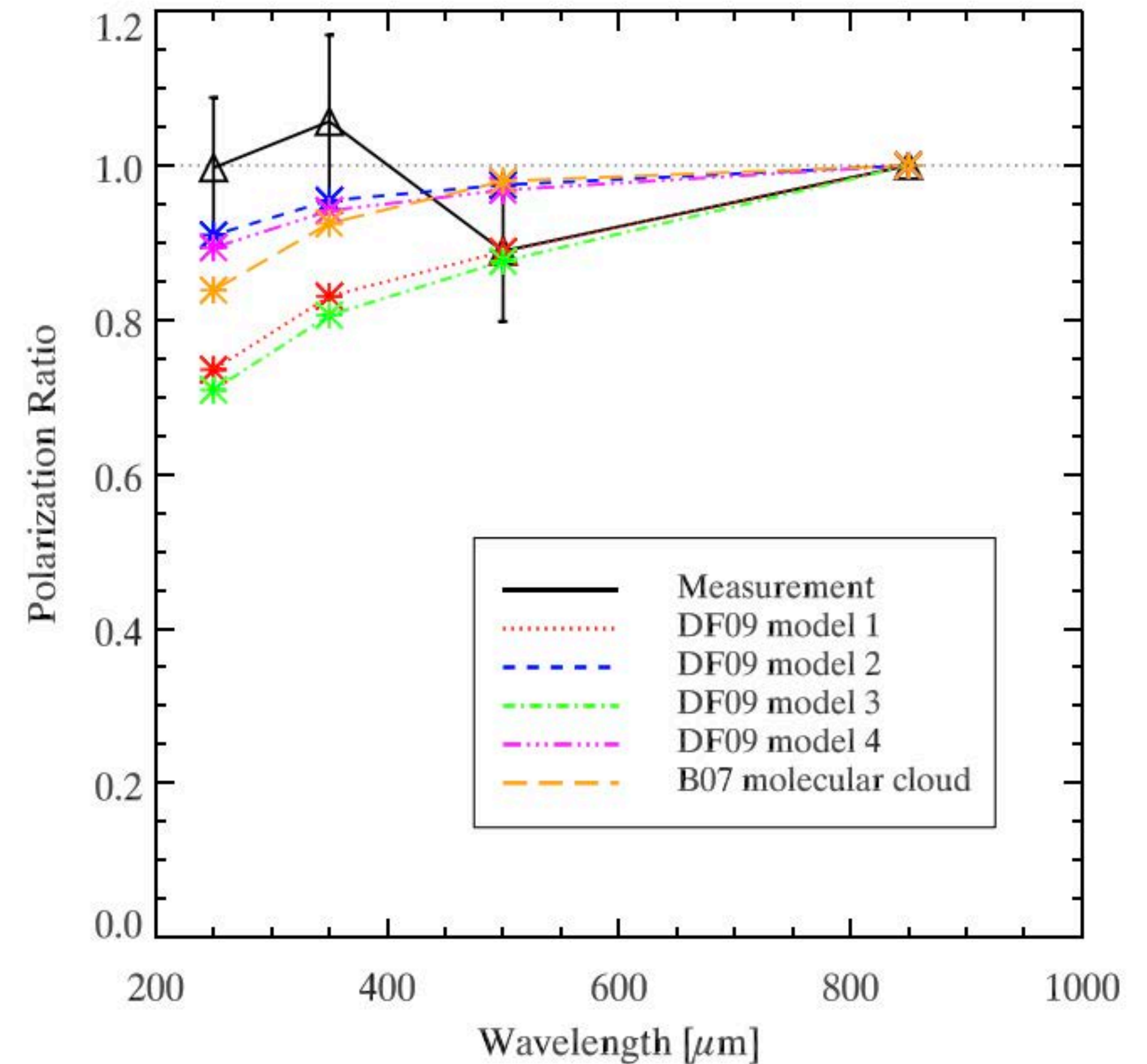
- Synergy with GASKAP (Galactic Australian SKA Pathfinder) survey
- McClure-Griffiths+ 2018
- Commissioning data: 21-cm HI emission in the SMC with 35" x 27" resolution





# Testing models of dust composition with CCAT-p

- Is interstellar dust composed of distinct silicate and carbonaceous grain populations?
- If yes, polarization fraction should change significantly with frequency (e.g. Draine & Fraisse 2009, Guillet+2018)
- See Hensley+ Astro2020 White Paper, “Determining the Composition of Interstellar Dust with Far-Infrared Polarimetry”

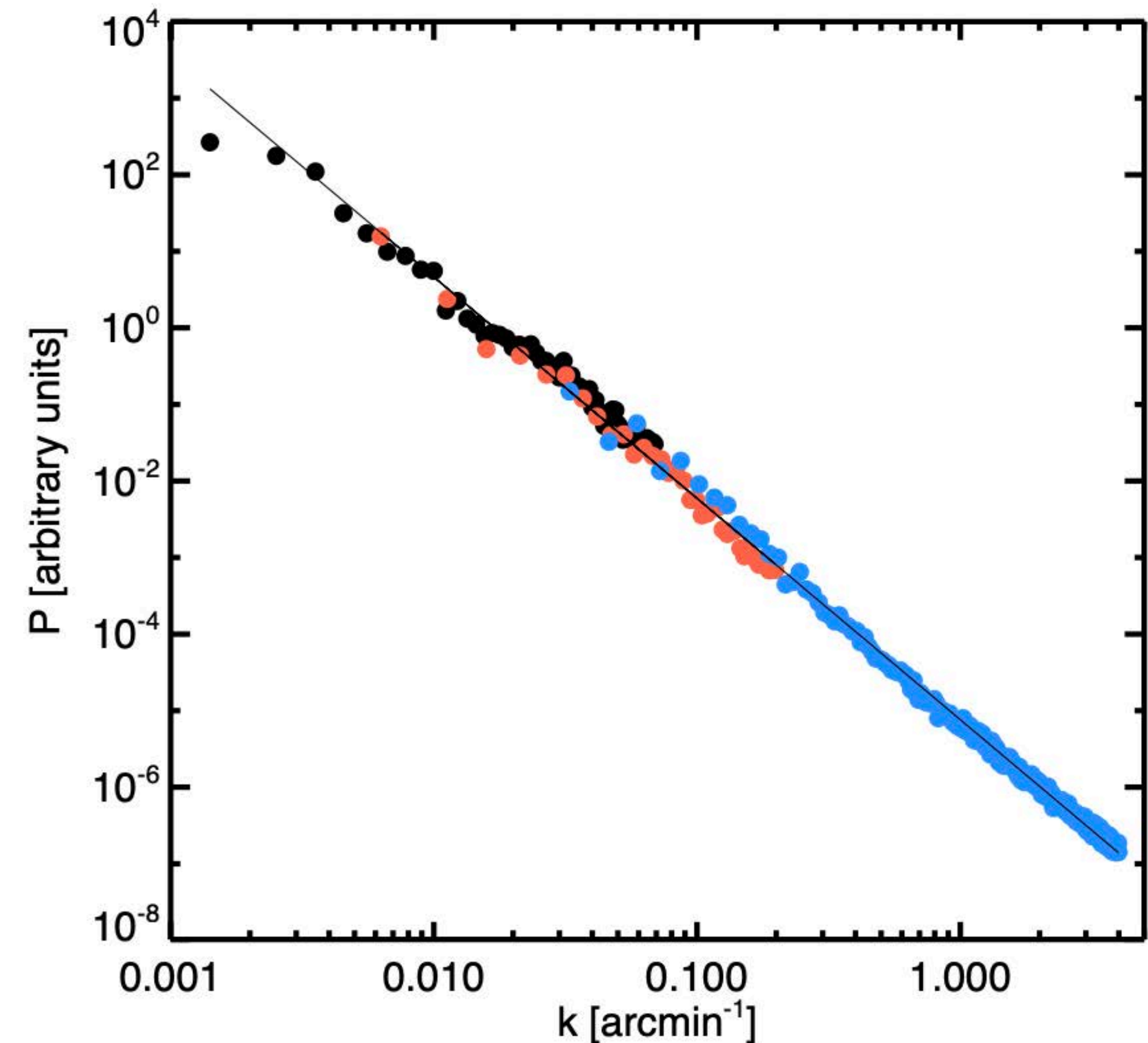


Ashton+ 2018



# Magnetohydrodynamic turbulence in the ISM

- What is the dissipation scale of turbulence in the ISM? Is it dominated by ion-neutral friction?
- The signature should be breaks or features in the dust intensity power spectrum, or polarized cross-power spectra.
- High dynamic range polarization measurements, including small angular scales, are crucial. 850 GHz channel important.
- Planned small, deep fields (e.g. COSMOS, CDF-S). Possible dedicated survey of an intermediate-column density ISM cloud.



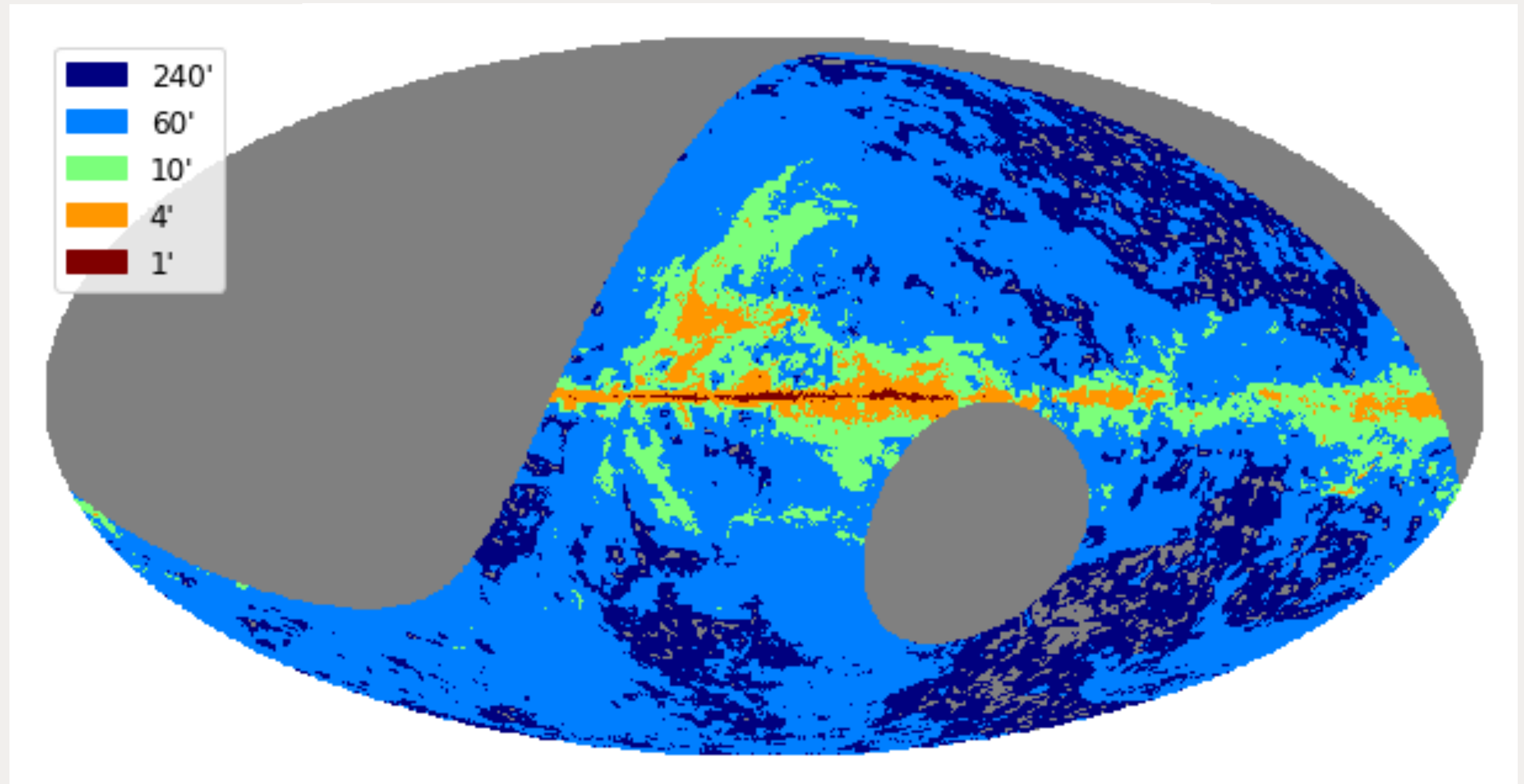
Miville-Deschênes+ 2018



# Magnetic fields and turbulence with CCAT-p

- Some diffuse ISM science can be done “for free”.
- A modest time investment would generate much more science, including magnetism in a galactic context in the LMC/SMC
- Resolution is crucial. 850 GHz channel is important.
- Happy to study other possibilities within this framework.

What resolution is needed for 3 sigma polarization detections?



Based on *Planck* 857 GHz intensity + 353 GHz polarization fraction