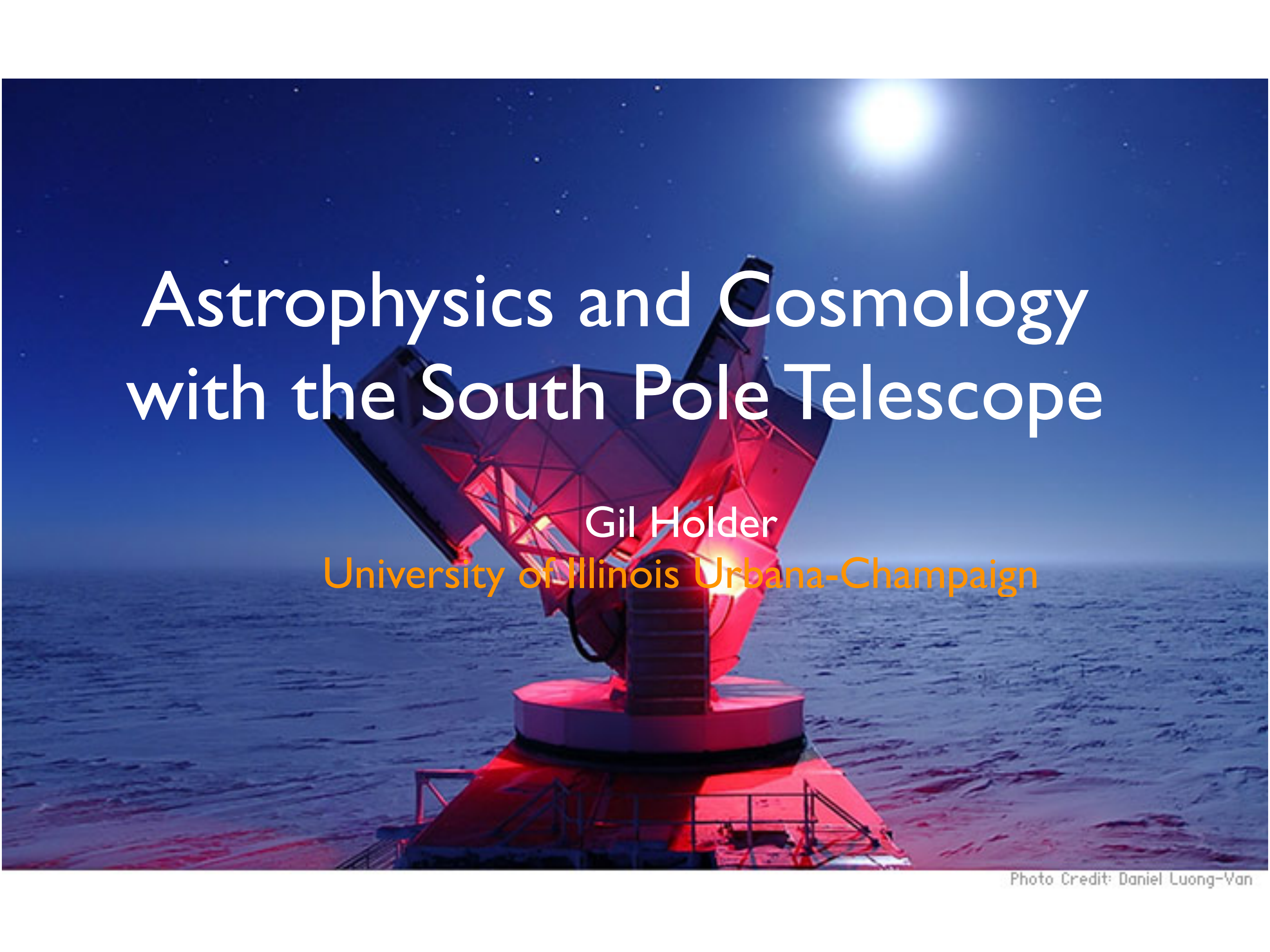


A large radio telescope dish, painted in a bright orange color, is mounted on a ship's deck. The dish is angled upwards towards a bright, glowing celestial object in a dark, star-filled night sky. The ship's deck and the dark, choppy ocean are visible in the foreground and background, respectively. The overall scene is illuminated by the light from the celestial object and the ship's own lights.

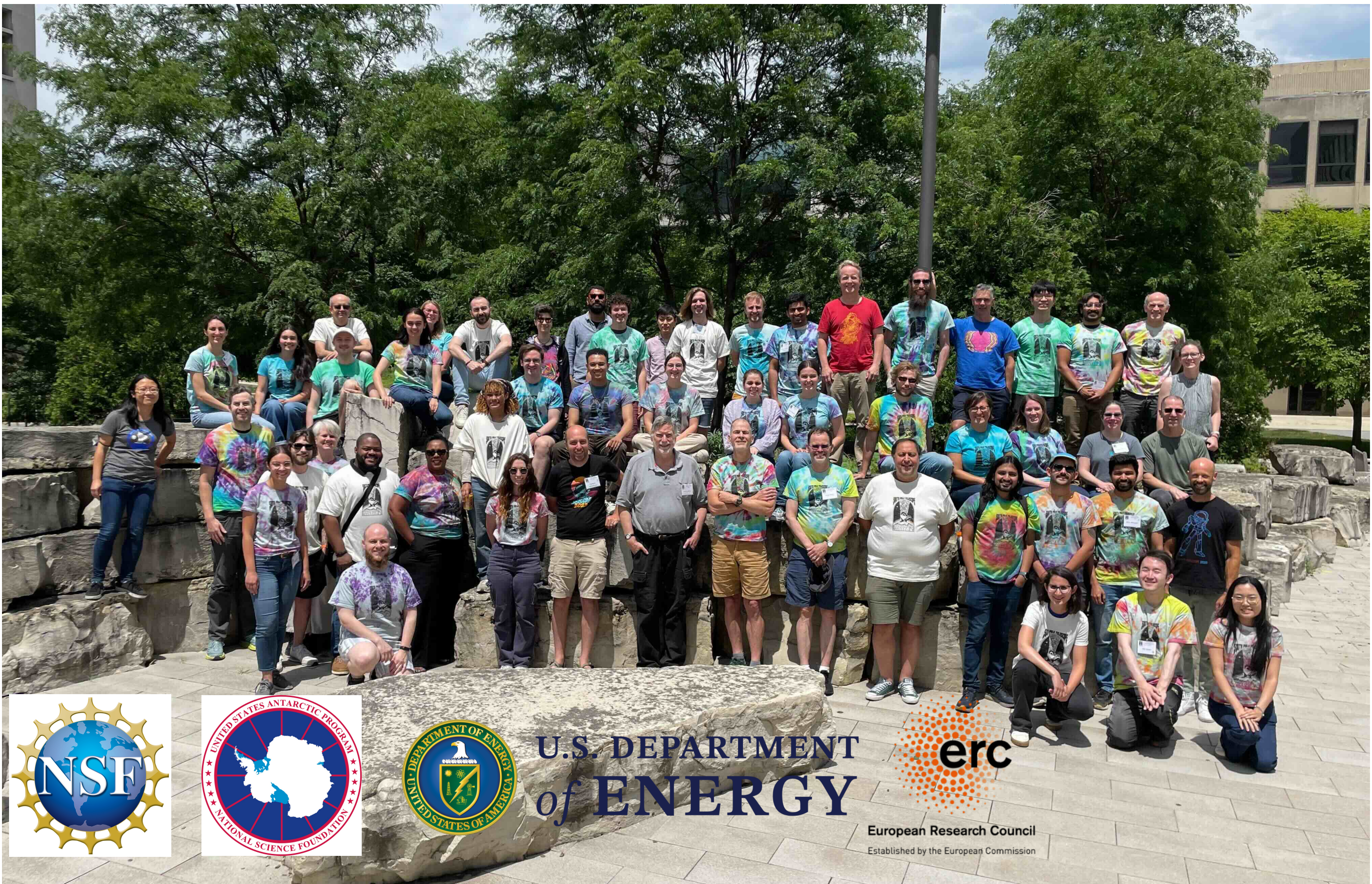
Astrophysics and Cosmology with the South Pole Telescope

Gil Holder

University of Illinois Urbana-Champaign

Outline

- the South Pole Telescope survey(s)
- objects
- patchy fields



U.S. DEPARTMENT
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European Research Council
Established by the European Commission

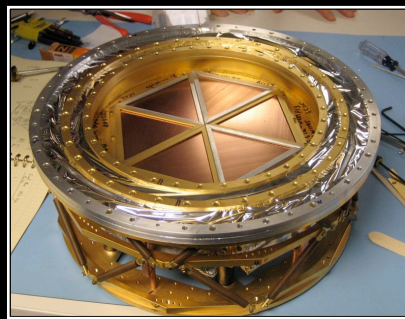
The South Pole Telescope (SPT)

10-meter sub-mm quality
wavelength telescope

95, 150, 220 GHz and
1.6, 1.2, 1.0 arcmin resolution

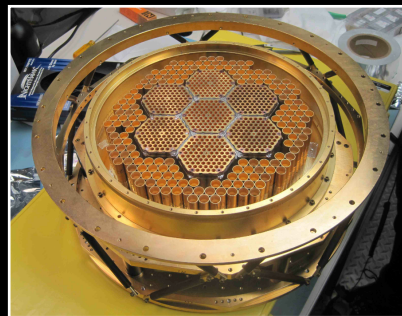
SPT-SZ

960 detectors
95, 150, 220 GHz



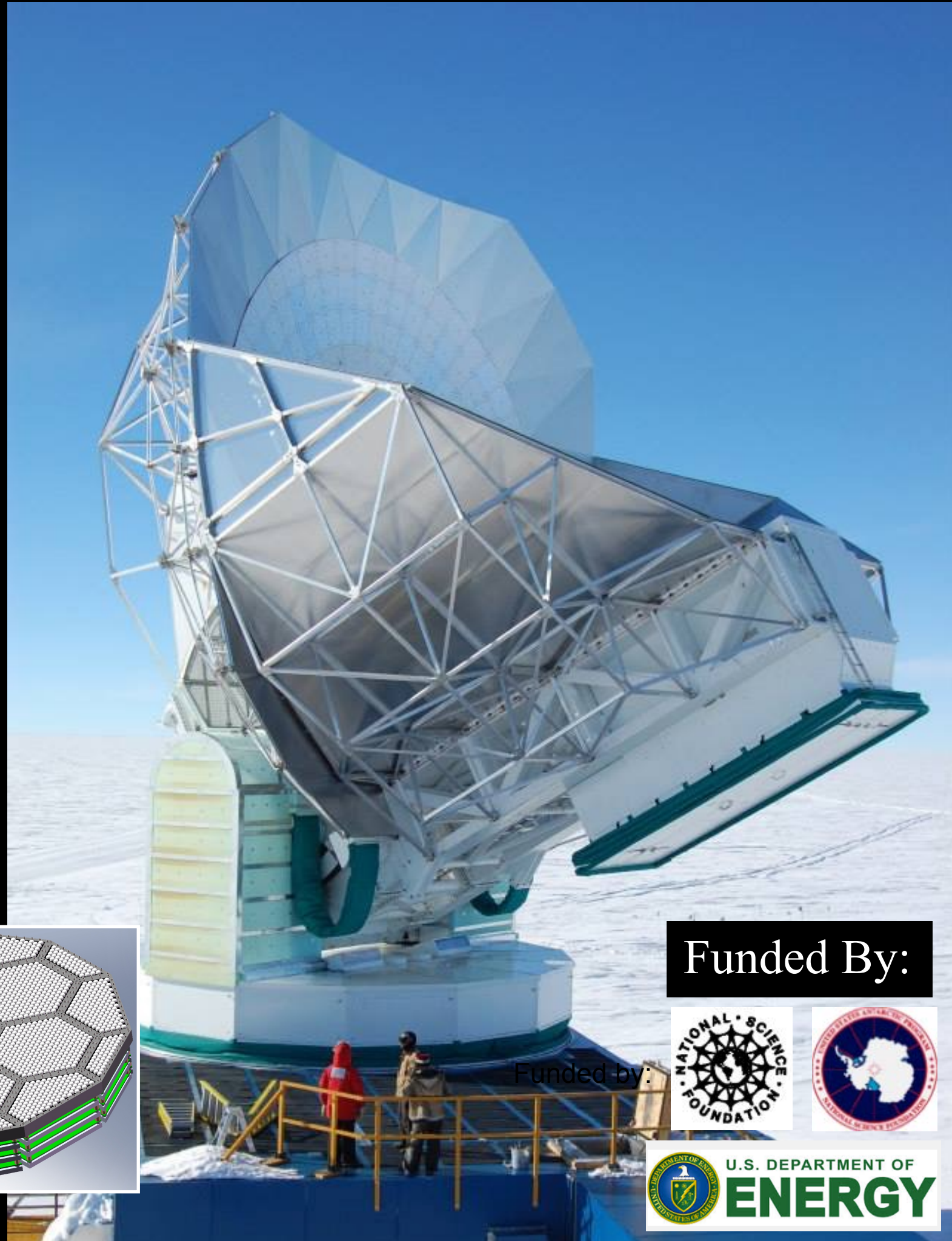
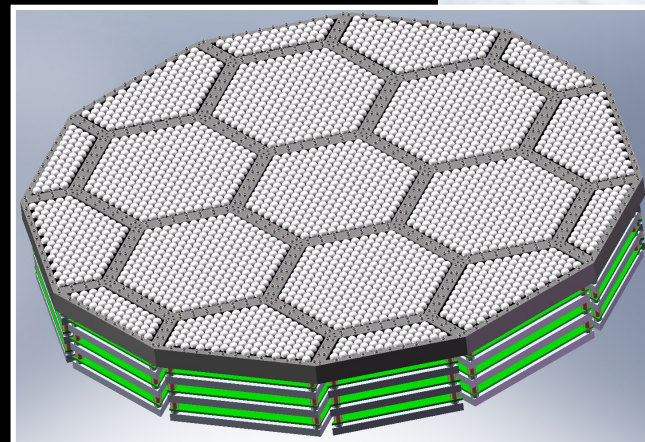
SPTpol

1600 detectors
95, 150 GHz
+Polarization



SPT-3G

~15,200 detectors
95, 150, 220 GHz
+Polarization

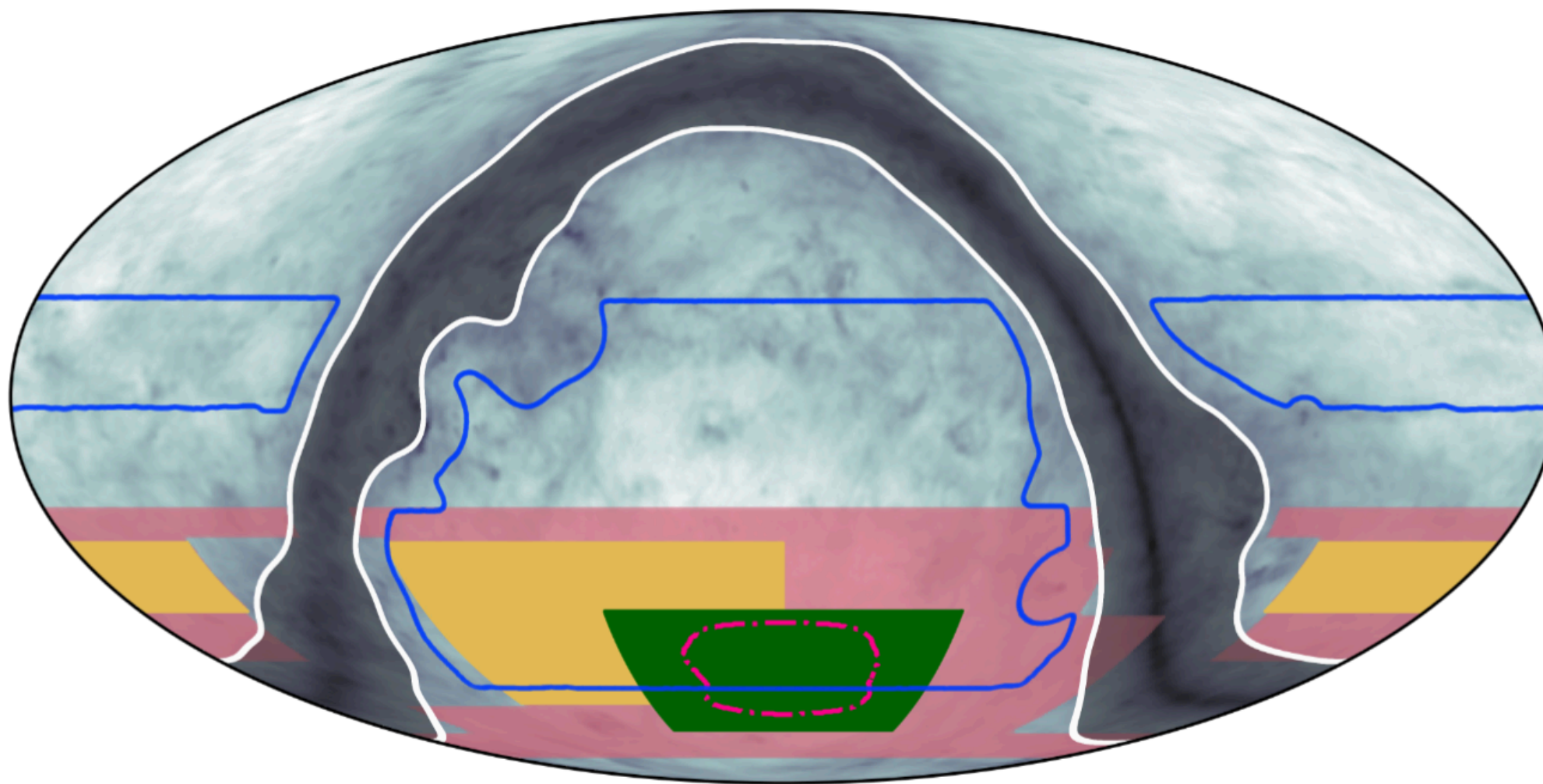


Funded By:



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ENERGY

SPT-3G - Total: ~10000 deg² → 25% of the sky



■ SPT-3G Main (this work)
■ Planck galactic mask

■ SPT-3G Summer
--- BICEP3

■ SPT-3G Wide
— ACT DR6



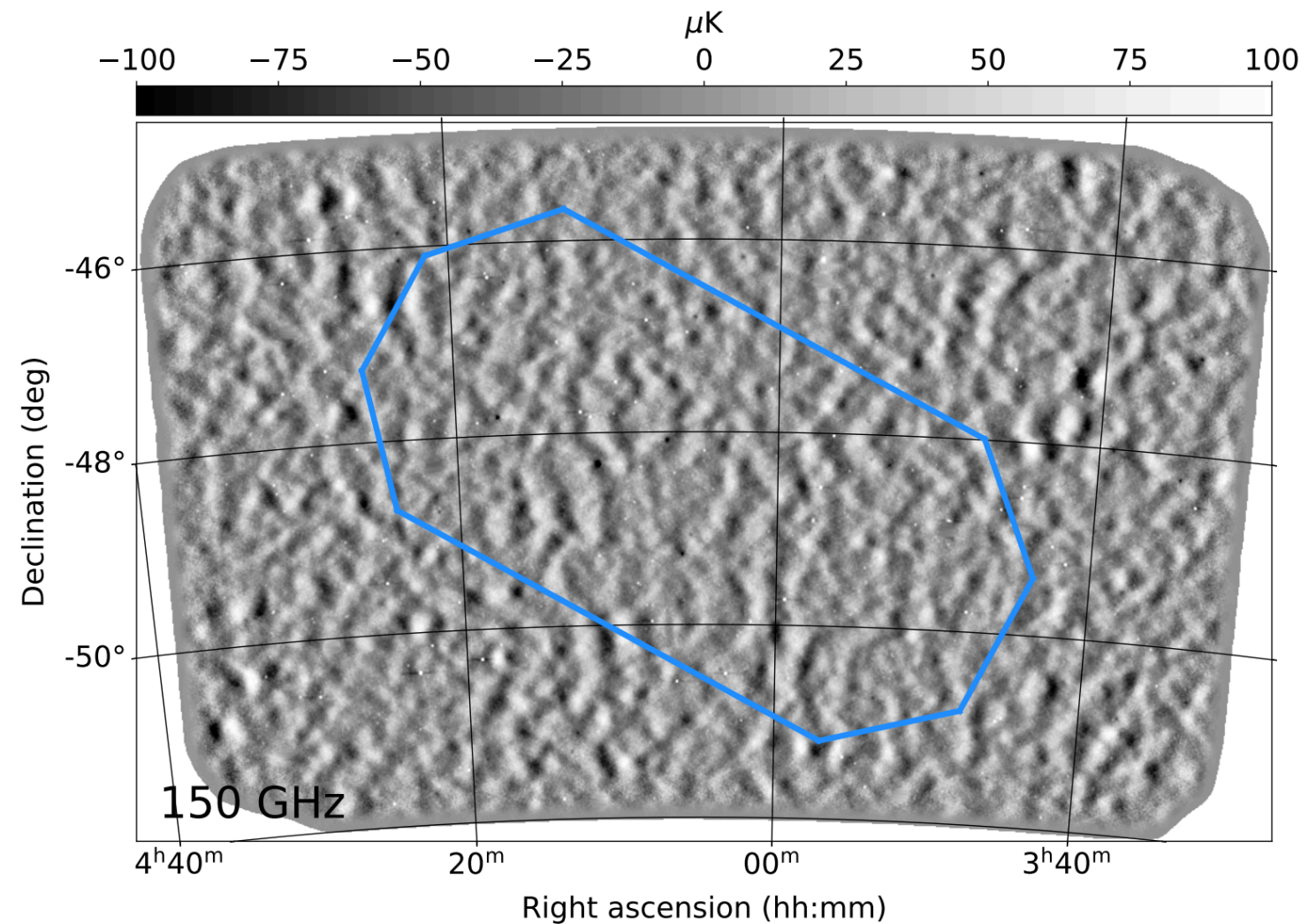
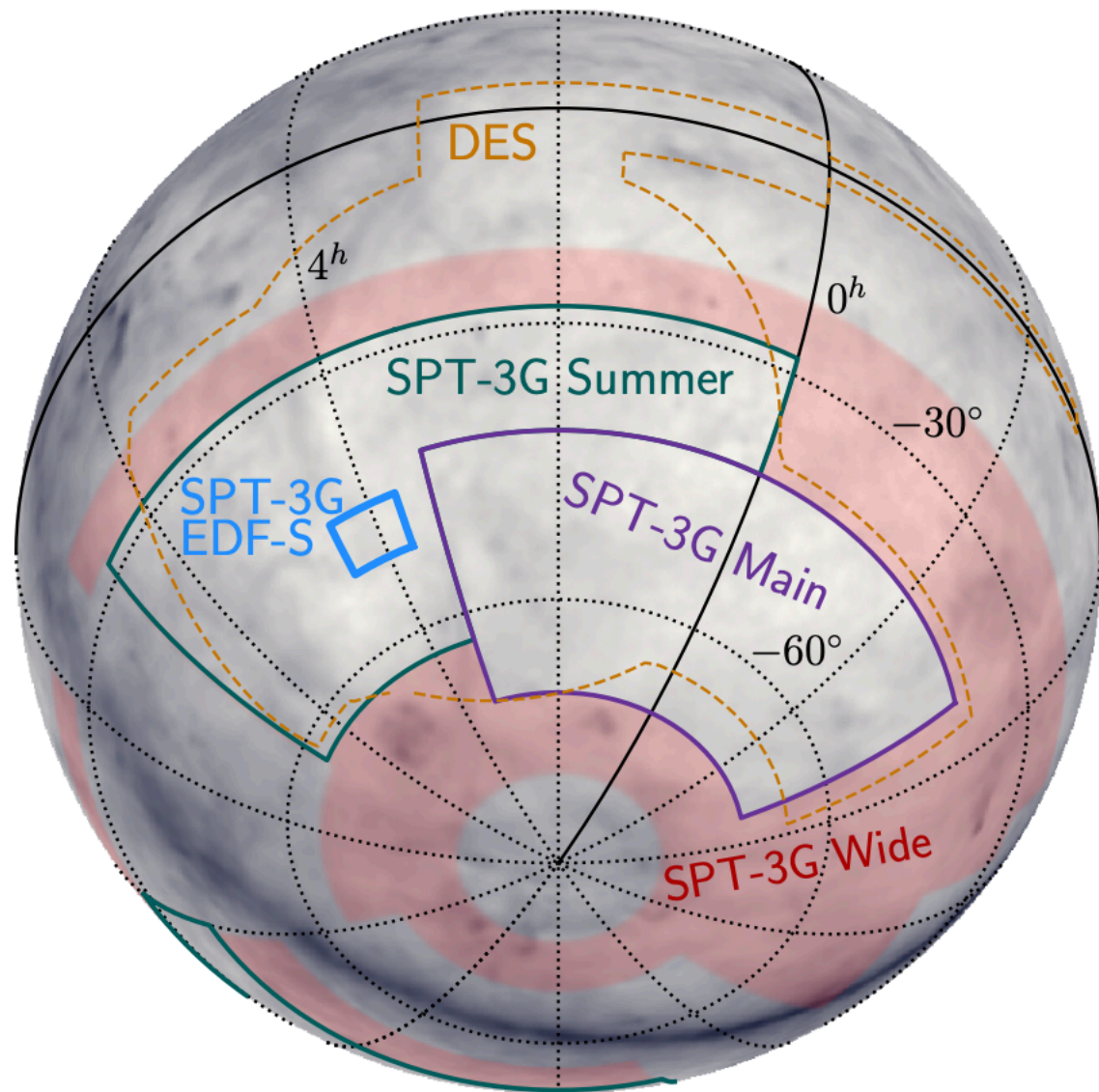
- Main, 8 months/yr,
2018, 2019-23,
2025-26+
1650 deg²

- Summer, 4 months/yr,
2019-23
2800 deg²

- Wide, 1yr, 2024
6000 deg²

Target noise levels
(at 95, 150, 220 GHz, temperature):
<2.5, 2.1, 7.6 $\mu\text{K-arcmin}$
8.5, 9, 31 $\mu\text{K-arcmin}$
14, 12, 42 $\mu\text{K-arcmin}$

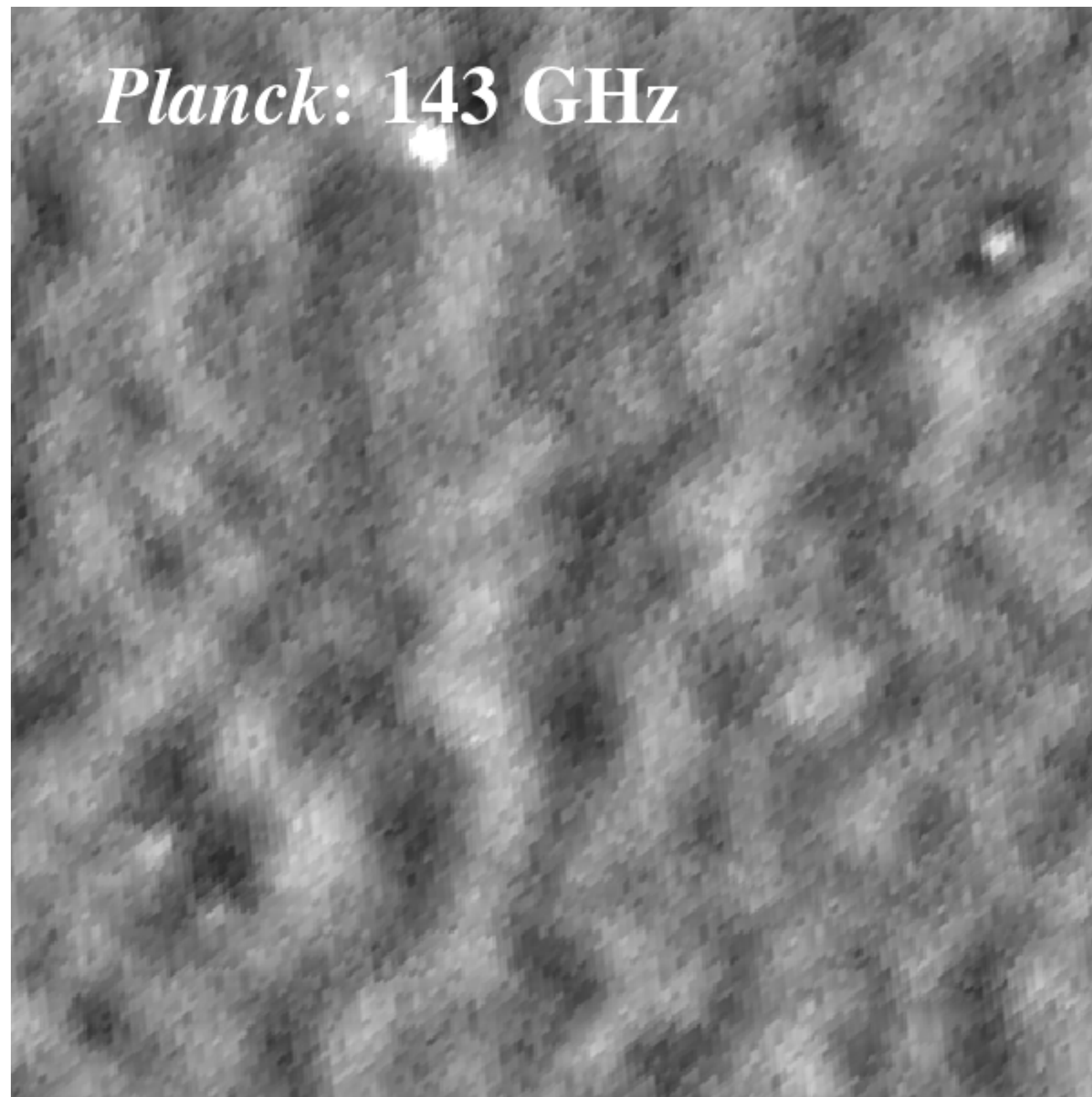
Euclid Deep Field South



Archipley et al
2506.00298

Nominal band (GHz)	95	150	220
Nominal band (mm)	3.3	2.0	1.4
Map noise ($\mu\text{K}_{\text{CMB-arcmin}}$)	4.3	3.8	13.2
5σ point source (mJy)	1.7	2.0	6.5

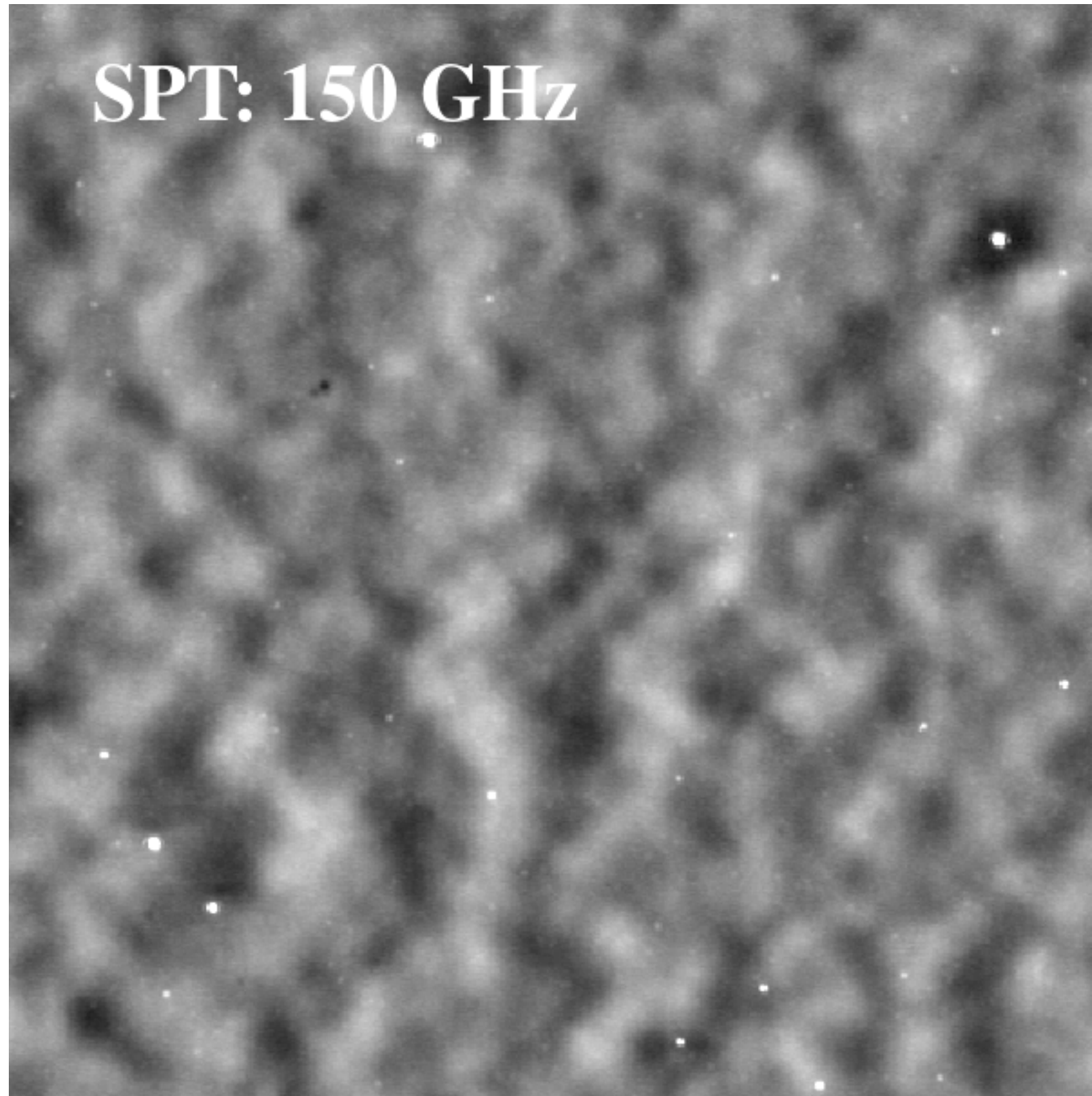
3 degrees



3 degrees

Srini Raghunathan

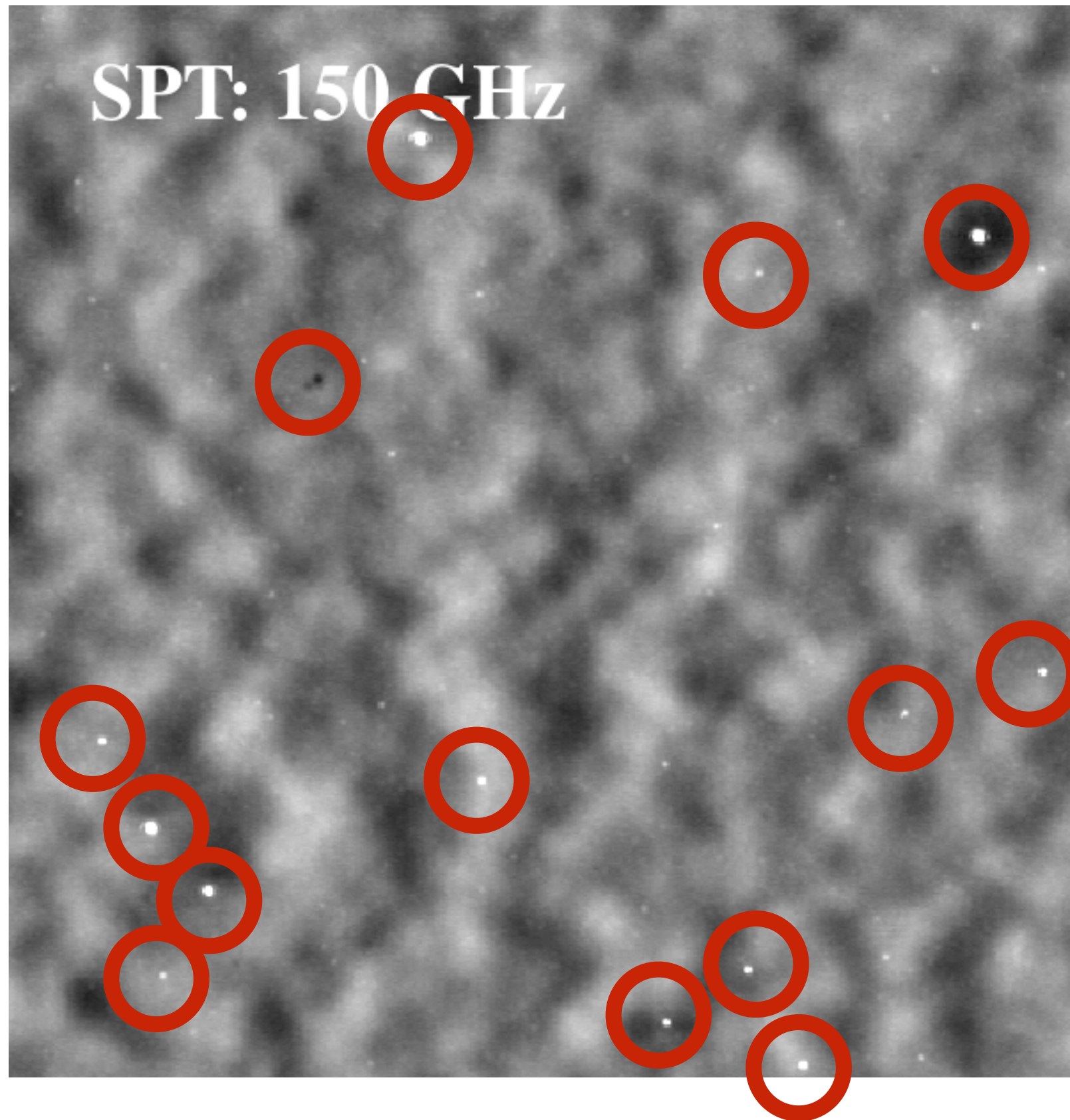
3 degrees



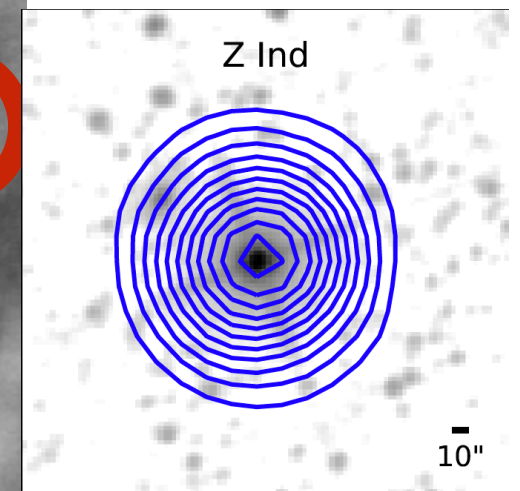
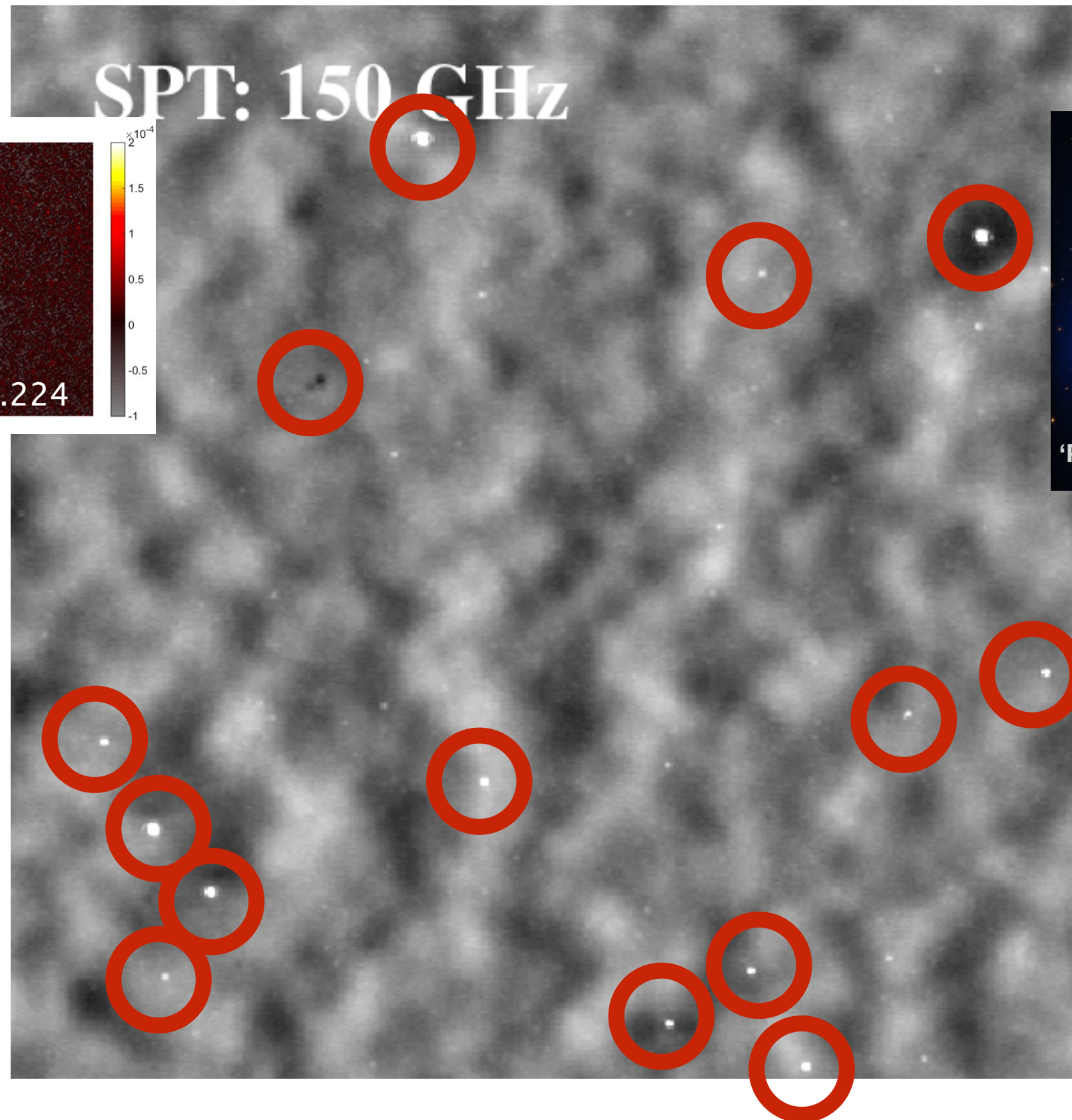
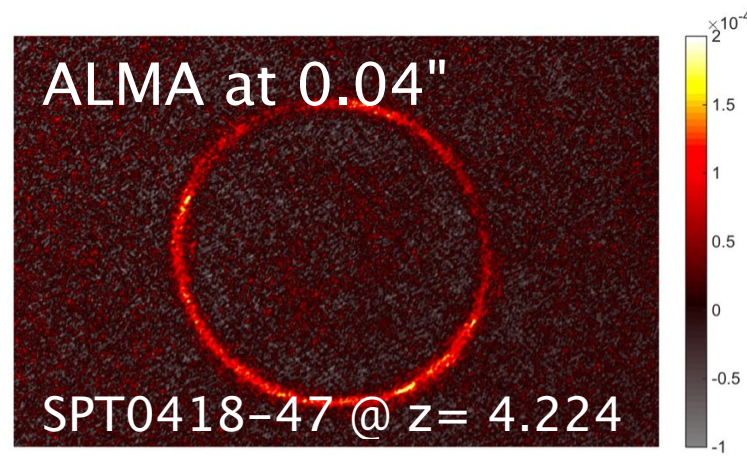
3 degrees

Srini Raghunathan

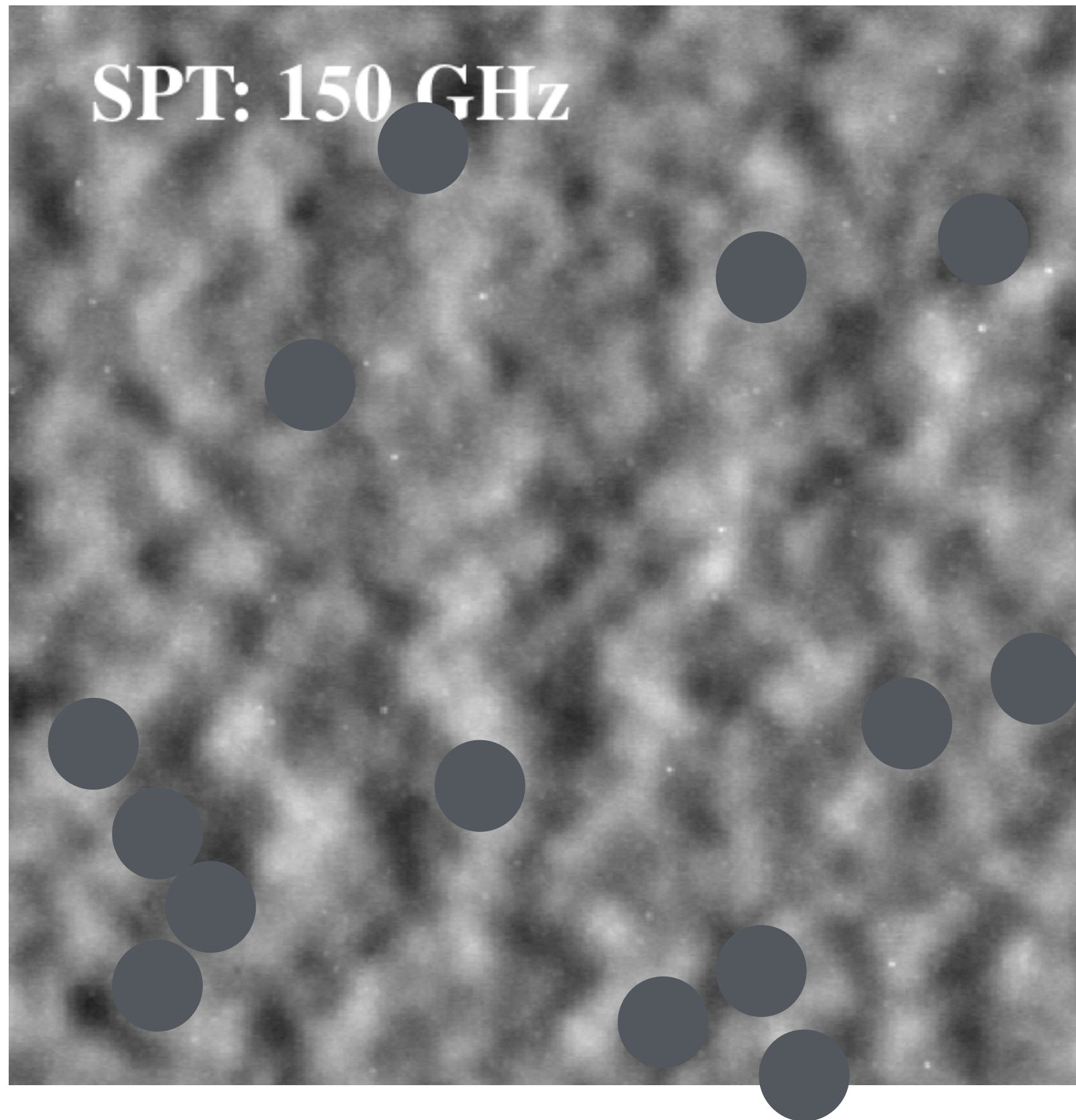
Science theme: What are those dots?



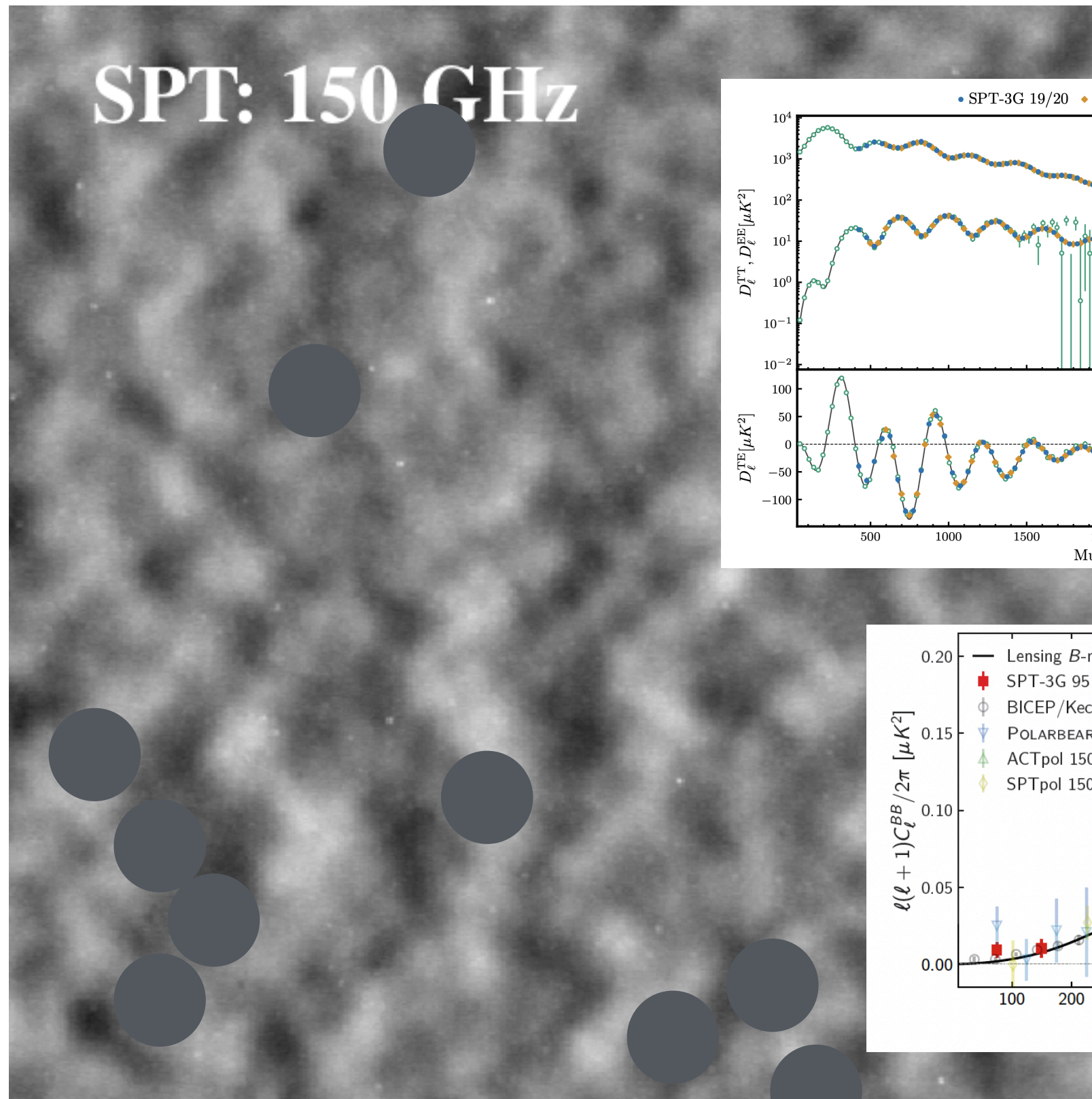
Science theme: *What are those dots?*



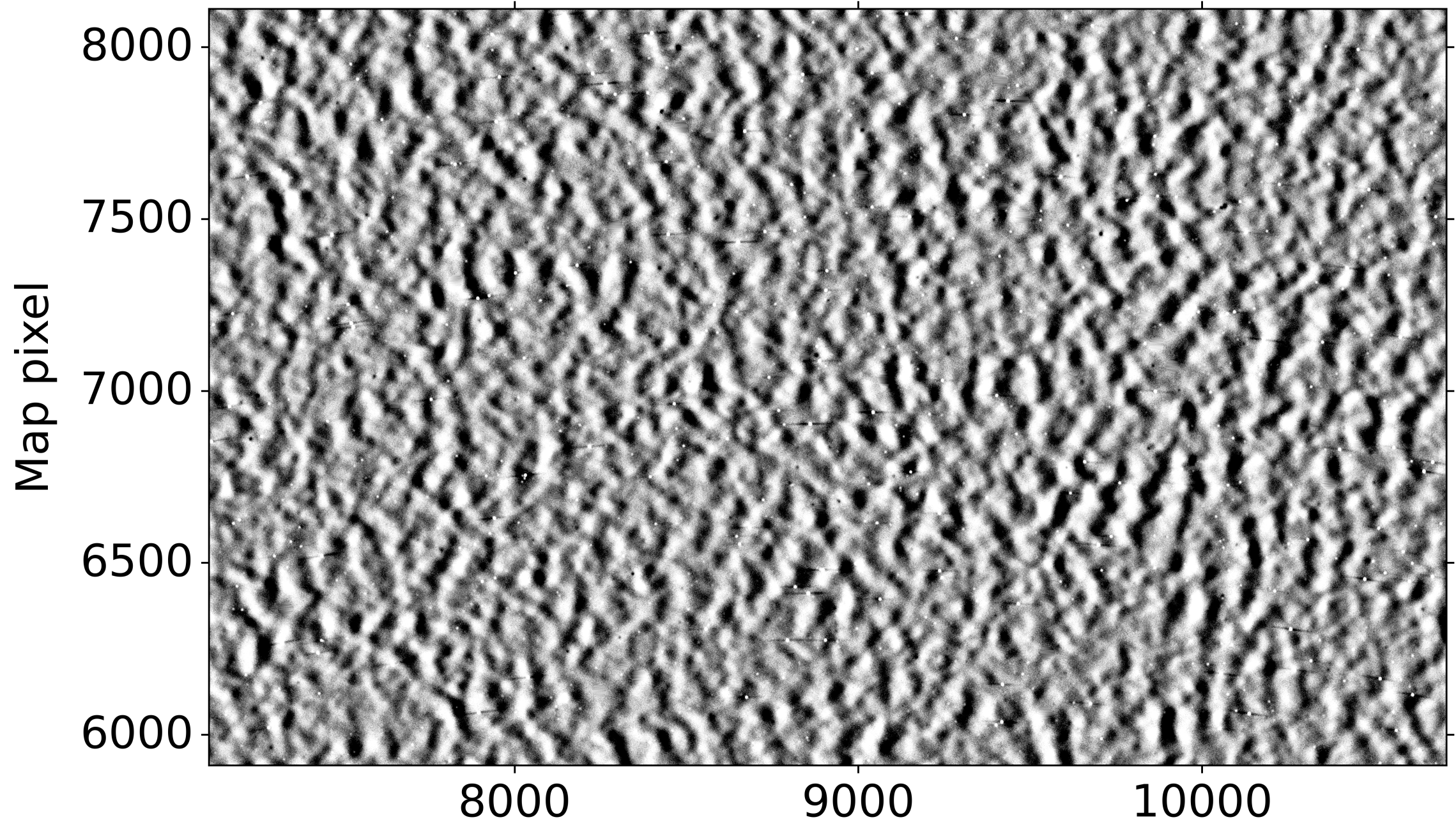
Science theme: What is that splotchiness?



Science theme: *What is that splotchiness?*



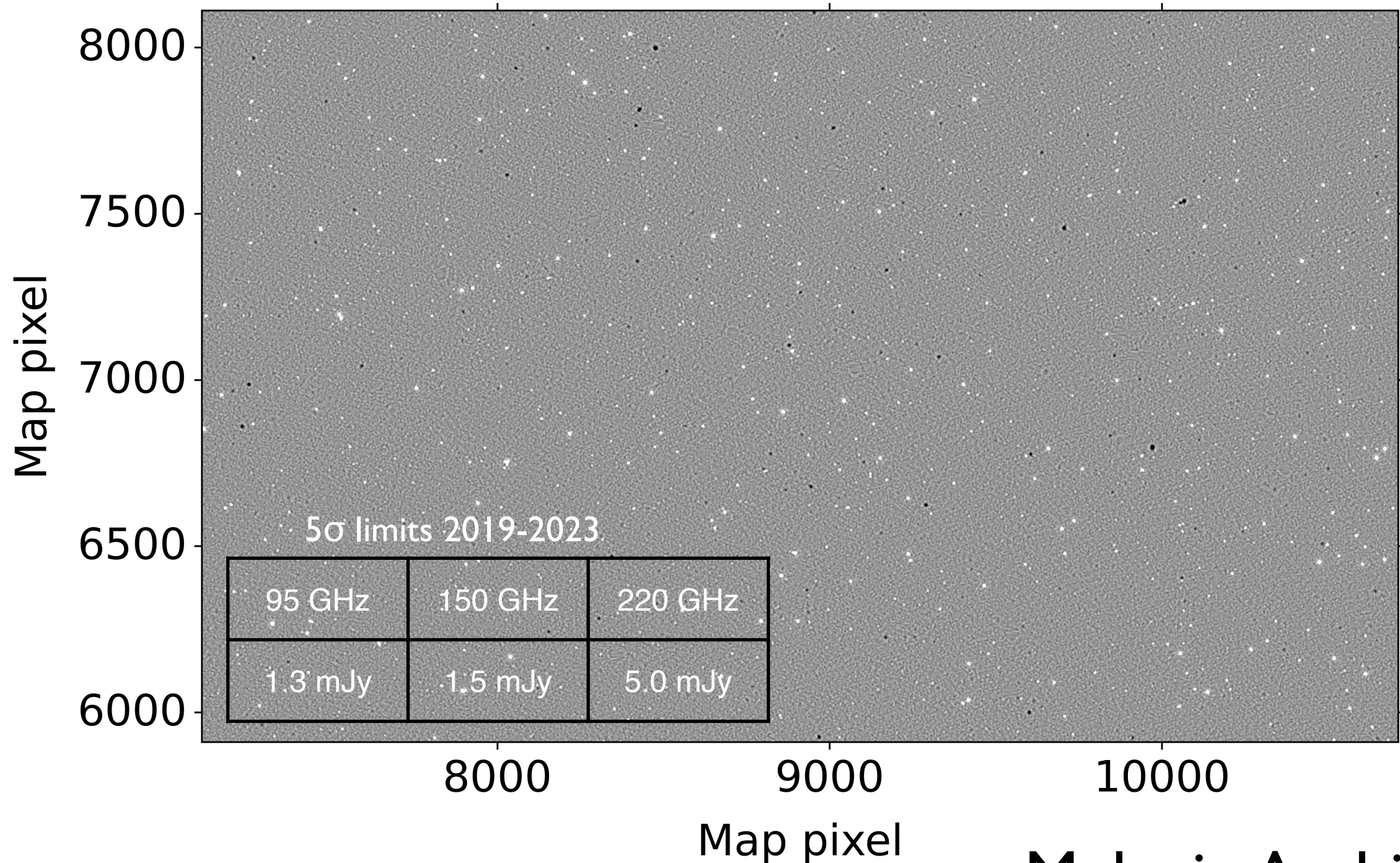
SPT 95 GHz map



Map pixel

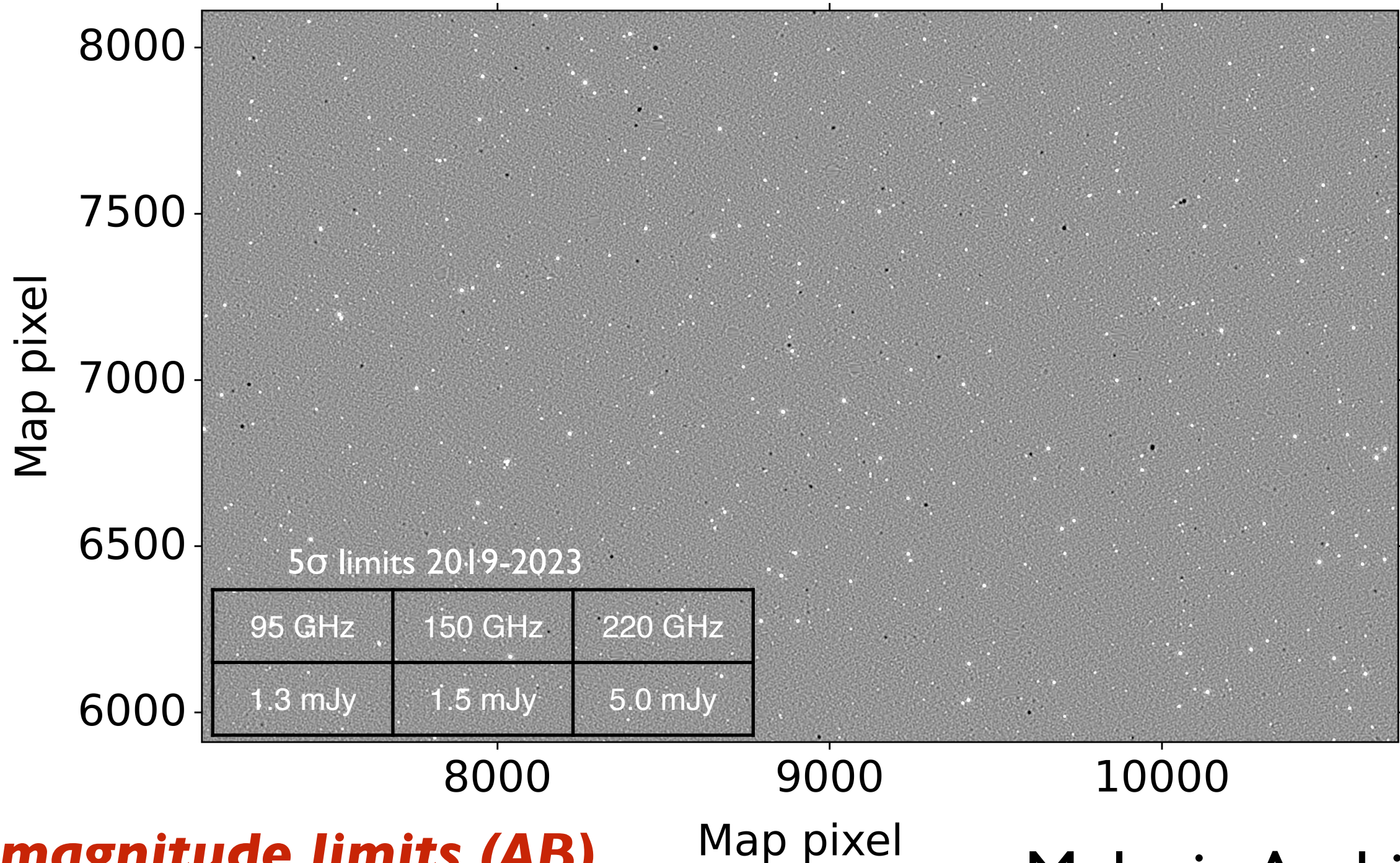
Melanie Archipley

SPT 95 GHz Sources



Melanie Archipley

SPT 95 GHz Sources



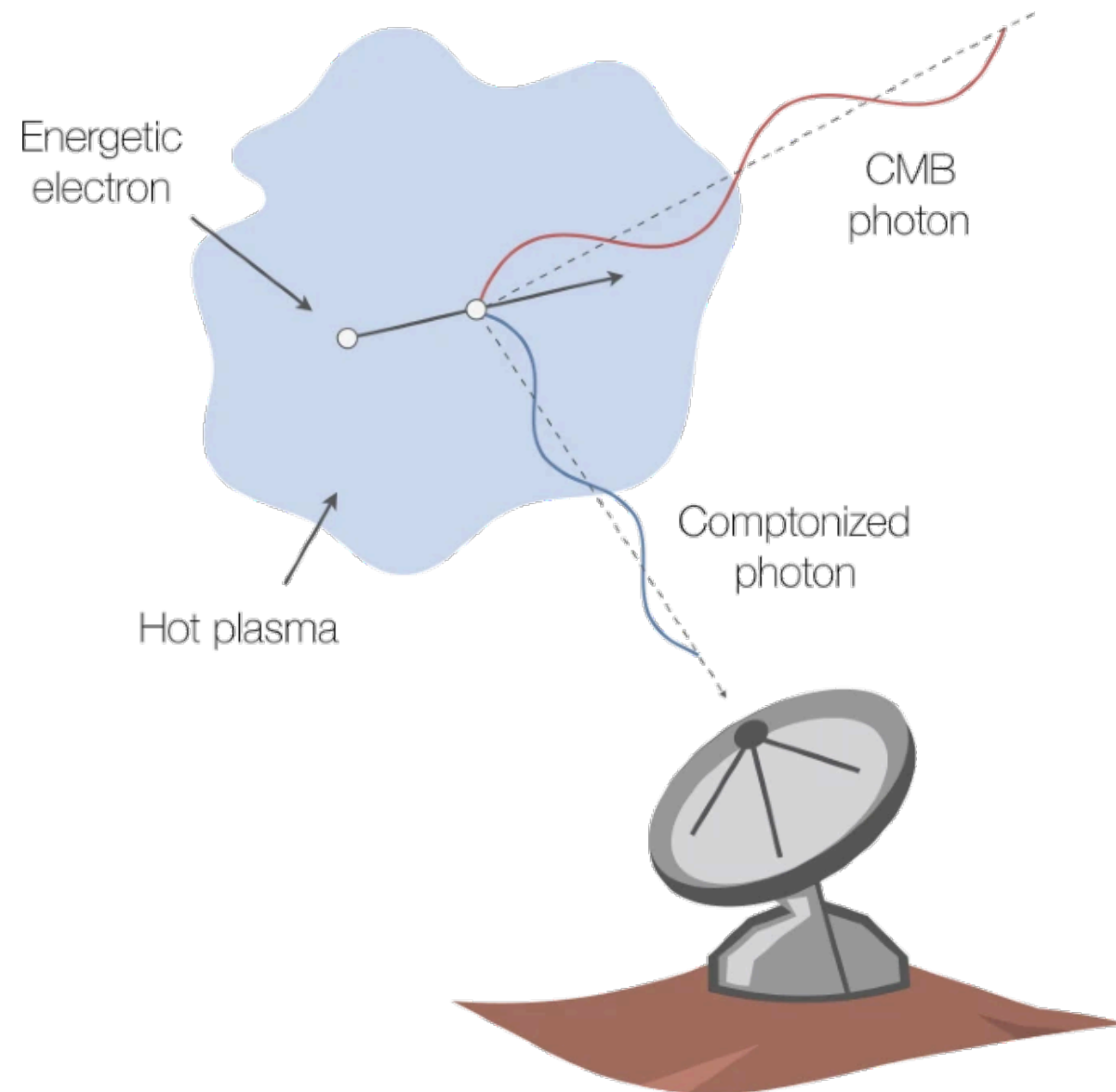
magnitude limits (AB)

16.1, 16, 14.7

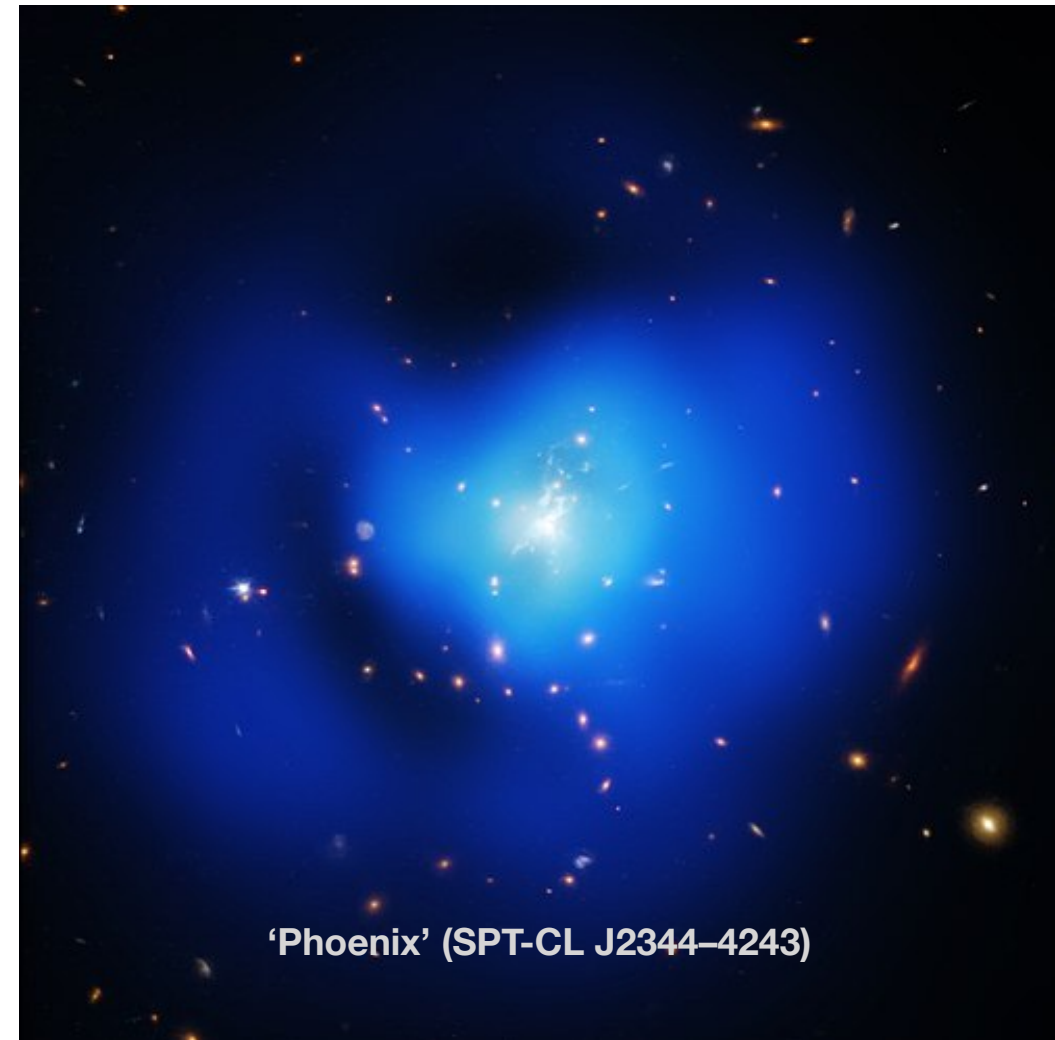
similar to 2MASS

Melanie Archipley

The Dark Dots

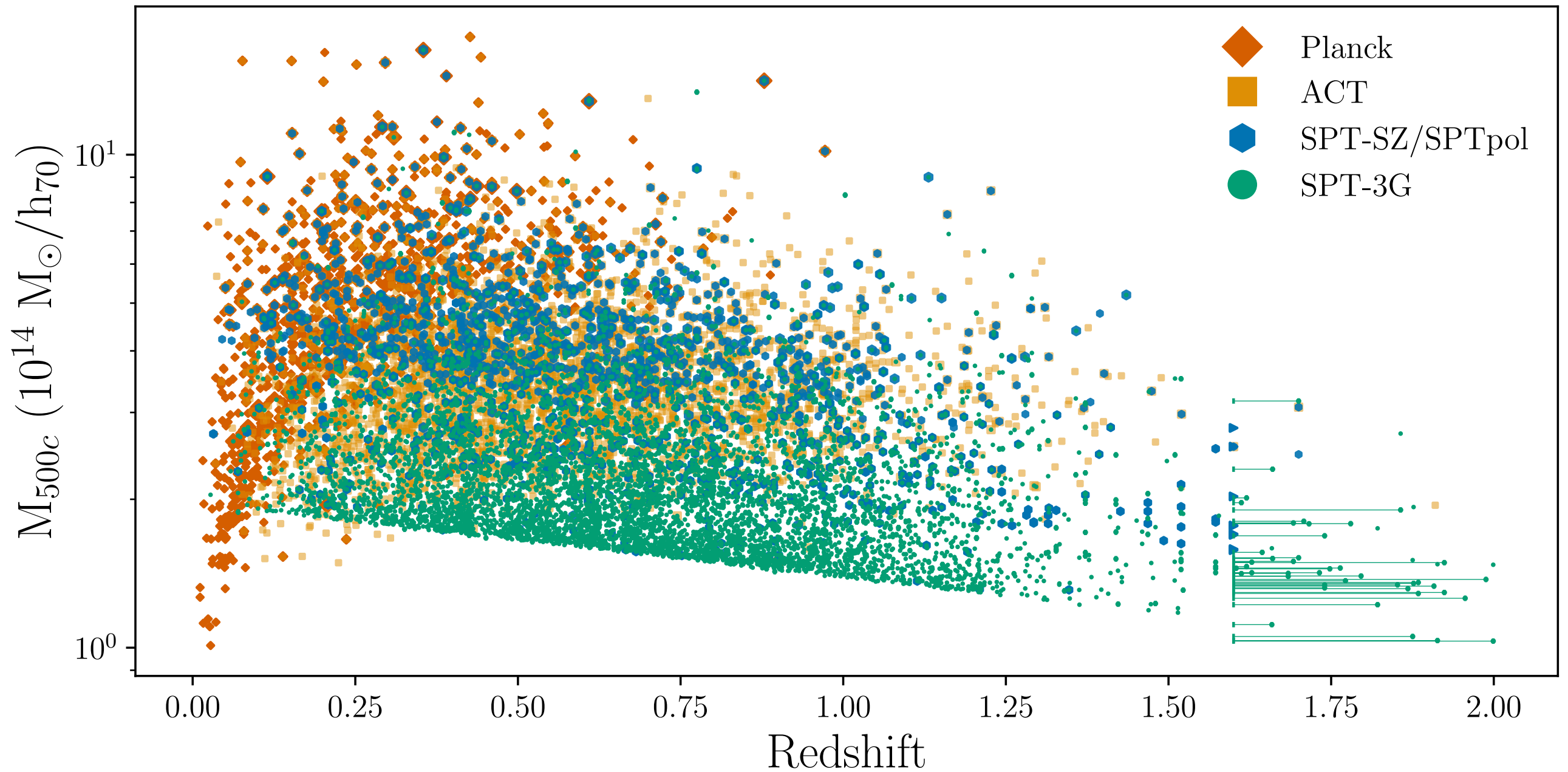


Mroczkowski et al 2019



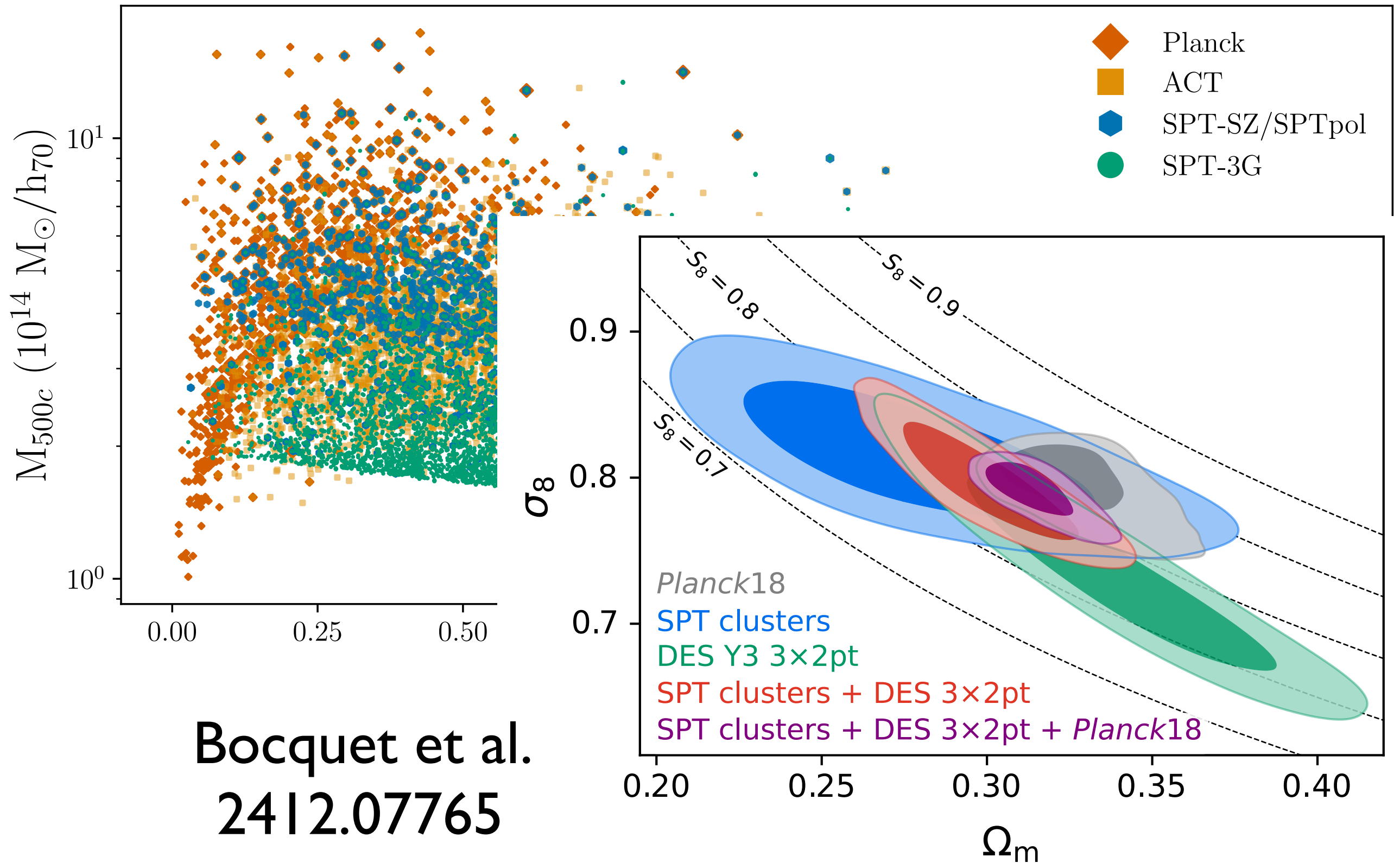
'Phoenix' (SPT-CL J2344-4243)

SZ-Selected Galaxy Clusters



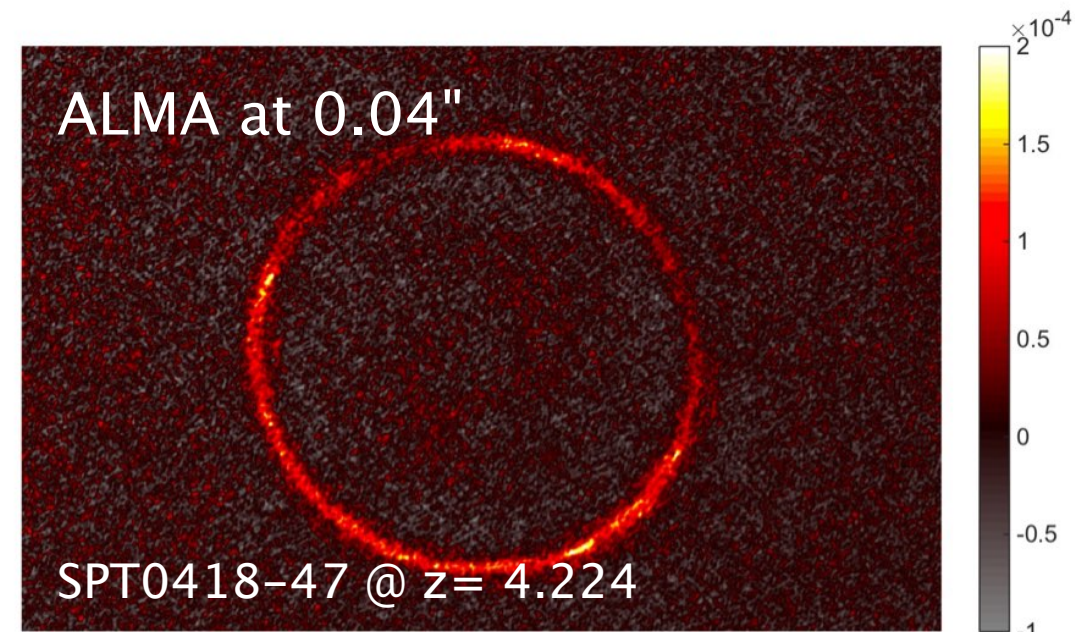
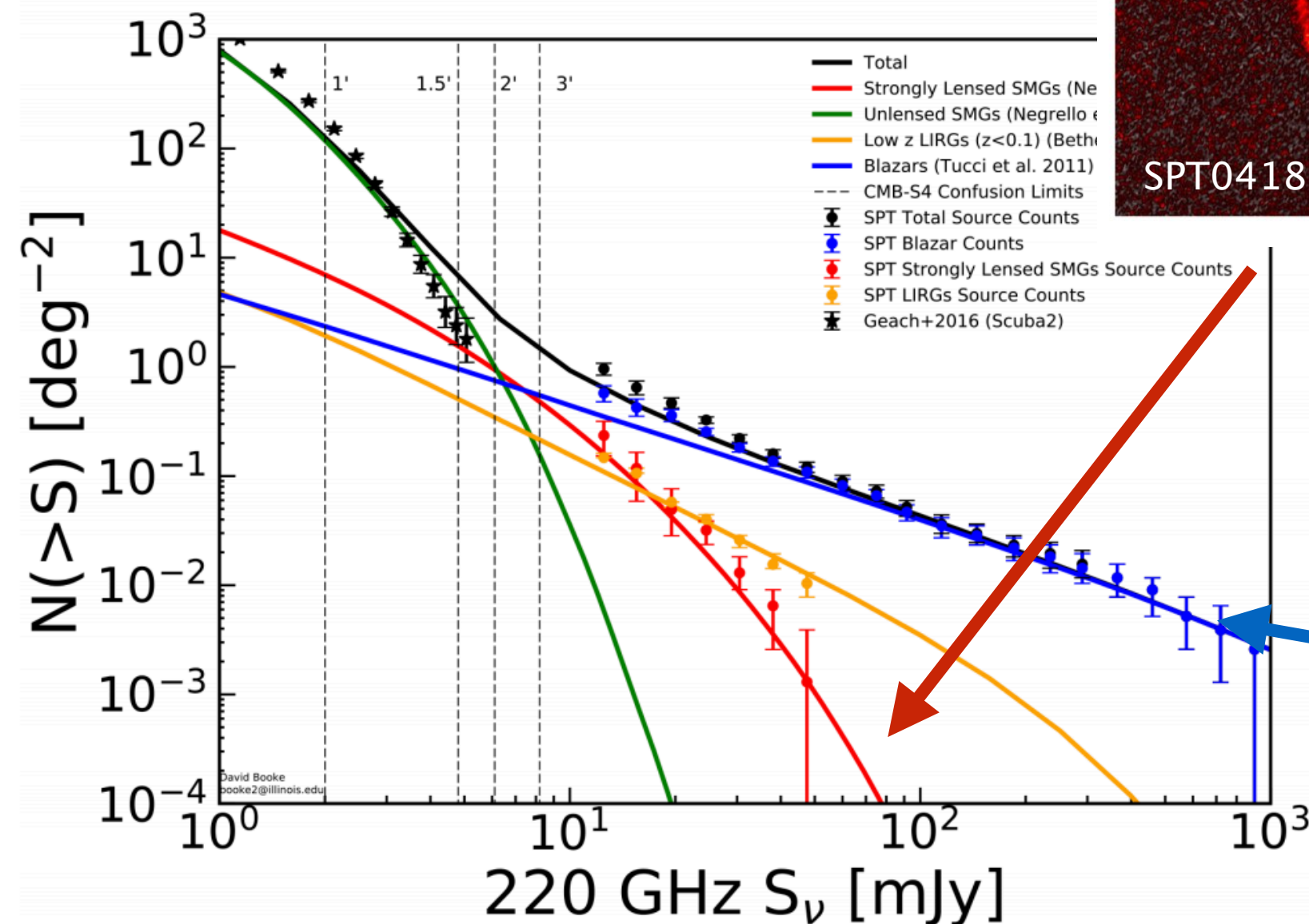
Bleem, Kornoelje, Hryciuk, Klein

SZ-Selected Galaxy Clusters



A mm-wave galaxy survey

Extragalactic Sources

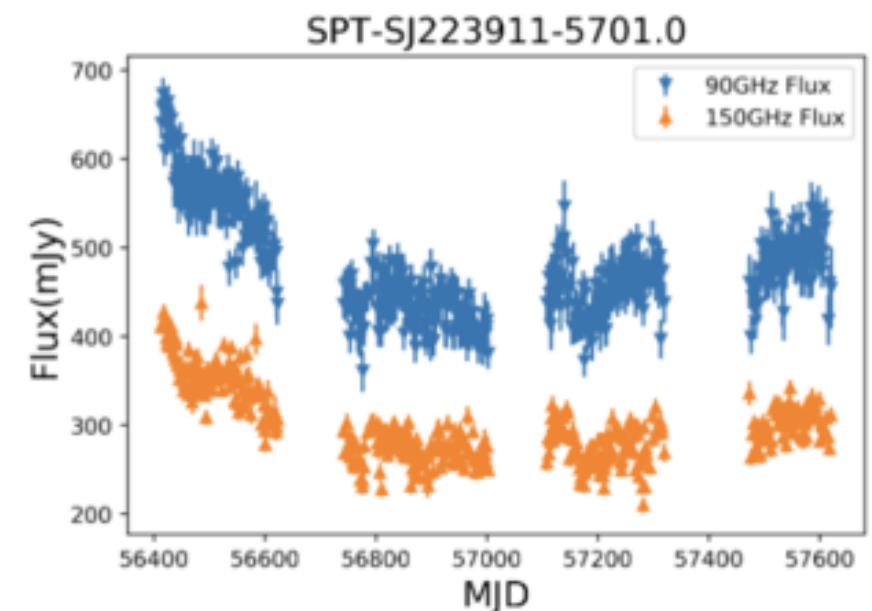
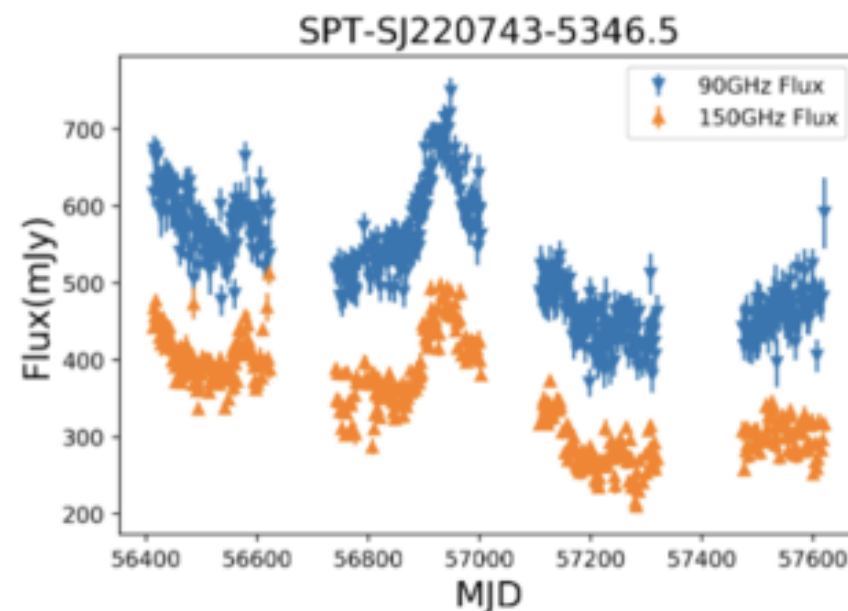
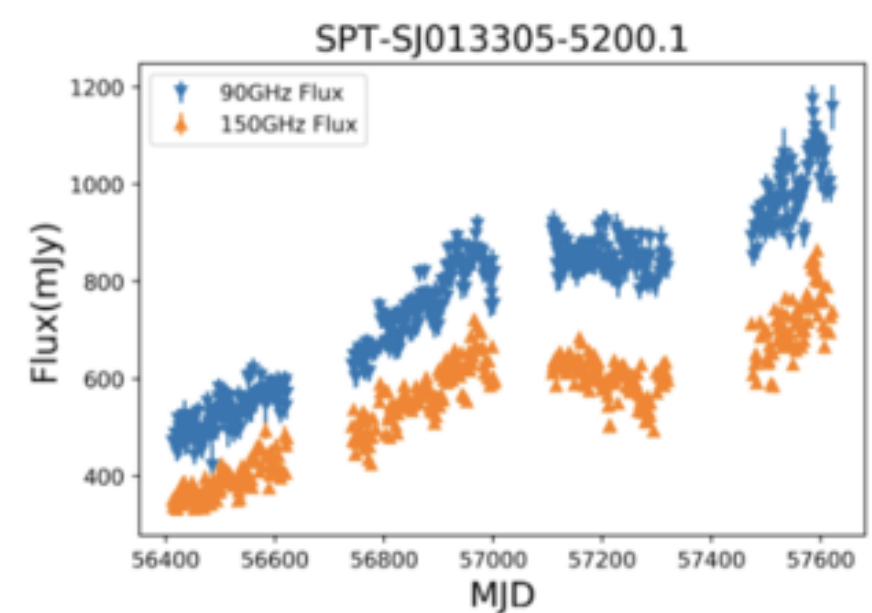
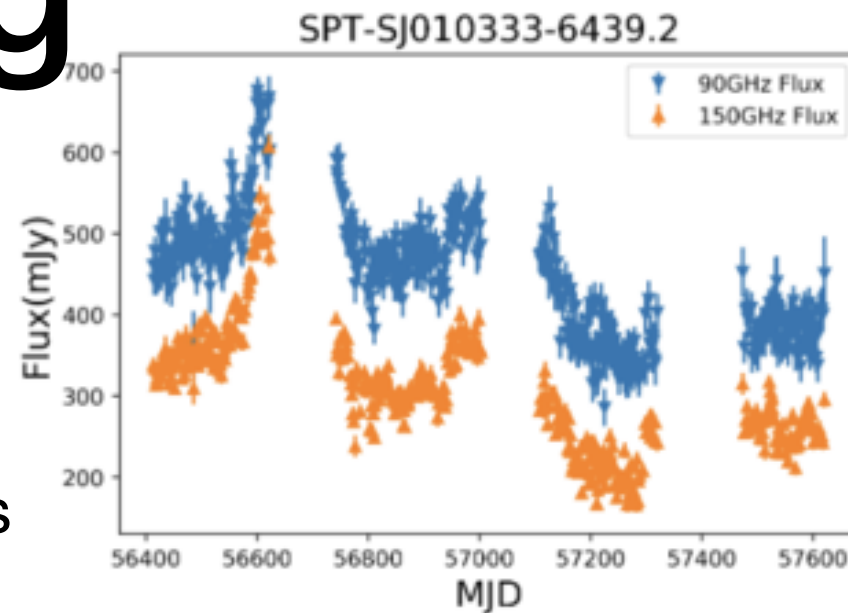
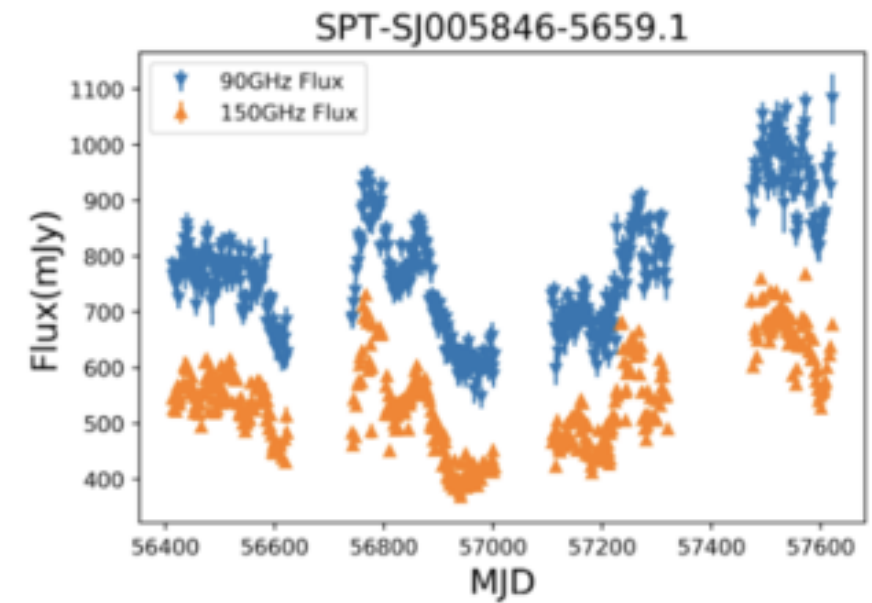
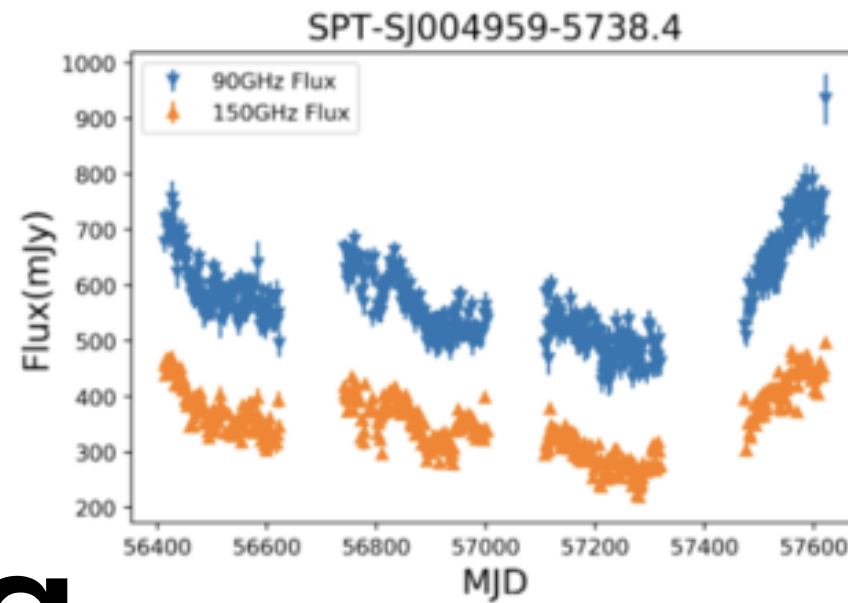


Figures from Joaquin Vieira

AGN Monitoring

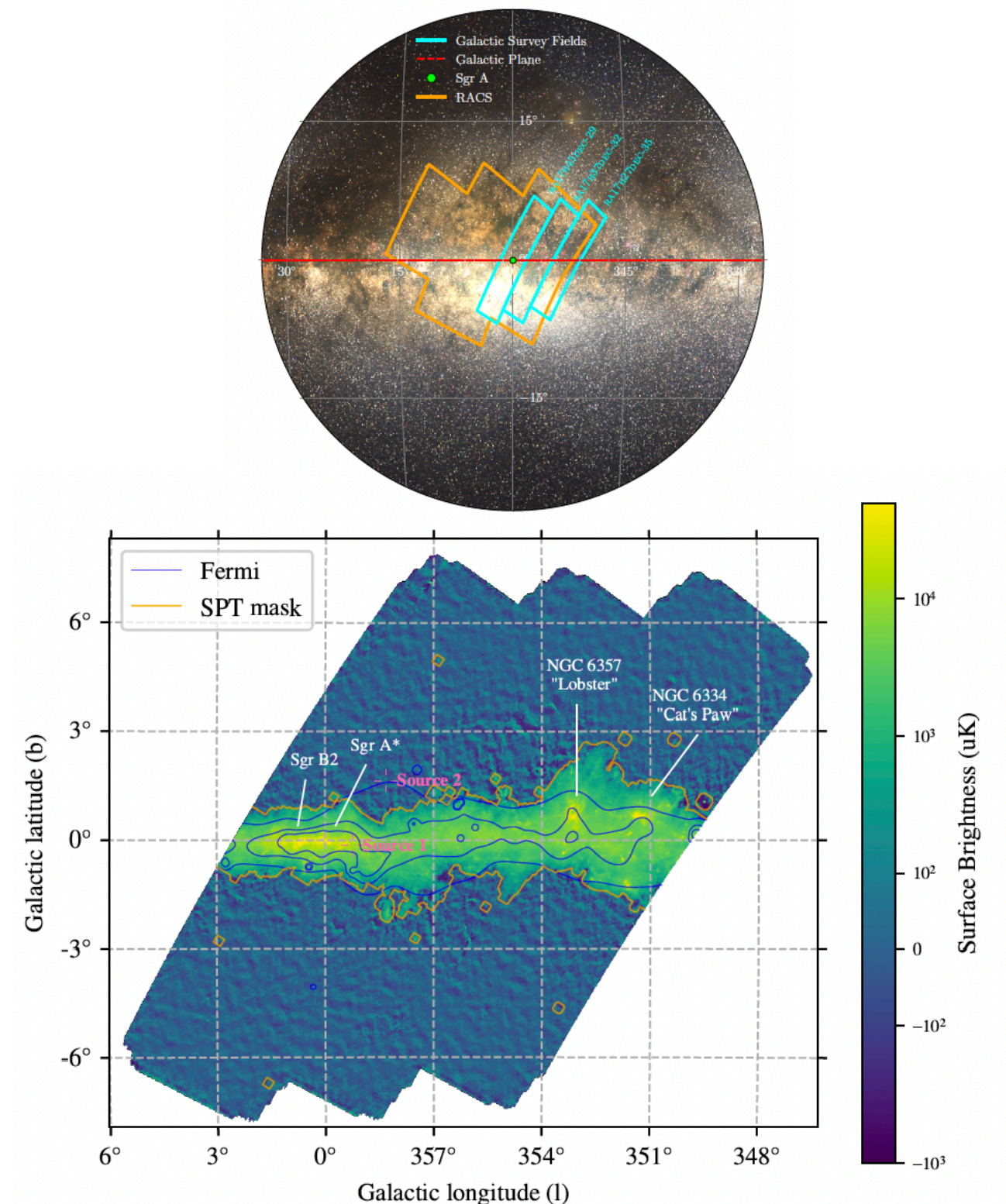
active galactic nuclei fluctuate
on a broad range of timescales

SPT has regular coverage
spanning years



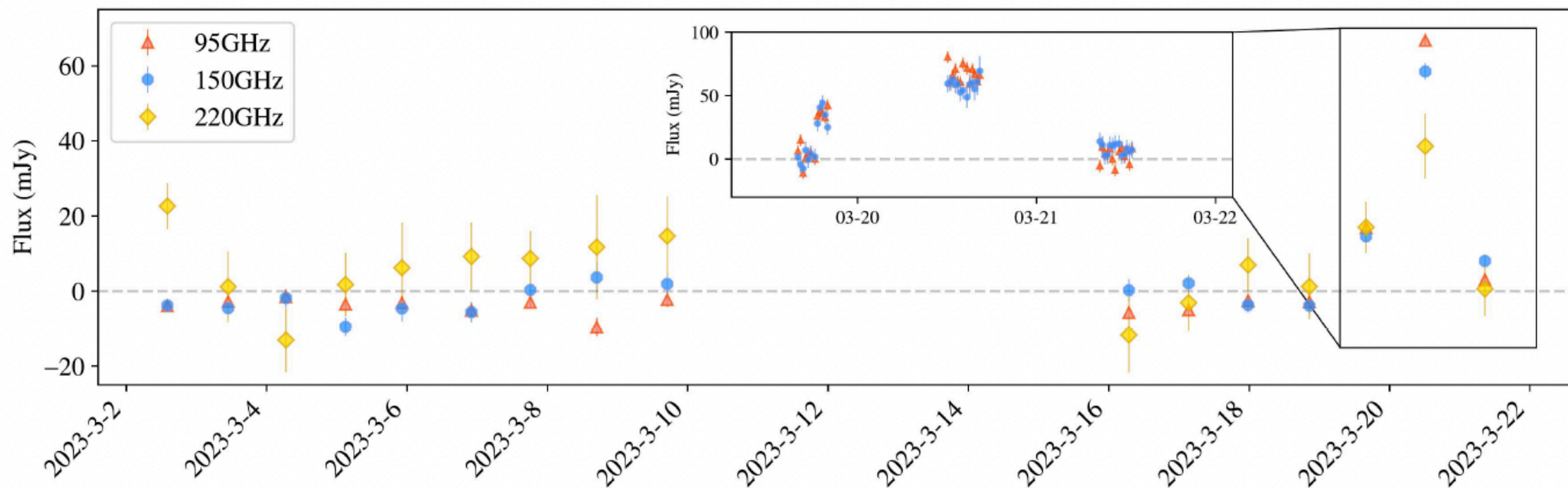
Galactic center

- 2023/24/25 we have observed galactic bulge for several weeks
- sometimes interleaved with monitoring of Sgr A* (led by Paul Chichura)



Yujie Wan et al (coming soon)

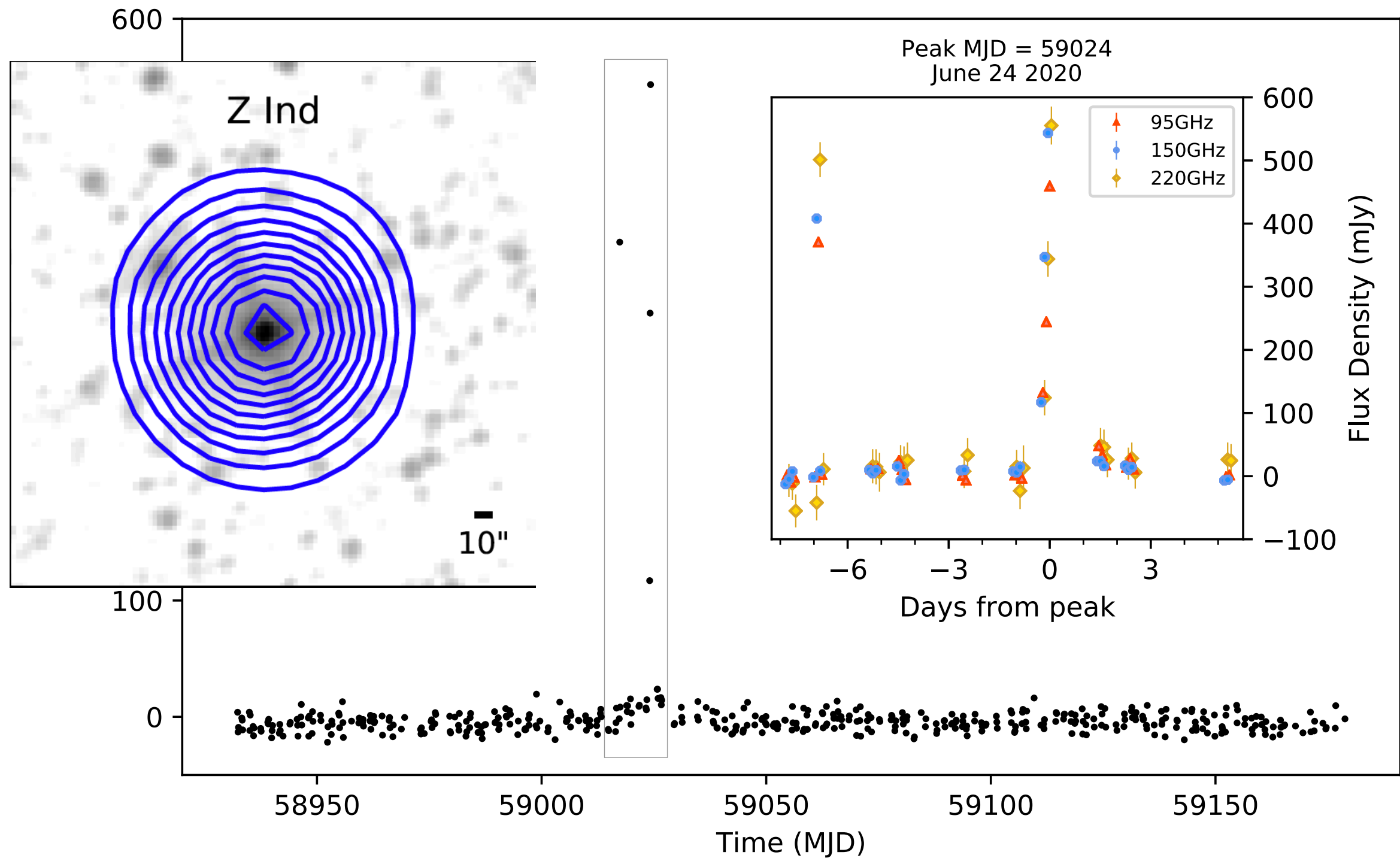
Galactic center transients



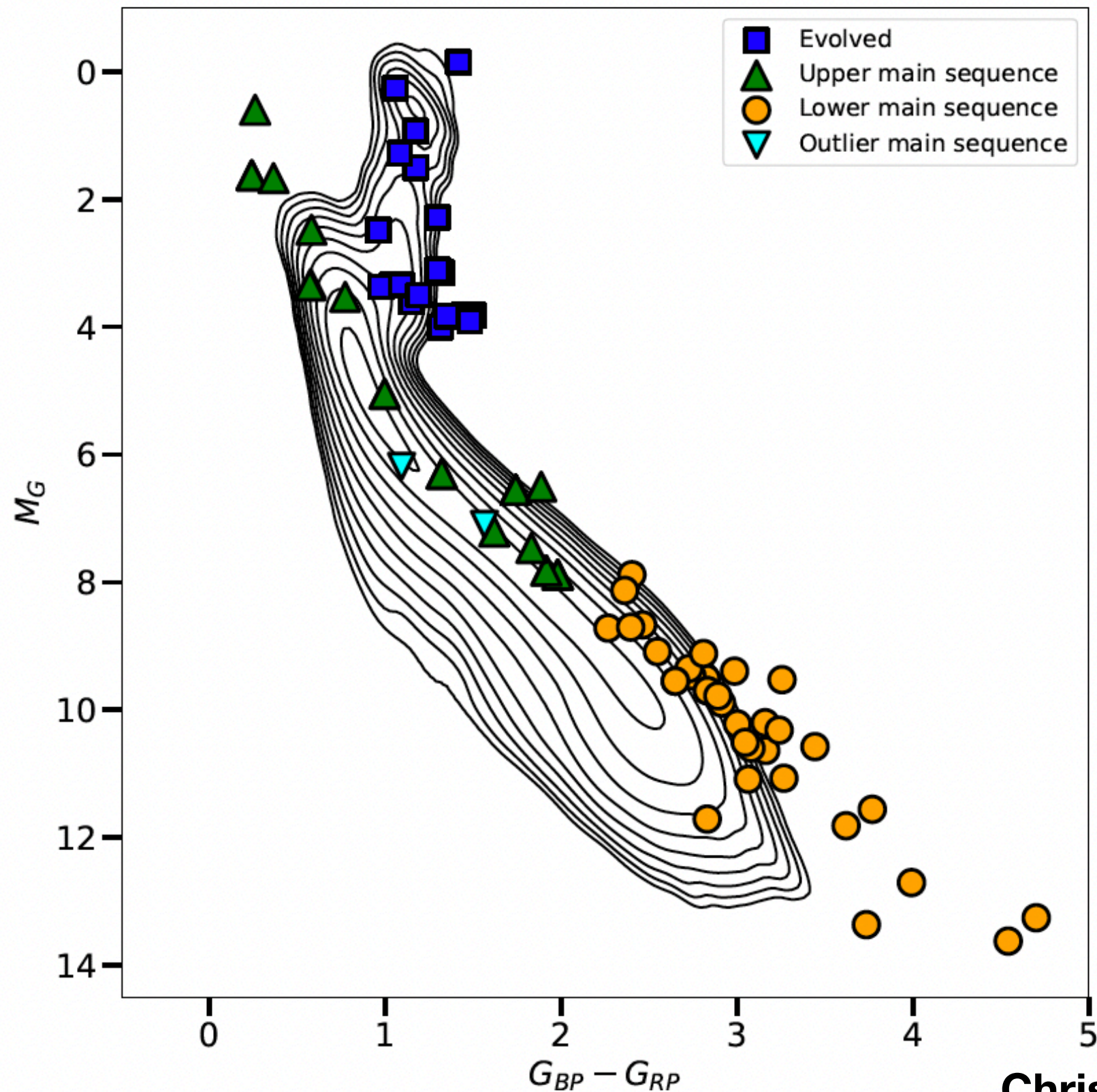
- we found two known symbiotic stars (accreting white dwarfs), nothing else so far

Yujie Wan et al (coming soon)

A Stellar Flare



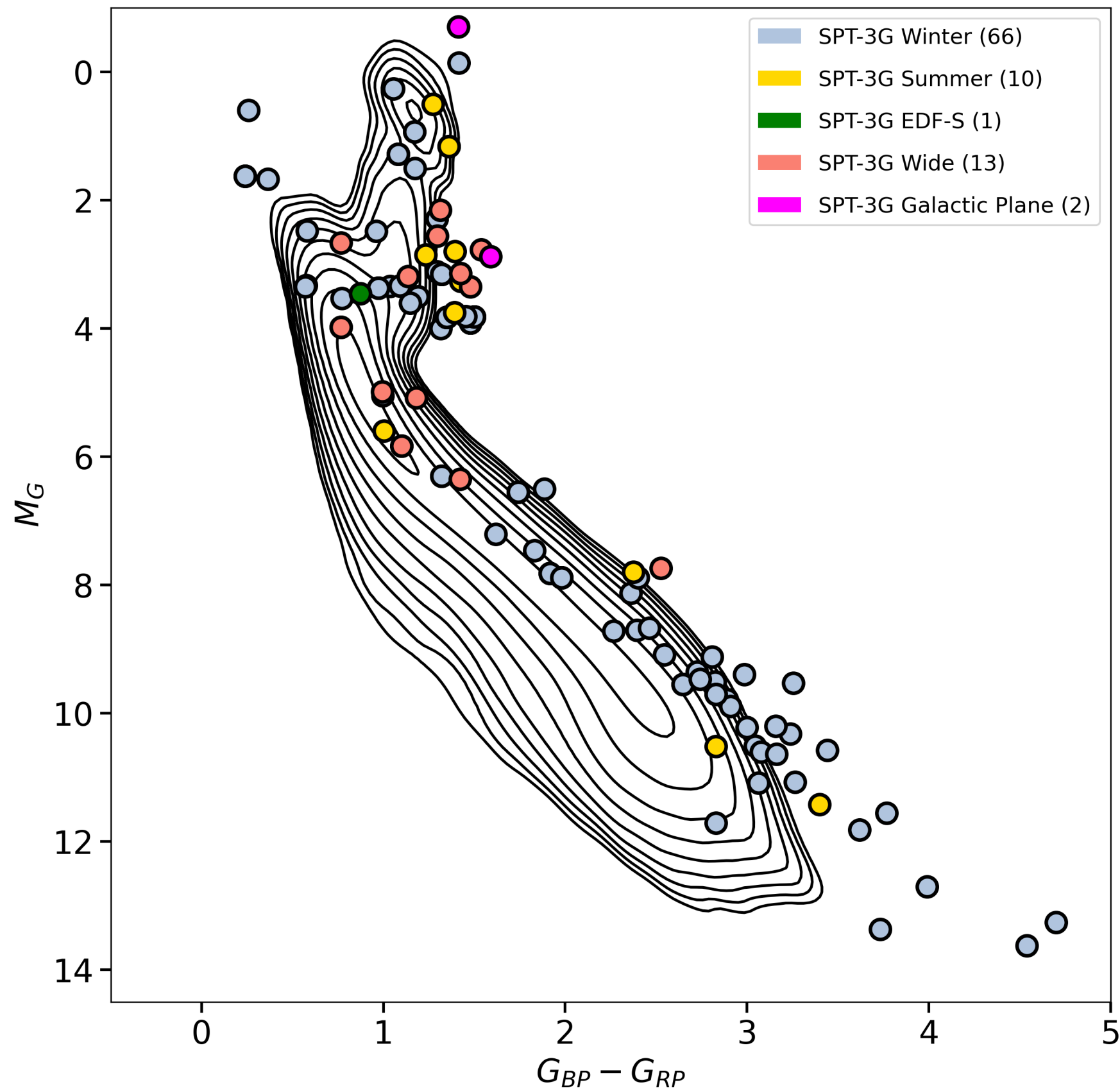
The SPT mm-flare HR diagram



**1000s of times
more luminous
than brightest
solar flares**

**most are
known to be
quiescent X-
ray emitters**

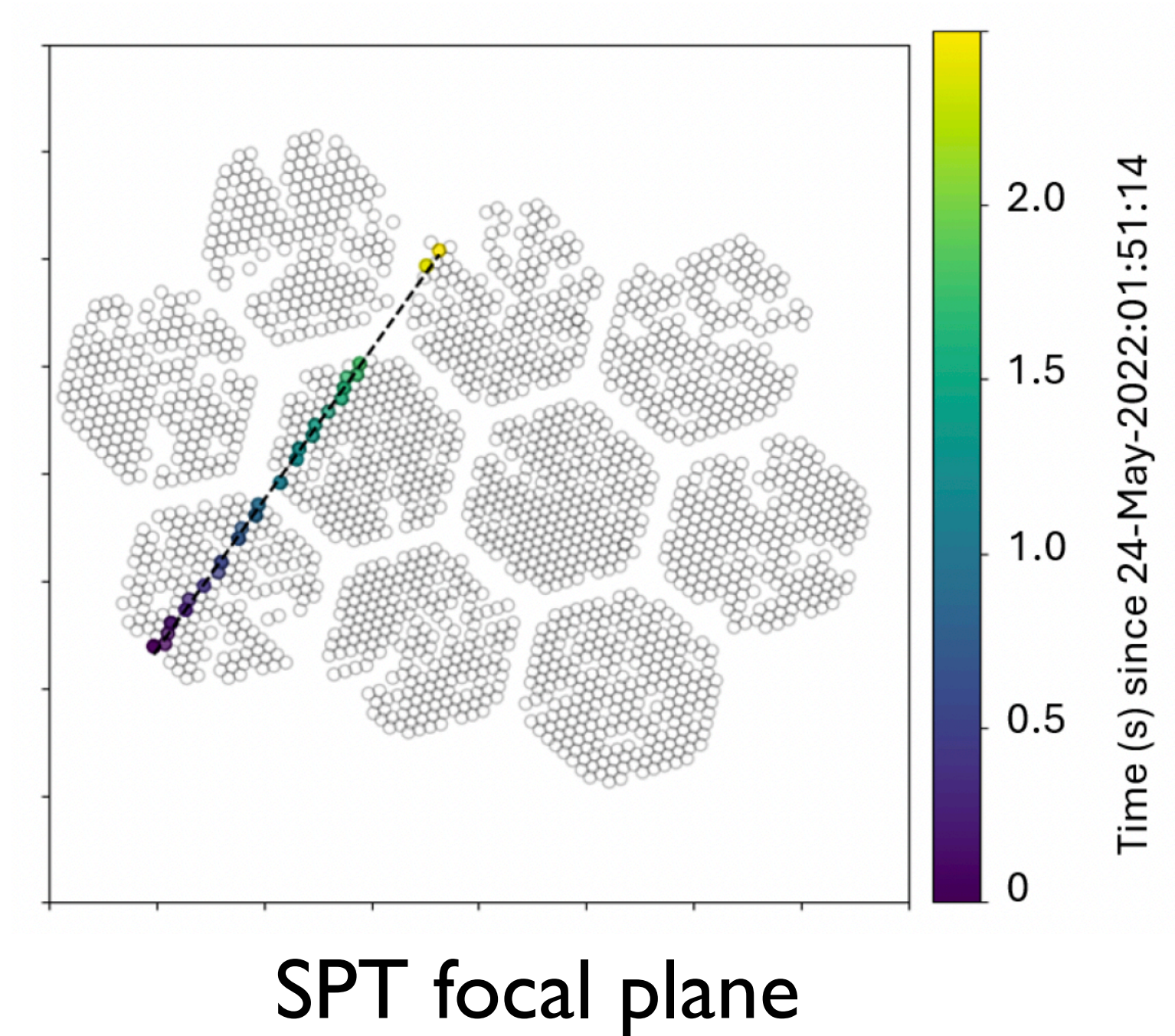
The SPT mm-flare HR diagram



**all SPT flares to
date**

Satellites

- (usually) thermal emission from satellites show up in CMB data if you look carefully

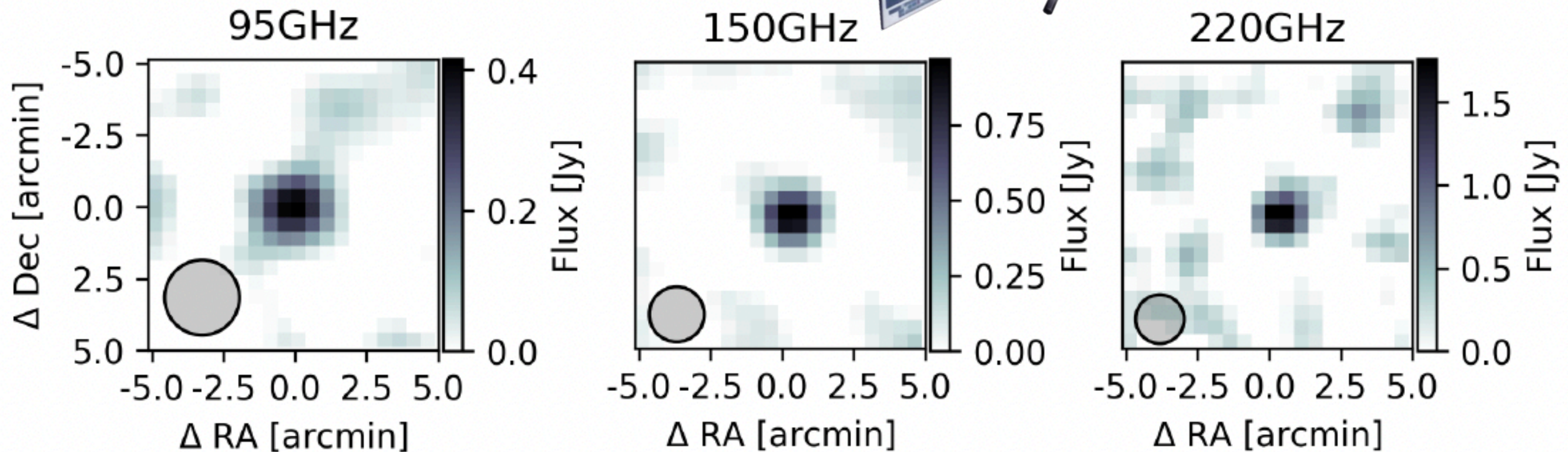


Foster, Chokshi et al. 2411.03374

Satellites

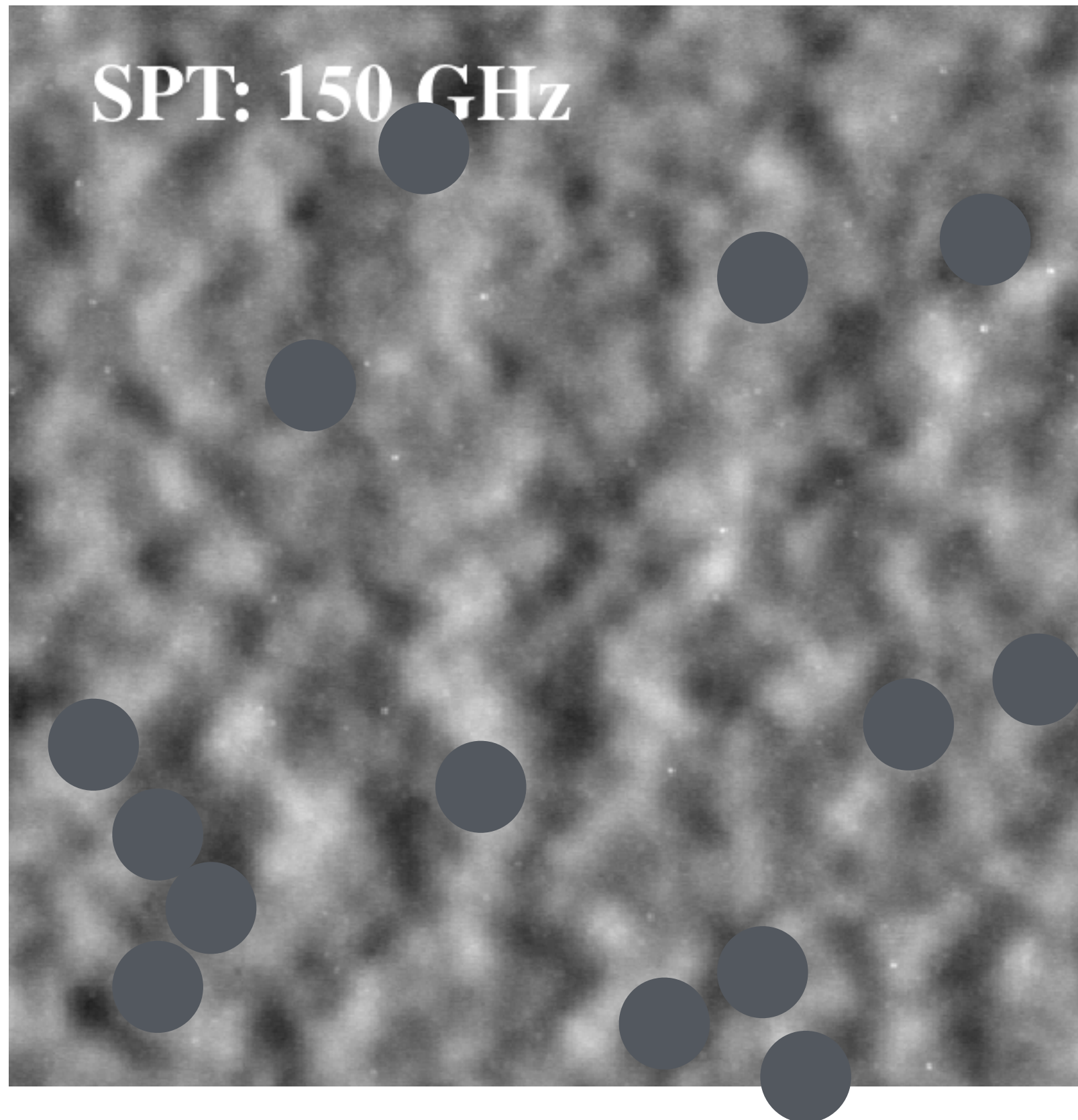


COBE as seen by SPT

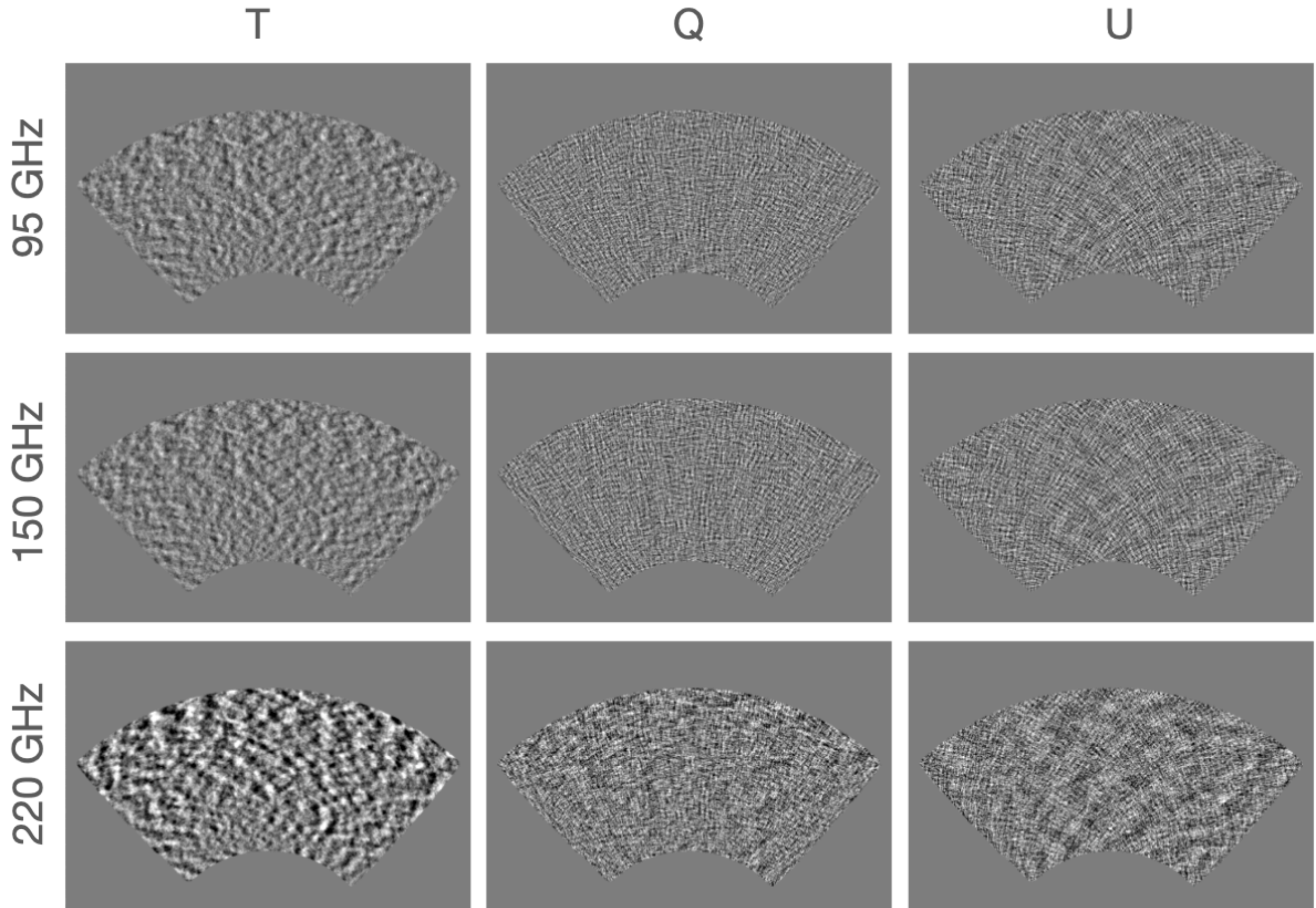


- satellites in general slightly annoying for short duration transient searches, but for now not a serious CMB contaminant

Science theme: What is that splotchiness?



Science theme: What is that plotchiness?

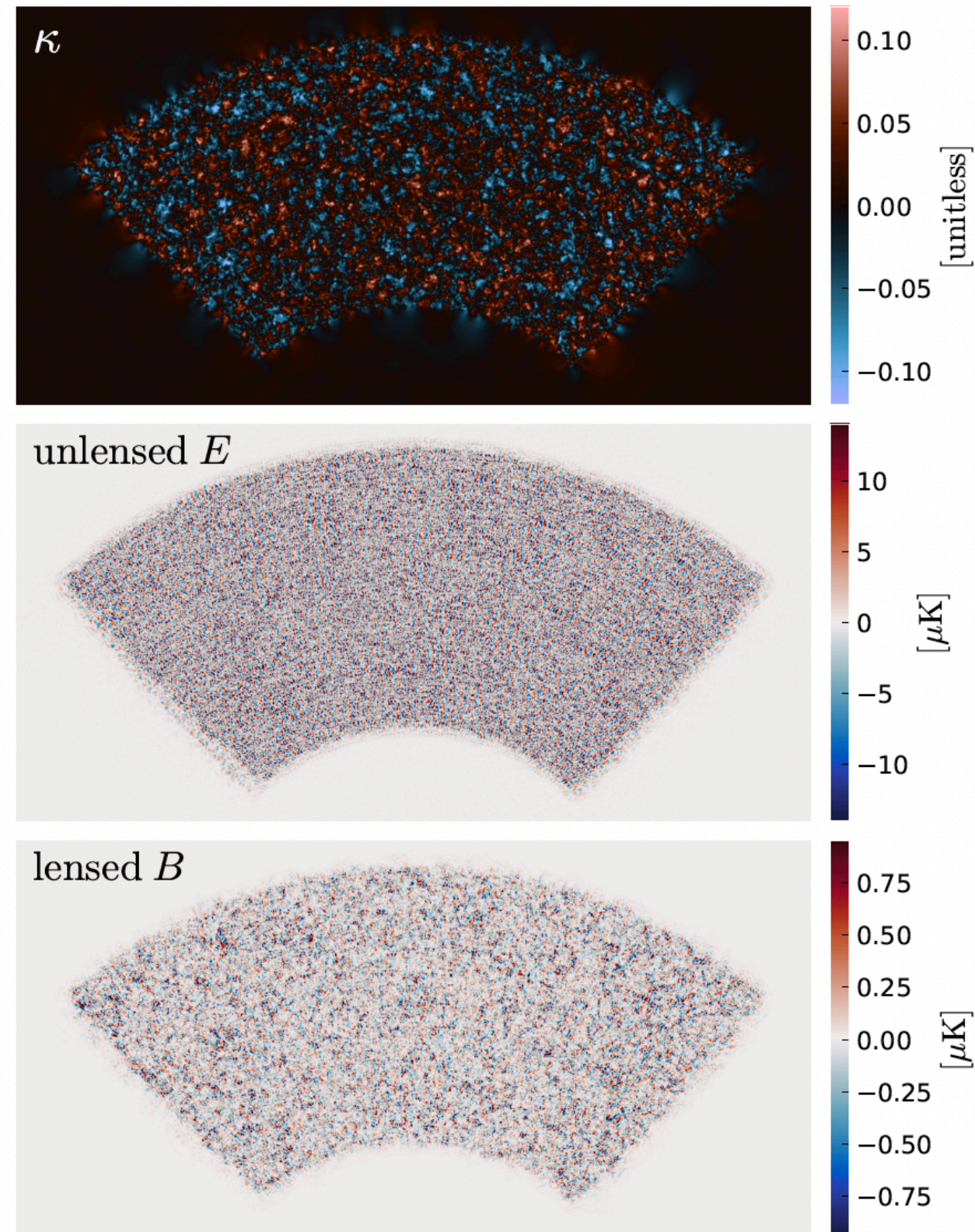


E modes + ϕ

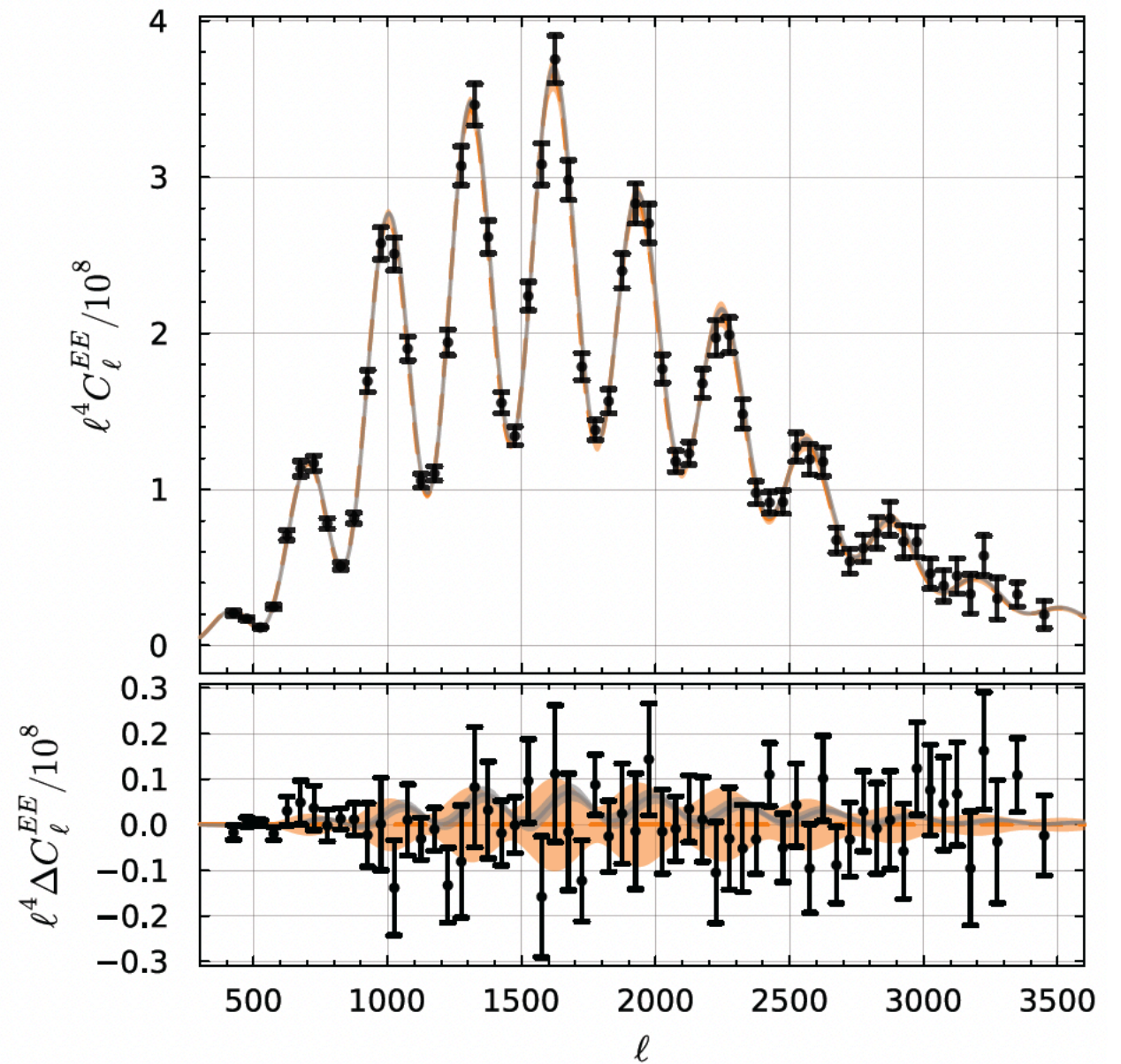
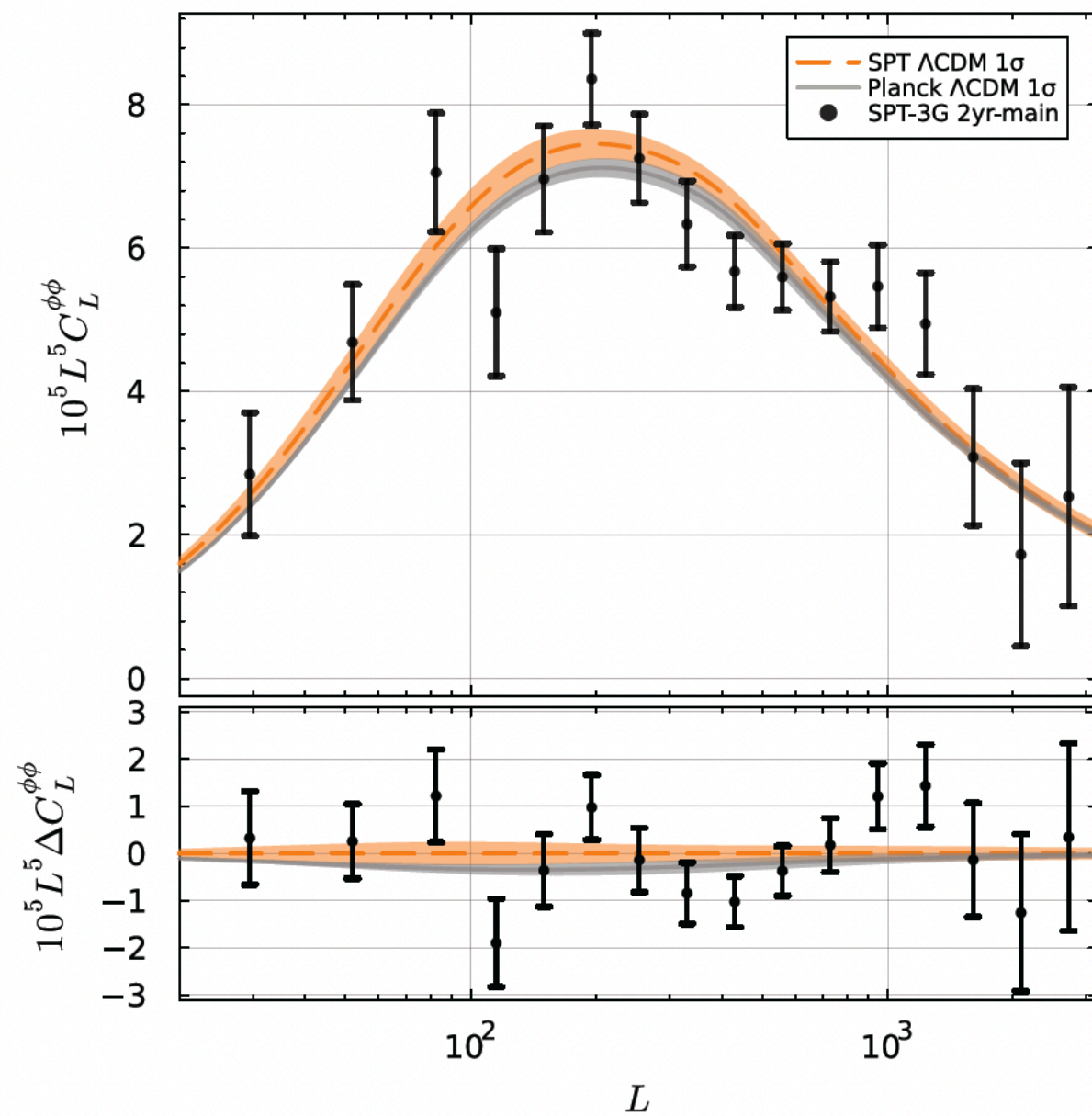
- Bayesian simultaneous fit for lensing and unlensed EE band powers, marginalized over possible unlensed CMB maps and lensing maps

Fei Ge, Marius Millea et al.
24 | 1.06000

most likely maps



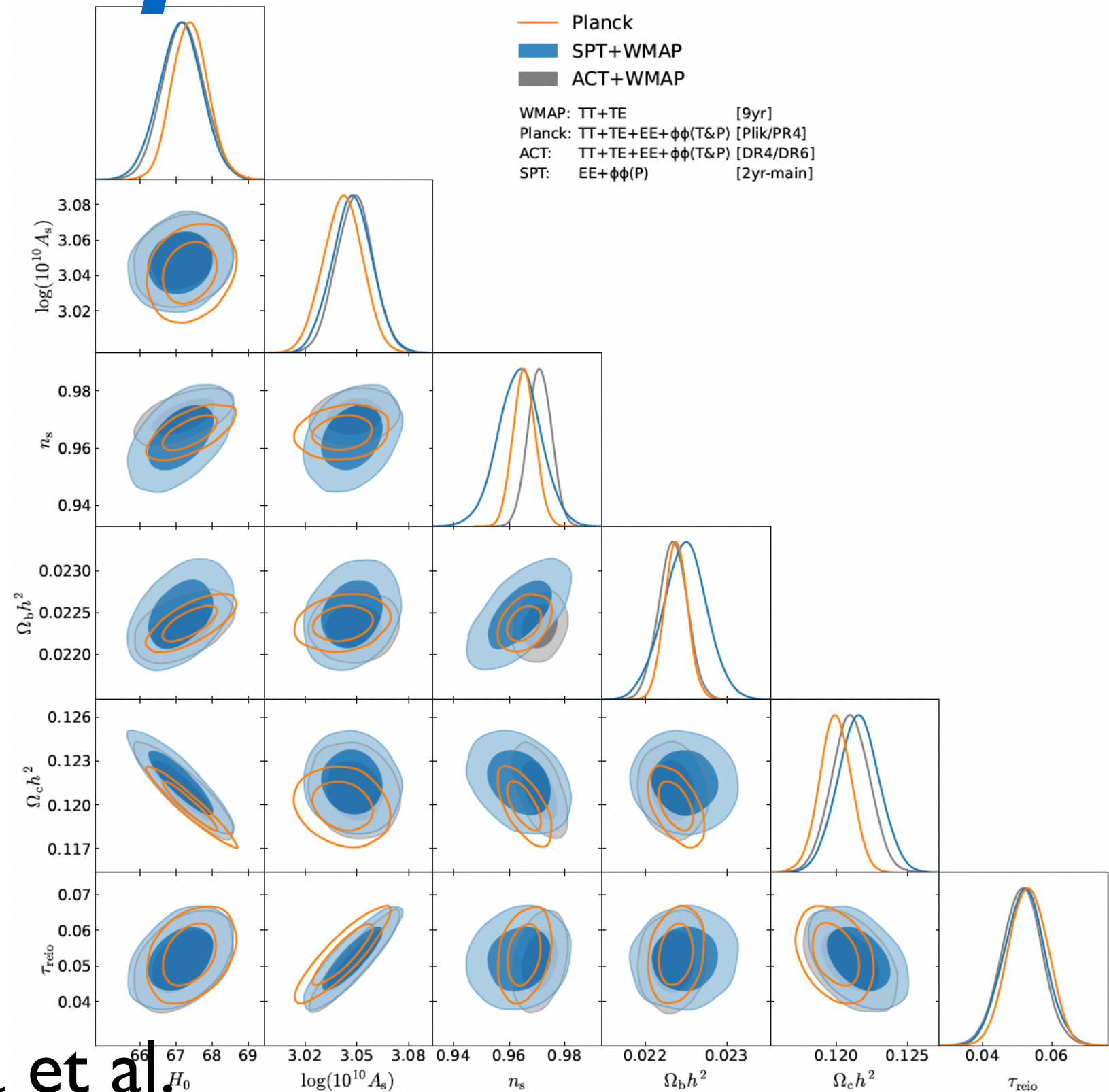
E modes+ ϕ



Fei Ge, Marius Millea et al.
2411.06000

E modes + ϕ

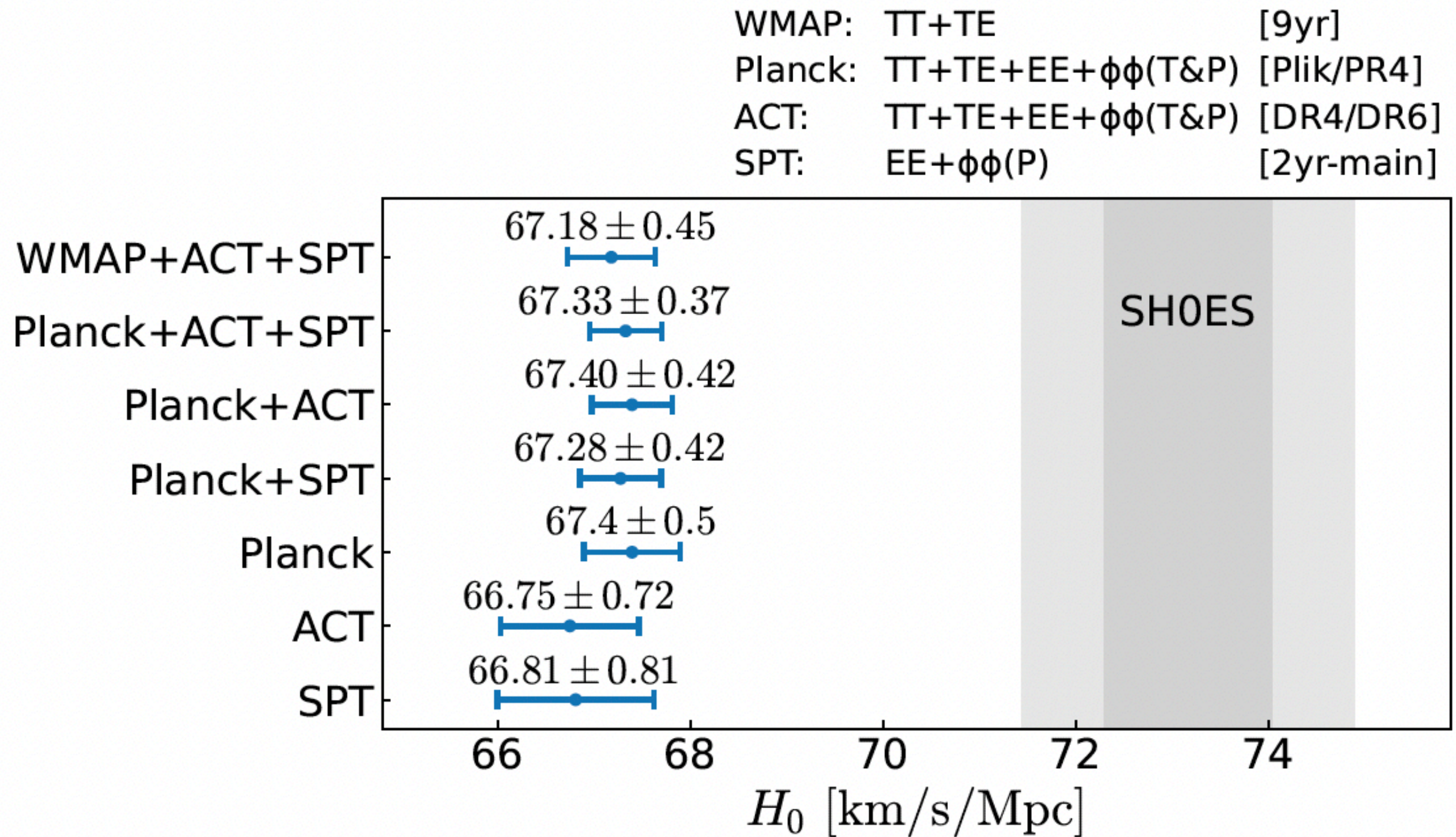
- SPT-3G **polarization only** + WMAP agrees very well with Planck
- nothing too weird



Fei Ge, Marius Millea et al.

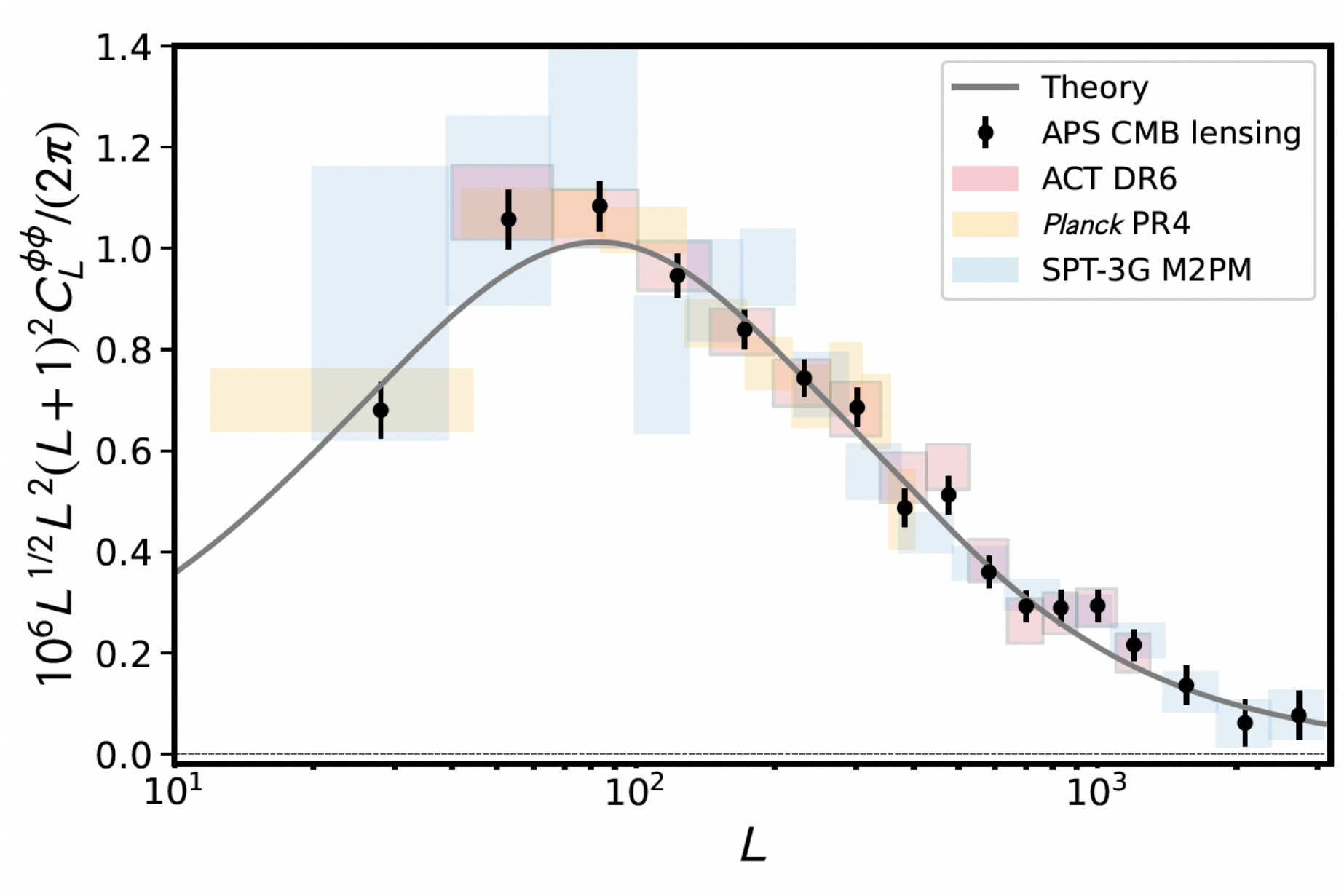
24 | 1.06000

Hubble tension continues



Fei Ge, Marius Millea et al.
24 | 1.06000

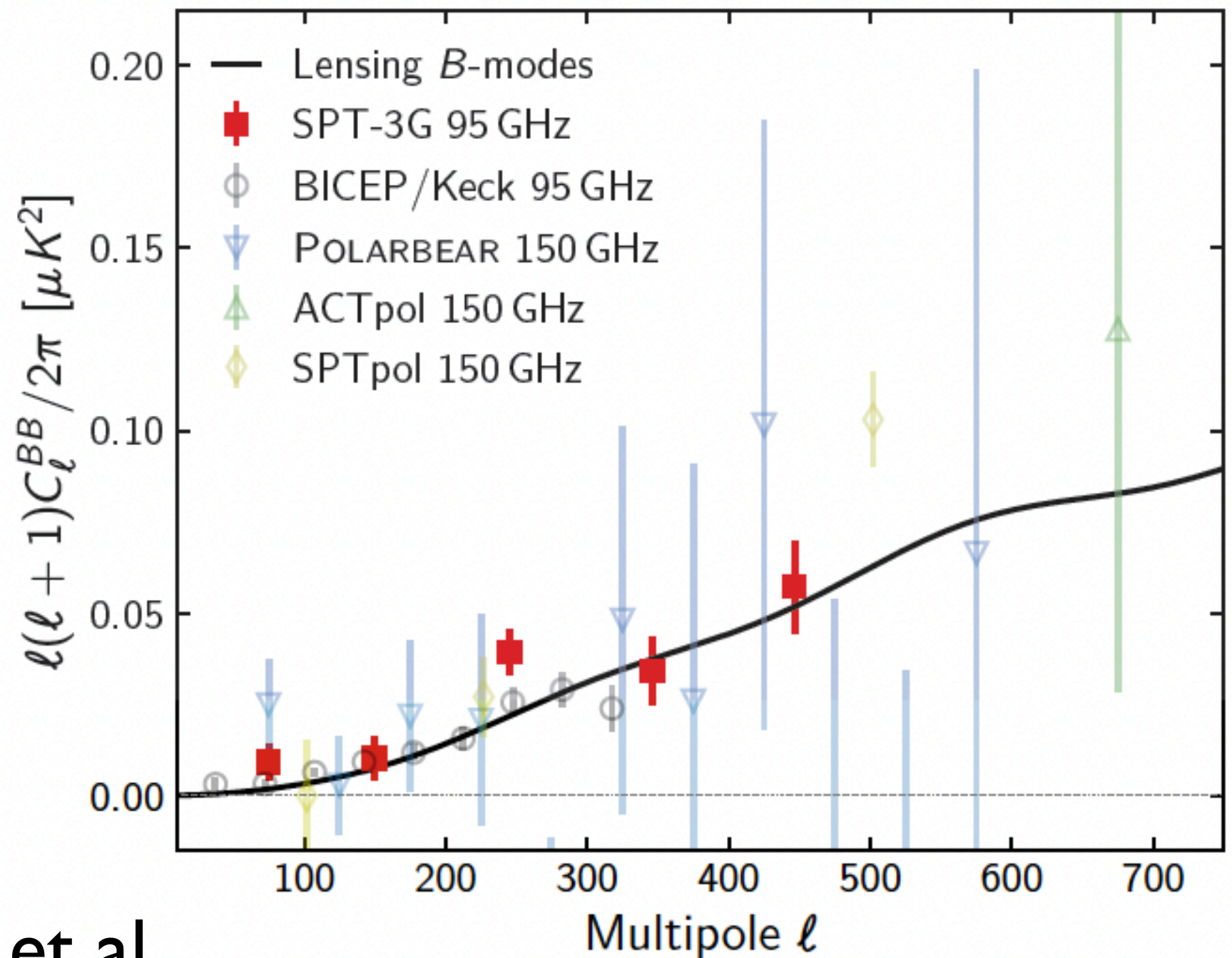
Combined ACT+Planck+SPT Lensing



Frank Qu, Fei Ge, Kimmy Wu et al.
2504.20038

B modes

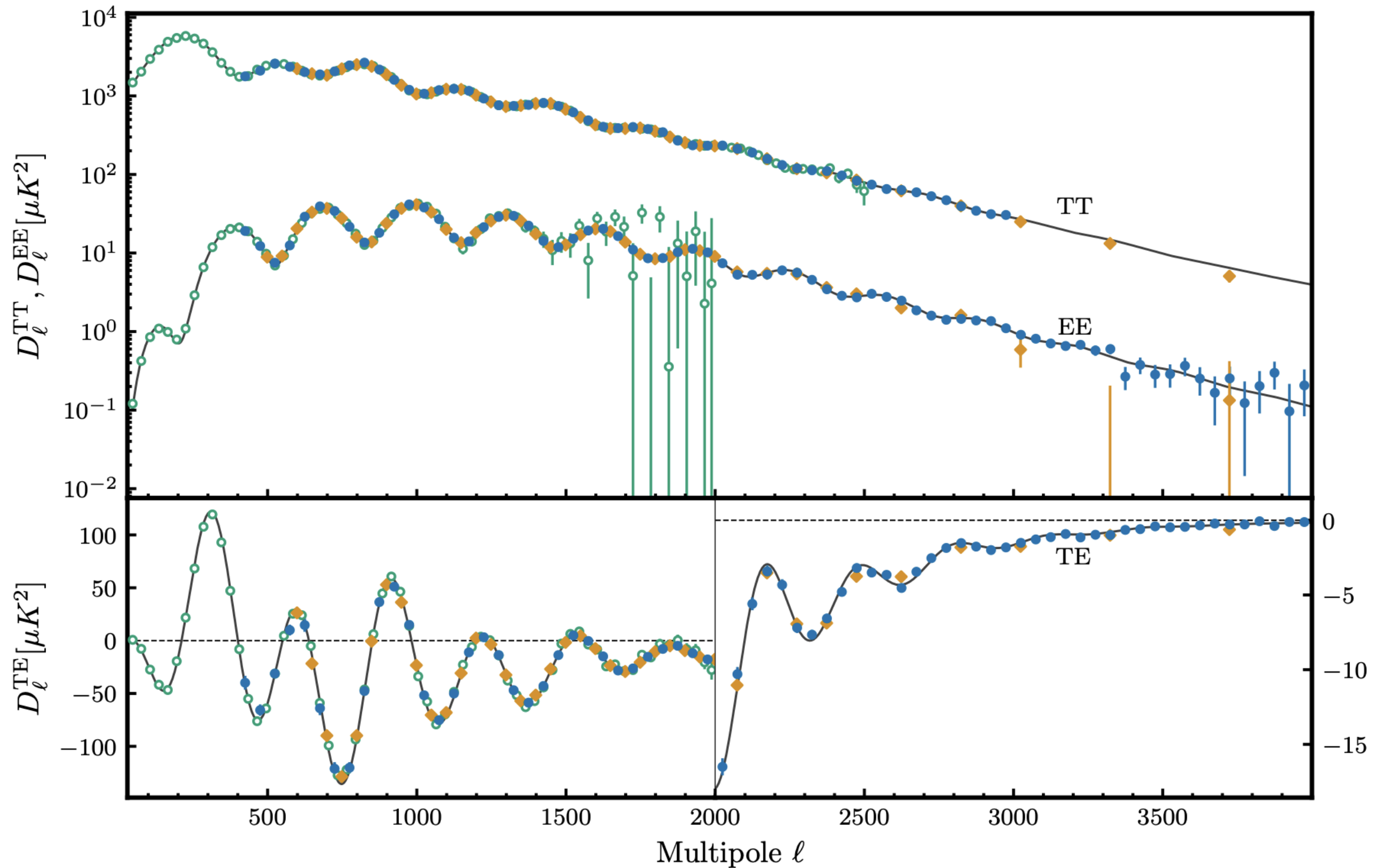
- deep dive into trying to get larger scales with SPT
- $\sigma(r)=0.067$



Jessica Zebrowski et al.
2505.02827

Coming Wednesday: New SPT TT/TE/EE spectra & likelihoods

• SPT-3G 19/20 • ACT DR6 • Planck 2018



Camphuis, Quan, Balkenhol, Khalife, Ge, Guidi, Huang, Lynch, Omori, Trendafilova et al

Webinar Wednesday!

<https://www.youtube.com/@southpoletelescope3111>

9:30am CDT



South Pole Telescope

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Summary

- objects
 - satellites, asteroids, stars, AGN, galaxies, galaxy clusters
- plotchy fields
 - CMB temperature & polarization, gravitational lensing convergence