Fireslide 2

Friday, March 12

Dealing w/ Systematics & Foregrounds

Giuseppe Puglisi - UC Berkeley

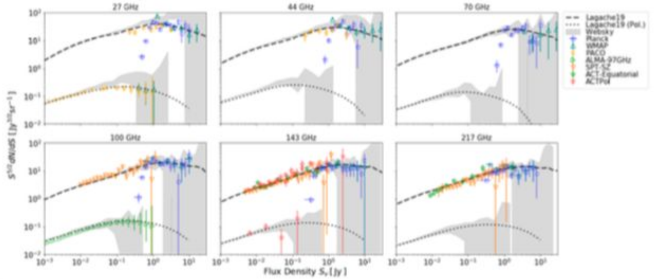
Systematics simulations with TOAST

(see my poster)

- Beam Side lobe convolution
- Calibration uncertainties
- Gain drifts
- Cosmic Ray glitches
- (HWP non-idealities ...)

Radio Source Simulations

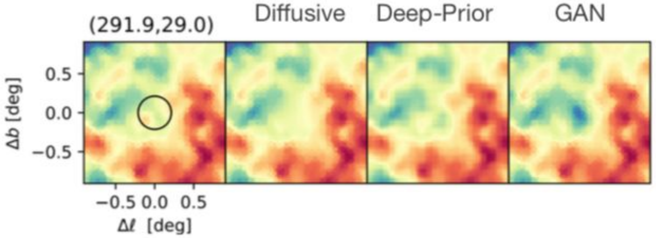
- **Constrained** realizations from Low-Freq. catalogs
- **Mock** realizations from Websky Halo catalogs



Foreground modelling using Neural Networks

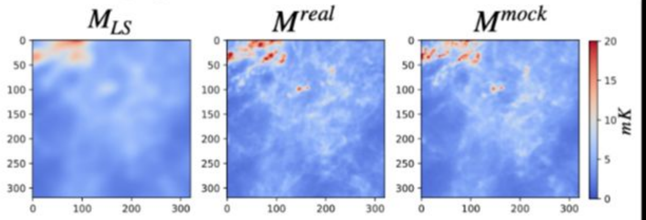
Inpainting Galactic Foreground Intensity and Polarization maps using Convolutional Neural Networks

https://iopscience.iop.org/article/10.3847/1538-4357/abc47c



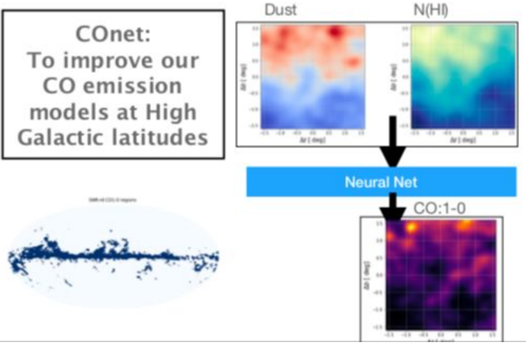
ForSE: a GAN based algorithm for extending CMB foreground models to sub-degree angular scales

Krachmalnicoff & Puglisi 2020

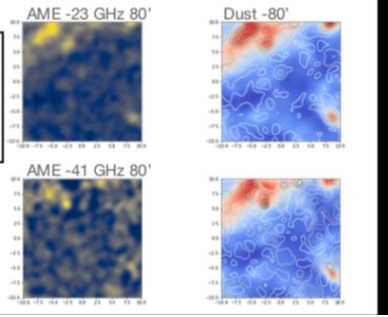


On-going projects:

COnet: To improve our CO emission models at High Galactic latitudes

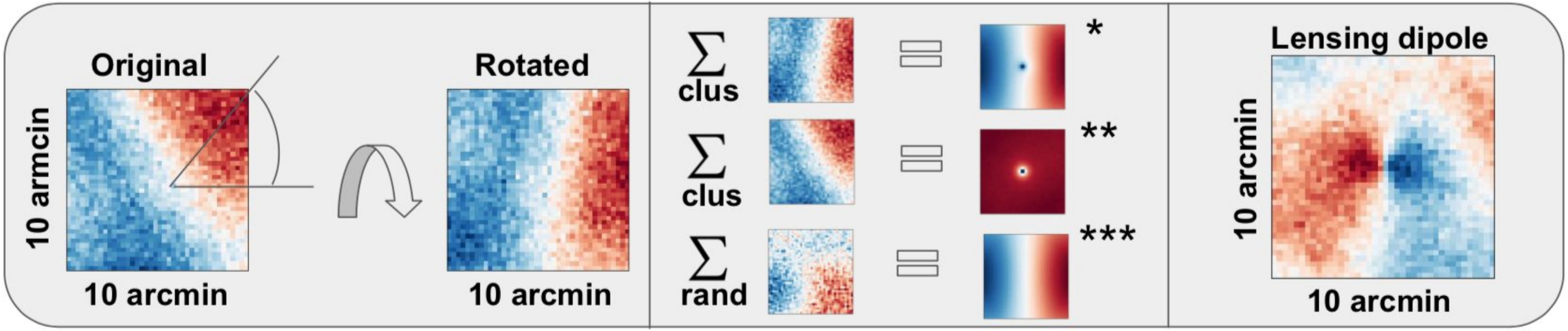


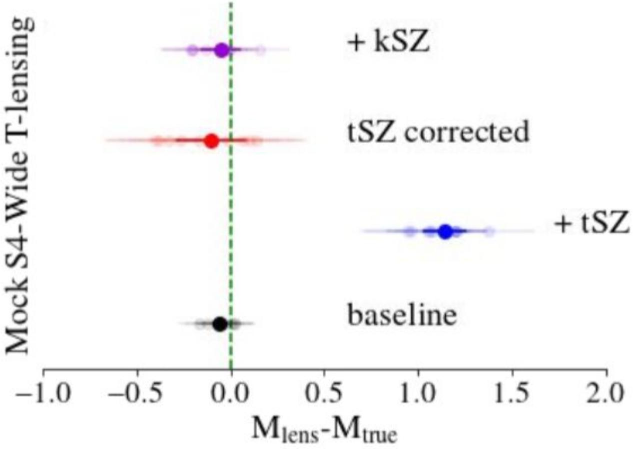
AMEnet To increase resolution of AME maps



A foreground-immune CMB-cluster lensing estimator

Kevin Levy (MSc student at U. Bonn), Srinivasan Raghunathan, Kaustuv Basu





- Rotate along gradient direction and stack (2% constraint 100k clusters).
- +tSZ (blue) introduces bias but easy to correct (red) at the expense of a slightly larger noise.
- +kSZ (purple) cancels upon stacking, i.e. only adds variance.
- SNR comparison with MLE/QE ongoing.
- Reference: S. Raghunathan et al. 2019, PRL (1907.08605) and *Levy* et al. in prep.

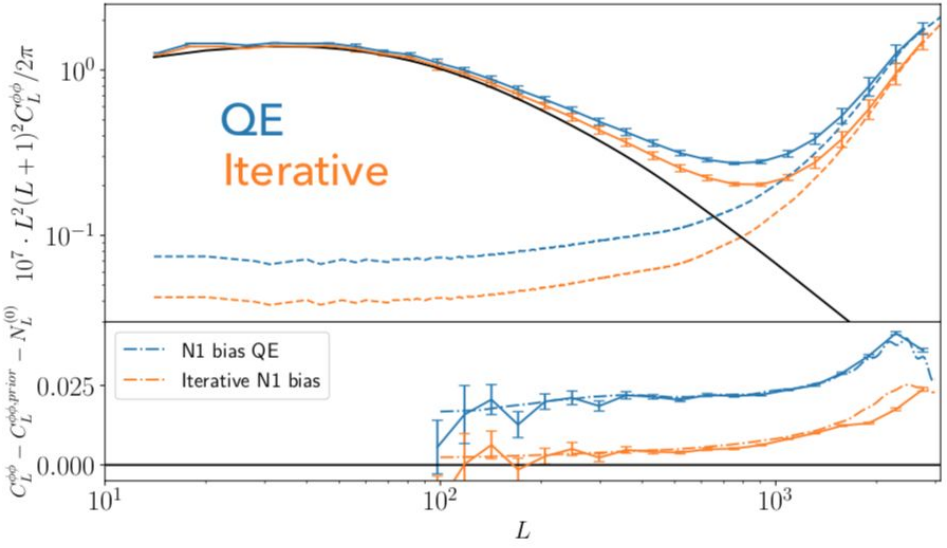
* rotated cluster stack, ** tSZ estimate (unrotated cluster stack),
***background stack (using random location)

LOUIS LEGRAND, JULIEN CARRON, SEBASTIAN BELKNER

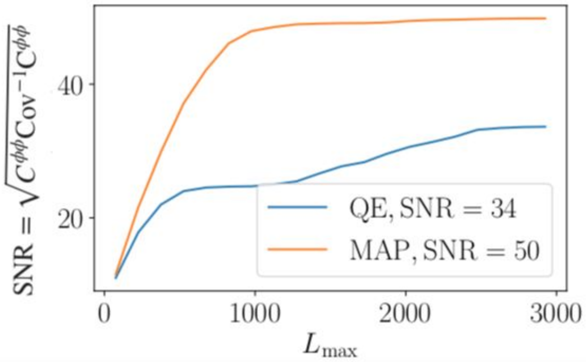
UNIVERSITÉ DE GENÈVE

Optimal CMB lensing power spectrum estimation

- Traditional lensing estimators (QE) are known to be sub-optimal for next-gen experiments such as CMB-S4
- New estimators are currently being developed (Carron et al. 2017, Millea et al. 2019)
- Our goal: develop a fast and robust pipeline to get an unbiased CMB lensing power spectrum
- Based on the iterative lensing estimator of Carron et al. 2017



- Reconstruction of lensing power spectra for CMB-S4 like maps
- N0 bias reduced with iterative delensing
- N1 bias doubly reduced
- Currently developing pipeline for iterative RDN0



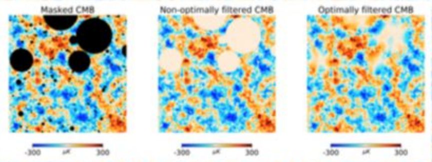
Margherita Lembo @ University of Sussex

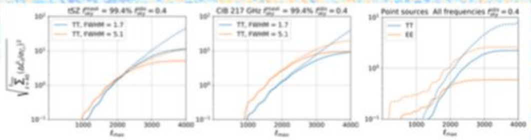
CMB lensing:

analyzing the **impact of masking extragalactic foregrounds** (such as CIB, tSZ, radio sources) on both the reconstructed **CMB lensing potential** and the **lensed CMB power spectra**.

- *Lensed CMB power spectrum biases from masking extragalactic sources*
G. Fabbian, J. Carron, A. Lewis, **ML** [arXiv:2011.08841]

- *CMB lensing reconstruction biases from masking extragalactic sources*
ML, G. Fabbian, J. Carron, A. Lewis *(in prep.)*



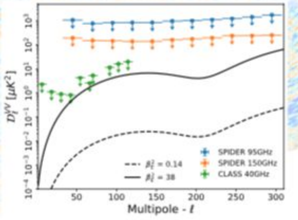


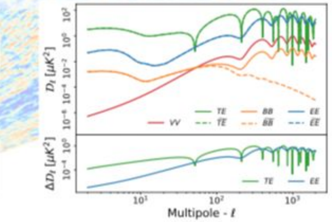
Cosmic Microwave Background
in view of **future experiments**:
Which information can be still extracted from the CMB?
How to extract this information in a reliable way?

CMB polarization:

working on formalism describing the in-vacuo **conversion between polarization states** of propagating radiation (GFE), in a cosmological context, which is a powerful tool for c**onstraining new physics beyond the standard model**.

Through a dark crystal: CMB polarization as a tool to constrain the optical properties of the Universe
ML, M. Lattanzi, L. Pagano, A. Gruppuso, P. Natoli, F. Forastieri [arXiv:2010.15190]





In short...

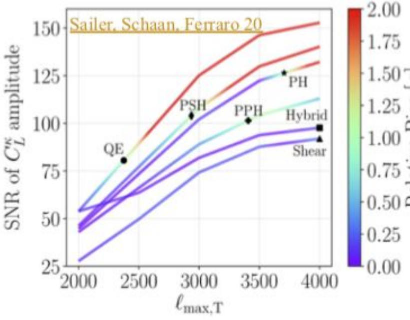
- **“*Angelo Della Riccia*” Fellowship, University of Sussex (Jan 2021 - Dec 2021)**
- Ph.D. in Physics, University of Ferrara (Nov 2017 - Nov 2020)
- Master in Theoretical Physics, University of Bari (Sep 2014 - Sep 2017)
- Bachelor in Physics, University of Bari (Sep 2010 - Sep 2014)

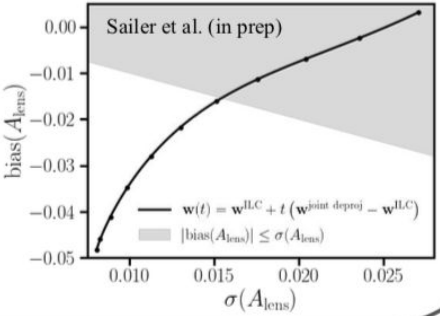
Noah Sailer - UC Berkeley
(2nd year physics student)

nsailer@berkeley.edu

CMB lensing - optimal bias mitigation

- Extragalactic foregrounds (CIB, tSZ, kSZ, radio point sources) in temperature maps significantly bias lensing reconstruction
- Extended a bias-hardening technique (based on Osborne+13) to simultaneously reduce point source, tSZ, and CIB bias at a small noise cost
- What are the optimal ILC weights for bias + noise reduction?

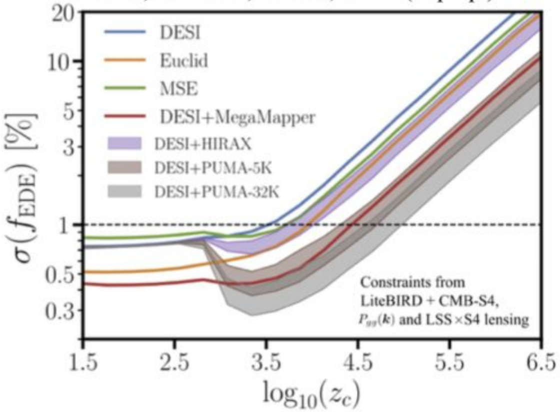




Cross-correlations with future high-z surveys

- Perturbation-theory based Fisher forecasting (github.com/NoahSailer/FishLSS) for 2-point measurements (galaxy and 21 cm clustering, cross-correlations with CMB lensing)
- Self-consistent forecasts for future LSS and CMB surveys (Euclid, MSE, MegaMapper, PUMA, S4, ...)
- Constraints on LCDM and usual extensions, EDE, DM interactions, gravitational slip, etc.

Sailer, Castorina, Ferraro, White (in prep.)



Berkeley
UNIVERSITY OF CALIFORNIA

Likelihood methods to infer the optical depth from *Planck* data

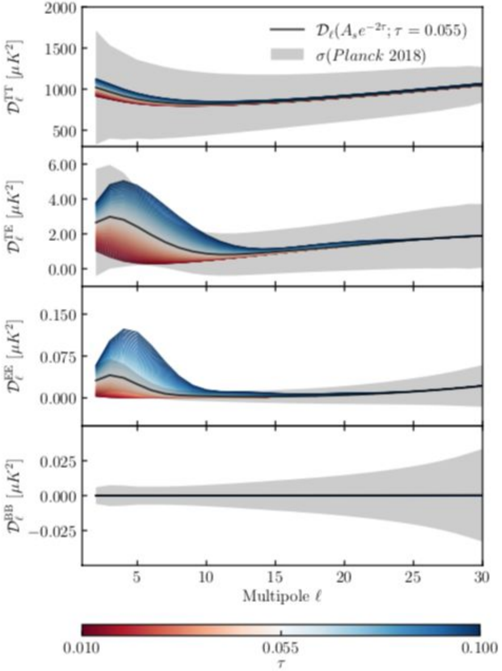
Roger de Belsunce - *with*: George Efstathiou, Steve, Gratton, Will Coulton (*arXiv: in prep.*)

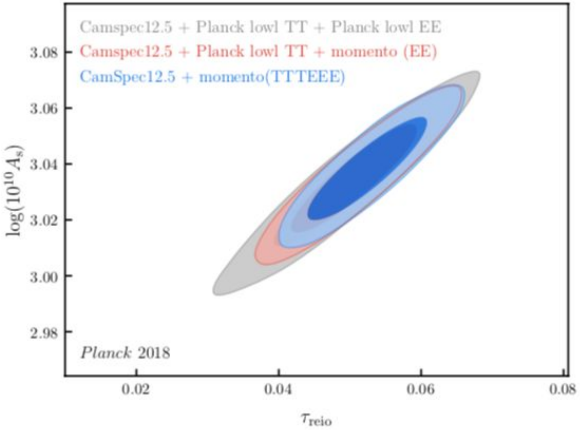
[1] *Planck* Collaboration XLVI (2016)
[2] Pagano et al. (2020)
[3] Gratton (2017)
[4] Alsing et al. (2018)

Problem
- noise- & systematics-dominated signal
- No exact analytic likelihood (masked sky)

Physical motivation
- τ relevant for M_υ, A_s, n_s, σ_8
- Constraints on reionization models

Solution
- Improved noise and systematics modelling
- Bayesian frameworks:
  - From likelihood-approximation[1,2,3] to likelihood-free[4] schemes
- First joint TTTEEE likelihood





Likelihoods	CamSpec ($TTTEEE$) + *Planck* low-ℓ TT+ momento (EE)	CamSpec ($TTTEEE$) + momento ($TTTEEE$)
	Planck 2018	
τ	$0.0508^{+0.0056}_{-0.0062}$	$0.0526^{+0.0051}_{-0.0060}$

Consistent results for three likelihoods on systematics dominated signal for τ

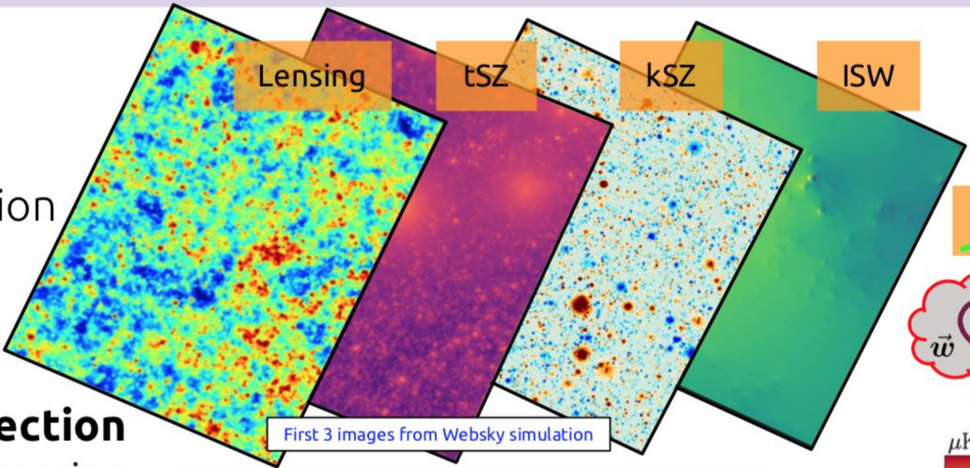
CMB secondaries with 

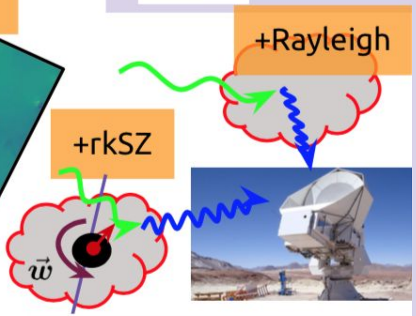
+ VERA C. RUBIN OBSERVATORY + SKA +...

1) **Identifying** new **observables**

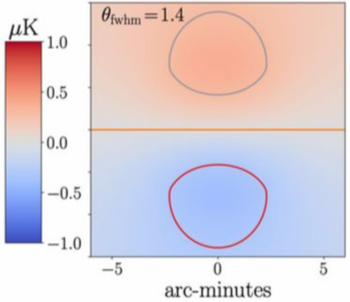
2) Extract information from data; **developing** different **methods**

3) Improve the **detection significance** of upcoming experiments to various cosmological observables





Large-scale **velocity** reconstruction from moving lens and kSZ effects



DETECTION: SNR~30 for S4

Moving lens: **1812.03167** and **2006.03060**

Primordial **isocurvature**: kSZ: **1908.08953**

Current CMB only: $\sigma(A) \sim 500$

Using kSZ velocities (S4): $\sigma(A) \simeq 0.5$

Improving astrophysics *and* cosmology from reionization kSZ: **2012.09851**

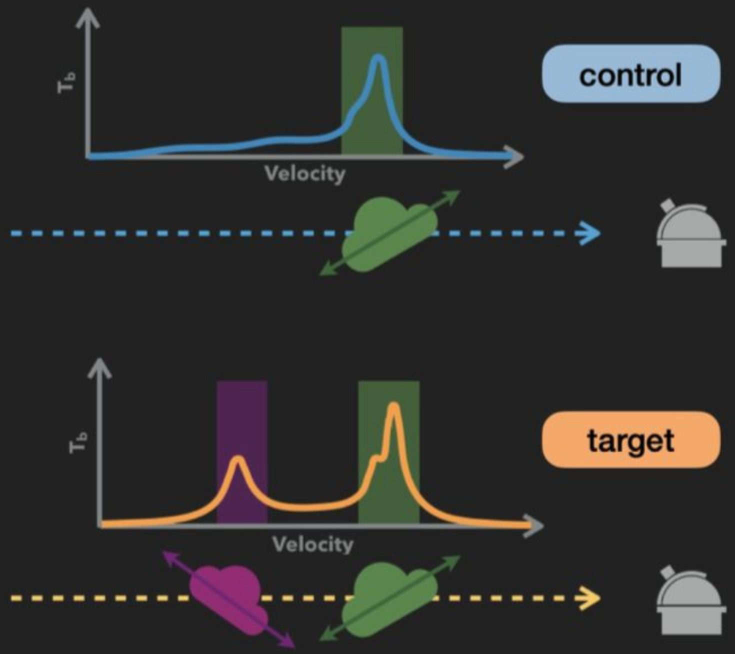
Delensing the CMB TT,TE,EE

1) Improving measurements of the BAO **peak locations**
2) Better measurement of the **damping tail** for **N_eff, H0**,++
3) Iterative delensing for **B-modes**

SELIM HOTINLI: shotinl1@jh.edu
JHU Horizon Fellow
JOHNS HOPKINS UNIVERSITY

Evidence for line-of-sight frequency decorrelation of polarized dust emission in *Planck* data

A&A 647, 16. arXiv:2101.09291



LOS frequency decorrelation:
If a single line of sight intercepts multiple dust clouds with different SEDs and different magnetic field orientations, the frequency scaling of Stokes *Q* and *U* may be different.

We detect this effect in *Planck* data at high significance.

The key is knowing where to look: we select sightlines based on their complexity in HI line emission. We use HI-based estimates of the number of clouds per sightline (Panopoulou & Lenz 2020) and the 3D magnetic field geometry (Clark & Hensley 2019).

V. Pelgrims, S.E. Clark, B.S. Hensley, G.V. Panopoulou, V. Pavlidou, K. Tassis, H.K. Eriksen, I.K. Wehus

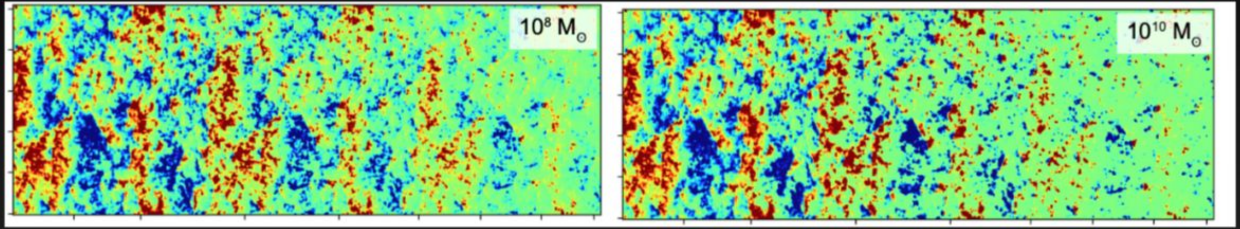
Suvodip Mukherjee

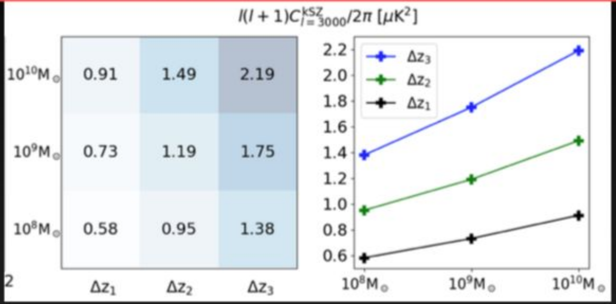
Connecting KSZ observable with the physics of reionization

Introduction to the KSZ-bias parameter

When it started ? How long it continued ? Is it driven by massive/lighter halos ?

arXiv:2005.05327





Scaling relation to understand the kSZ power spectrum

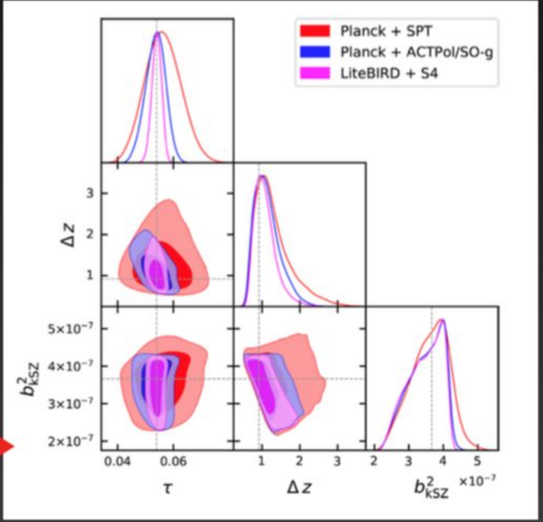
Commonly used scaling relation

$$\frac{l(l+1)}{2\pi}C^{\rm kSZ}_{l=3000} \approx 2.02\mu{\rm K}^2\left[\left(\frac{1+\bar{z}}{11}\right)-0.12\right]\left(\frac{\Delta z}{1.05}\right)^{0.47}$$

New scaling relation

$$\frac{l(l+1)C^{\rm kSZ}_{l=3000}}{2\pi} \approx 0.65\mu{\rm K}^2\left(\frac{0.097+\tau}{0.151}\right)\left(\frac{\Delta z}{1.0}\right)^{0.54}\left(\frac{b^2_{\rm kSZ}(l=3000)}{4.0\times10^{-7}}\right)^{0.92}$$

arXiv:2007.03705

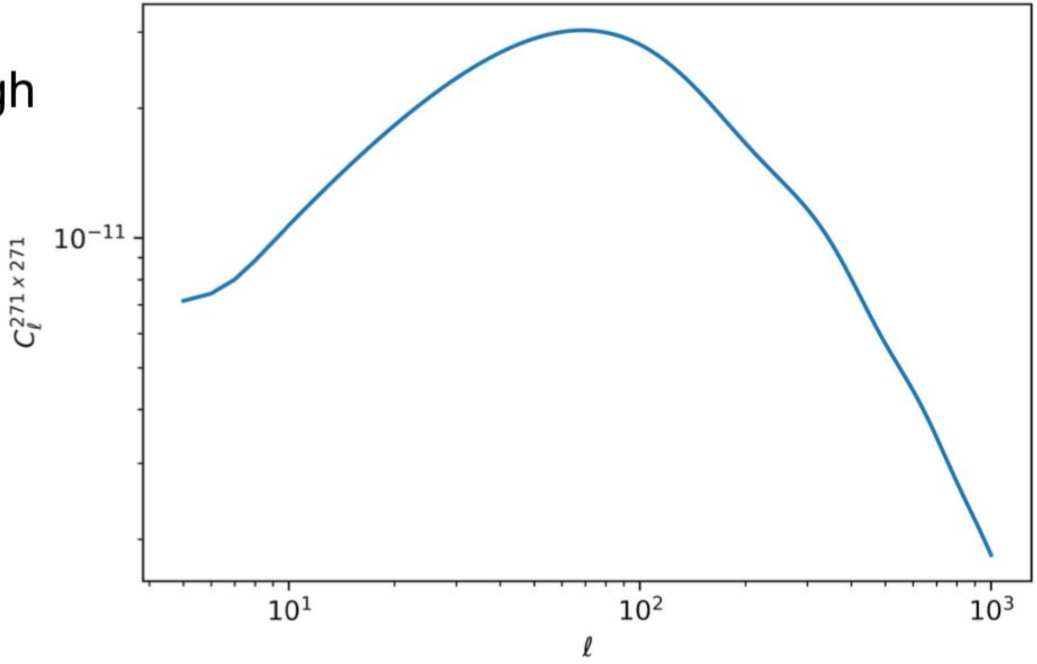


Yogesh Mehta, PhD student
Arizona State University
Advisor: Alexander van Engelen

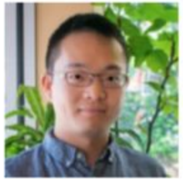
Cosmic Infrared Background (CIB)

- Far infrared of galaxy emission
- Dusty, star-forming galaxies at high redshift
- Theoretical power spectrum
- Cross correlations with CMB lensing, SZ, matter power spectrum, …
- ACT x Planck
- SFRD
- Constrain f_{NL}

Preliminary

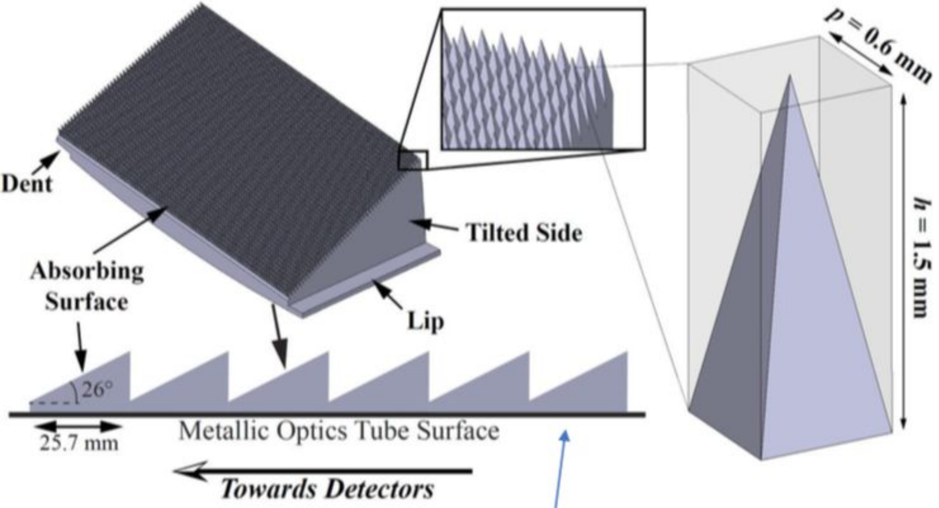


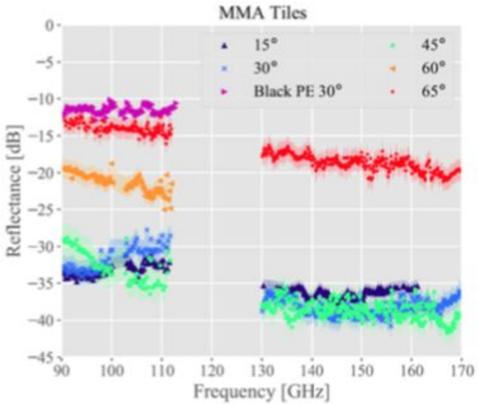
Metamaterial Microwave Absorber (MMA)

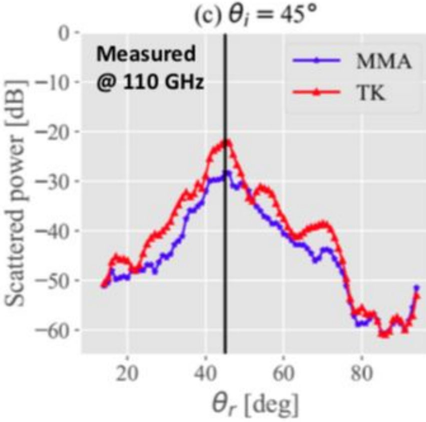


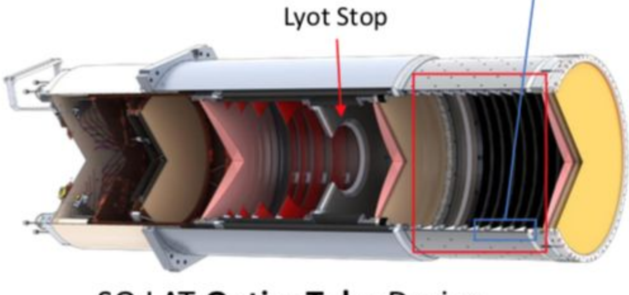
Presenter: **Zhilei Xu**; other major contributors: Grace Chesmore, Mark Devlin, Jeff McMahon

Xu, Chesmore, et al. 2021 (Applied Optics, doi:10.1364/AO.411711)









SO LAT **Optics Tube** Design

- **Injection-molded** for low cost
- Cools down to **1K** reliably
- Measured **< -30dB** reflection/scattering with <45° angle of incidence
- Flat version for more general use