



ASPEN CENTER  
FOR PHYSICS



# 2023 SUMMER PROGRAM

May 28 to September 17, 2023

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Groups and Clusters of Galaxies at the Crossroad between Astrophysics and Cosmology

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Aug 27 to Sept 17

Organizers:

**Boris Bolliet**, Cambridge University

**Stefano Borgani**, University of Trieste

**Stefano Ettori**, European Southern Observatory

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APPLICATION DEADLINE — JANUARY 31, 2023

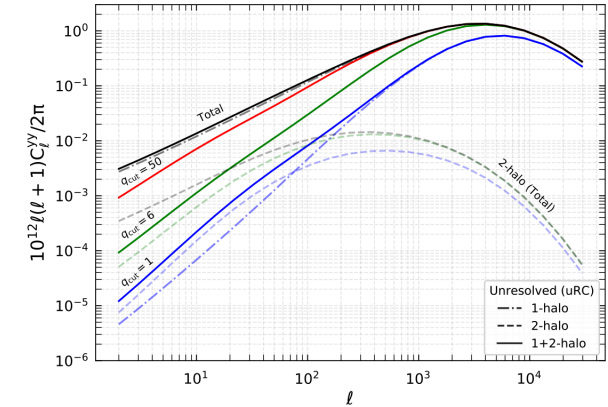
Link: <https://aspenphys.org/physicists/summer/program/index.html>

# Fast and accurate CMB x LSS cross-correlations computation with class\_sz

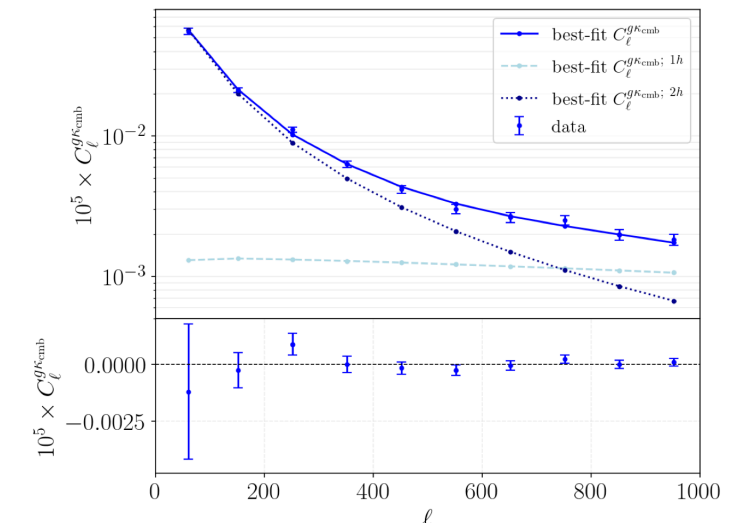
Boris Bolliet  
(Cambridge/  
*DAMTP*)

- class\_sz = class (Lesgourgues et al 12) + halo model for large scale structure
- Thermal SZ (Arnaud et al 10, Battaglia et al 12, Planck 13)  
Kinetic SZ (Battaglia et al 12)  
Galaxies Clustering (Halofit/hmcode, HOD)  
Galaxy Lensing (Halofit/hmcode, NFW)  
CMB Lensing (Halofit/hmcode, NFW)  
Cosmic Infrared Background (Shaang et al 12, Maniyar et al 20)  
Cluster Counts (Planck, ACT, SO)
- Cross-correlations of the above
- As fast as it gets (maximal parallelization, FFTLog and GSL)
- Halo Mass Function (Tinker 08, 10, Boqcuat 15, Jenkins 01)
- 2-pt and 3-pt functions (Tree-level and halo-model Bispectra)
- Scale dependent bias from non-Gaussianity (Dalal et al 08)
- CCL was benchmarked on class\_sz for tsz and CIB
- Extensively used within ACT and SO
- [https://github.com/borisbolliet/class\\_sz](https://github.com/borisbolliet/class_sz)
- Command: \$ ./class class\_sz\_test.ini
- Python wrapper, see:  
[https://github.com/borisbolliet/class\\_sz/tree/master/notebooks](https://github.com/borisbolliet/class_sz/tree/master/notebooks)
- Command: classy\_sz.set({params}); classy\_sz.compute()

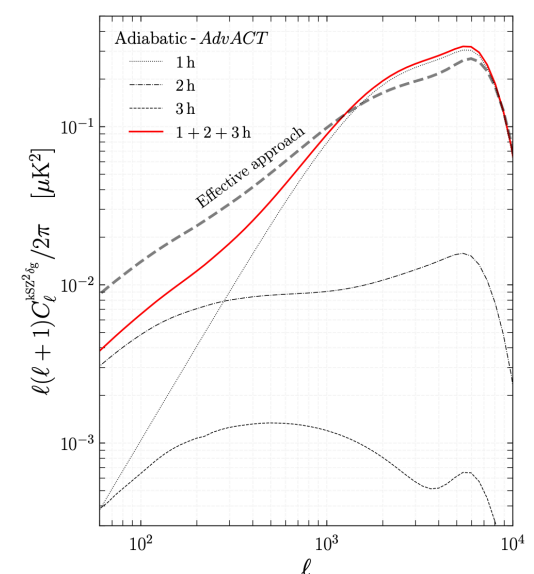
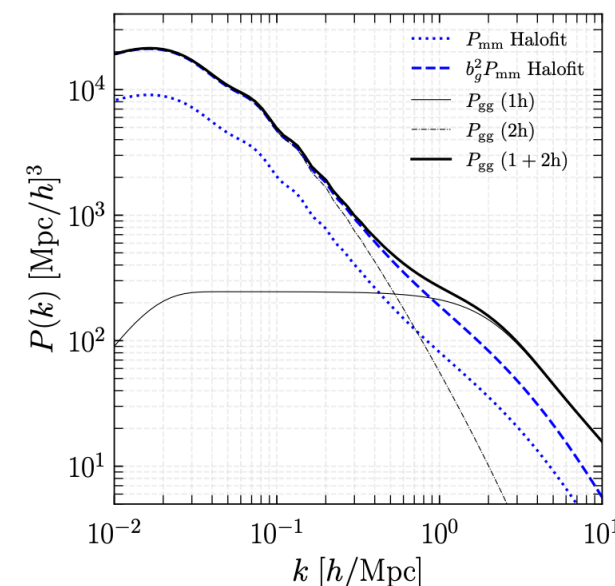
Rotti et al 20



Kusiak et al 21



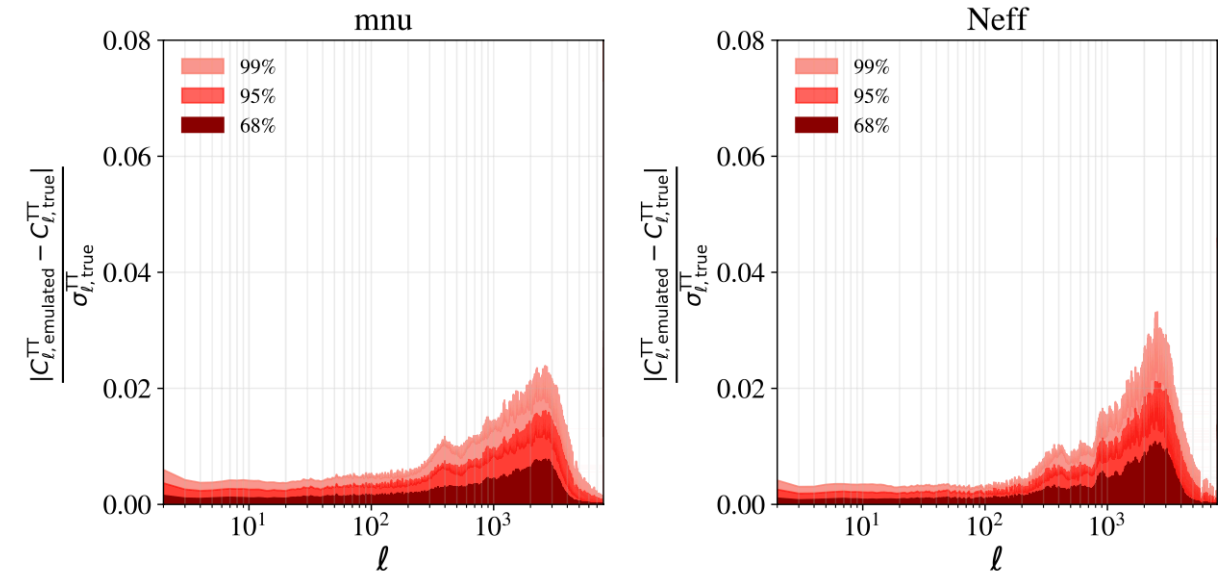
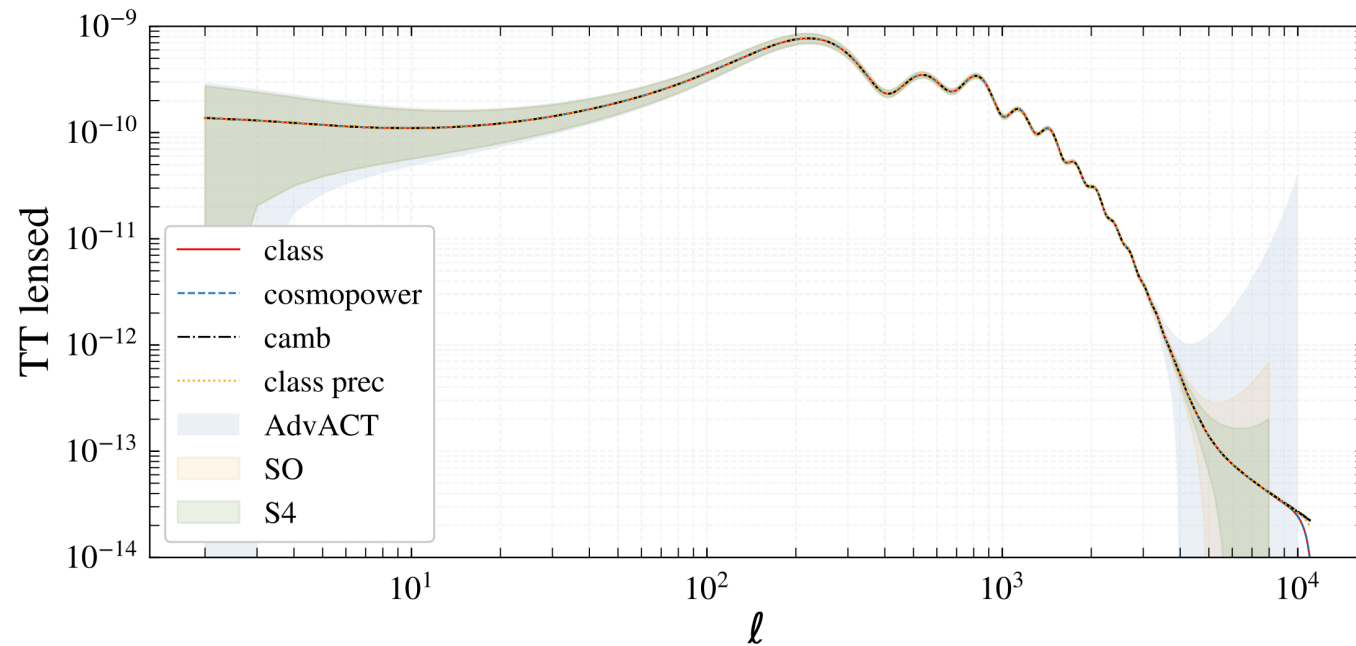
Bolliet et al 22



# Towards high-precision emulation of cosmological observables at all scales with Machine Learning

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To appear with Alessio Spurio-Mancini, Colin Hill, Mathew Madhavacheril, Erminia Calabrese, +



- Tensorflow Neural Networks from Cosmopower based on high-precision class and/or camb
  - LCDM
  - $\Sigma m_\nu$
- Models and Extensions
  - $w$
  - $N_{\text{eff}}$
  - ...
- CMB  $C_\ell$ 's, Matter  $P(k)$ , Weak-Lensing, BAOs, RSDs,  $f\sigma_8$  in  $\mathcal{O}(0.03\text{s})$
- Imminent public release — get in touch if you are interested! see <https://github.com/orgs/cosmopower-organization>
- Stage-4 cosmological parameter extractions on a laptop

