

Germany Update

Eiichiro Komatsu (Max-Planck-Institut für Astrophysik)

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CMB in Germany

- Ramping up momentum via participation to various proposals
 - Happened during ESA's M4 and M5 calls - “**CORe+**” and “**CORE**” proposals. (I was the German representative for both.), as well as via a ground-based telescope “**CCAT-p**”
- Now we have a list of **19 scientists** who contributed to these proposals
- **LiteBIRD**: I have not involved anyone in Germany in the discussion of LiteBIRD yet because I would like to get a better sense of what Germany could do before launching more serious discussions in Germany

CORE German Consortium

- Torsten Enßlin, E. Komatsu, Rashid Sunyaev (MPA)
- Sebastian Grandis, Steffen Hagstotz, Joe Mohr, Alex Saro, Jochen Weller (LMU/USM)
- Karl Menten, Bernd Klein (MPIfR) [readout electronics for KIDs](#)
- Jörn Beyer (PTB) [readout electronics for TES](#)
- Hans Böhringer, Gayoung Chon (MPE)
- Thejs Brinckmann, Sebastien Clesse, Julian Lesgourgues (Aachen)
- Kaustuv Basu (Univ. Bonn)

Ground-based effort in Germany

Germany Makes Telescope!

- **CCAT-p**: 6-m, **Cross-dragone** design, on Cerro Chajnantor (5600 m)
 - Initial design study completed, and the contract has been signed by “VERTEX Antennentechnik”
 - EK sees the CCAT-p as a great opportunity for Germany to make significant contributions towards the CMB S-4 landscape (both US and Europe) by providing telescope designs and the “lessons learned” with prototypes. The “Large Aperture Telescope (LAT)” design of the Simons Observatory collaboration was derived from this
 - The CCAT-p project is co-led by Cornell and the German consortium. The latter is led by **Frank Bertoldi** in Bonn and **Jürgen Stutzki** in Köln. (You heard this already from Frank.) The other partners include Stanford and the Canadian consortium
 - **E. Komatsu** and **S. White** (MPI f. Astrophysik) and **J. Mohr** (Munich Univ.) are joining the German consortium. Possibly also MPI f. Radioastronomie

First light science case:

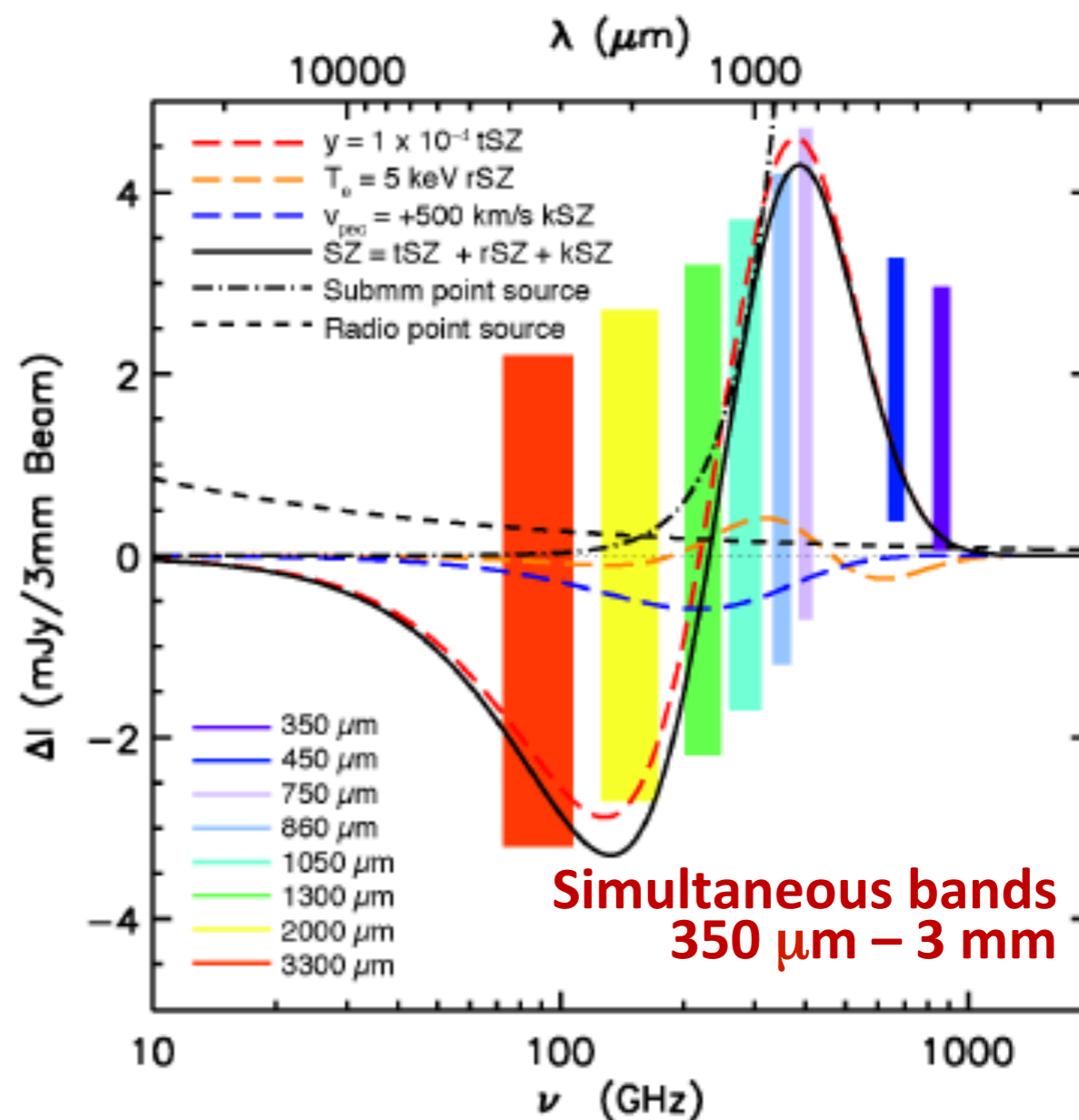
Precision measurements of galaxy clusters via the Sunyaev-Zel'dovich (SZ) Effects

tSZ: thermal SZ **red**

rSZ: relativistic SZ **orange**

kSZ: kinetic SZ **blue**

- Challenge to characterize and remove CMB, tSZ, bright submm galaxies and radio sources
 - Observations over wider range of λ s inc. submm
 - Better sensitivity and resolution than Planck



Software and computing expertise in Germany

Computing:

We have resources in Garching

- Max Planck Society has its own computing centre (MPCDF; The Max Planck Computing and Data Facility)
 - Situated in Garching; and MPA has close connection
- We have also an easy access to the Leibniz Computing Centre (LRZ) of the state of Bavaria
 - Also situated in Garching; and MPA has close connection
- Need a data centre? We can do it!

Software/Analysis Expertise

- Analysis expertise from WMAP, SPT, APEX, and a few large-scale structure surveys (SDSS I-II, BOSS, eBOSS, DES, HETDEX, PFS, Euclid)
- Some examples applicable to the CMB include (but not limited to):
 - Foreground cleaning and characterisation - both temperature and polarisation (e.g., internal template group of LiteBIRD)
 - Two-, three-, and four-point analyses: Tests of Gaussianity of the primordial tensor modes
 - SZ science
 - Cross-correlations

Software/Analysis Expertise

- **Simulation tools**, e.g.,
 - Foreground Sky Model (“GM100” used by LiteBIRD)
 - Log-normal suite of mock generators (“*synfast*” for galaxies and density fields; arXiv:1706.09195)
 - Simultaneous (and fast) simulation of maps of CMB lensing, galaxies, and weak lensing cosmic shears with all the cross-correlations properly included
 - High-fidelity full-sky cosmological hydro simulations (e.g., Dolag, Komatsu & Sunyaev, arXiv:1509.05134)
 - Up-to-date linear Boltzmann solver “CLASS”

Agencies position in Germany

I have not spoken to DLR about LiteBIRD, so I can only provide my insights based on my experiences from the last two ESA calls (M4 and M5)

My experiences so far

- My experience with German space agency (DLR) comes from two CORE proposals (M4 and M5). The basic messages were:
 - *“We do not have money”*
 - For M4 (ESA cap of 450M) and M5 (550M), I got feeling that we would be lucky if we could get ~10M out of DLR
 - Rather small, given Germany’s contribution to ESA I must say!
 - *“Talk to us once you are selected by ESA”*
 - They claim no influence on the decision process of ESA

For LiteBIRD: My guesses are...

- We would probably have to involve ESA; otherwise we would not get anything out of DLR
- If we were to make substantial contributions to the payload (e.g., readout electronics), we would need endorsement of ESA. [This is my guess - not substantiated by any comments from DLR.]
- But something may still be possible without ESA: such as to use DLR's telescope for communication with LiteBIRD when it could not be seen from JAXA's stations

Funding channels for ground-based efforts

- **DFG** (German funding agency)
 - We will be getting funding from DFG for ground-based campaigns, i.e., CCAT-p
 - I don't think we can ask for funding to help space missions
- **MPG** (Max Planck Society)
 - On the order of a million EUR or two would be a possibility for design/proto-typing, but we cannot expect much more than that.