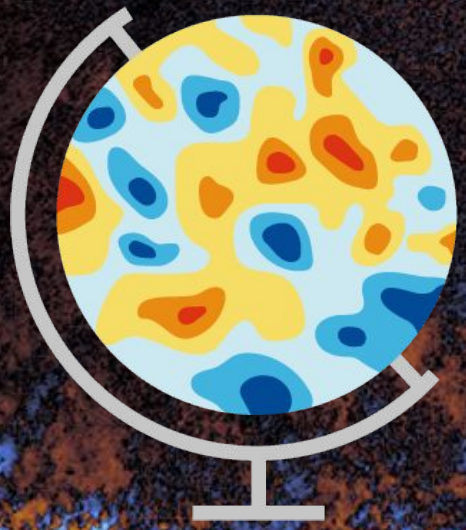
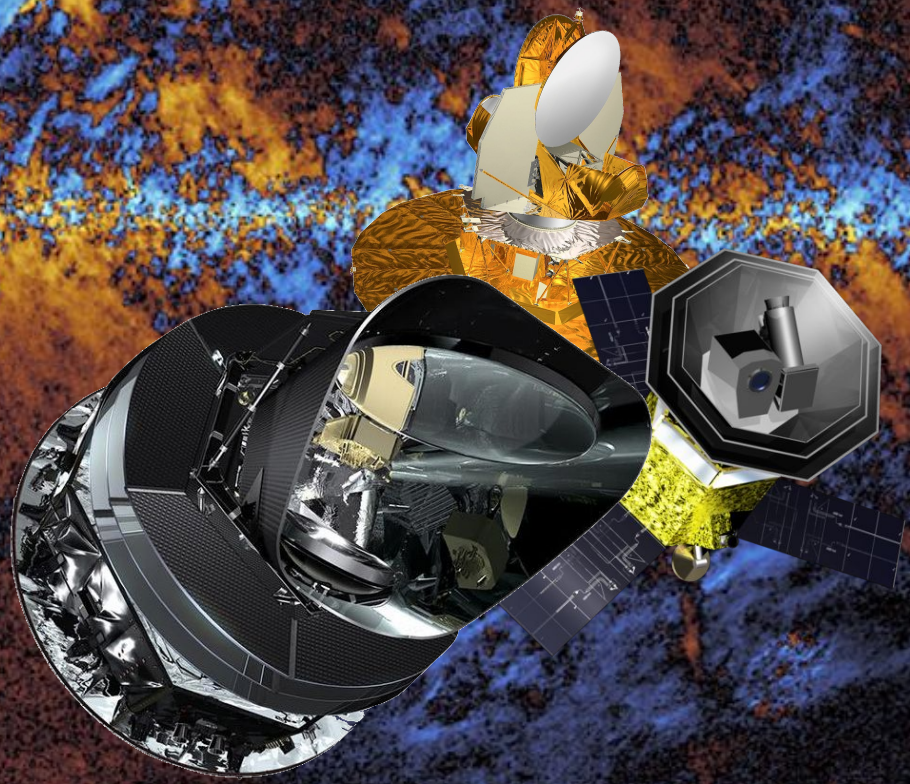
European Commission

Beyond PLANCK



Cosmoglobe

Ingunn Kathrine Wehus

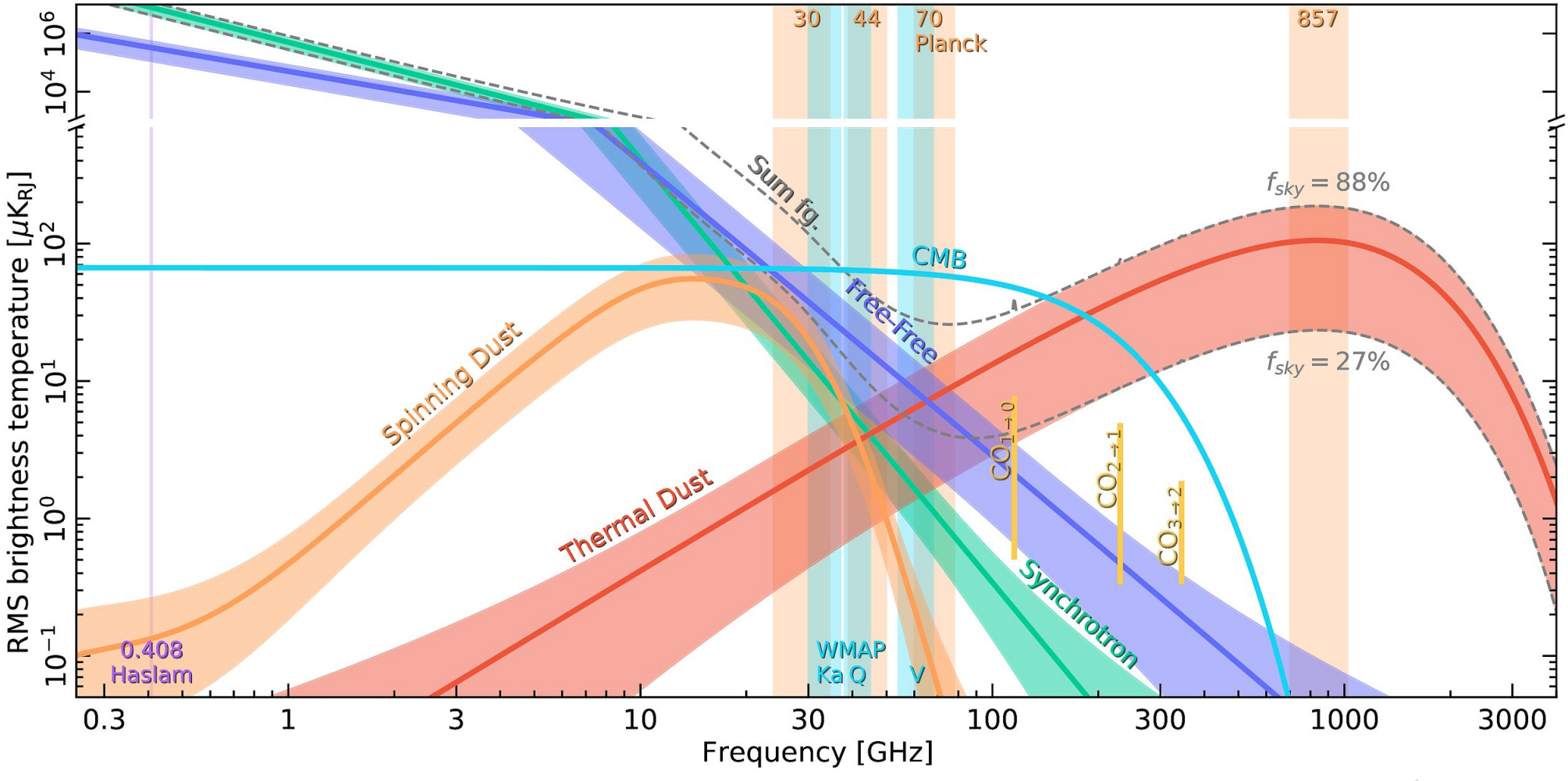


BeyondPlanck online release conference, November 18-20, 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 819478

Extended sky model

Andersen et al. (2020)
Svalheim et al. (2020)



Cosmoglobe

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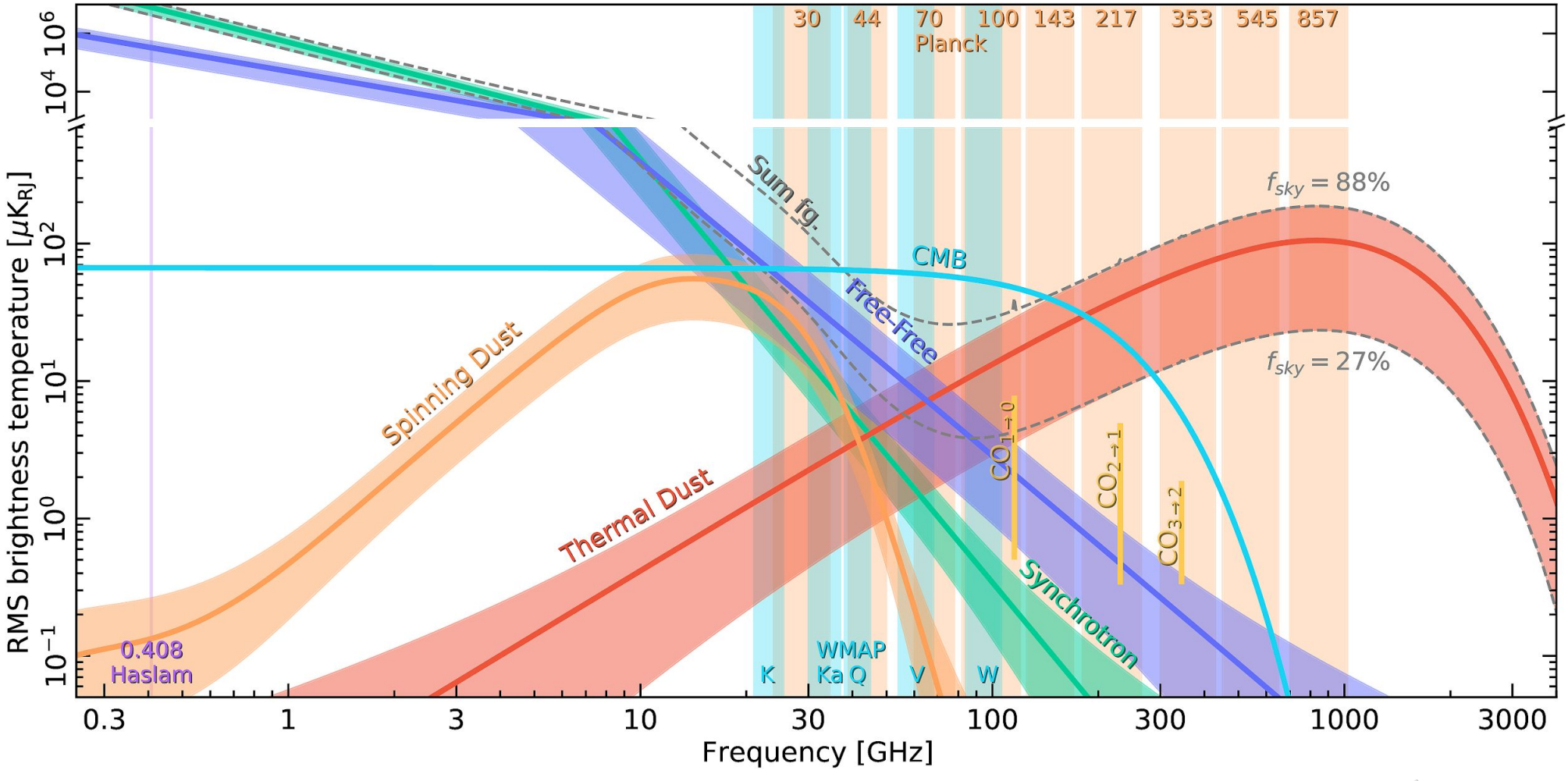

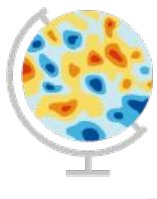

Cosmoglobe

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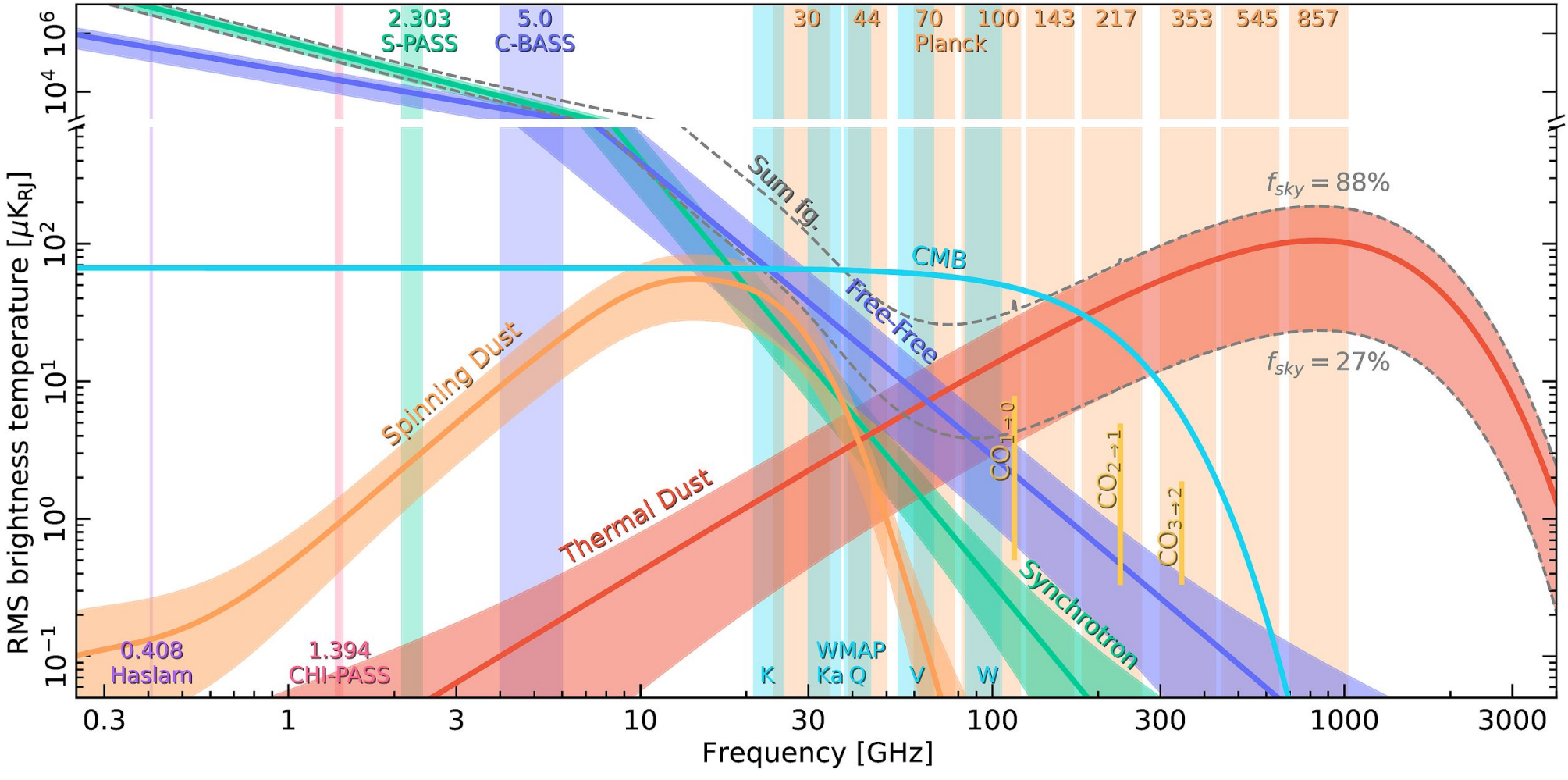

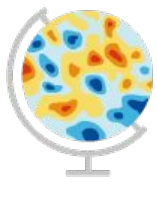

Cosmoglobe

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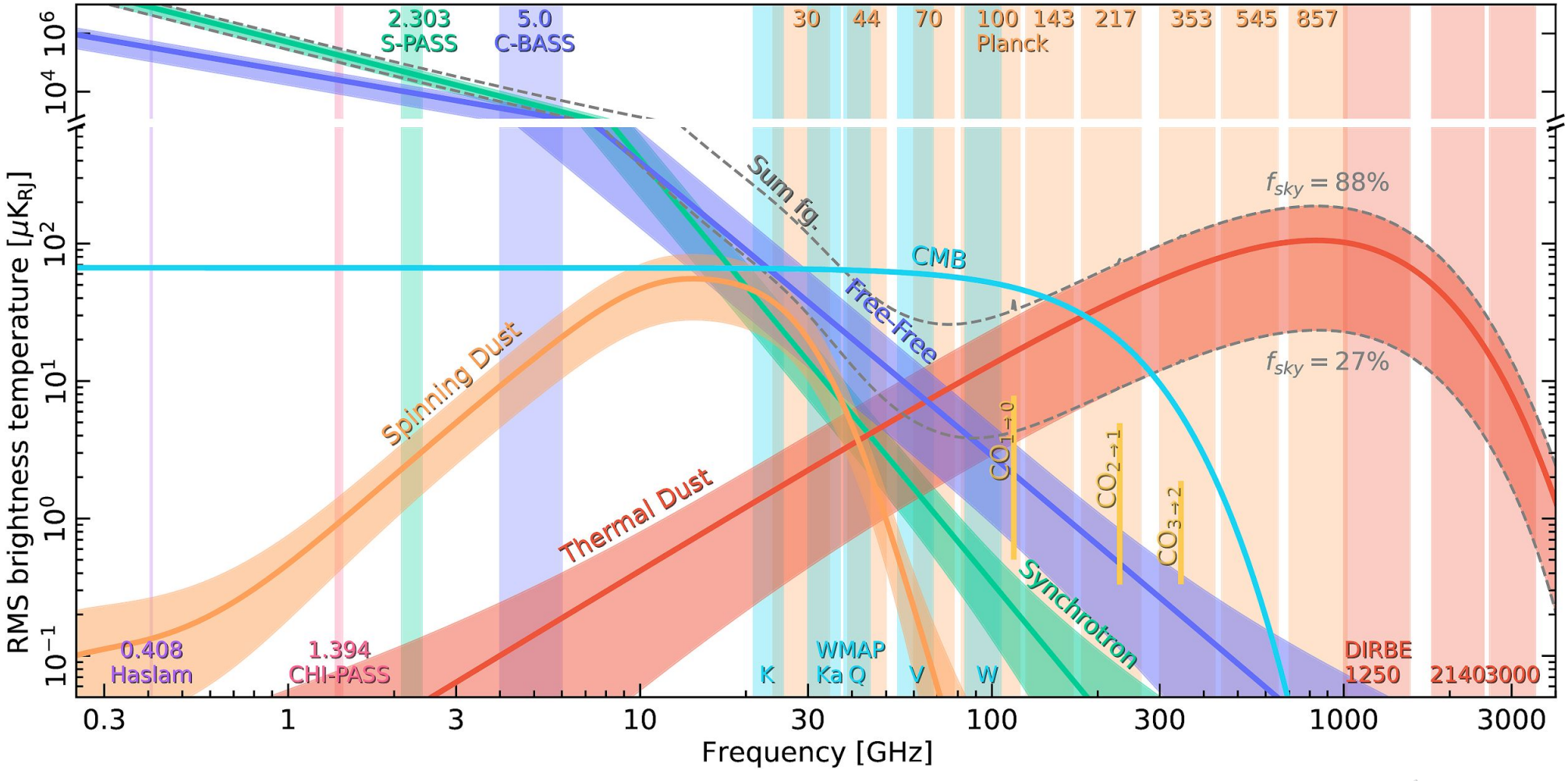
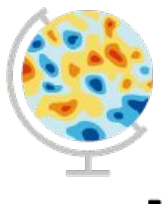


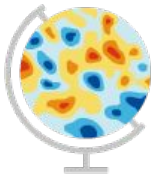


Cosmoglobe

Cosmoglobe

"Mapping the universe from the Milky Way to the Big Bang"

- Goal: To integrate the world's best data from radio to sub-mm wavelengths into a single global model
- Improve CMB B-mode foreground model through global analysis
- Use Cosmoglobe sky model to optimize and forecast future missions
- Natural extension of BeyondPlanck using Commander technology
- Global community building effort



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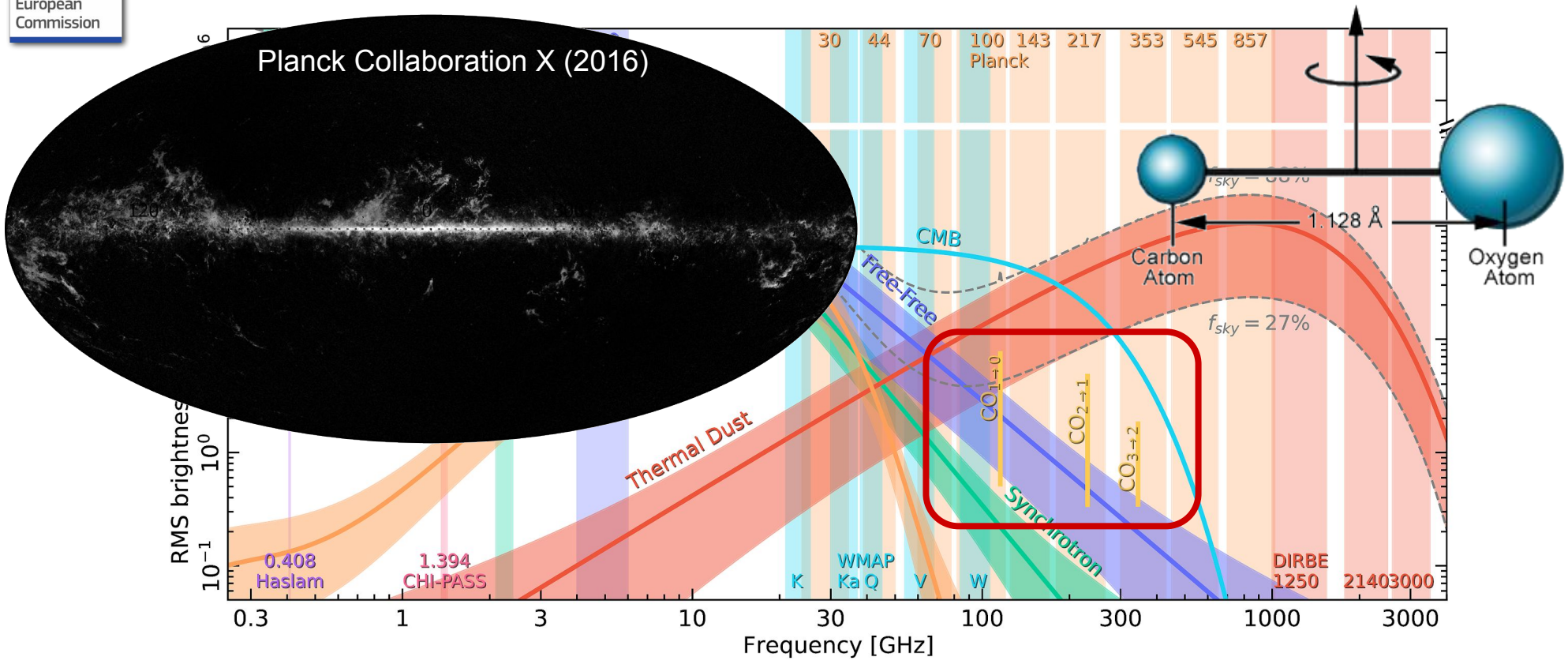
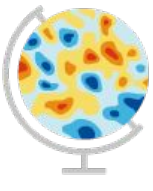
CO line emission



- Radiation emitted by CO molecule transitions between different rotation states
- Sharp line emission centered on 115 GHz, 230 GHz…
- Very well constrained by Planck HFI

Important experiments: Planck HFI



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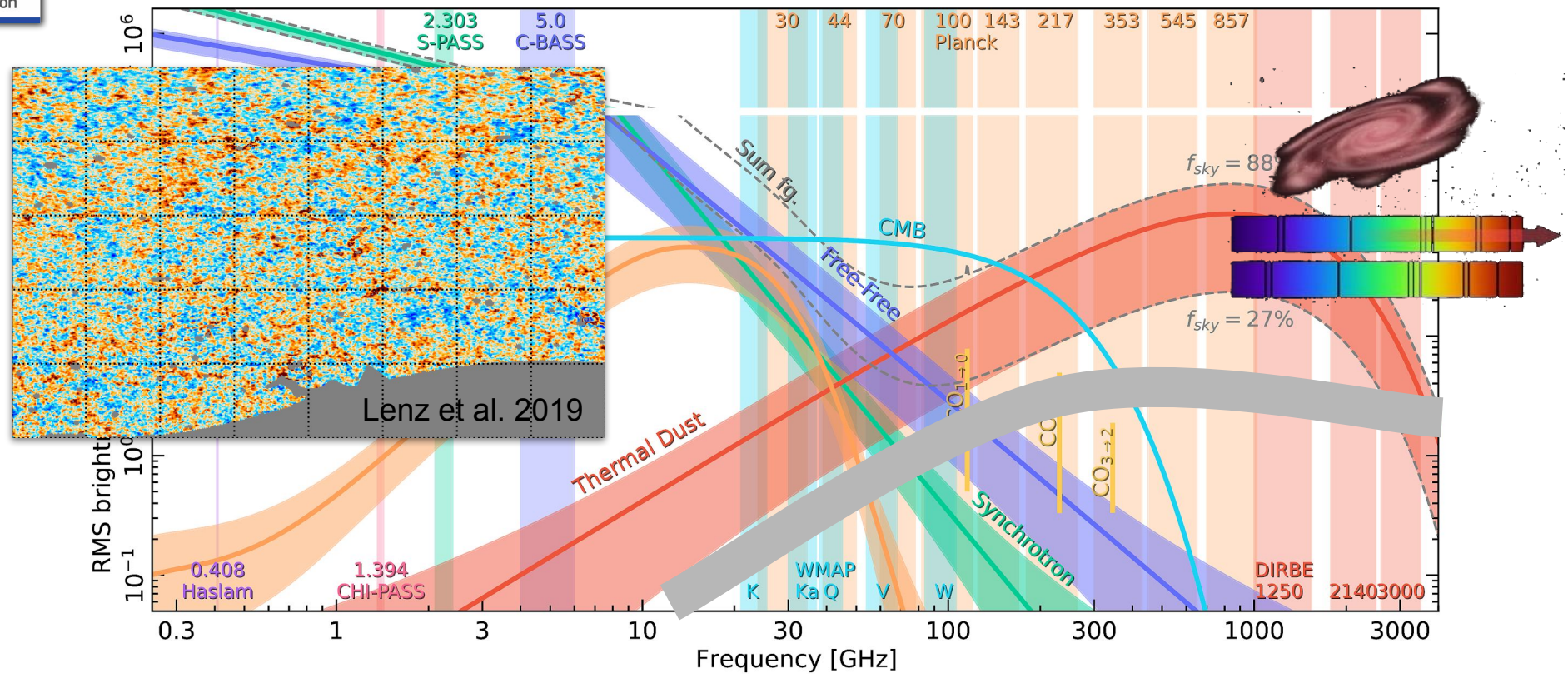
Cosmic Infrared Background



- Thermal dust radiation emitted by high-redshift galaxies
- Can be roughly described by a modified blackbody SED with low temperature
- The sky signal is statistically isotropic, similar to the CMB

Important experiments: Planck HFI, COBE-DIRBE, SphereX etc.

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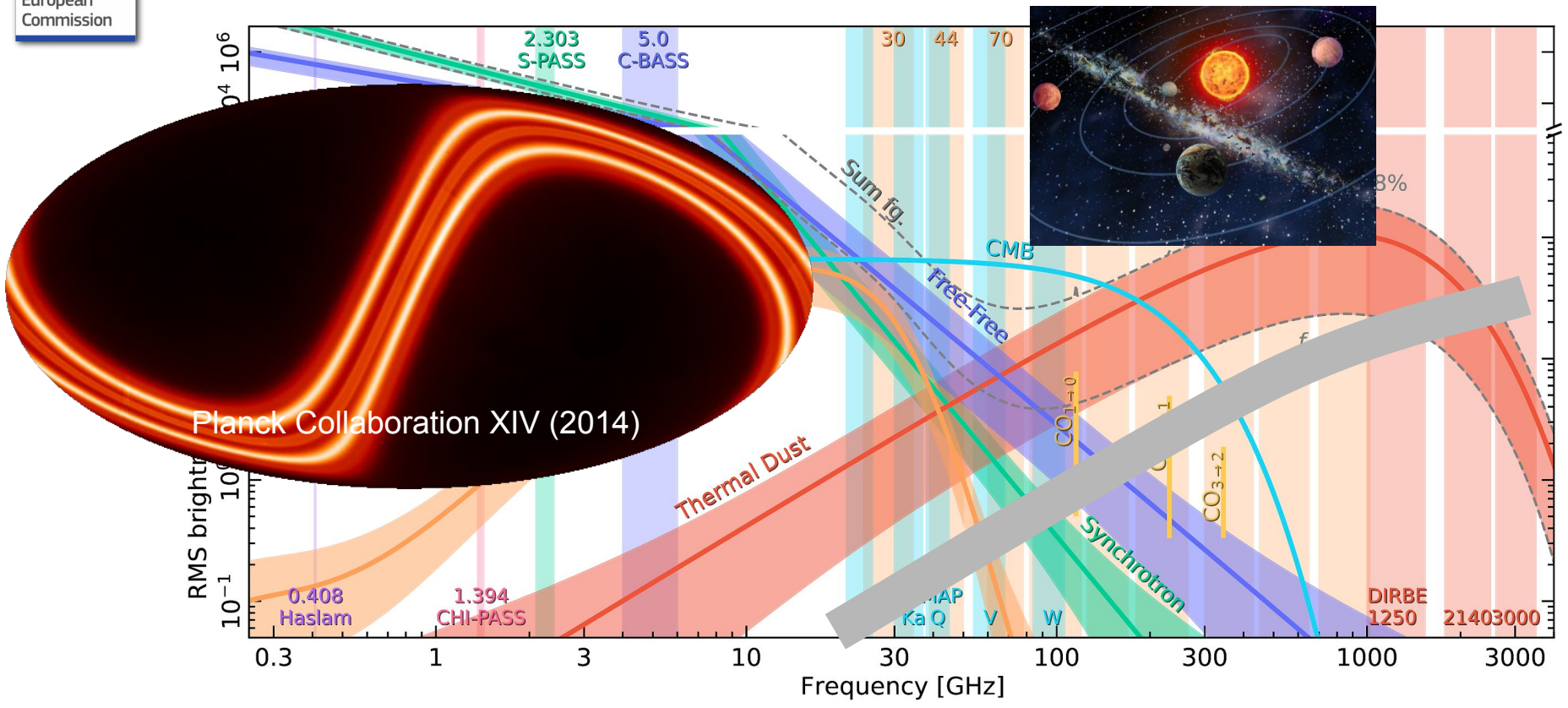
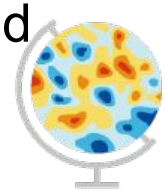
Zodiacal Light Emission



- Thermal from dust grains within the Solar system
- Spectrum can be described roughly as a modified blackbody with T ~ 280K ⇒ dominates over Galactic dust at high frequencies
- Zodi signal is time-dependent, because of Earth's motion around the sun each year

Important experiments: Planck HFI, COBE-DIRBE, SphereX etc.



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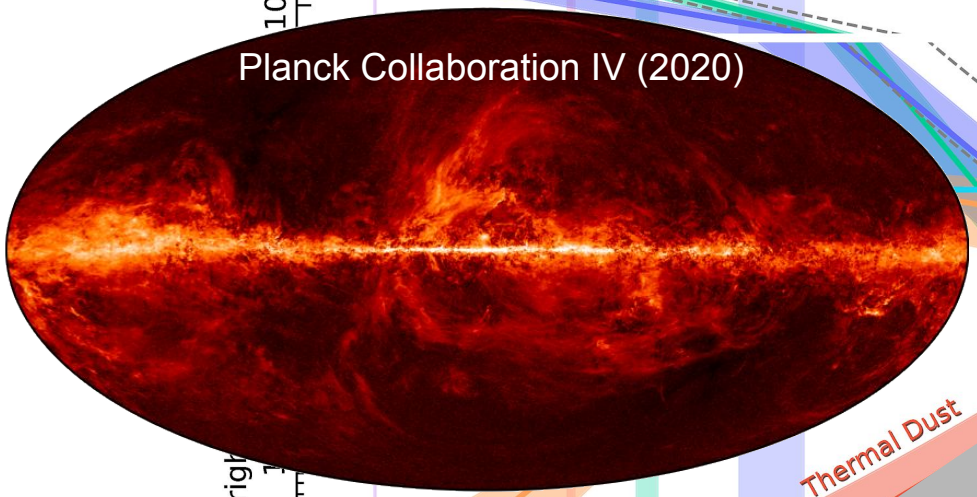
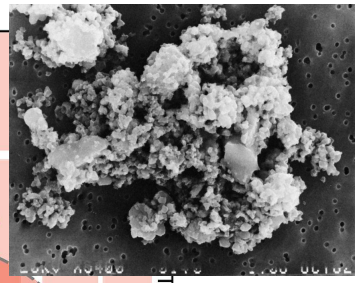
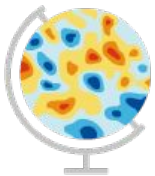
Physical dust modelling





- Interstellar dust consists of many types of grain types
- The true spectrum is certainly much more complicated than a simple modified blackbody
- Want to model thermal dust emission in terms of physical parameters, such as grain composition and radiation field

Important experiments: Planck HFI, COBE-DIRBE and FIRAS, IRAS, WISE, AKARI, SphereX etc.



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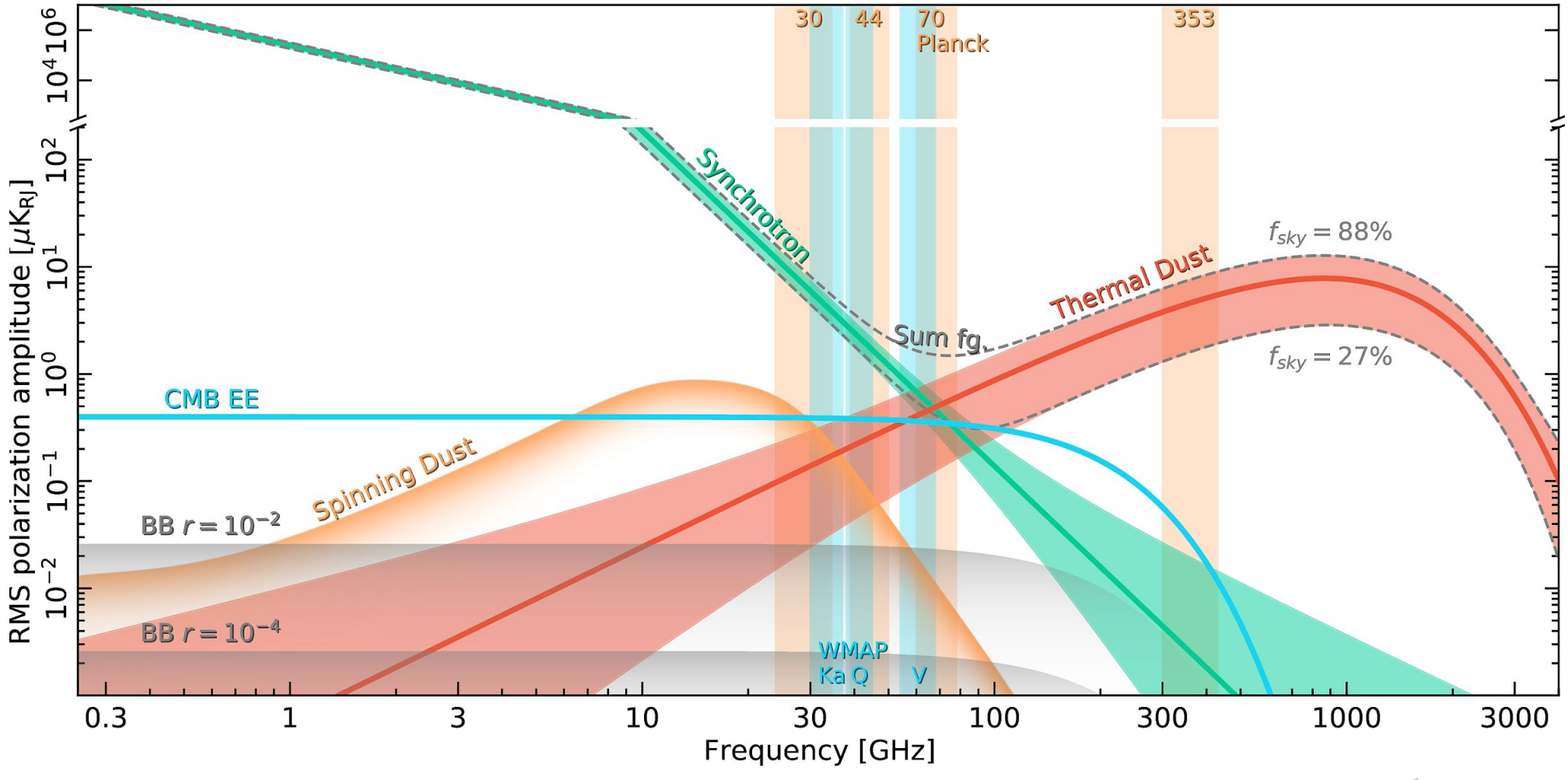
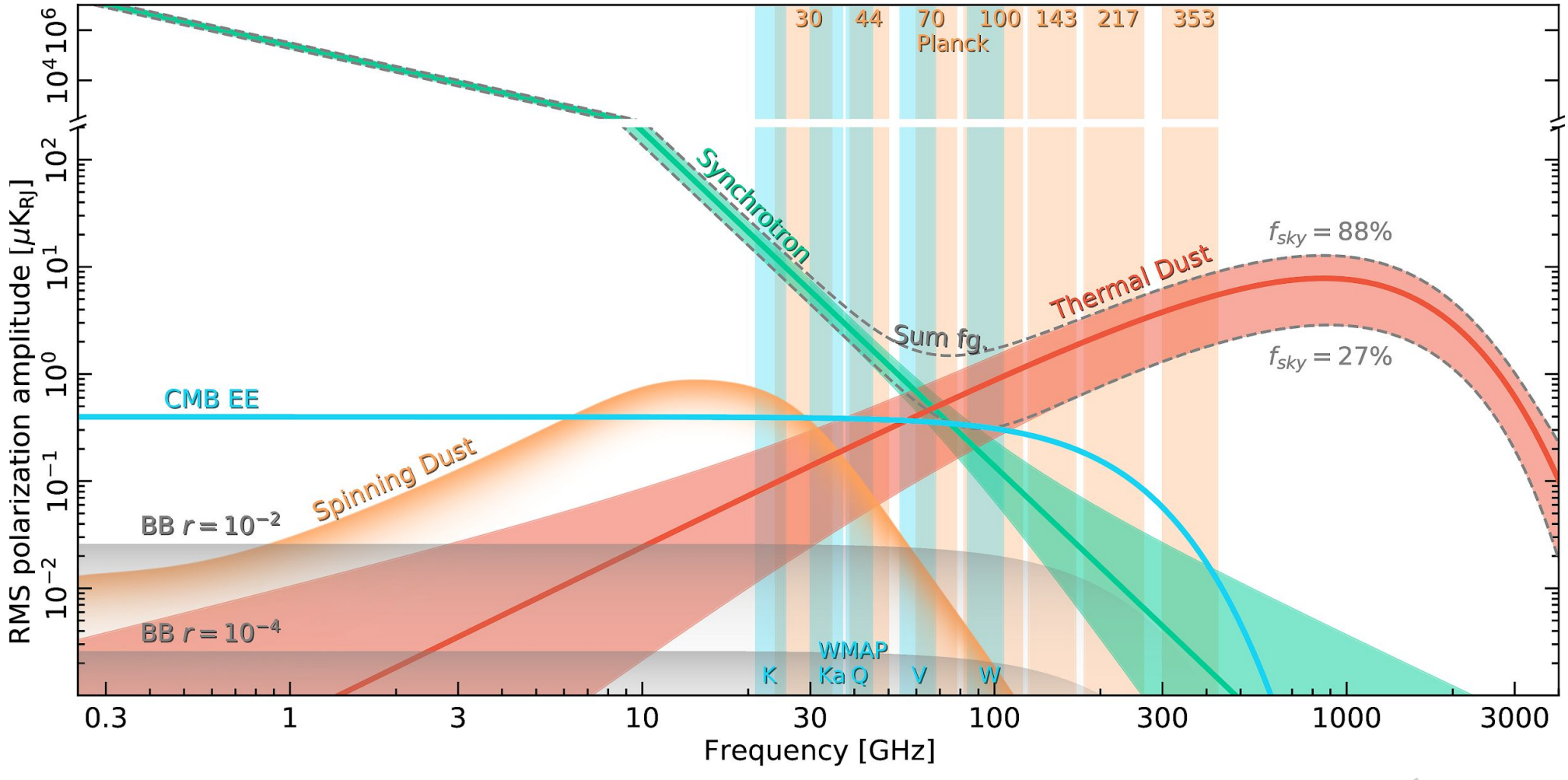
Extended sky model



Polarization

Cosmoglobe

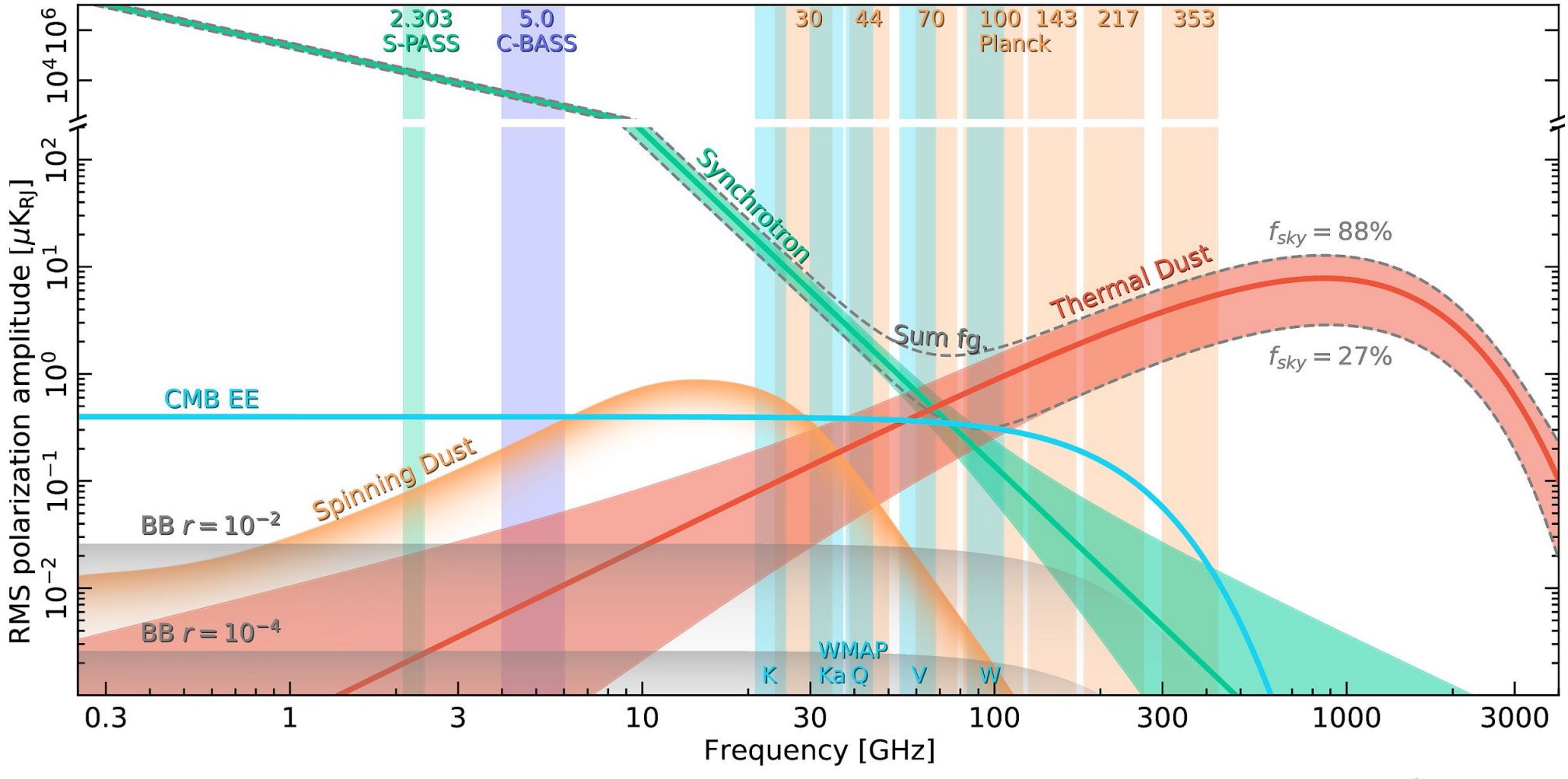
Extended sky model



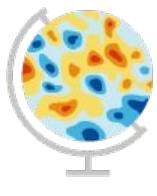
Polarization

Cosmoglobe

Extended sky model



Polarization



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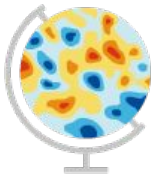
Adding new data sets

Two methods to add new data to Commander:

1. Time-domain
   - Data model defined in terms of TOD
   - Preferred method, allows full systematic error mitigation
   - Computationally expensive
   - e.g. LFI in BeyondPlanck

2. Map-domain
   - Data model defined in terms of sky maps
   - Traditional method, only allows limited systematic error mitigation
   - Computationally cheap
   - e.g. Haslam in BeyondPlanck



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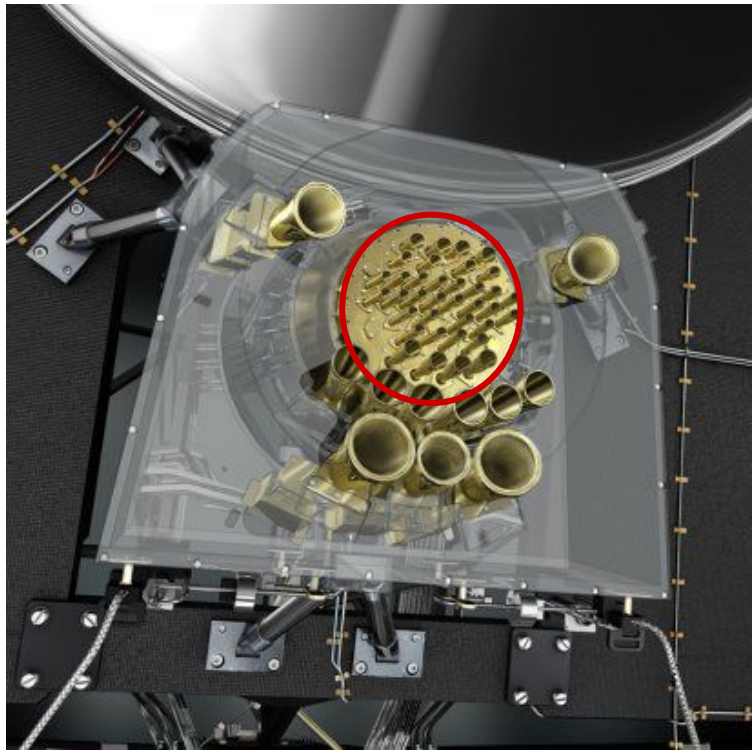
Full Planck and WMAP

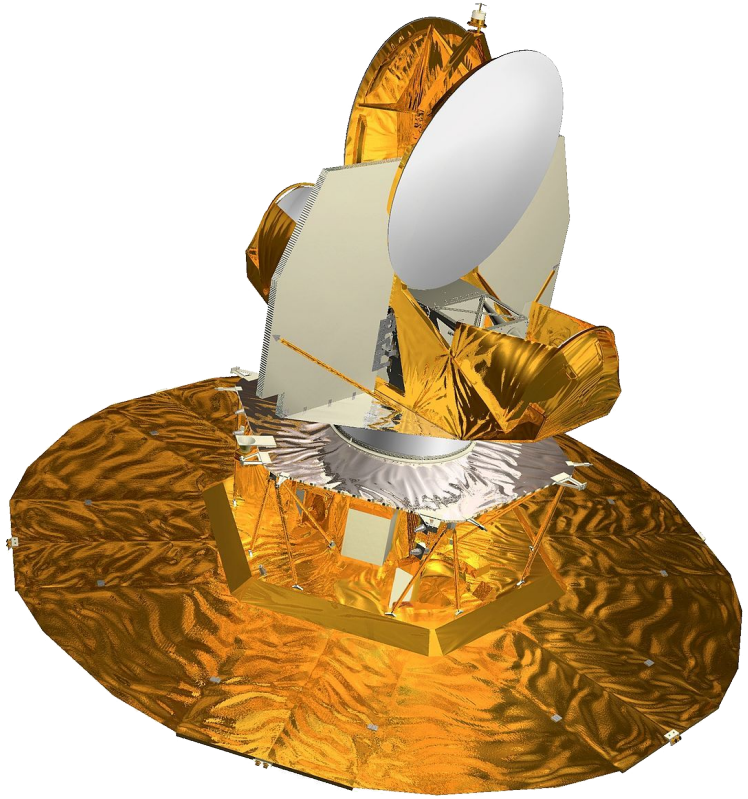
Planck HFI



- 6 channels covering 100 - 857 GHz
- 5-10 arcmin FWHM

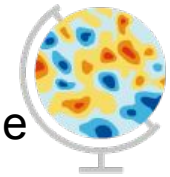
- Constrains CMB, thermal dust, free-free, CO, CIB, zodi, SZ…
- First map-domain, gradually replace channel-by-channel with TOD

WMAP



- 5 channels covering 23 - 94 GHz
- 14-54 arcmin FWHM

- Constrains synchrotron, free-free, AME.
- K-band is particularly valuable for polarized synchrotron



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Low-frequency surveys

C-BASS

- Center frequency 5 GHz
- 45 arcmin FWHM

- Particularly valuable for polarized synchrotron and intensity AME
- Map or TOD? Preliminary collaboration access

S-PASS

- Center frequency of 2.3 GHz
- 8.9 arcmin FWHM

- Particularly valuable for polarized synchrotron and AME intensity
- Map publicly available

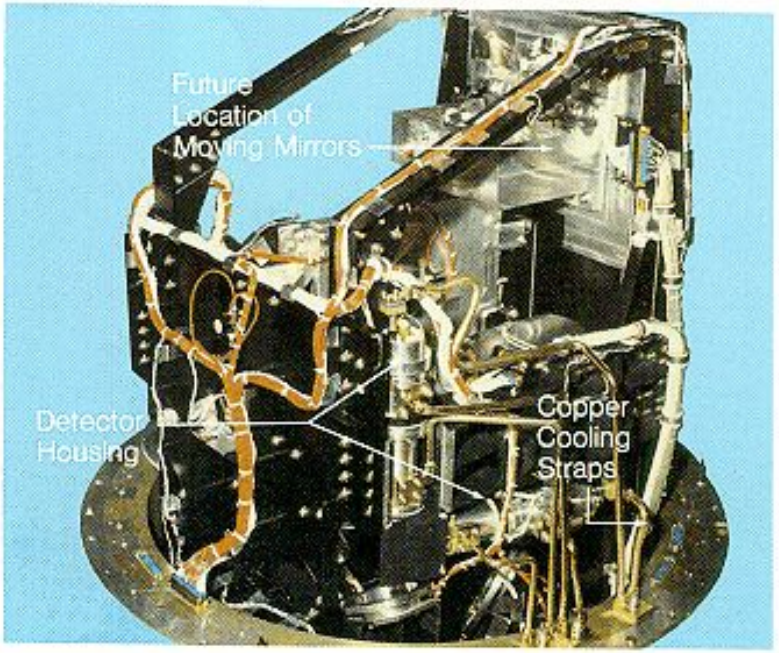
QUIJOTE

- 6 channels between 11 and 40 GHz
- 17 - 55 arcmin FWHM

- Particularly valuable for polarized synchrotron and intensity AME
- Maps or TOD? Release date?

High-frequency surveys

COBE-FIRAS

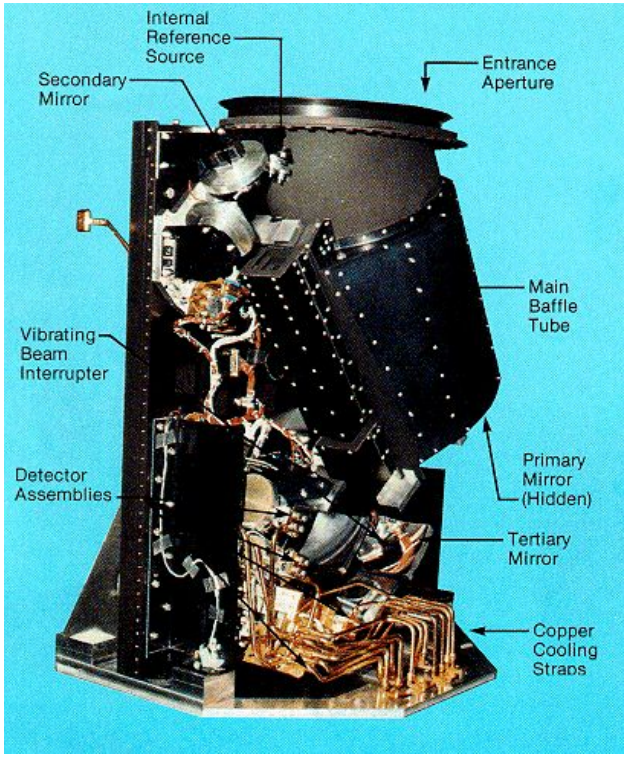


Test unit being prepared for vibration test. Horn, calibrator, and mirror mechanism are not shown.

- ~200 channels between 60 and 2900 GHz
- 7 deg FWHM

- Uniquely valuable for absolute calibration of high-frequency channels
- Probably maps, but TOD/interferograms would be interesting (preparing for PIXIE or similar)

COBE-DIRBE



- 10 channels above 1250 GHz
- 0.7 deg FWHM

- Valuable for thermal dust, zodi, CIB
- TOD if still exists? Otherwise 2-week maps

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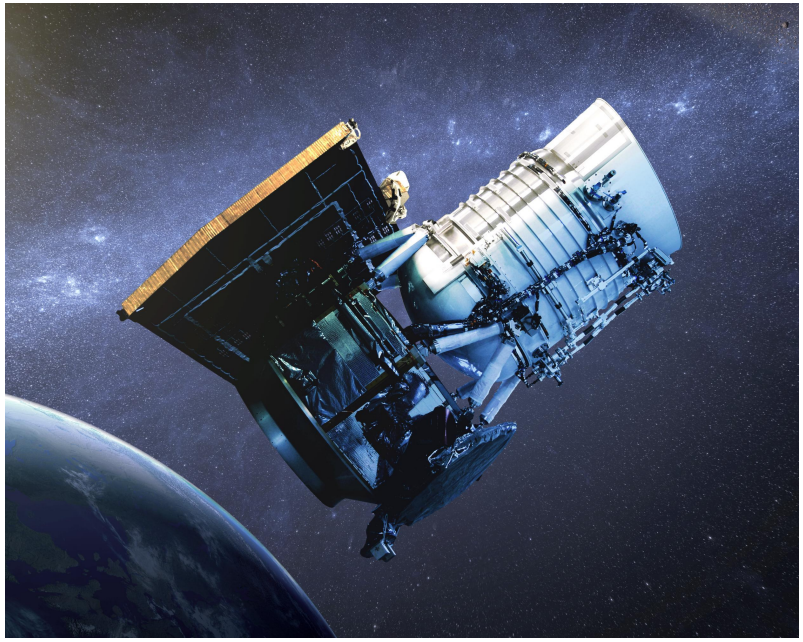
High-frequency surveys

IRAS

- 4 channels above 3000 GHz
- 30 arcsec to 2 arcmin FWHM

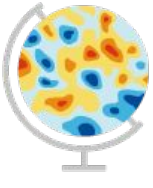
- Valuable for thermal dust, CIB, zodi
- Maps publicly available

WISE



- 12 μm = 25 THz (Meissner and Finkbeiner 2015)
- 12 arcmin

- Valuable for thermal dust, CIB
- Map publicly available



High-sensitivity polarization experiments

QUIET

- 2 channels at 43 and 95 GHz
- 15 - 30 arcmin FWHM

- Valuable for polarized synchrotron emission
- TOD; proprietary, collaboration access

SPIDER

- 2 channels at 90 and 150 GHz
- 30 - 42 arcmin FWHM

- Valuable for polarized CMB and thermal dust
- TOD; proprietary, collaboration access

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COMAP

- 1024 channels between 26 and 34 GHz
- 4 arcmin FWHM

- Designed for non-CMB science, but contains valuable information about AME
- TOD, analysis already in progress

European Commission

PASIPHAE

- Optical polarized starlight experiment

- Combine with GAIA measurements to produce a 3D template of polarized dust
- Unique probe for resolving line-of-sight effects, necessary to go below $r < 10^{-3}$
- On-going, already collaboration agreement

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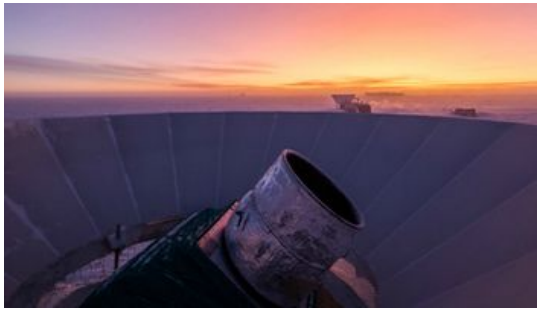
Open invitation to all interested collaborations

European Commission

BICEPx?



CLASS?

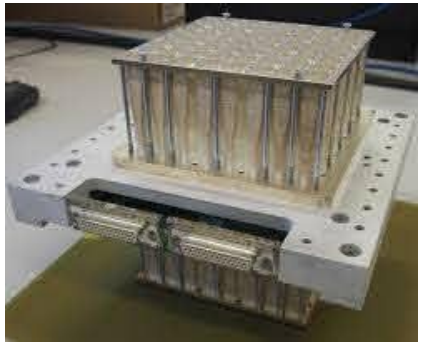
ACTpol?

SPT?

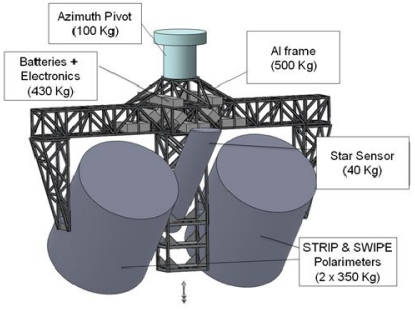
POLARBEAR?

Simons Observatory

QUBIC?



LSPE?



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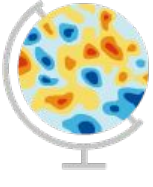

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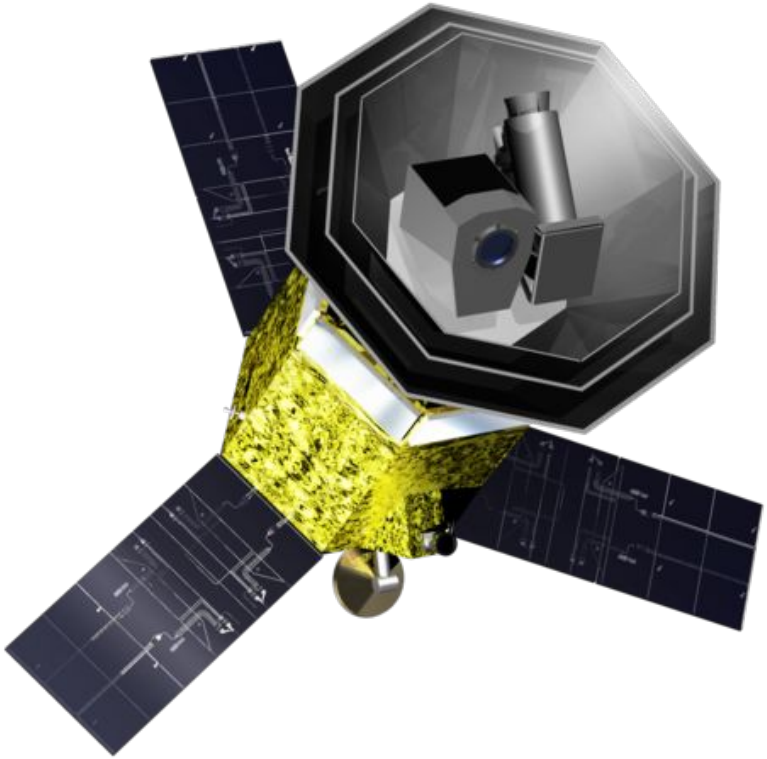
Cosmoglobe Sky Model and forecasting

LiteBIRD



PICO

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CMB-S4

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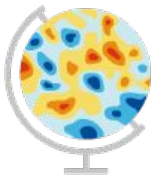
Community effort

- This research program is extremely ambitious, and will not succeed without active participation by large parts of the community
- Fortunately, the work can be done gradually, adding one experiment at a time
- One major challenge will be data access -- who will be interested in collaborating?



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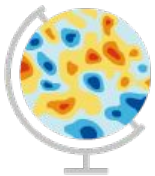
The Cosmoglobe environment

http://cosmoglobe.uio.no

Join community mailing list: cosmoglobe@astro.uio.no

Contact coordinators: cosmoglobe-contact@astro.uio.no



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Getting organized

- We plan to arrange a digital workshop during first half of 2021 for all interested parties to discuss common collaboration policies
  - Everything is open for discussion and input

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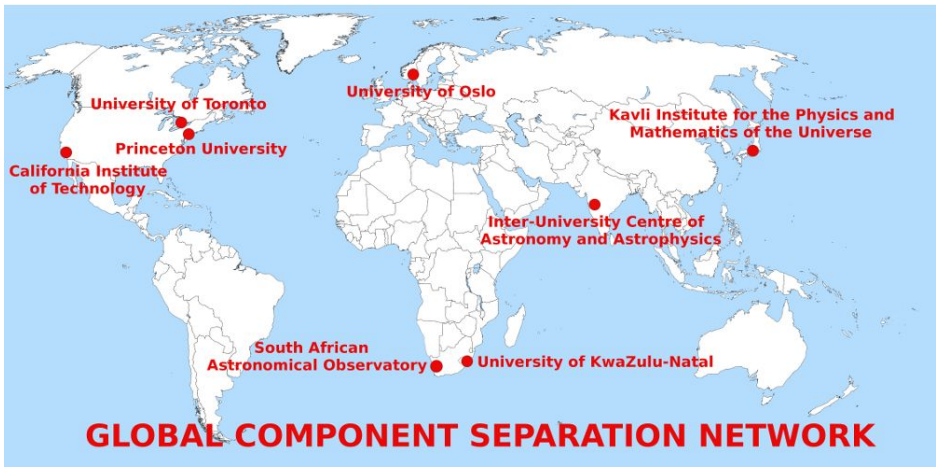
Global Component Separation Network

Global Component Separation Network



- Diku/RCN funding for collaboration between Brazil, Canada, China, India, Japan, Russia, South Africa, USA and Norway
- Covers travel, meetings, workshops, schools etc.
- **All activities are coordinated with Cosmoglobe, and open to everybody.**
  - Only member institutions from the above countries can get expenses covered through GCSN
- Founding institutions in Canada, India, Japan, Norway, South Africa and USA
  - Still growing!
  - If your institution is interested in joining, please contact gcsn-admin@astro.uio.no

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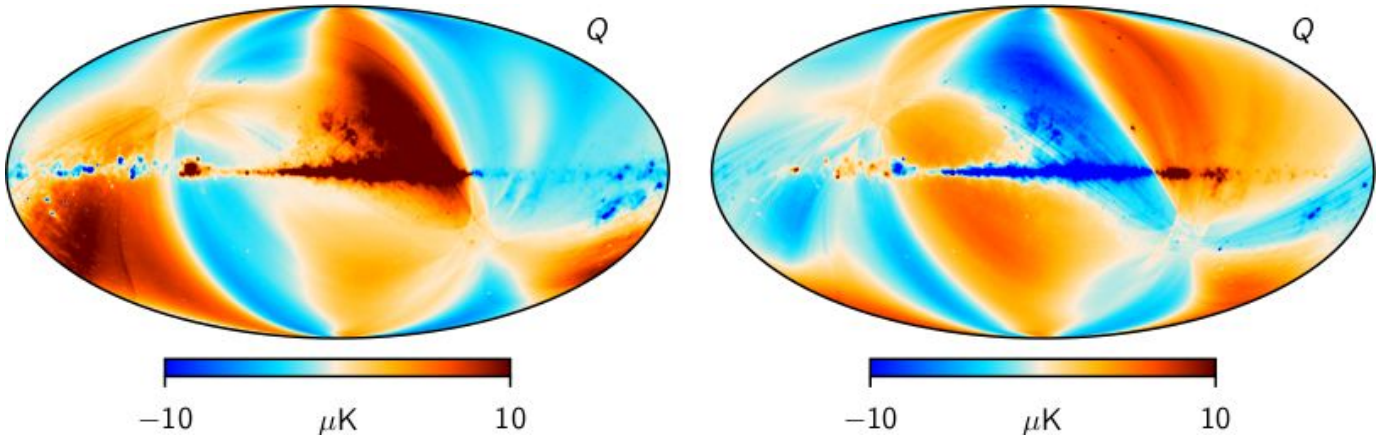
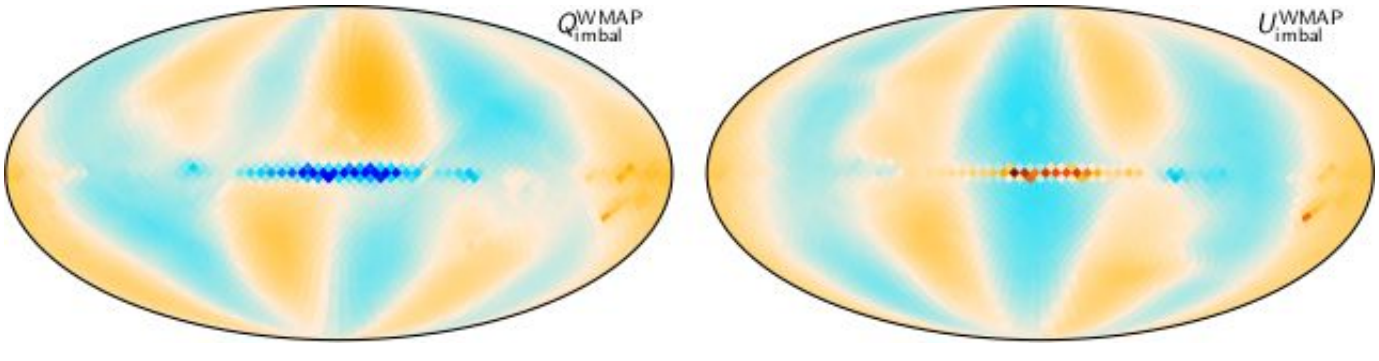
Concluding remarks

Gjerløw et al. (2020)

Poorly measured modes in Planck:



Poorly measured modes in WMAP:



Everybody benefits from working together!

http://cosmoglobe.uio.no

Cosmoglobe

Funding

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- *Cosmoglobe*
  - ERC Consolidator Grant
  - PI: Ingunn Wehus
  - Grant no: 819 478
  - Period: June 2019 to May 2024

Collaborating projects:

- *bits2cosmology*
  - ERC Consolidator Grant
  - PI: Hans Kristian Eriksen
  - Grant no: 772 253
  - Period: April 2018 to March 2023
- *BeyondPlanck*
  - COMPET-4 program
  - PI: Hans Kristian Eriksen
  - Grant no.: 776 282
  - Period: Mar 2018 to Nov 2020

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