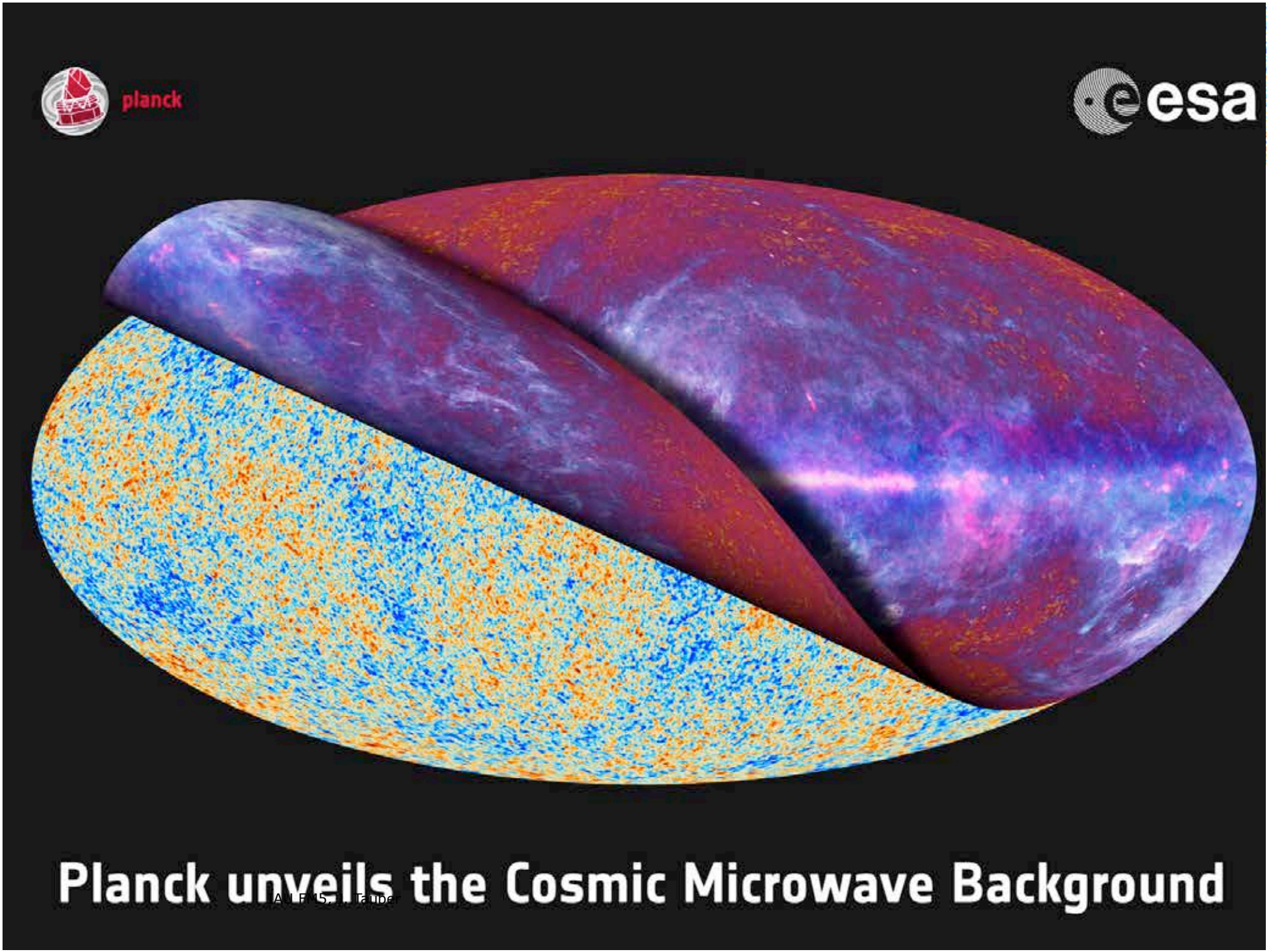
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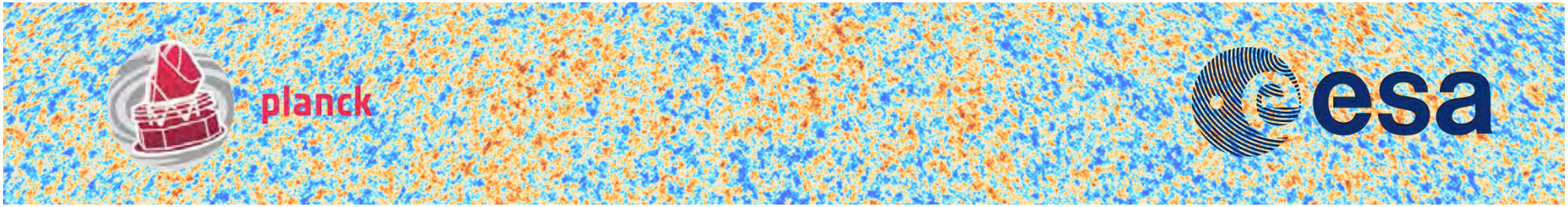
Planck unveils the Cosmic Microwave Background



IAU GA Focus Meeting 5

The Legacy of Planck

Honolulu, 11-13 August 2015

FM5: The Legacy of Planck

planck

The aims of FM5 are to:
- publicize the wide variety of current and potential uses of Planck data
- foster exchanges between users of Planck data
- get feedback to optimize the last delivery of Planck data products

FM5 is sponsored by Div H (Interstellar Matter and Local Universe) and Div J (Galaxies and Cosmology)

Scientific Organizing Committee

Chair: J. Tauber - European Space Agency - The Netherlands
Co-Chair: N. Mandolesi - IASF - INAF - Italy
Co-Chair: J. L. Puget - Institut d'Astrophysique Spatiale – France
B. Barbuy, M. Bersanelli, F. R. Bouchet, J. Dunkley, G. Efstathiou, E. Falgarone, W. Freedman, M. Hazumi, J. M. Lamarre, C. Lawrence, P. Martin, H.U. Norgaard-Nielsen, T. Souradeep, R. Sunyaev, A. Zacchei

Practical points for FM5

1. Warning: last-minute modifications to the programme may not be included in the online programme

   Last talk of FM5 (Thursday @ 12:15): Rashid Sunyaev on "Planck and spectral distortions of the CMB"

2. Speakers:

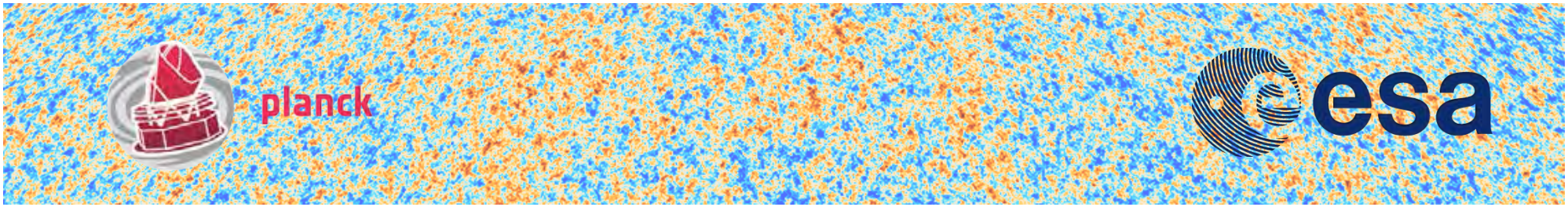
   please make sure that your talks are uploaded BEFORE your session !

   a. Contributed talks: <15 mins

   b. Invited talks: <30 mins

   please allow 2-3 mins for questions !

3. Take time to visit all the posters !
4. Visit the ESA booth – direct access to the Planck Legacy Archive is available, with expert support



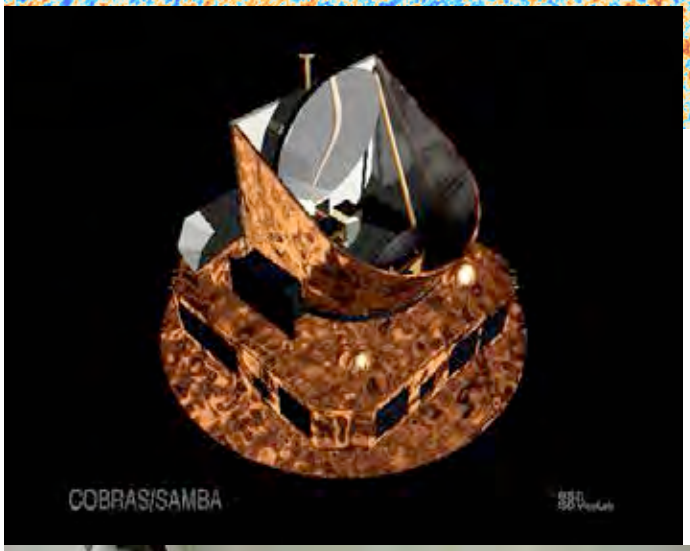
Introduction
The Planck products

J. Tauber
Planck Project Scientist
European Space Agency
on behalf of ESA and the Planck Collaboration

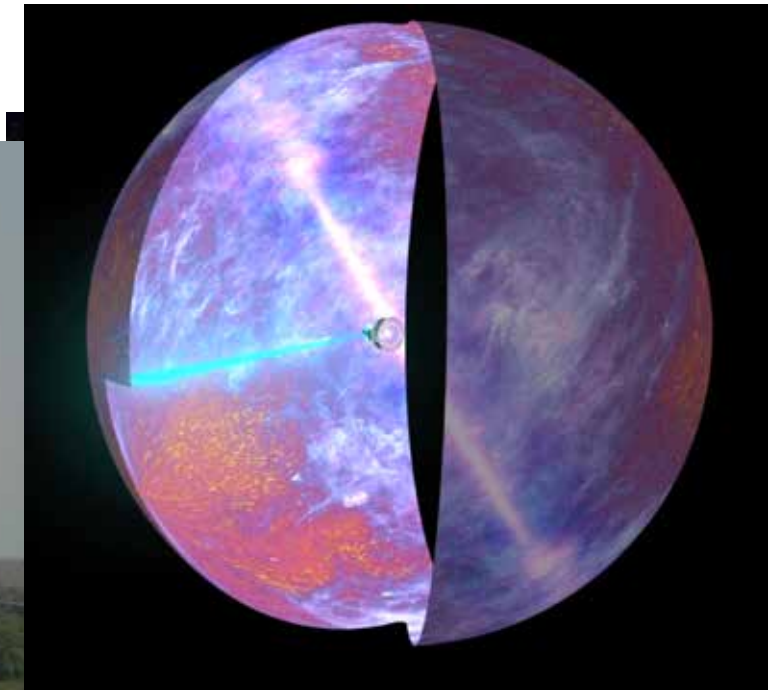
Plan for this Introduction

1. A little background on Planck
2. Overview of the Planck data products
3. Overview of the Planck Legacy Archive

A little background



- First proposals – COBRAS & SAMBA – in 1993
- Start of Planck in 1995
- Launch in May 2009
- Operations Aug 2009- Oct 2013
- First data release March 2013
- Second data release Feb – July 2015



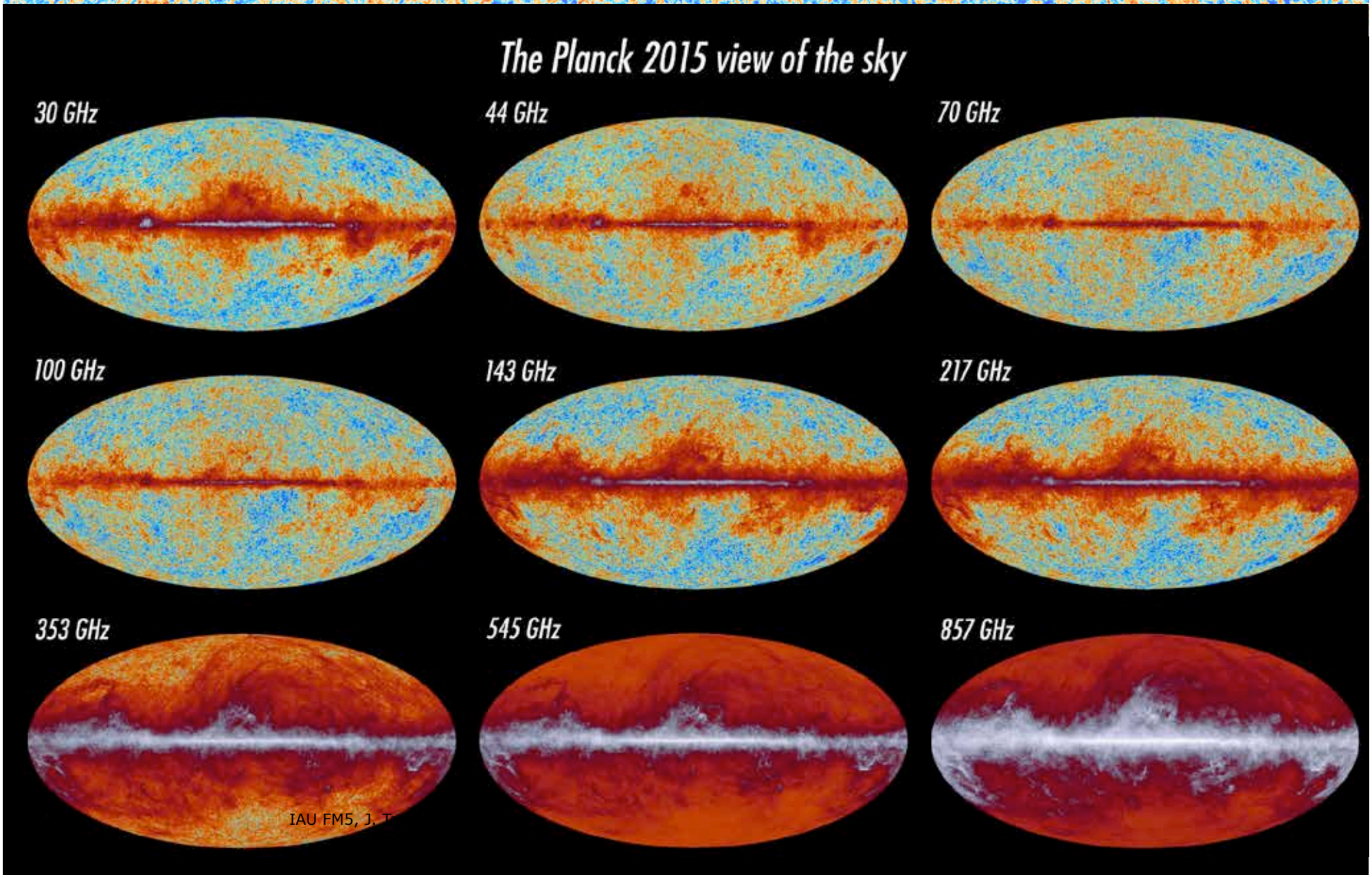
Planck Legacy Archive

- The Planck data products are generated by the LFI and HFI Data Processing Centres, under the supervision of the Planck Science Team
- The Planck Legacy Archive is the main distribution means of Planck data
    - It contains all the data released by Planck since 2011
        - ALL the data acquired by Planck is now available !
    - http://pla.esac.sci.int
    - Visit the ESA booth in the Exhibition Hall to get direct access and support !
- A partial mirror of the PLA exists at IPAC
    - http://irsa.ipac.caltech.edu/data/Planck/docs/index.html

Planck data releases

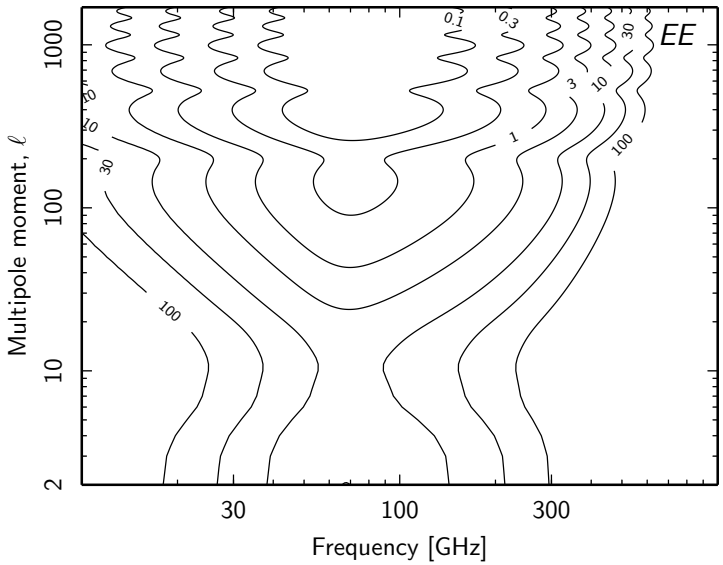
- 2011: The Early Release Compact Source Catalogue
  - Intended as a "quick" product to enable follow-up of interesting sources, mainly with Herschel
- 2013: the first major release of data
  - Contained data products based on the first 15 months of observations, calibrated on the WMAP solar dipole
    - All-sky Temperature maps – by frequency
    - physical component maps and catalogues
- 2015: the first complete release of data
  - Data products using ALL the data acquired by Planck, calibrated on the orbital dipole
    - All-sky Temperature and Polarization maps – by frequency
    - Physical component maps and catalogues
    - Timelines of cleaned and calibrated data
- 2016: the "final" release of data
  - Data products with improved handling of systematic effects
  - "semi-raw" timelines

The main Planck products: 2015 temperature maps

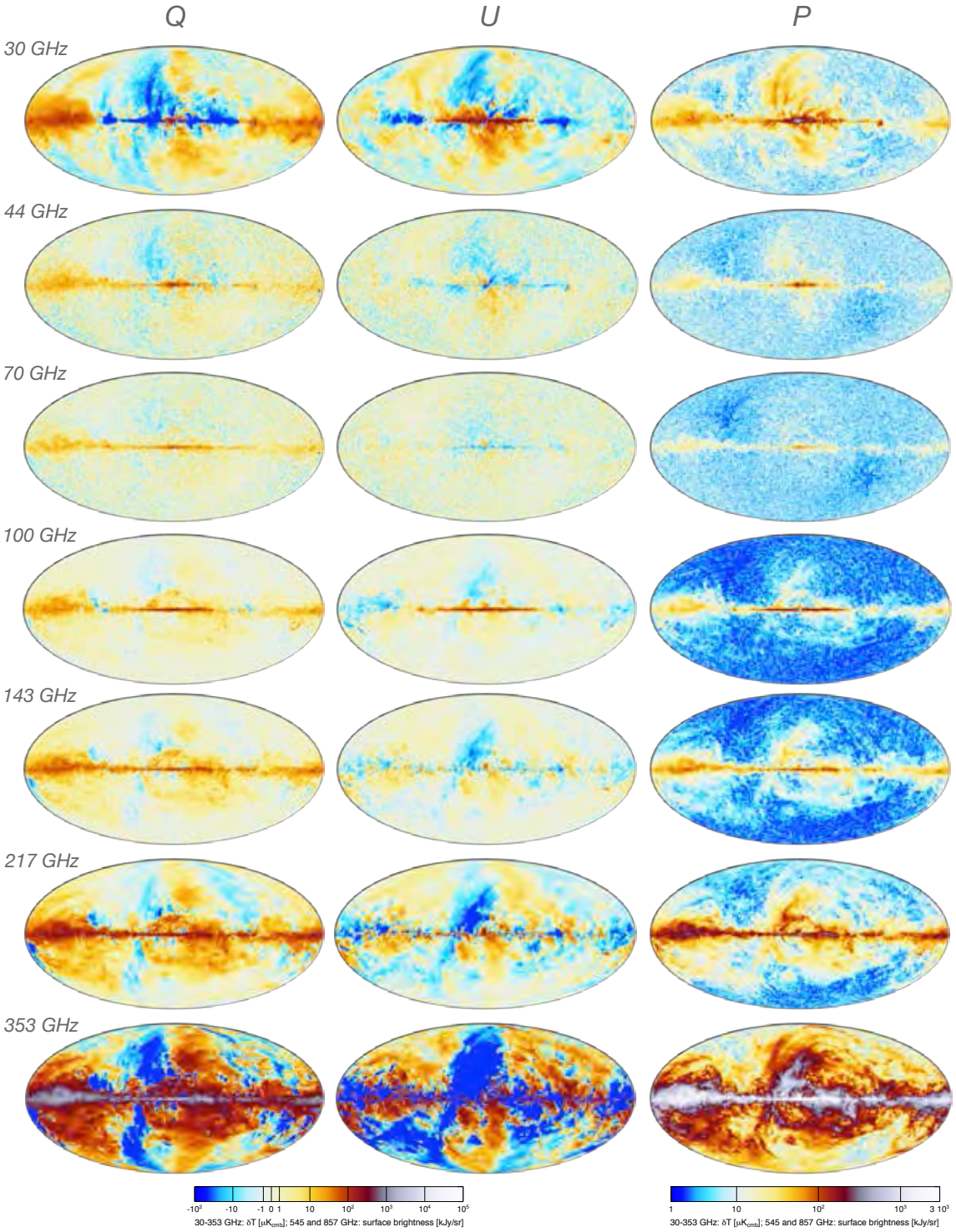


The 2015 polarization maps

Ratio of amplitude of polarized foregrounds to CMB is <1 for ell>40 at ~70 GHz



Foregrounds/CMB, 73% sky

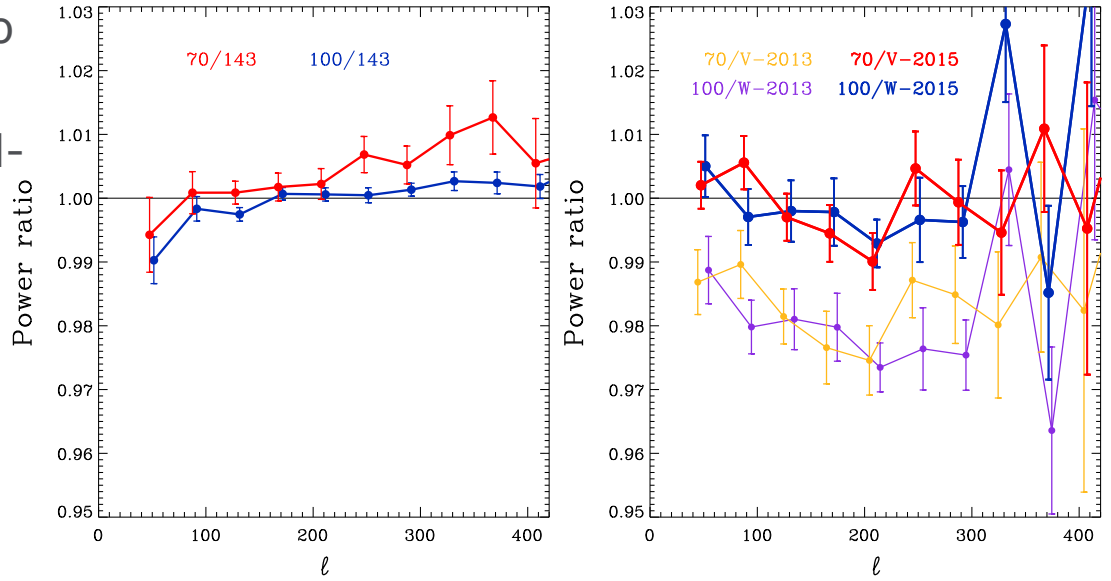


IAU FM5, J. Tauber

Characteristics of the maps

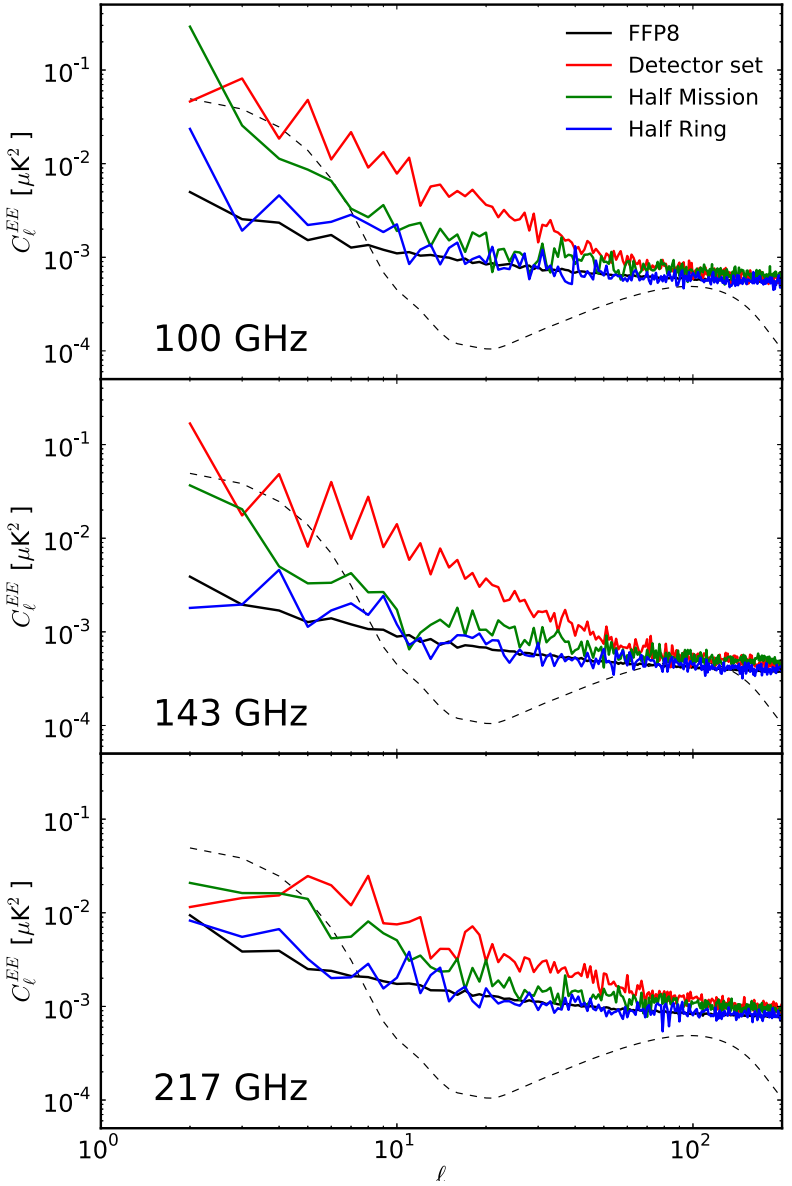
- The Planck temperature frequency maps are the most exquisitely calibrated maps you have ever seen in this wavelength range !
  - Absolute calibration accuracy is as low as ~0.1% (100-143 GHz)
  - The Solar dipole amplitude is determined by Planck to 0.06% (0.02° in direction); worst residual 0.2% at 217 GHz
  - Relative calibration between 70 and 217 GHz <0.3% (0.5% when including 353 GHz)
  - The 545 and 857 GHz maps are calibrated on planets
    - The relative calibration is ~1%, but the absolute calibration is driven by the model uncertainty of 5%

- Planck has the potential to become a calibration standard for many ground- and space-based observatories



Low-ell systematics

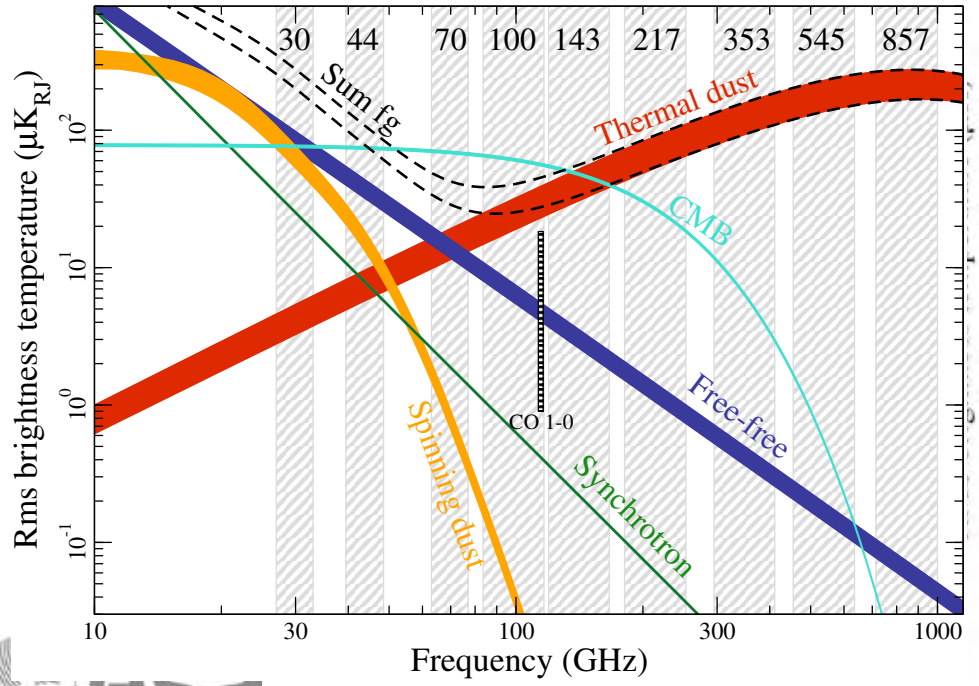
- At large angular scales (>10°), the HFI polarized maps (100-217 GHz) still contain significant levels of systematics
- Large angular scales (ℓ < 30) should NOT be used for cosmological analysis
- The polarized CMB maps produced using these maps and described in Planck papers have been high-pass-filtered accordingly
- We already know how to reduce the level of systematics very significantly – the 2016 products will incorporate this



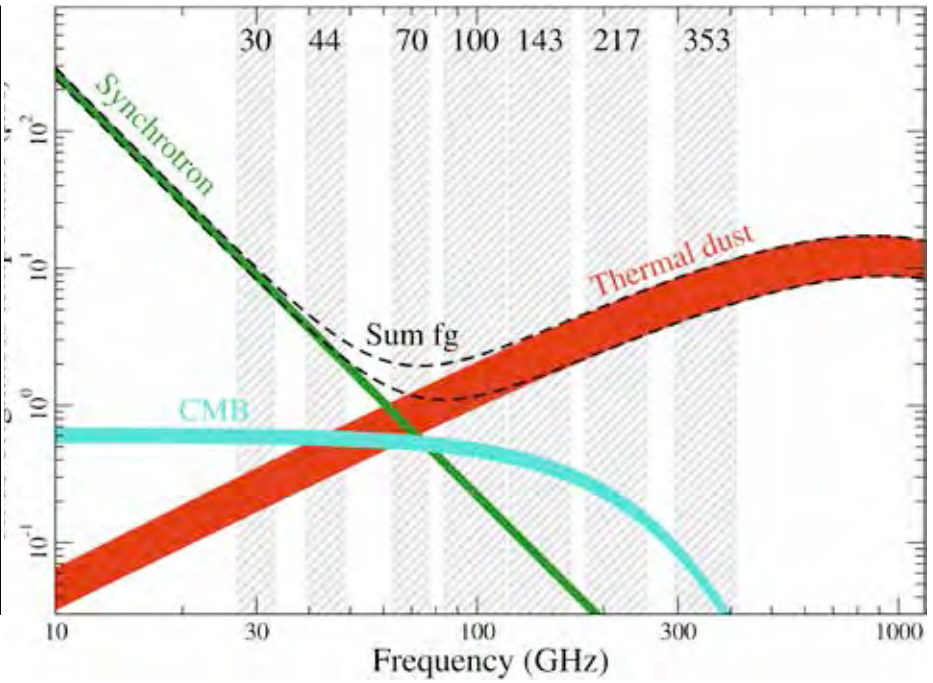
Component separation

- The main tool to separate physical components are their spectral characteristics
- Separating CMB and foregrounds are different processes: 4 methods are used for the CMB, 1-2 methods to resolve foregrounds
- Separating temperature and polarization are independent processes

Temperature



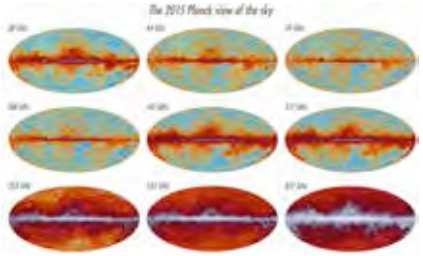
Polarization

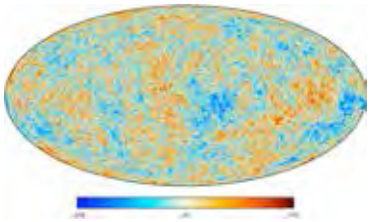


Component separation

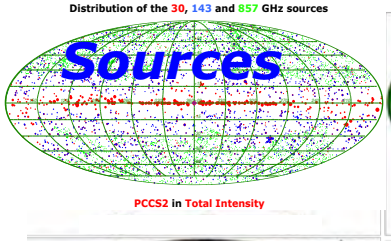
planck

Temperature

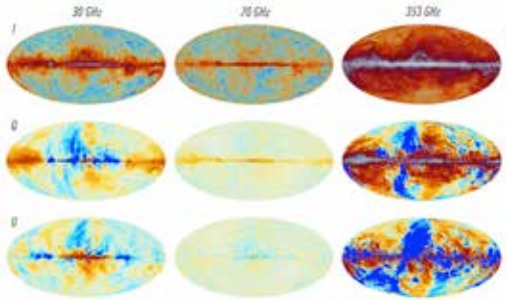


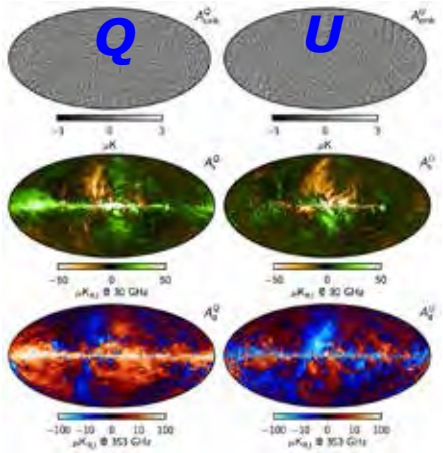


CMB



Polarization





CMB

Synchr

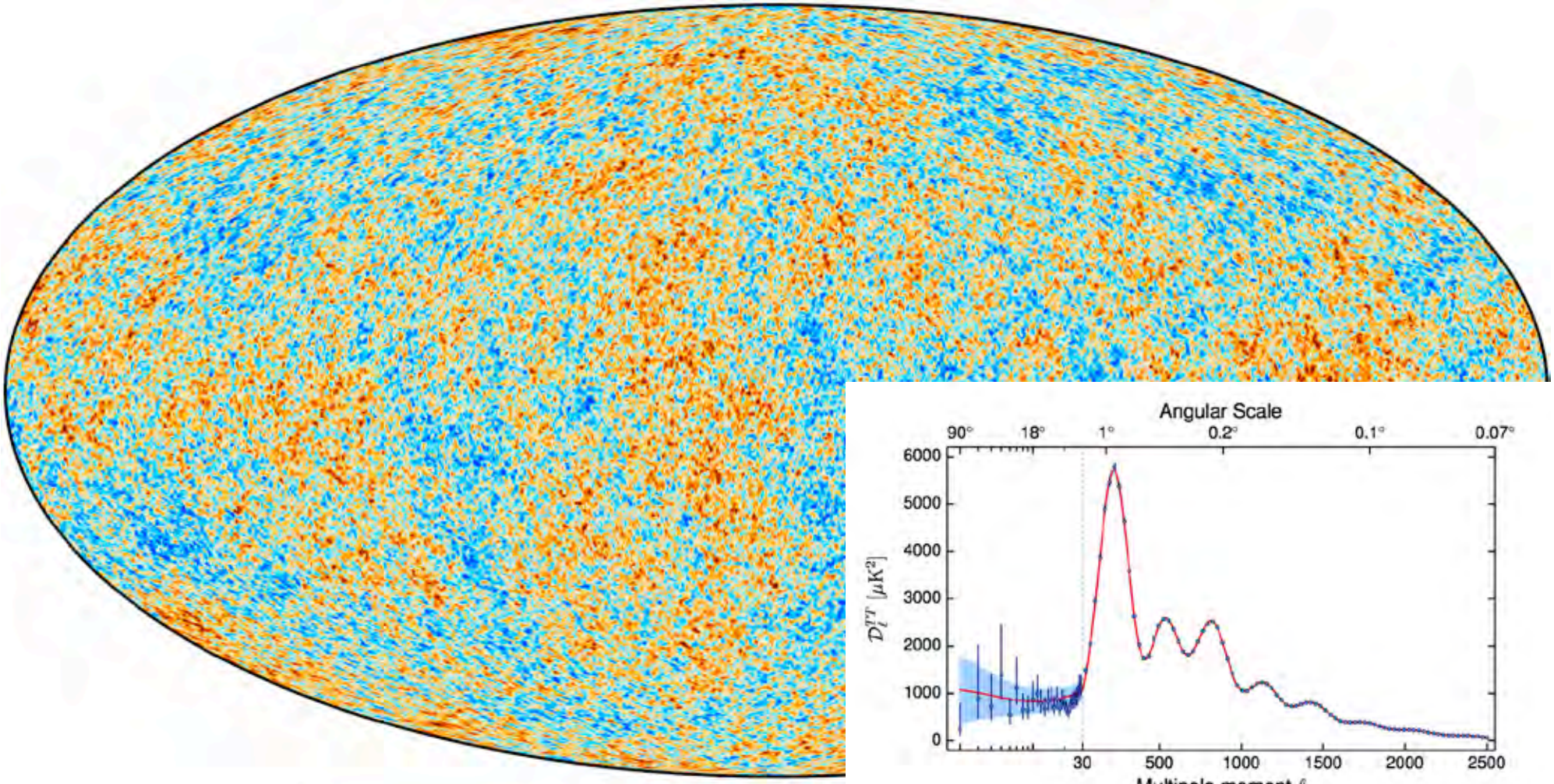
Th. dust

esa

IAU FM5, J. Tauber

Planck Collaboration 2015

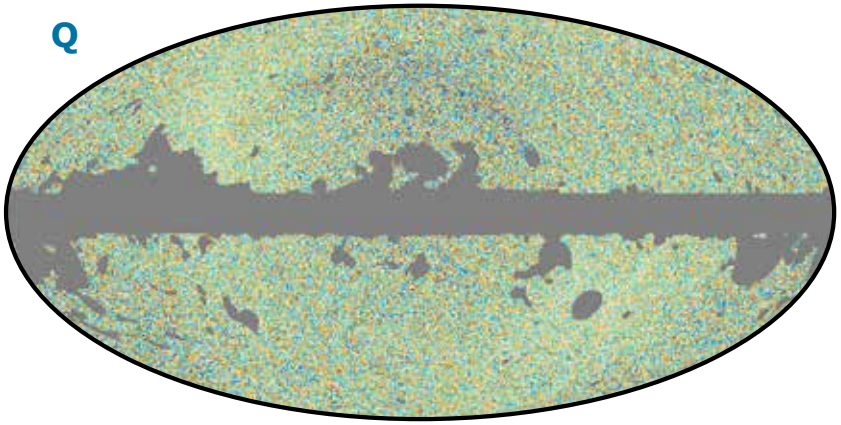
The temperature anisotropies of the Cosmic Microwave Background

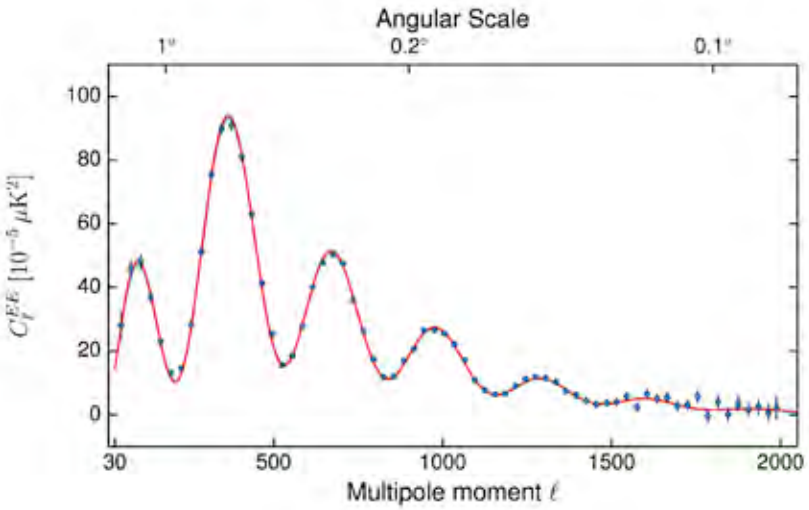


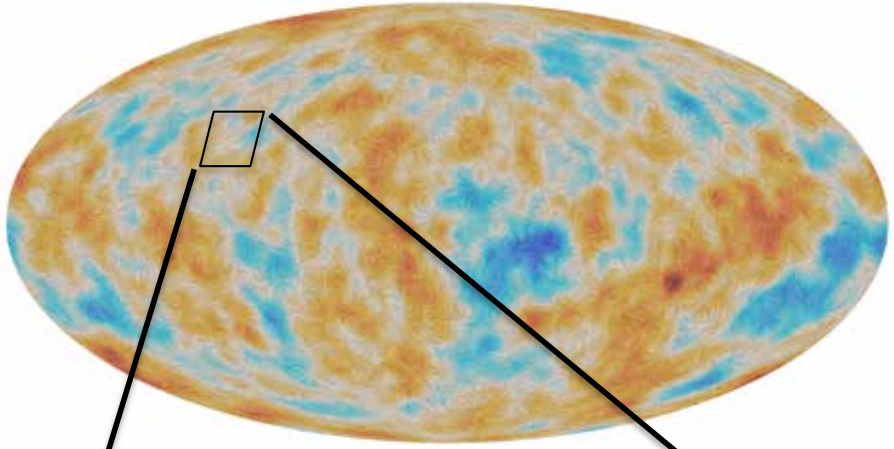
The polarization anisotropies of the Cosmic Microwave Background

SMICA

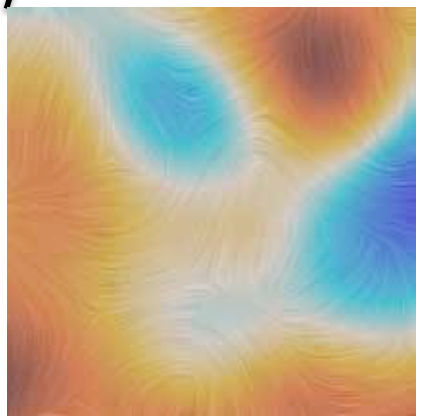
Q

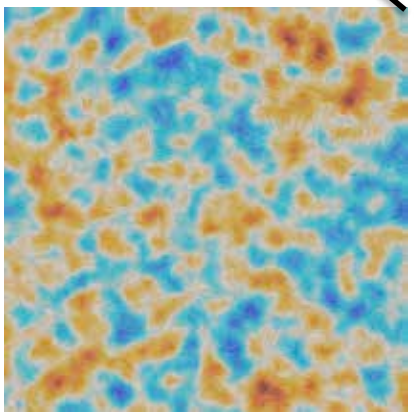






E-modes

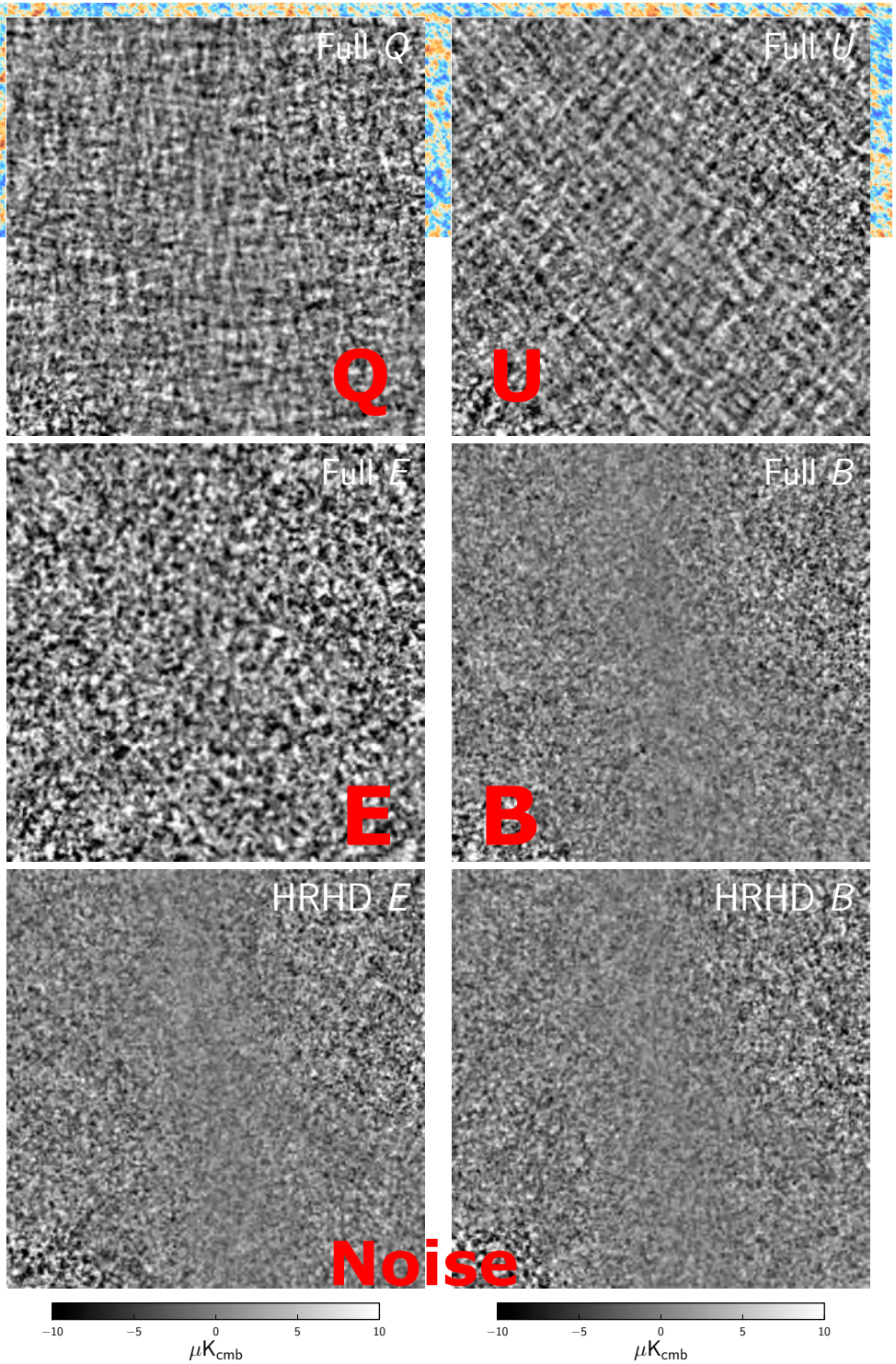




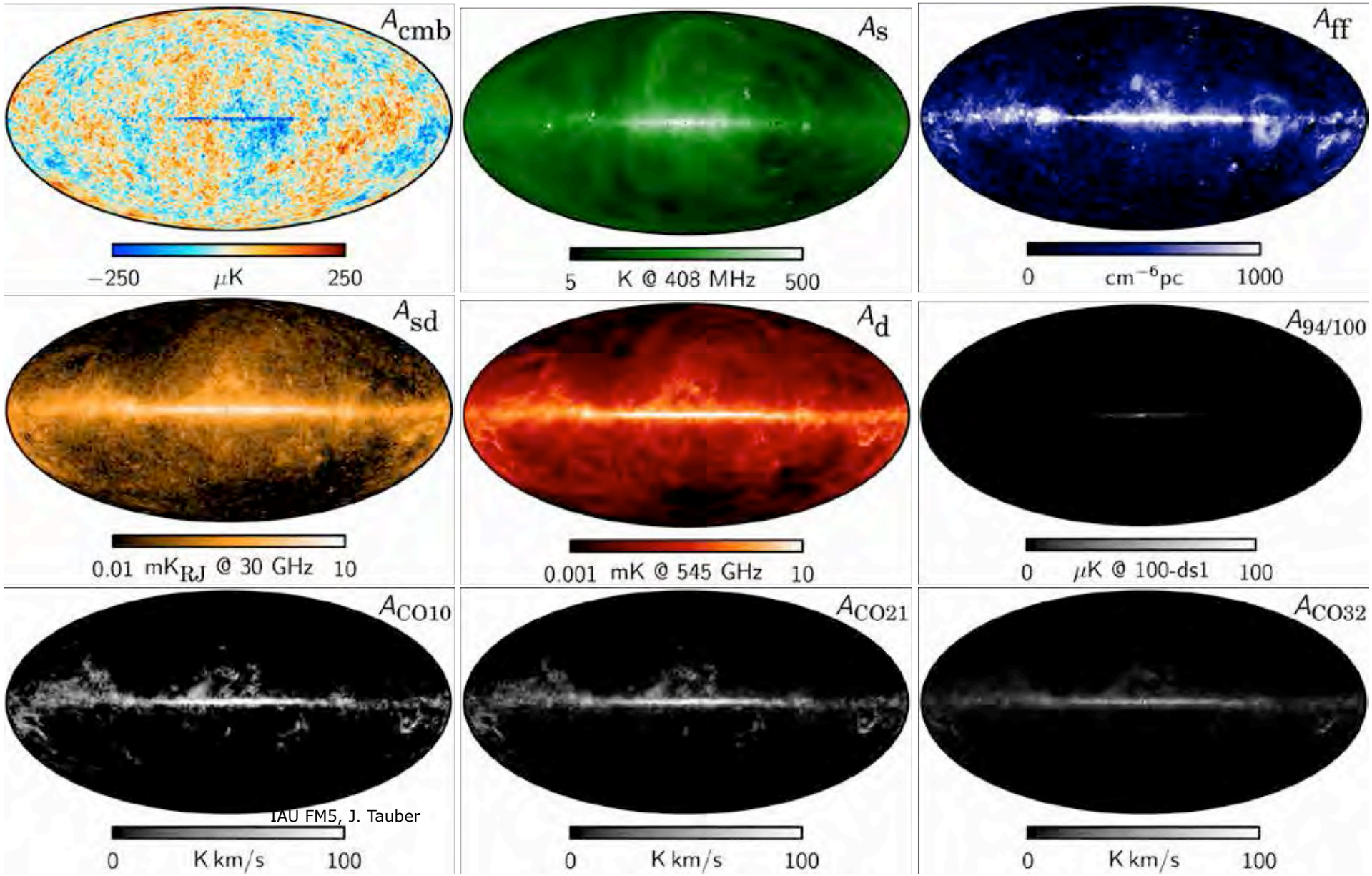
Polarized CMB

Zooming into a 20x20 deg patch (NEP) shows:

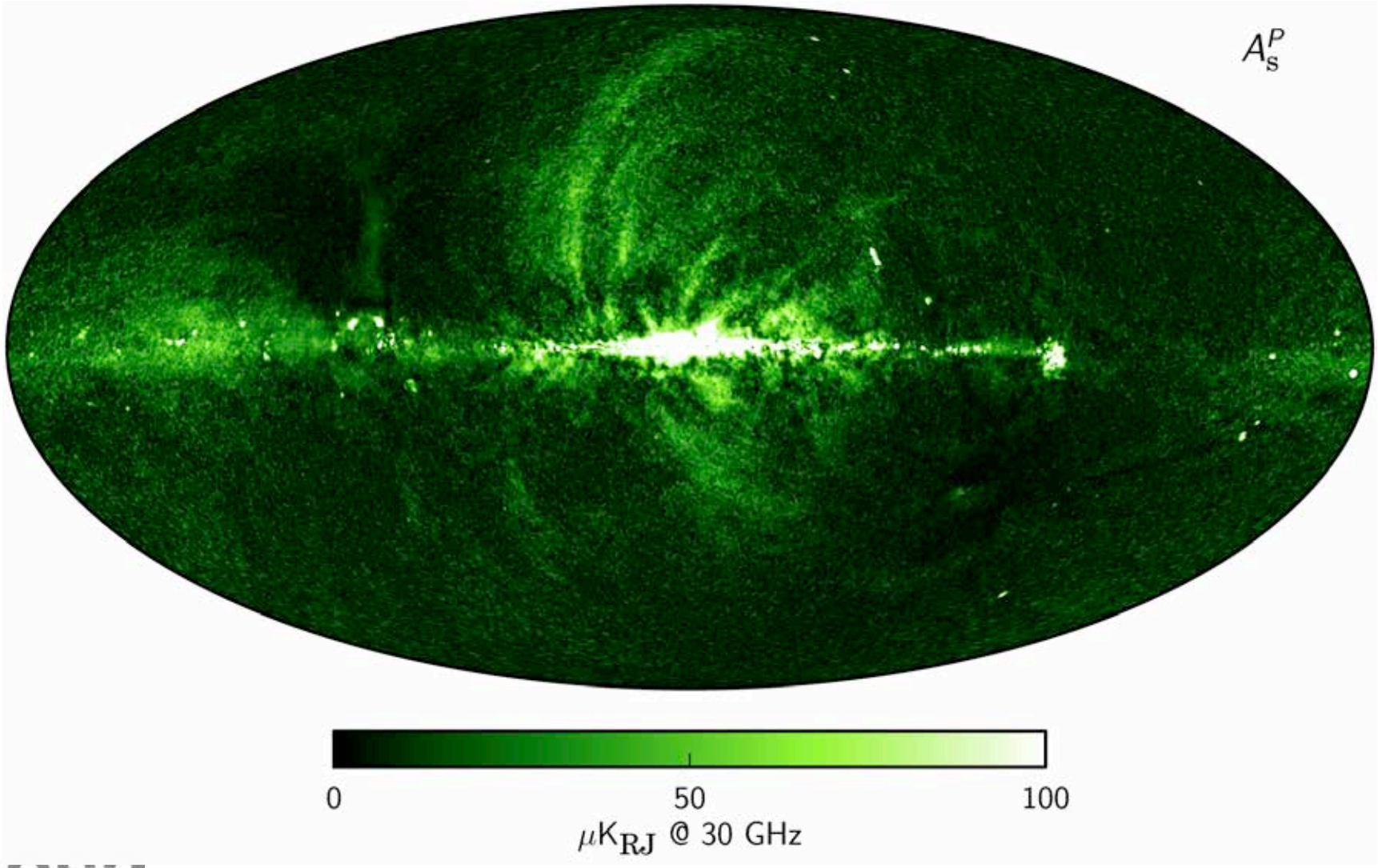
- Characteristics (+ and x) patterns for U and Q maps
- High signal-to-noise for E-modes
- Very low signal-to-noise for B-modes



Astrophysical foregrounds from Planck: a complete view of the submm sky

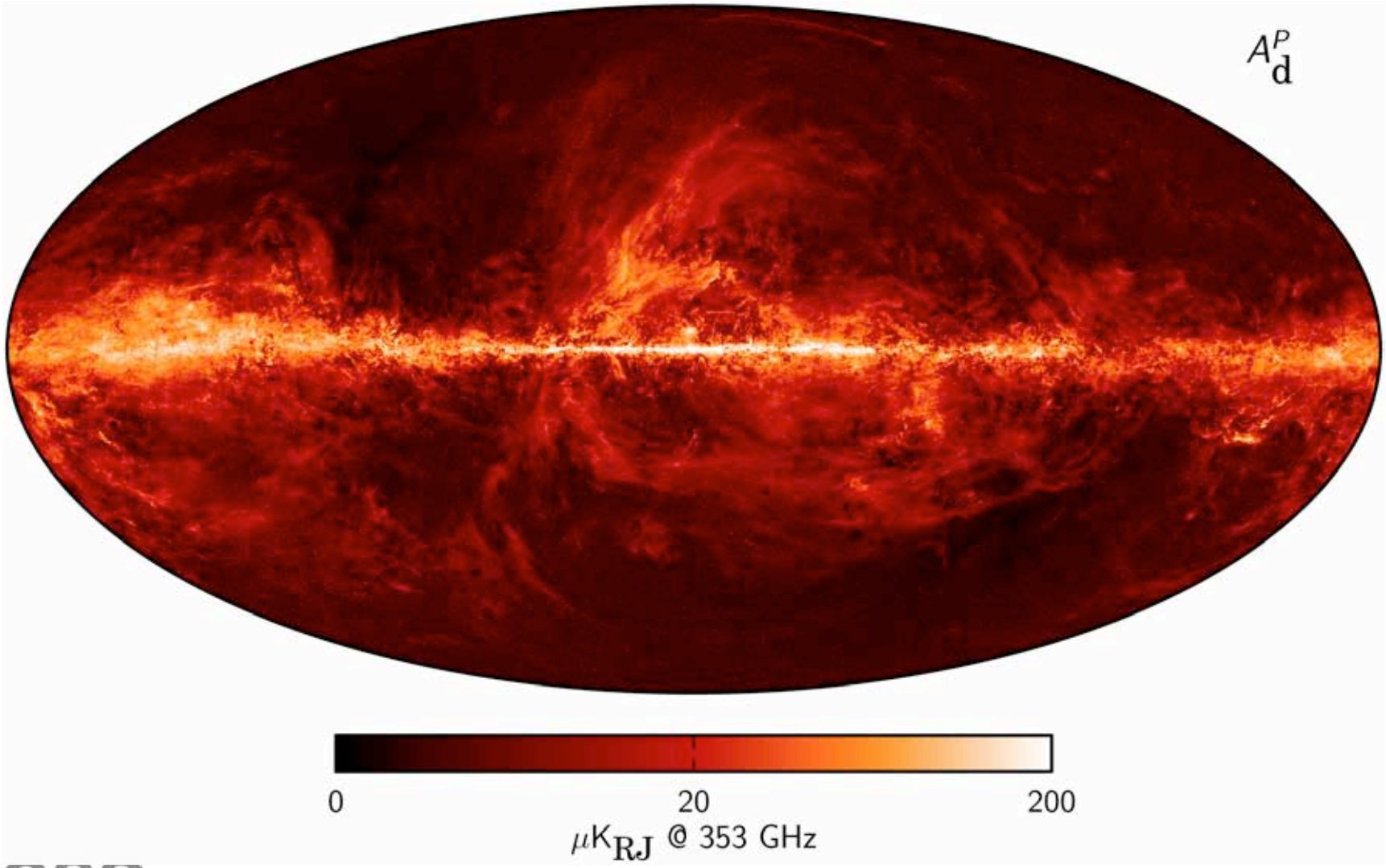


Polarized synchrotron emission



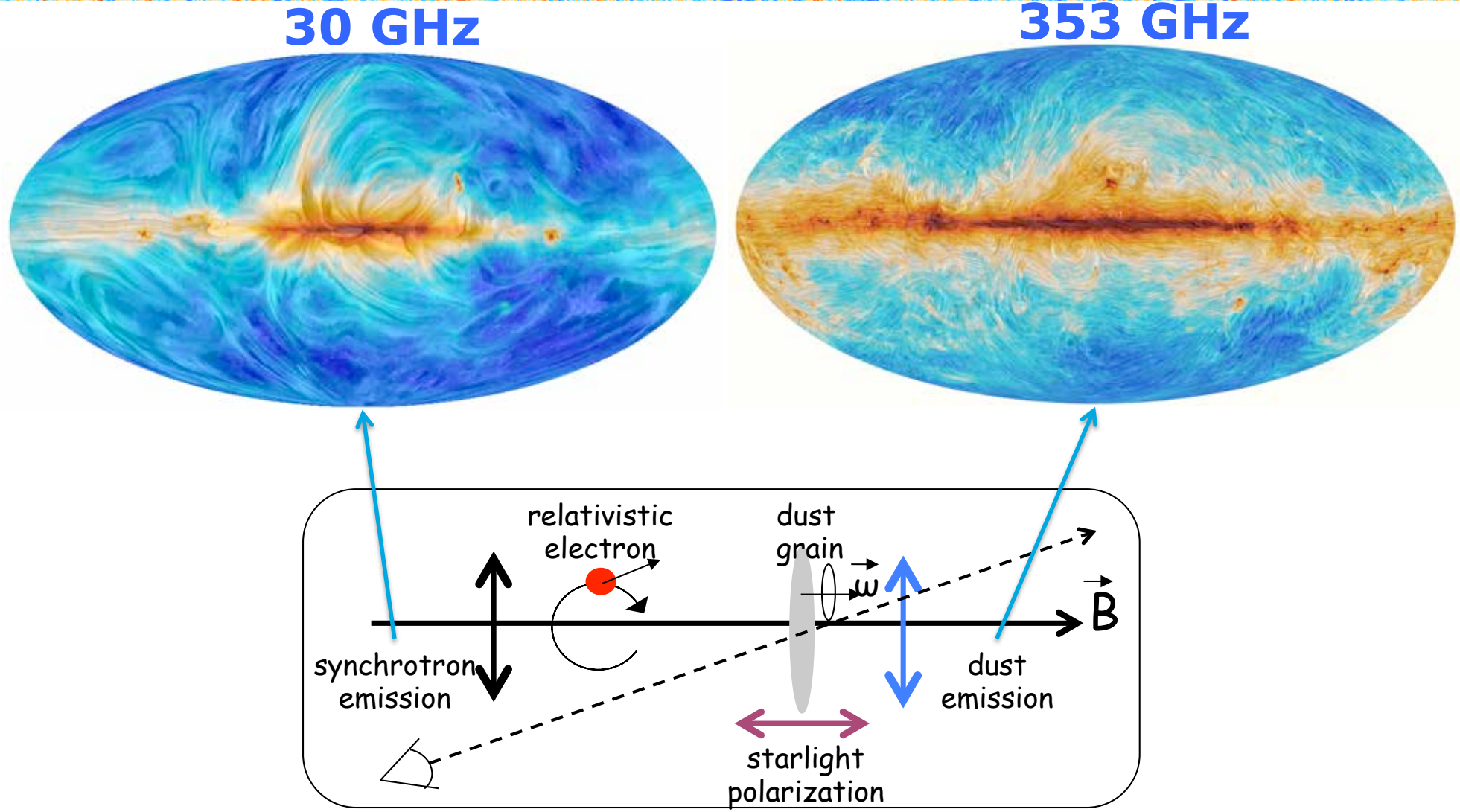
Planck Collaboration 2015

The first complete view of polarized dust emission



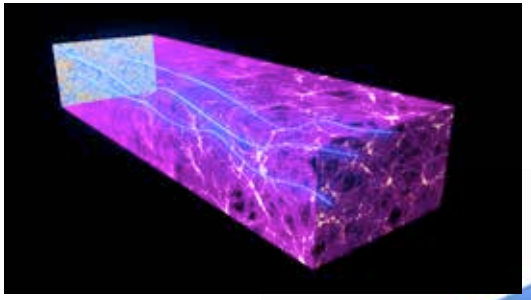
Planck Collaboration 2015

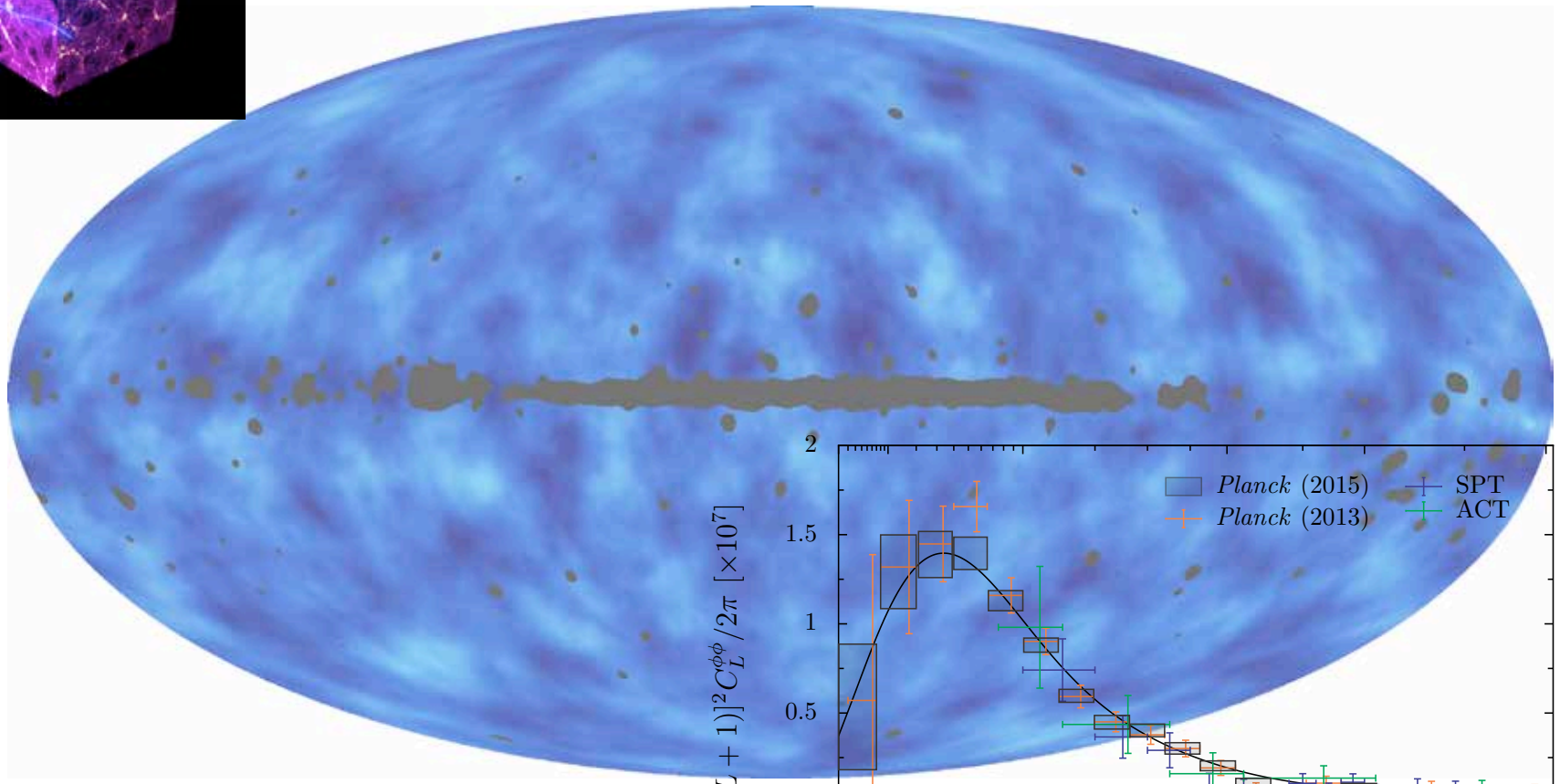
Tracing the Galactic magnetic field



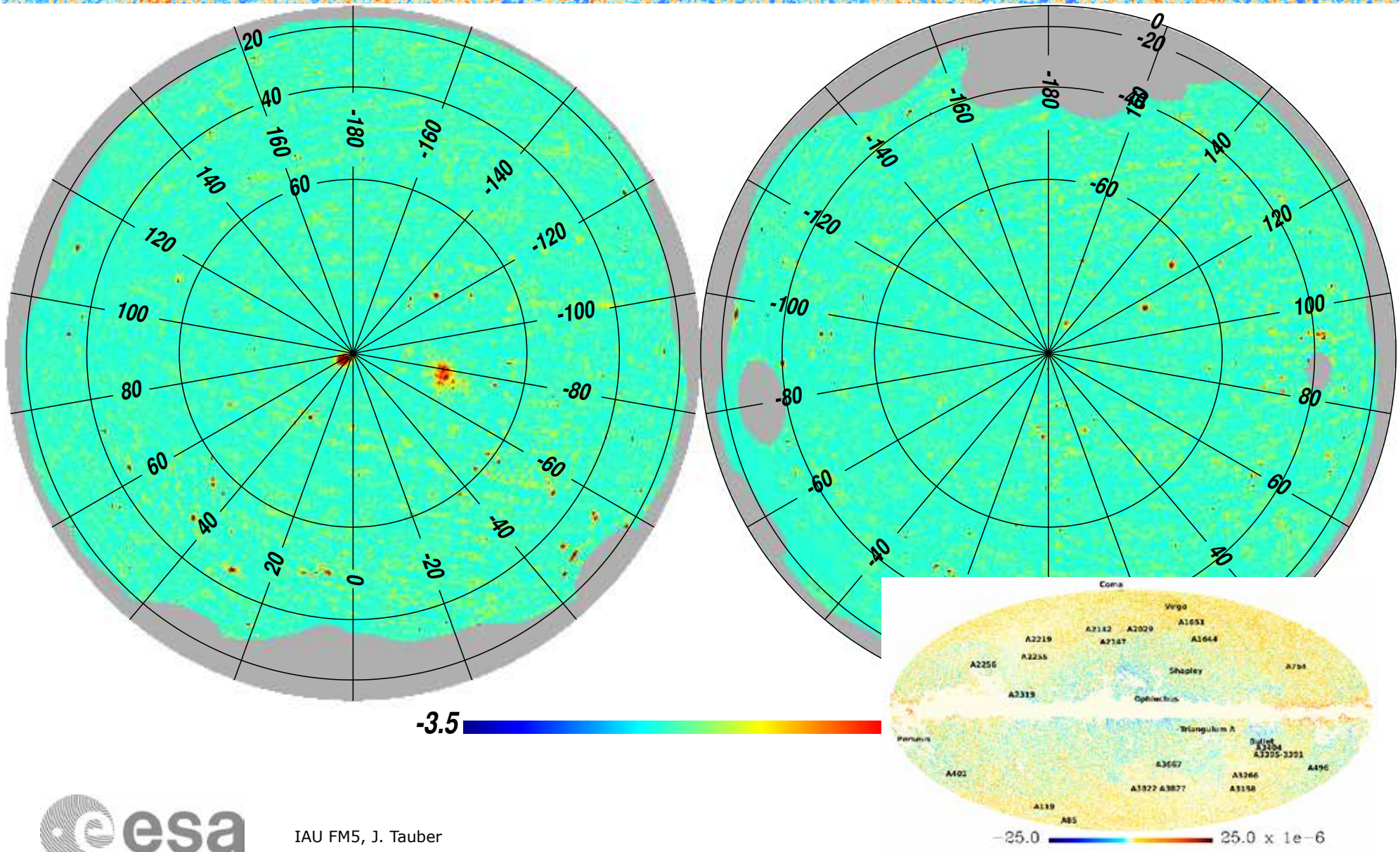
Planck Collaboration 2015

Lensing of the CMB





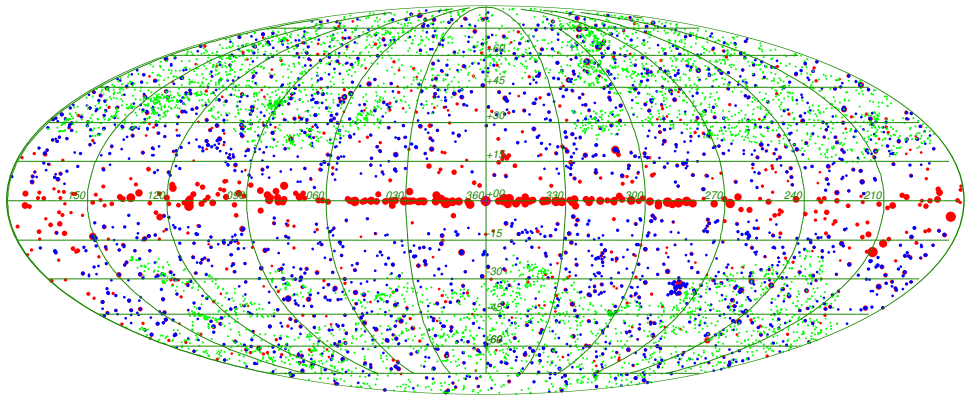
Diffuse Sunyaev-Zeldovich emission



Planck source catalogues

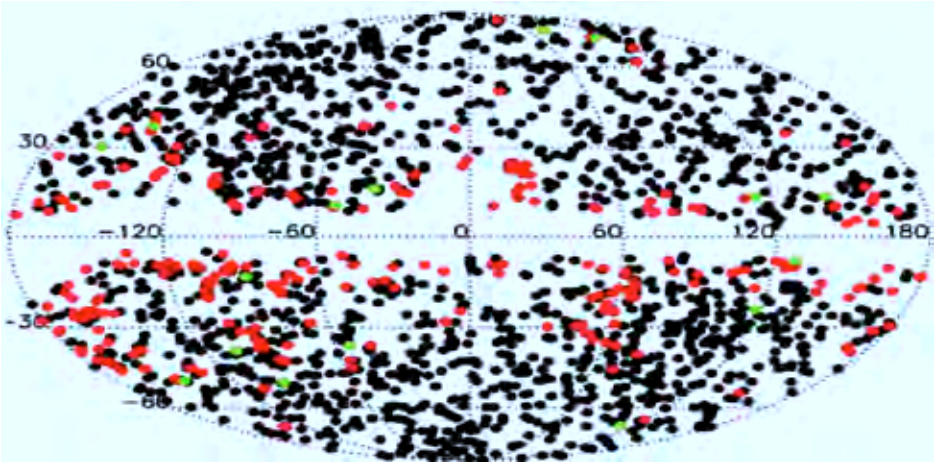
Radio and dusty galaxies

Distribution of the 30, 143 and 857 GHz sources

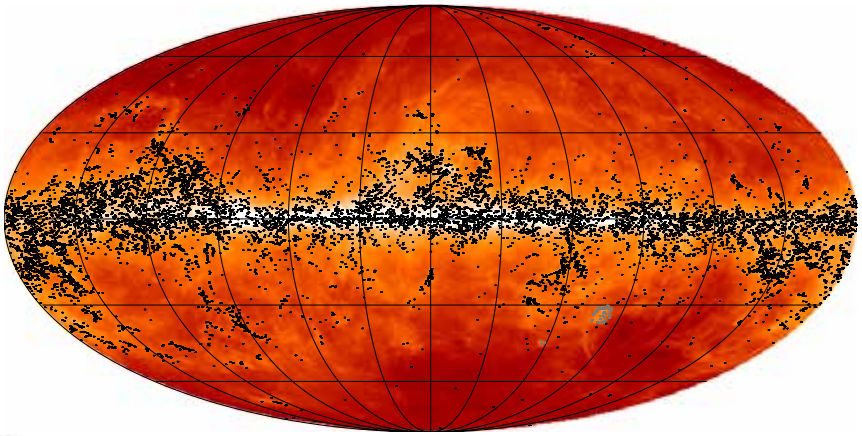


PCCS2 in Total Intensity

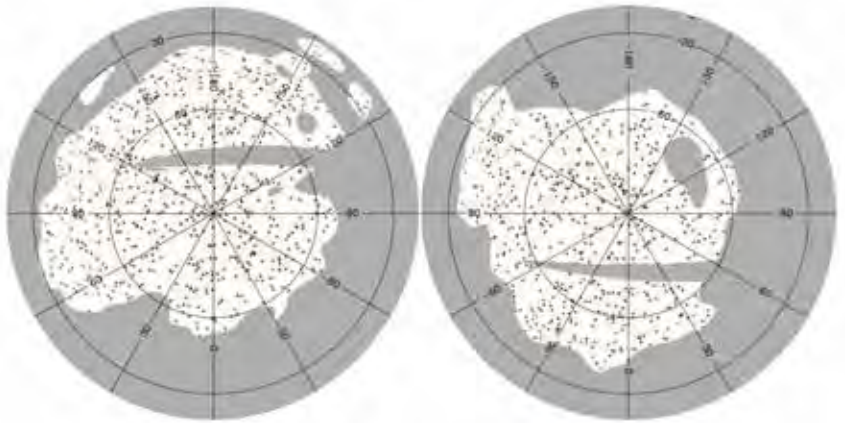
Galaxy clusters via the SZ effect



Cold galactic clumps



High-redshift sources



The Planck Legacy Archive

planck

- Contains all the Planck data products
  - Timelines
  - Frequency maps
    - Full and Partial data maps
    - Instrument characterisation data
    - Beams
  - Physical component maps
    - CMB: 4 different versions
    - Commander foreground products
  - Likelihood code
  - Cosmological data (power spectra, parameters, etc)
  - Helpful software, e.g. unit conversion, color correction etc
  - Online documentation (the Explanatory Supplement)
- In the future: the Planck Sky Model…

esa

http://pla.esac.sci.int

PLA product downloads

- Most downloaded products:
    1. Likelihood code
    2. Frequency maps
    3. Catalogues
    4. CMB maps
    5. Component maps
    6. Simulations
    7. …

Papers based on Planck data

- Since launch (9 May 2009):
  - 120 papers published by the Planck Collaboration
    - 81 of these accepted by a refereed journal (by 30 Jul)
  - Cited by ~6000 individual papers (5600 refereed)
    - About 10% of these actually use Planck data
      - (remaining 90% "only" use the Planck best-fit cosmology)
      - Breakdown by topic:
        - 55% CMB cosmology
        - 16% SZ & clusters
        - 16% external galaxies
        - 11% interstellar medium

Summary

- Planck provides a very complete view of both the near and the very distant Universe
- It will remain for many years a unique source of data to address a wide range of problems, from cosmology to astrophysics
- The Planck Legacy Archive already provides all the data that Planck has acquired
  - *Every cosmologist and astronomer will find something useful in it*
  - *USE IT !!!*
- Look out for the 2016 release
- *Visit the ESA booth to get hands-on support on how to use the PLA*


esa
planck
cnes
agenzia spaziale italiana
NASA
cnrs
DTU Space
National Space Institute
Science & Technology Facilities Council
National Research Council of Italy
CSA ASC
DLR
Deutsches Zentrum für Luft- und Raumfahrt e.V.
UK SPACE AGENCY
MAX-PLANCK-GESELLSCHAFT
CSIC
HFI PLANCK
a look back to the birth of Universe
PLANCK LFI
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IAP
INAF - IASF BO
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CITA–ICAT
INSU
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Imperial College London
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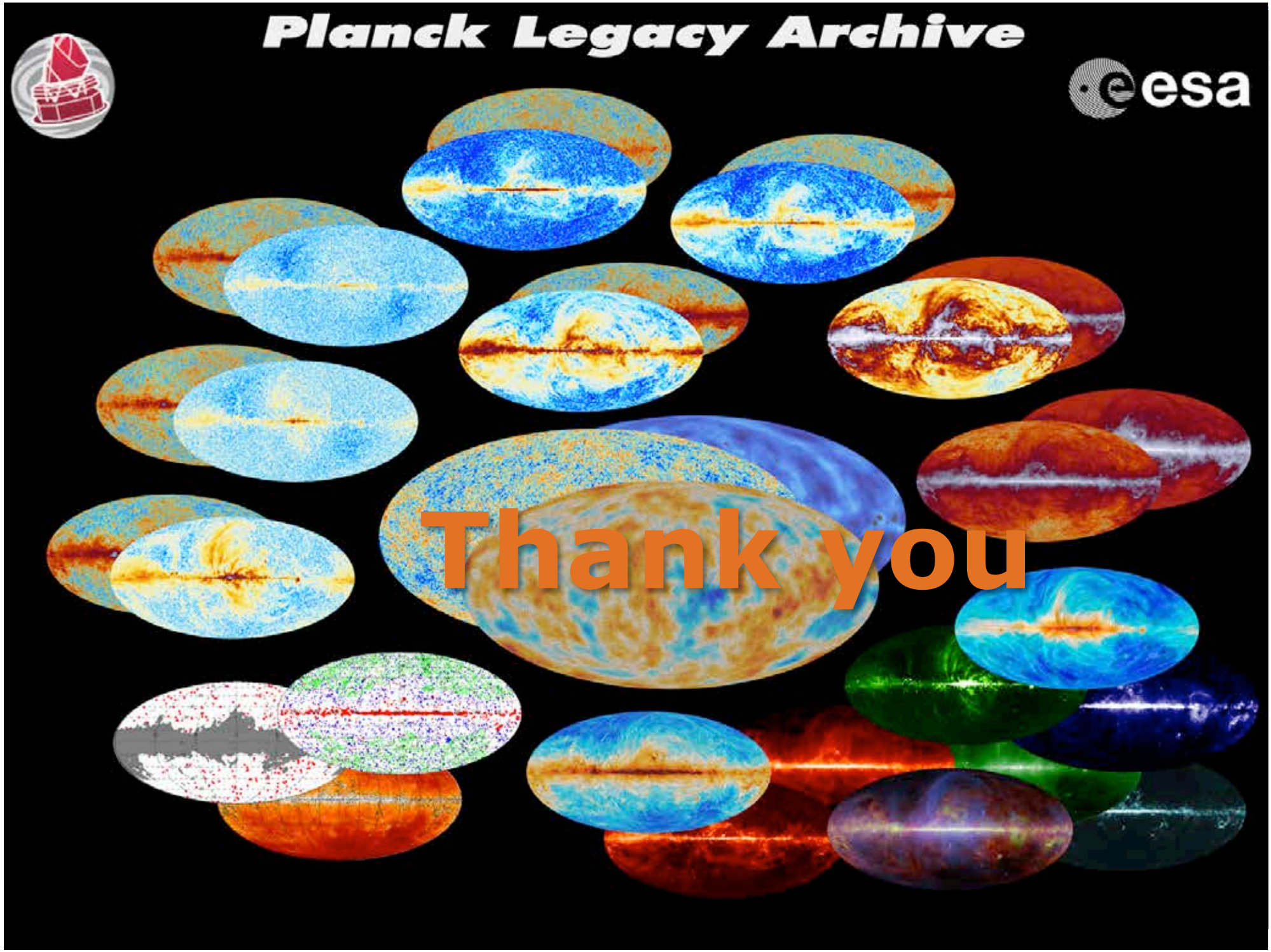
asdc


Astronomy & Astrophysics

Special feature

Planck pre-launch status: The Planck mission

IAU FM5, J. Tauber


Planck Legacy Archive
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Thank you