Planck 2015 results. XXV.
Diffuse low-frequency Galactic foregrounds

A&A (submitted), arXiv: 1506.06660

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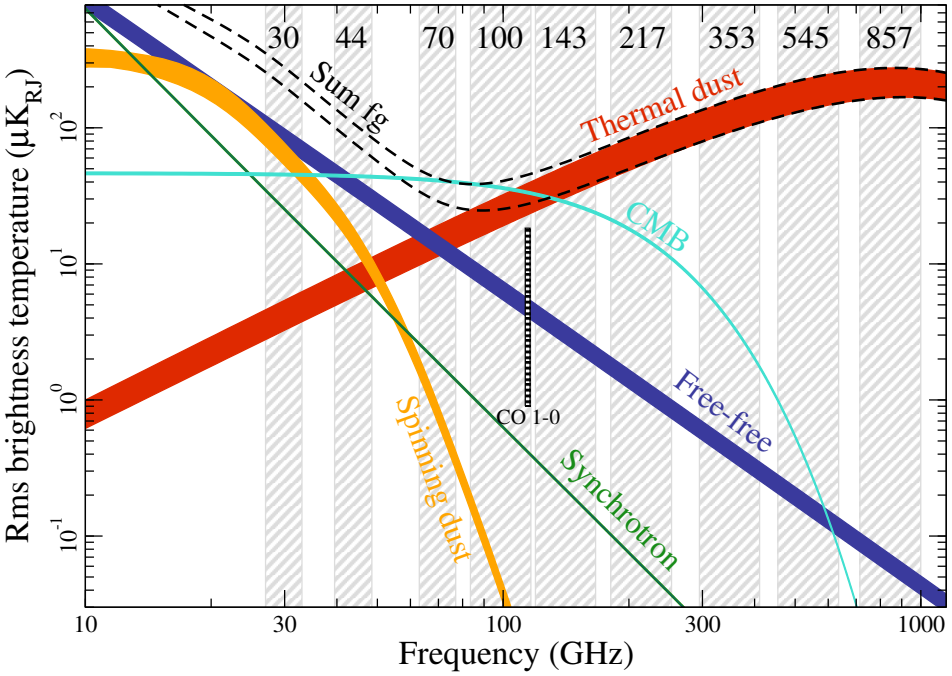
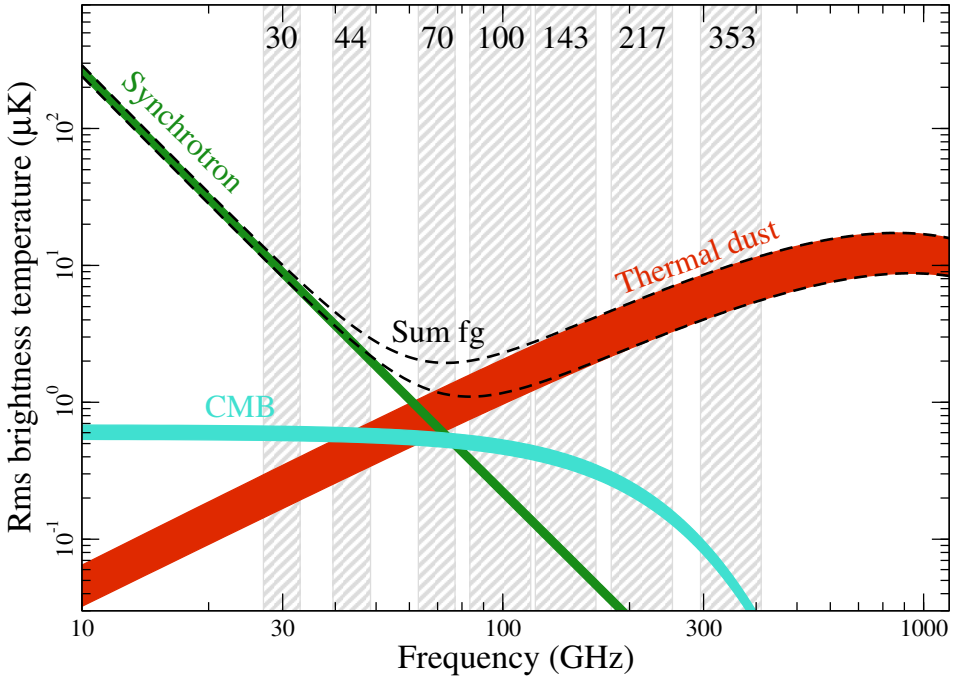
on behalf of the Planck Collaboration

Overview

Total intensity

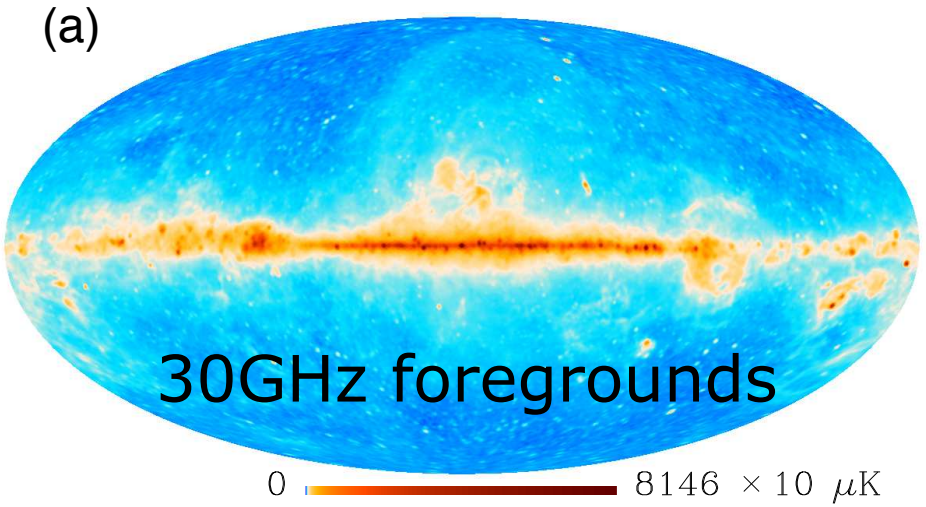


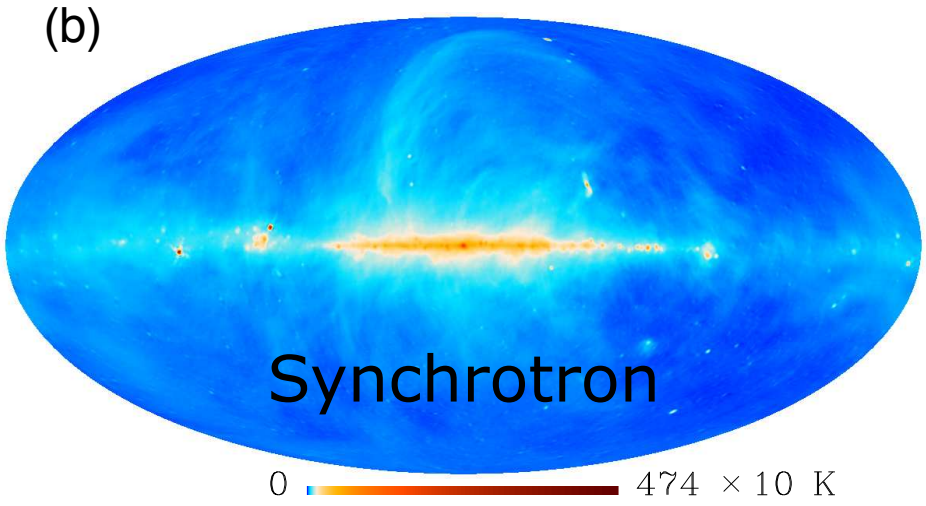
Polarization

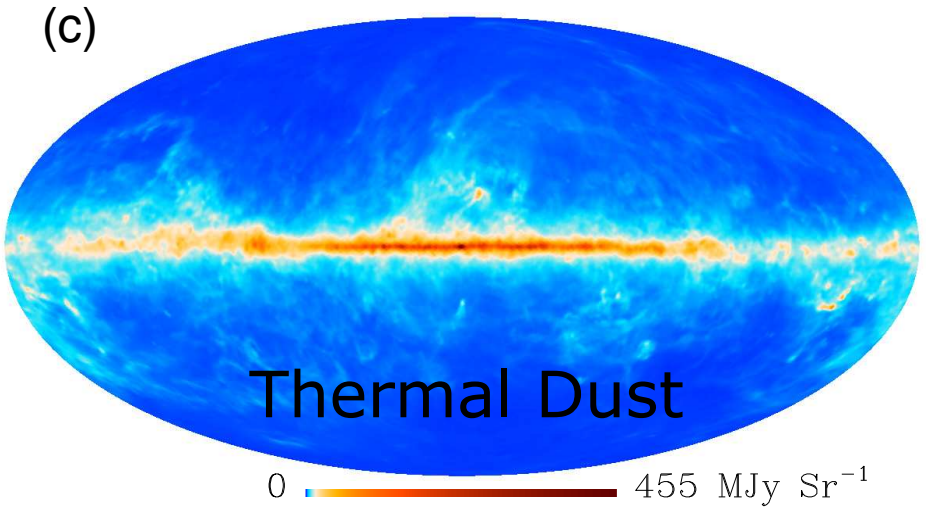


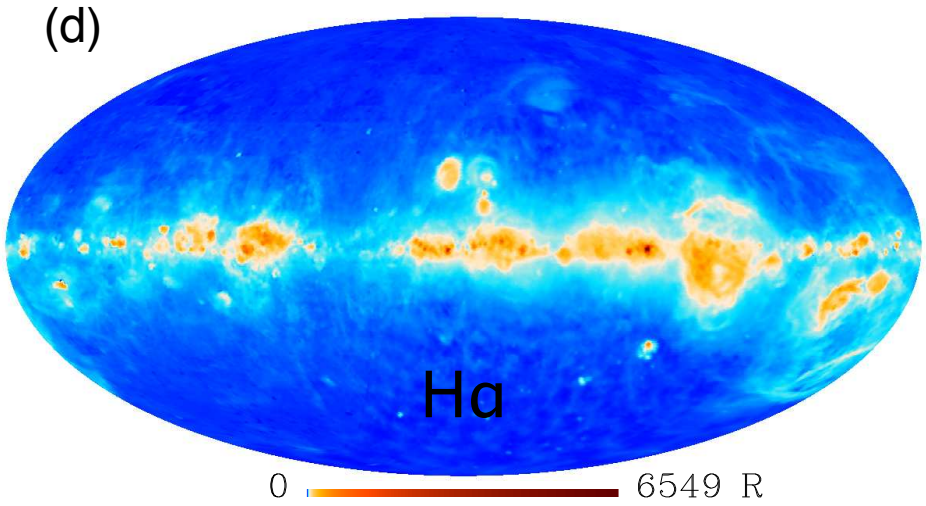
Dominated by Galactic emission at nearly every frequency
Need to understand them well to subtract them.
Also interesting in their own right!

Overview


(a)
30GHz foregrounds
0
8146 × 10 μK


(b)
Synchrotron
0
474 × 10 K


(c)
Thermal Dust
0
455 MJy Sr^{-1}


(d)
Hα
0
6549 R

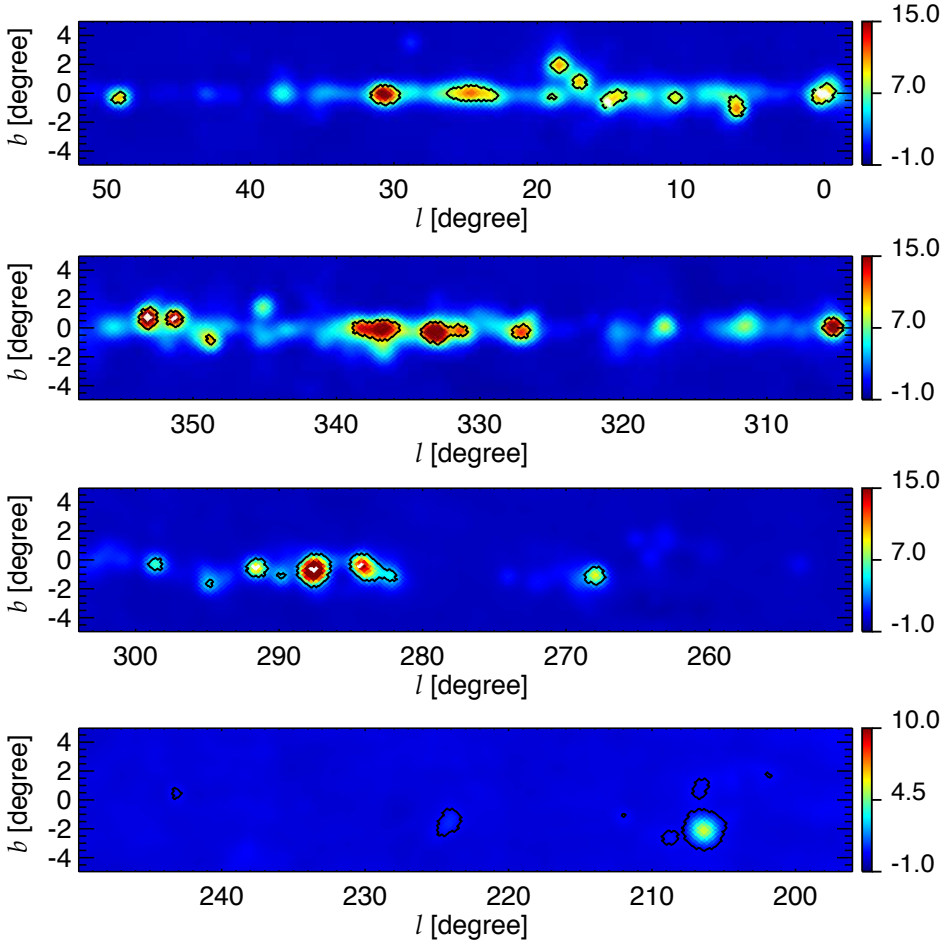
Motivation

1. Many previous attempts at component separation
2. Spinning dust predicted 1957 …
3. By-product of CMB maps

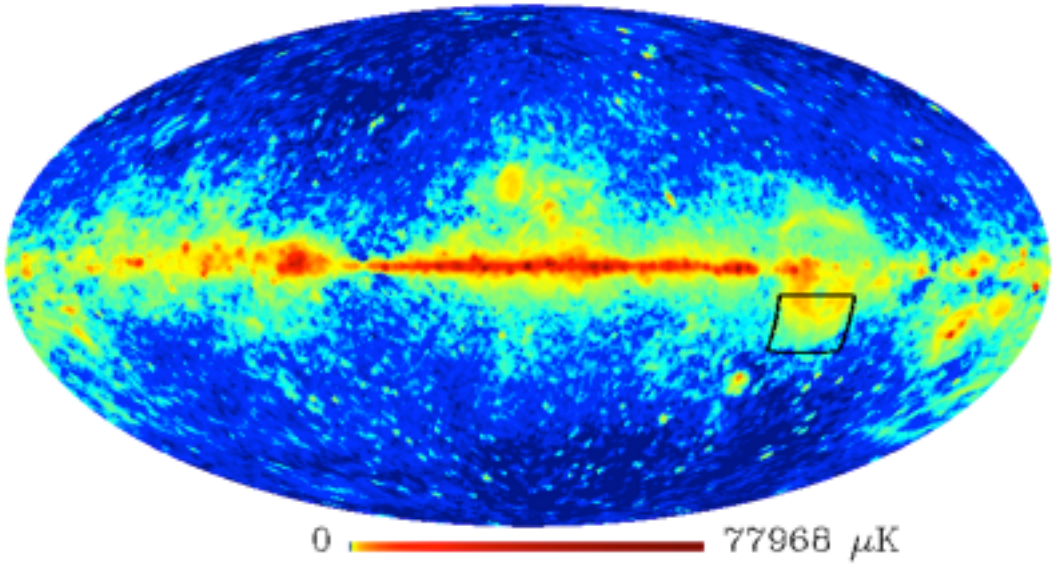
Free-free emission

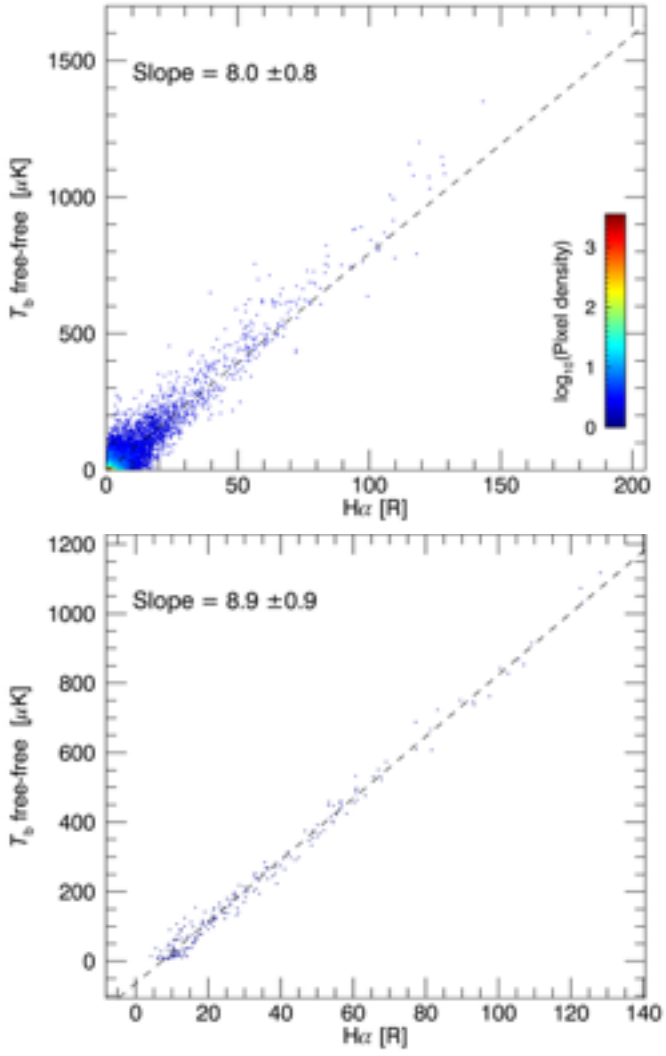
RRLs (Alves et al.)

Commander free-free

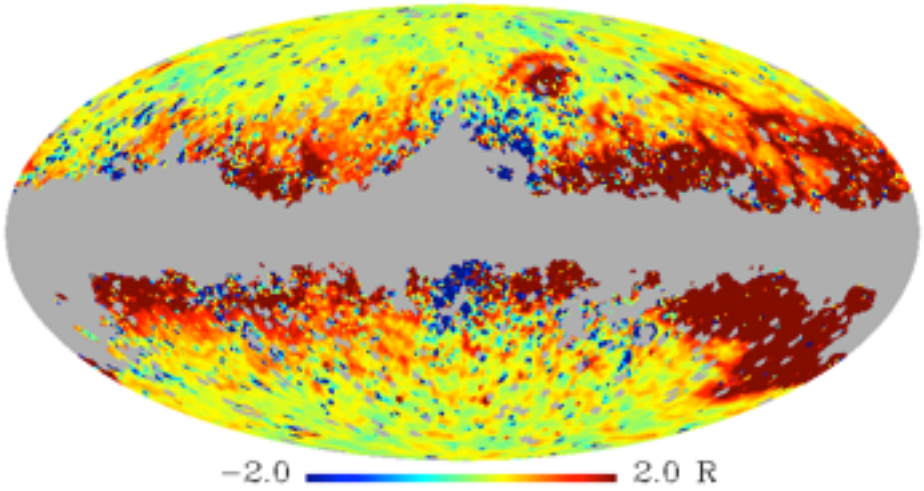


Free-free emission

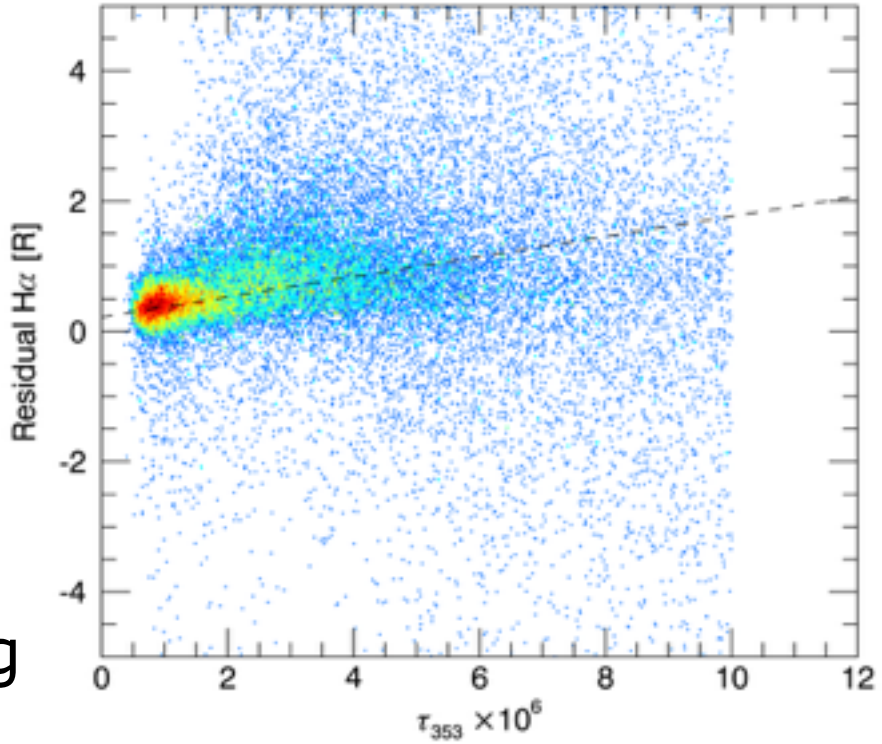




Hα scattering



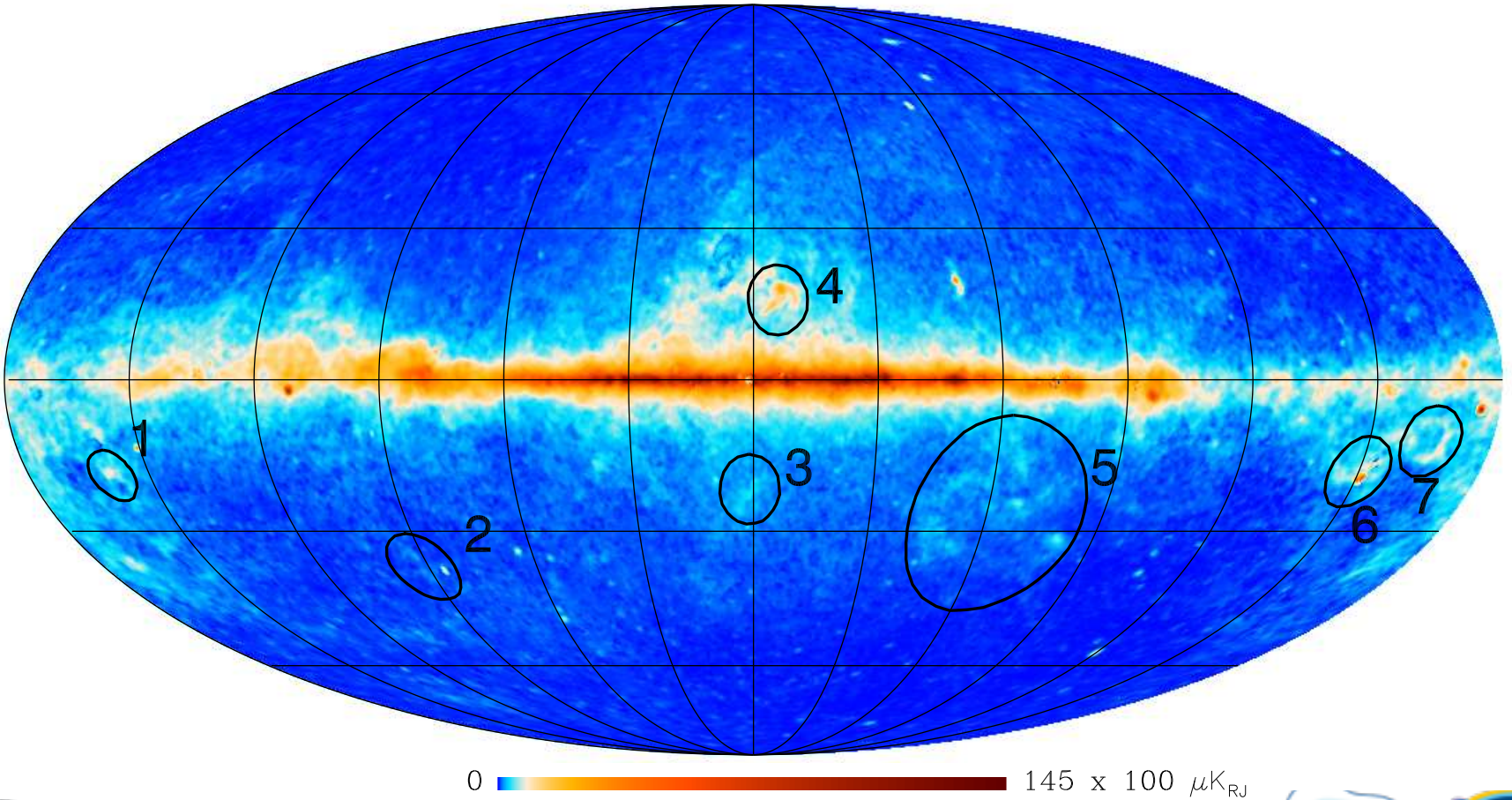
Residual Ha after subtracting mean correlation
Traces scattered light?



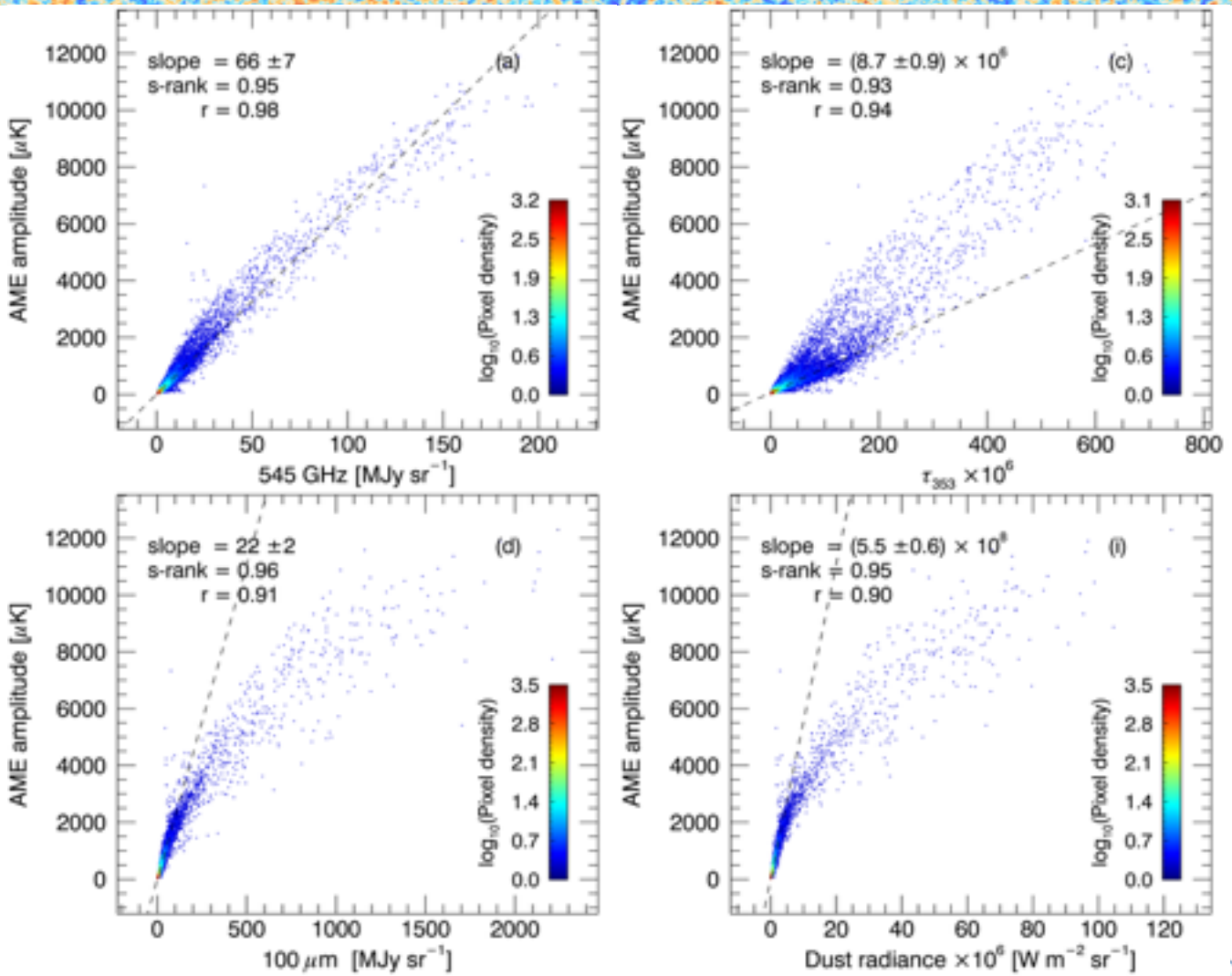
28+-12%
36+-12% (after dust absorption correction)

Anomalous Microwave Emission

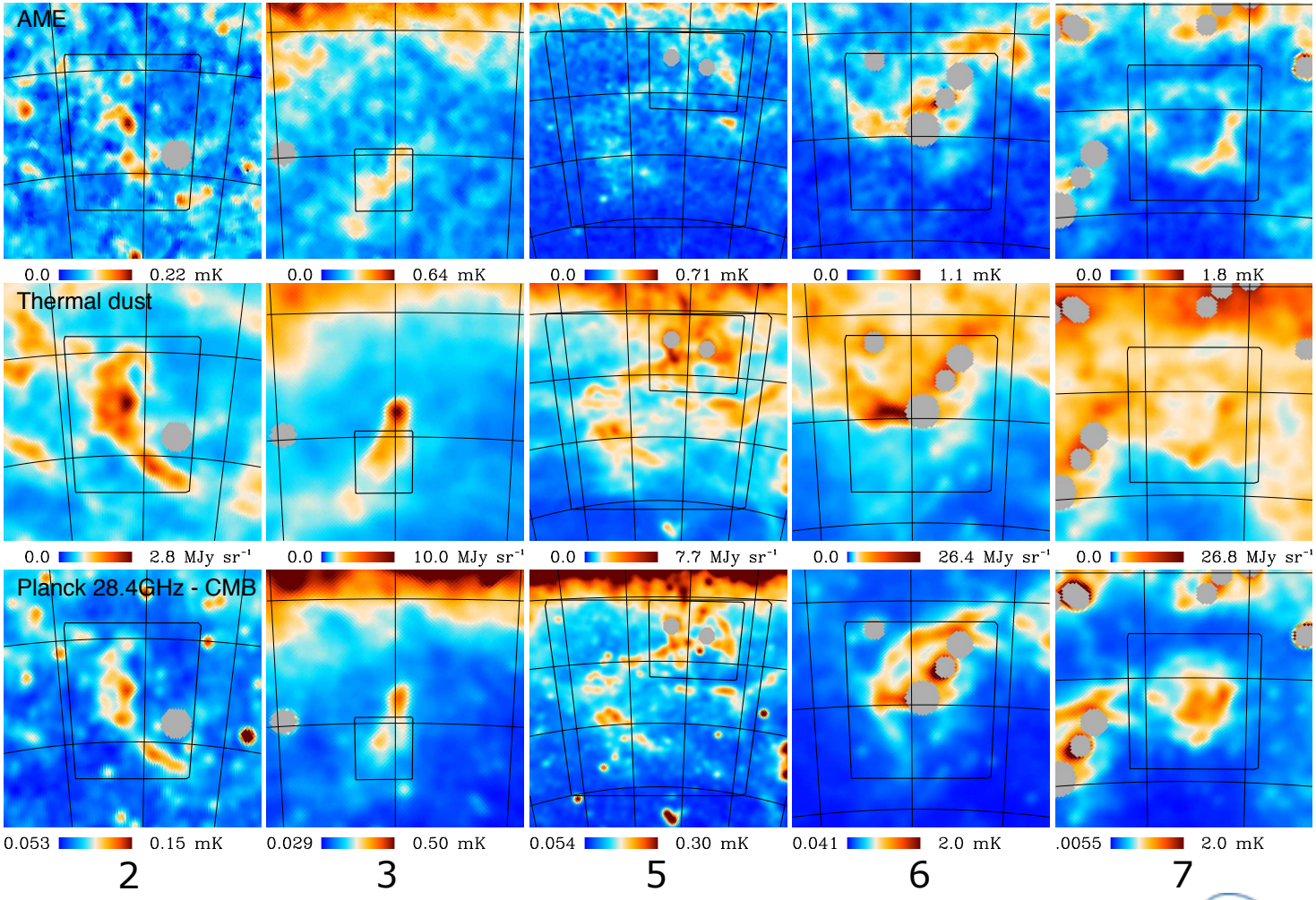
Commander AME solution



AME correlations



New AME regions

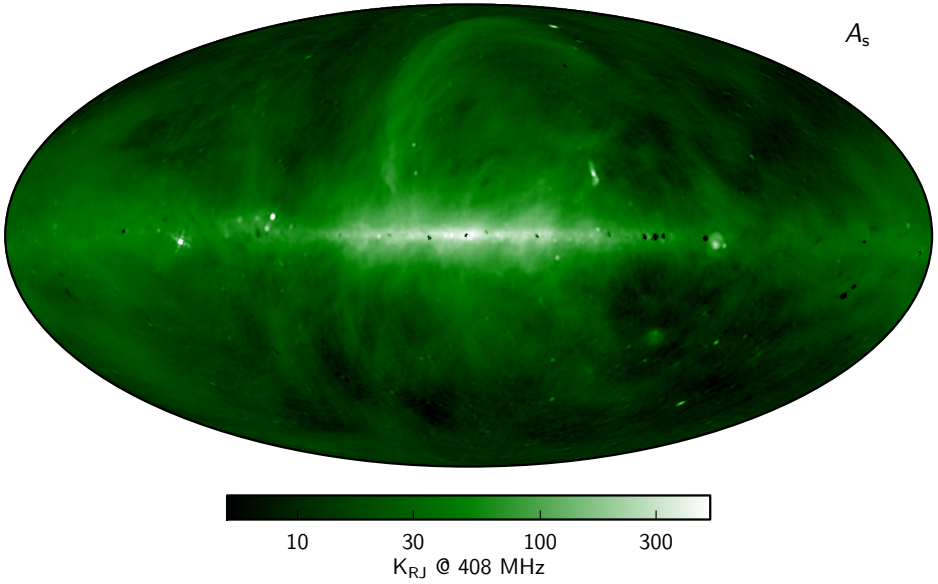


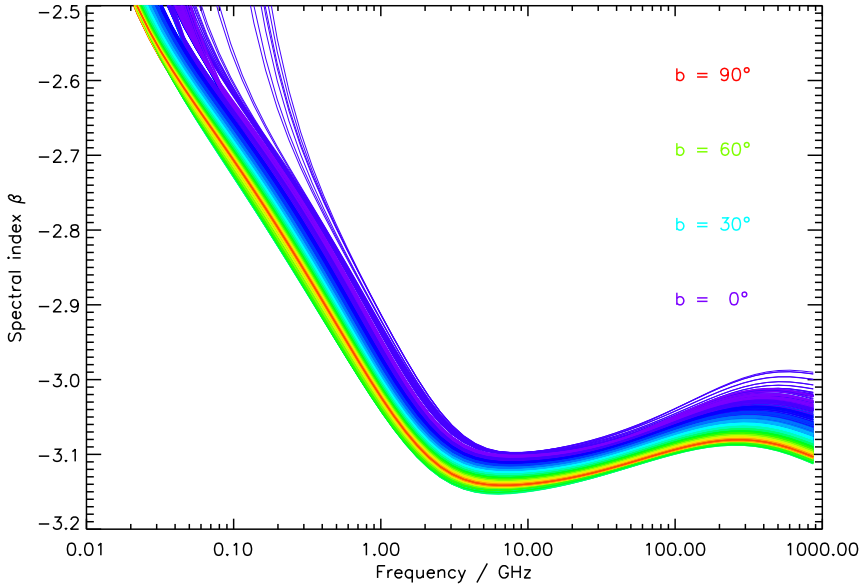
Emissivities

Emissivities against 545/t353 vary by factor of 2
v. high emissivity in λ Orionis
…

Region	AME/545 GHz [μK (MJy sr^{-1})$^{-1}$]	AME/100 μm [μK (MJy sr^{-1})$^{-1}$]	AME/τ_{353} [μK 10^{-6}]
R1: Perseus	24 ± 7	12.3 ± 1.9	1.5 ± 0.9
R2: Plume	47 ± 6	18 ± 2	7.7 ± 1.0
R3: R CrA	36 ± 14	50 ± 12	4.1 ± 1.8
R4: ρ Oph	40 ± 9	4.6 ± 0.9	2.2 ± 1.2
R5: Musca	59 ± 8	26 ± 3	6.9 ± 1.0
Chamaeleon	74 ± 8	22 ± 2	11 ± 1.1
R6: Orion	47 ± 5	20 ± 2	4.7 ± 0.6
R7: λ Orionis	104 ± 11	25 ± 3	15 ± 1.8
Entire sky	65 ± 7	22 ± 2	8.3 ± 0.8
$\|b\| > 10°$	70 ± 7	21 ± 2	9.7 ± 1.0
XV: Perseus	…	24 ± 4	…
XV: ρ Oph	…	8.3 ± 1.1	…
XV: Mean	…	32 ± 4	…
D06: Kp2 mask	…	21.8 ± 1.0	…
D06: Region mean	…	25.7 ± 1.3	…

Synchrotron emission





Amplitude based on Haslam 408MHz

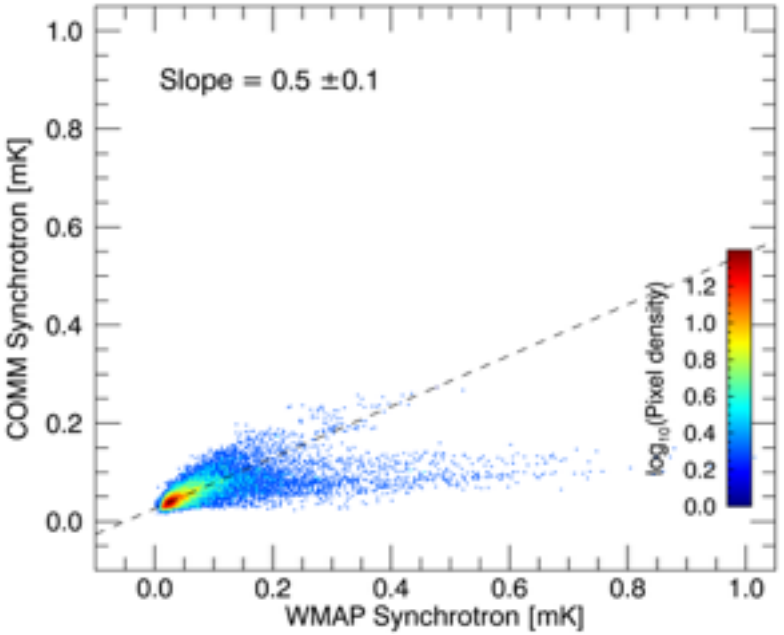
Synchrotron spectrum based on Galprop (Orlando & Strong 2013)

Comparison with WMAP

Run	Sync		Free-free		AME	
	a	*r*	*a*	*r*	*a*	*r*
MCMC-c base	0.50	0.62	0.68	0.77	...	...
MCMC-e sdcnm	0.52	0.92	0.77	0.87	4.91	0.75
MCMC-f fs	0.52	0.62	0.80	0.77	3.18	0.67
MCMC-g fss	0.55	0.62	0.77	0.78	3.14	0.70
MEM	0.34	0.84	0.76	0.79	2.18	0.86
MCMC-c base	0.12	0.74	0.91	0.83	...	...
MCMC-e sdcnm	0.61	0.99	0.67	0.98	2.71	0.91
MCMC-f fs	0.13	0.78	1.09	0.89	4.71	0.86
MCMC-g fss	0.15	0.77	1.06	0.93	3.22	0.88
MEM	0.19	0.90	1.01	0.97	2.36	0.93

a>1 = commander > WMAP

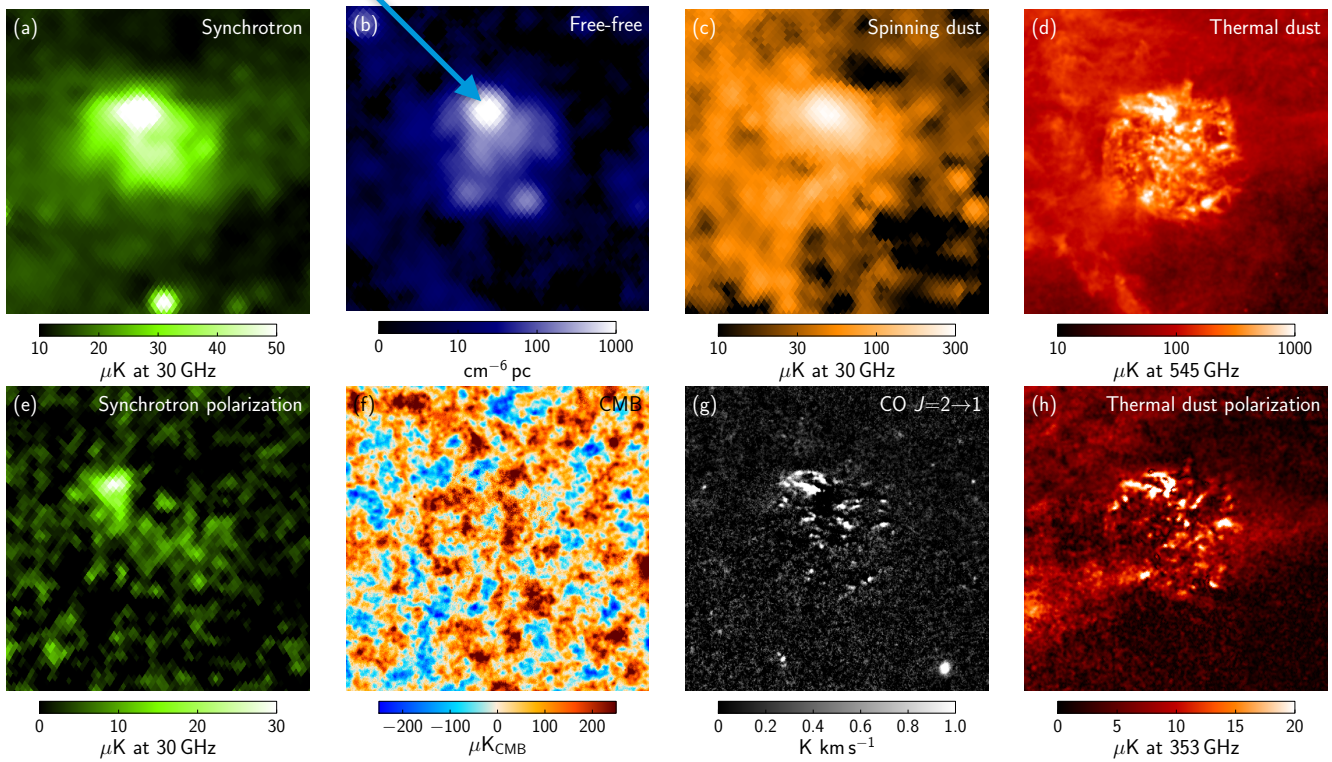
Trust values if r≳0.9



AME systematically higher
Free-free about the same
Synchrotron lower, however:

Synchrotron is not 1:1 - two populations due to spectral indices

LMC/SMC

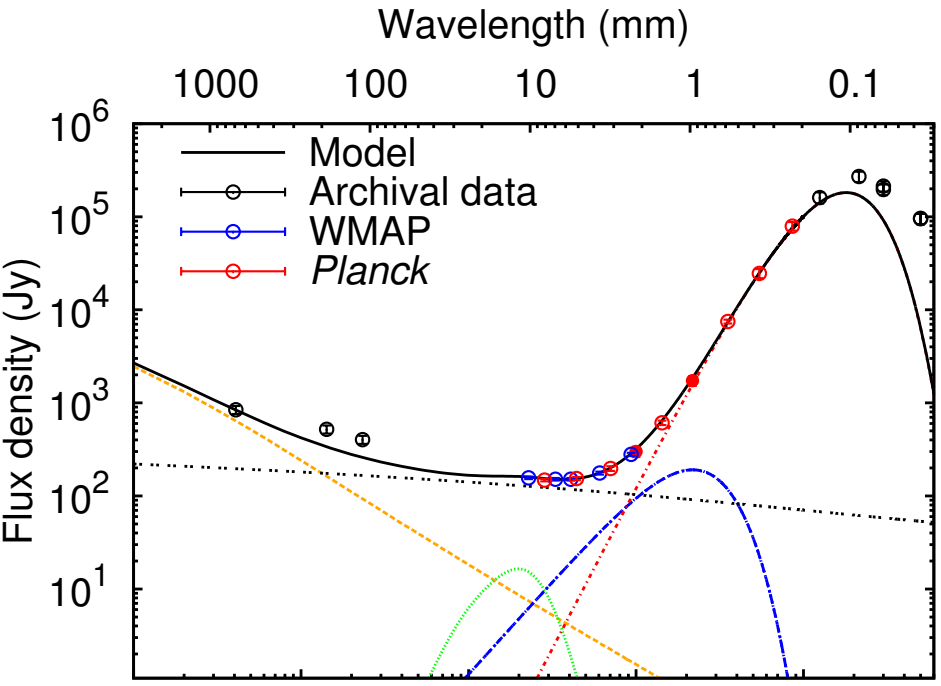


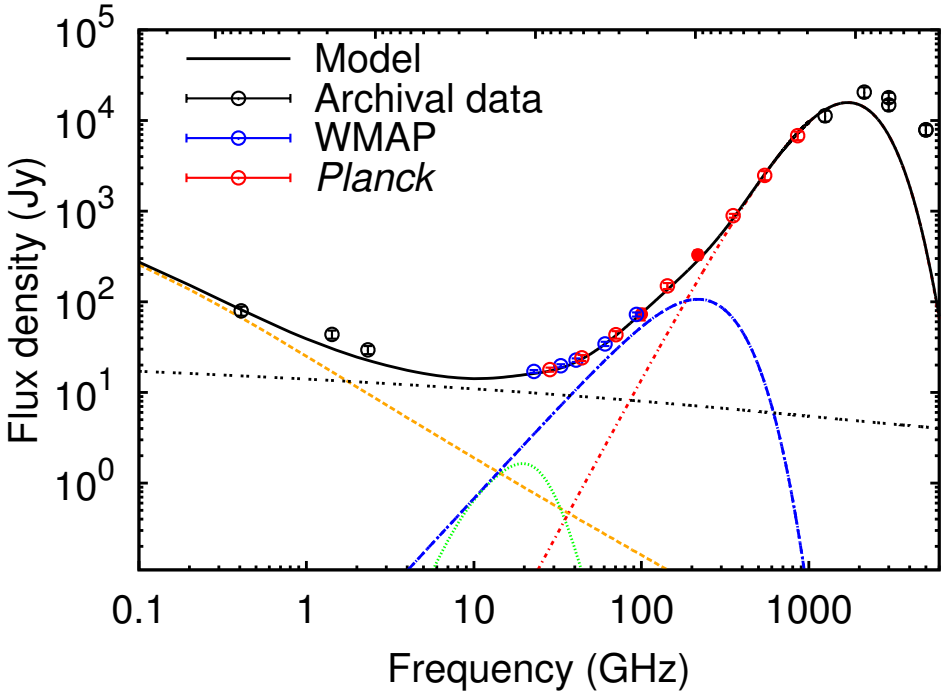
Up to 30% pol.

Clean CMB map

Good agreement with ground-based surveys

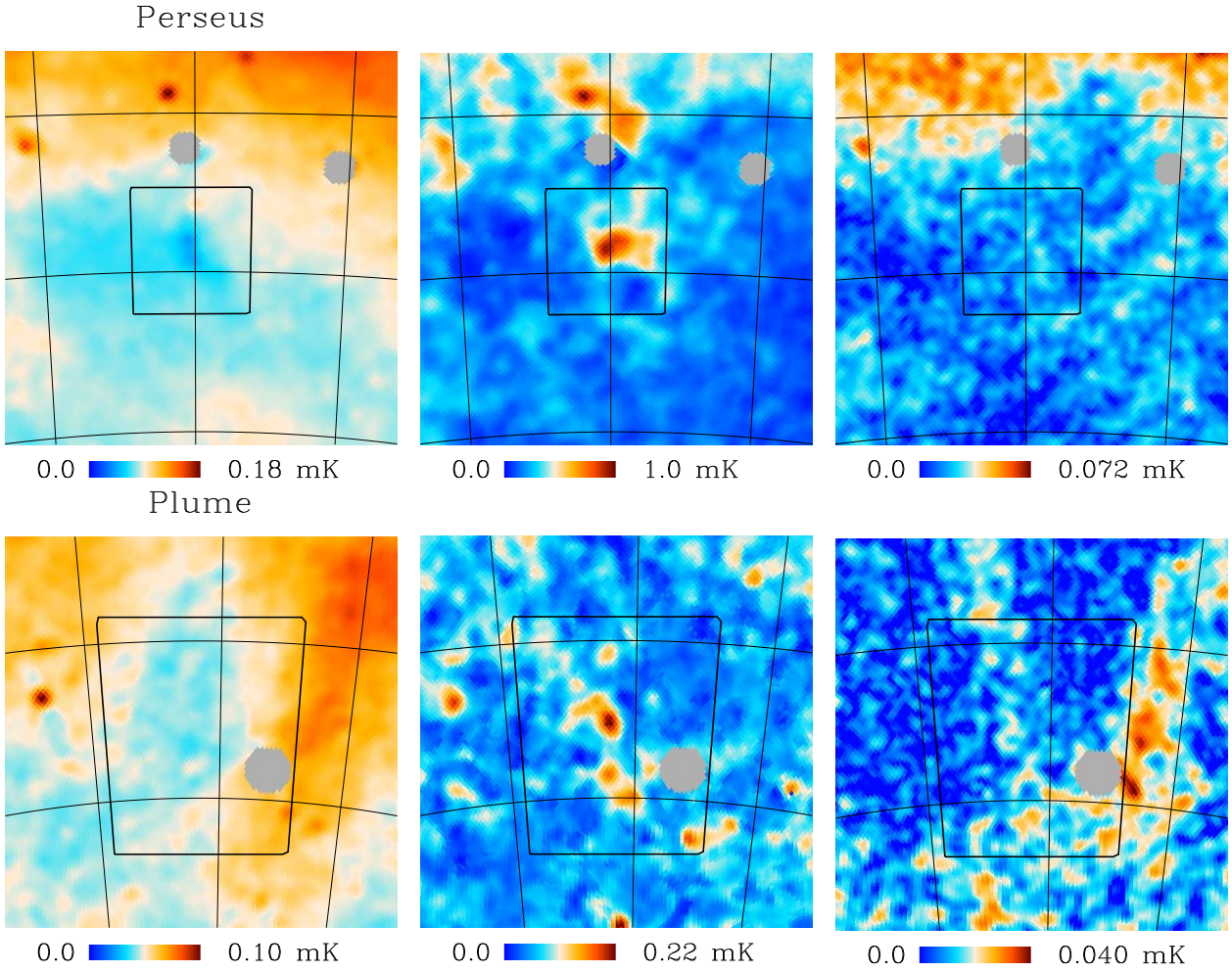
SMC/LMC

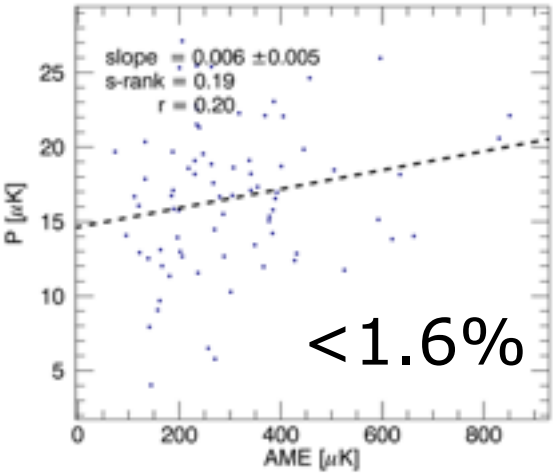


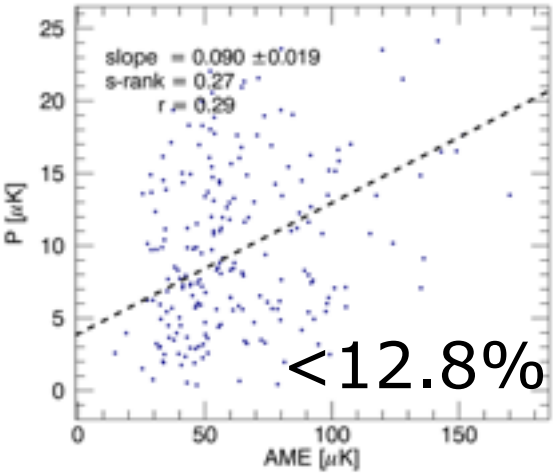


(plots to be redone to fill in empty x-axes!)

AME polarization







See Paddy Leahy's talk about Planck polarization!

Conclusions

1. Commander has done a relatively clean separation of Planck & WMAP data into synchrotron, free-free, AME & thermal dust emission (+CO, HCN)
2. New diffuse AME regions identified, λ Orionis particularly interesting.
3. Upper limit on pol. AME of 1.6%: need better pol. synchrotron maps!
4. Need better data at 2-15GHz, e.g. S-PASS, C-BASS & QUIJOTE

5. For Commander results, see arXiv:1502.01588
6. For the results presented here, see arXiv:1506.06660
7. For more polarization results, see Paddy Leahy's talk

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada.

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.


Thank you

C-Band All-Sky Survey: A First Look at the Galaxy

Irfan et al. (2015), MNRAS, 448, 3572; arXiv:1501.06069