CMB Foreground from Aligned Dust

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Goal of the research:

Disentangle CMB polarized emission from the polarized dust contribution

Science:

CMB: additional info on cosmological parameters, e.g. reionization optical depth, tensor to scalar amplitude ratio

IMPORTANCE: constrains inflationary models, provides model-independent test of the existence of primordial gravitational wave background

Magnetic fields: maps of magnetic fields including high and intermediate attitudes

IMPORTANCE: provides understanding of magnetic field origin and evolution

Physics of Dust: dust polarization as a function of wavelength

IMPORTANCE: contributes to the solution of the mystery of grain alignment; constrains grain-size distribution and interstellar conditions

Polarized Foreground from Dust

1. Rotational emission from spinning ultra-small grains ($a < 10^{-7}$ cm, $\nu < 70$ GHz).
2. Vibrational emission from classical large grains ($a > 10^{-6}$ cm, $\nu > 70$ GHz)

Reviews:

Lazarian, A., Goodman, A., & Myers, P. 1997, *ApJ*, **490**, pgs 273

Draine, B.T., & Lazarian, A. 1999, astro-ph 9902356

Prunet, S., & Lazarian, A. 1999, astro-ph 9902314

Approach to foregrounds

To separate the contribution at the frequency range of interest for CMB one can measure the polarized signal at higher frequencies at which the contribution is dominated by dust. Then one can subtract the emission provided that we know how polarized emissivity scales with frequency.

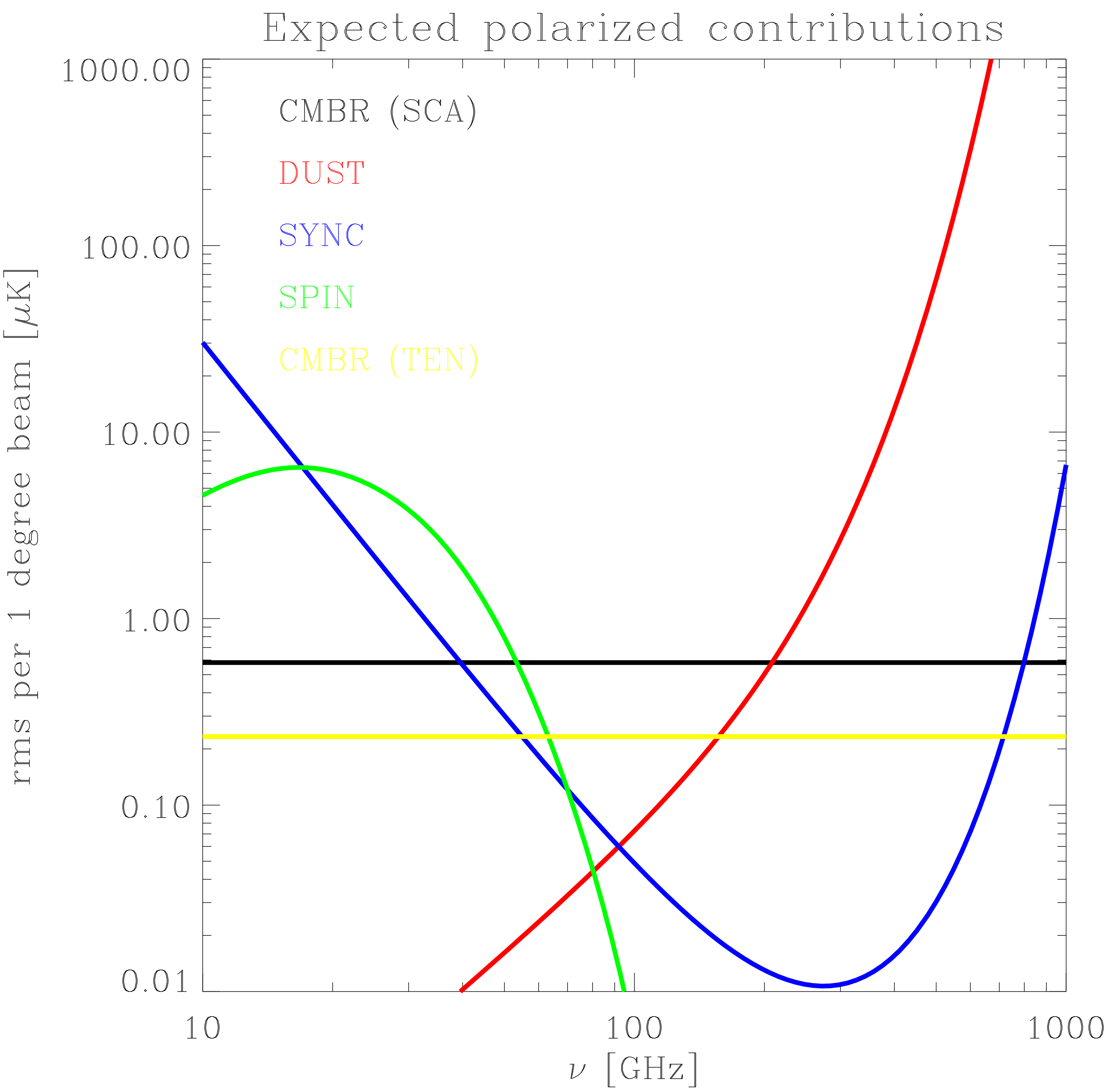
Ongoing measurements of CMB polarization.

Most of these observations will have begun in the next two years, with the exception of the PLANCK LFI and HFI instruments, which are scheduled for launch in 2007. For each experiment, the beam size listed is the smallest, since many of the experiments have beam sizes that vary with frequency.

Experiment	Beamsize (Degrees)	Frequency (GHz)	Receiver	Site
VLA	0.02	8.44	interfer.	NM desert
POLATRON	0.04	96	bolometers	OVRO
PLANCK HFI	0.08	143, 217, 545	bolometers	space L2
PIQU	0.22	40, 92	HEMT	Princeton
PIQU2	$\lesssim 0.2$	40, 92	HEMT	high alt.$\tilde{s}$ite
MAP	0.23	22, 33, 40, 61, 98	HEMT	space L2
boomerang2000	???	???	bolometers	l.-d. balloon
PLANCK LFI	0.20	30, 44, 70, 100	HEMT	space L2
POLAR	7	30, 90	HEMT	Madison
COMPASS	$\lesssim 0.2$	40, 90	HEMT	high alt. site
SPORT	7	22, 32, 60, 90	HEMT	space
Milano	7, 14	33	HEMT	Antarctica
Milano2	1	33	HEMT	Alps

data from

Staggs, S. T., Gundersen, J. O., & Church, S. E. 1999, astro-ph/9904062



Expected rms contributions of the different polarization mechanisms as a function of frequency. The CMB polarization signals, both scalar- and tensor-induced, are shown for comparison. Spinning dust grains and synchrotron polarized contributions are taken to be 10% of their unpolarized counterpart. From Prunet & Lazarian (1999).

Significance of M4

- Before Planck (2007?) Provide templates for correcting for dust contribution. Prior to 2007 or probably later M4 will be the only instrument that can supply info on aligned grain contribution.

- After Planck (2007?) Planck will measure emission at much lower frequencies. M4 will provide benchmark tests to determine to what extend Planck's highest frequency channels are dominated by dust polarization. Studies of magnetic field in various environments.

- After Planck (2007?) Insight to dust physics by comparing Planck and M4 data.