Foreground limits on the detectability of the B-mode by Bpol

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Layout

- Expected polarized emission from Galactic and extragalactic foreground.
- Foreground subtraction errors.
- Limits on r using the Fisher matrix:
  - Galactic
  - Extragalactic
- Best strategy for measuring B-modes:
  - All-sky versus a patch (30x30 degrees)
  - Low frequencies versus high frequencies
  - Sensitivity

Problems for detecting polarization induced by gravitational waves

$\Longrightarrow$ Cosmological B–mode polarization is very weak (in very optimistic cases, $B_{\rm rms} \sim 0.1\,\mu$K)

$\Longrightarrow$ Foregrounds contamination:

- high degree of polarization compared to CMB
- no difference between E– and B–mode

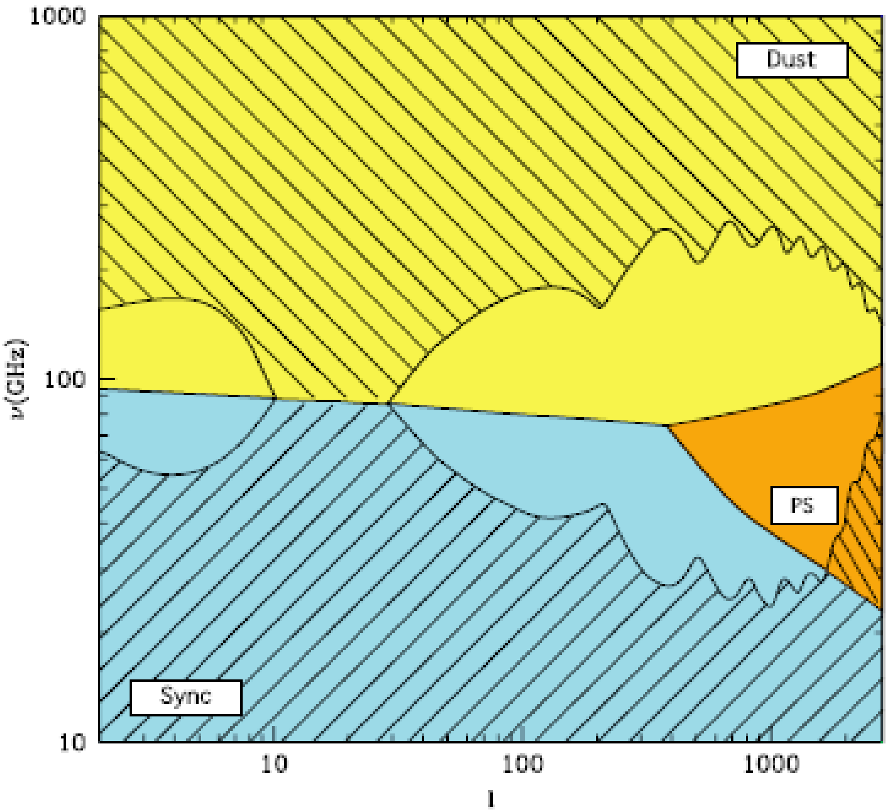
Galactic foregrounds: Synchrotron and Dust emission

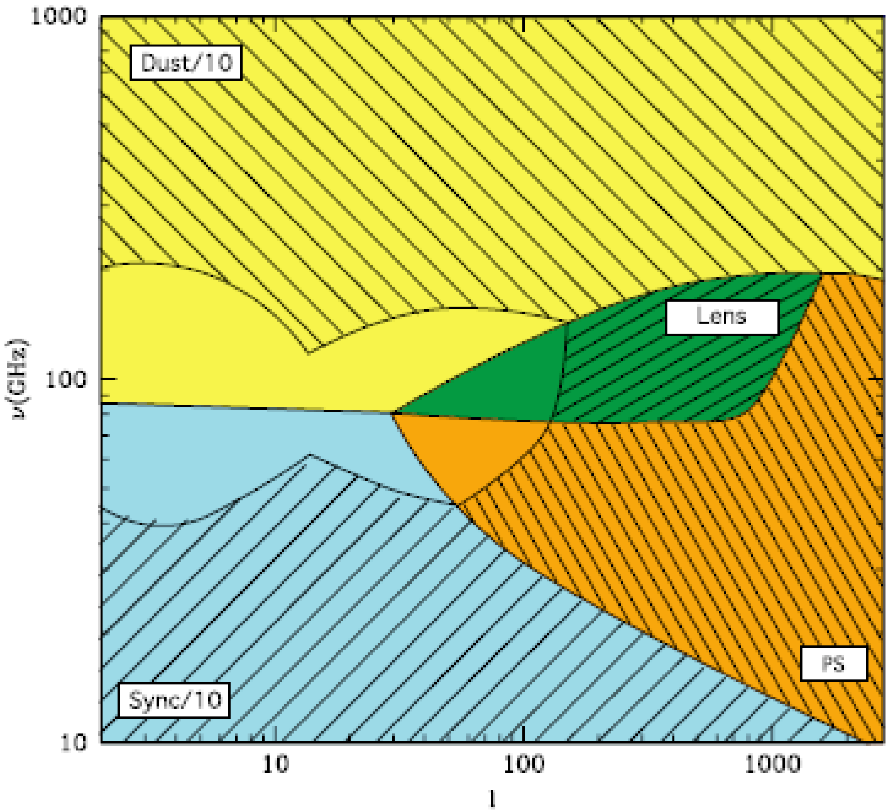
Extragalactic foregrounds: Radio sources and leansing–induced polarization

Polarized emission from foregrounds

Tucci, E.M.-G., Vielva, Delabrouille 2005, MNRAS, 360, 935

E-mode τ=0.1 B-mode, r=0.1





S<1Jy

E and B rms values versus frequency, FWHM=1°

Synchrotron (β_s=-3.1)

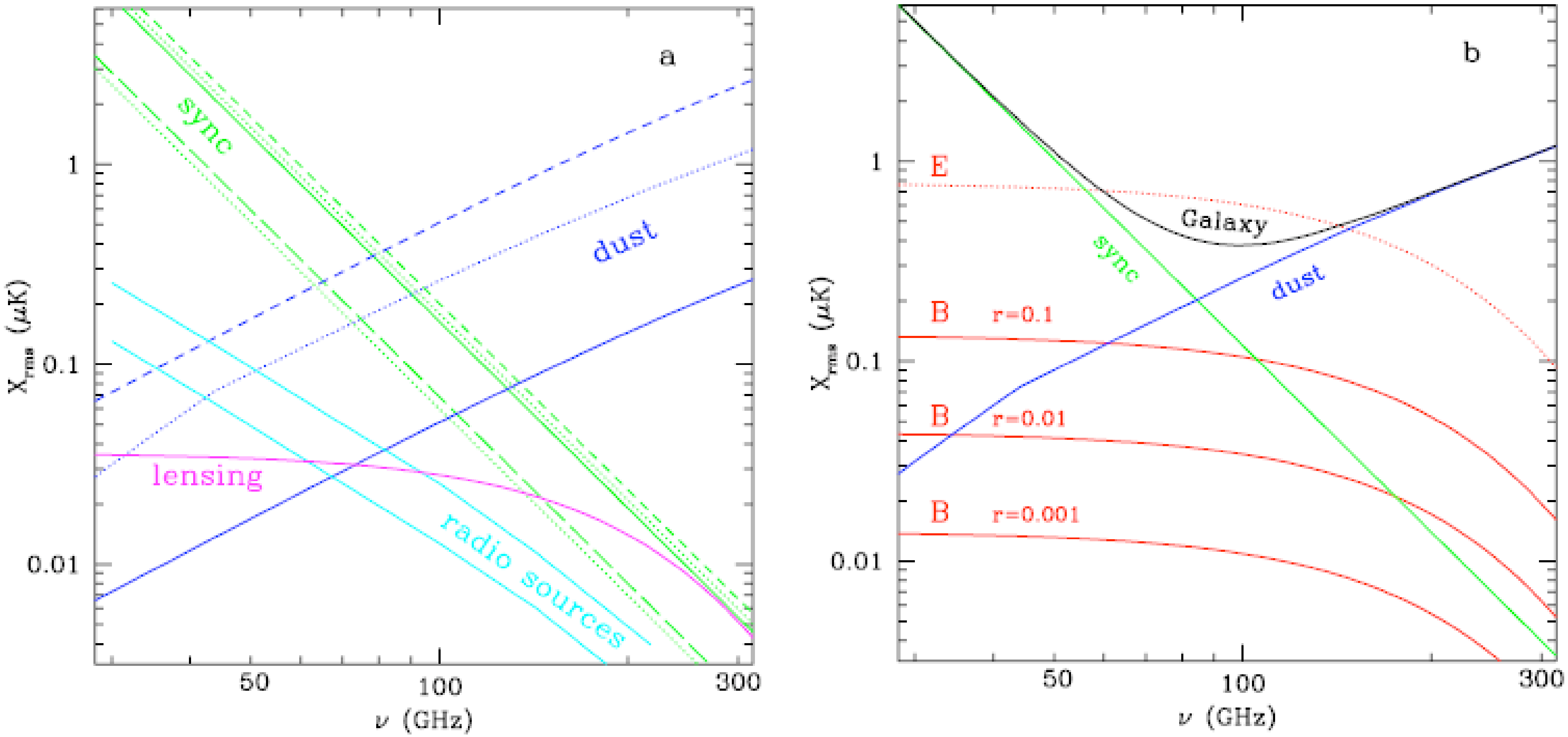
- .... 10%-30% of WMAP ΔT_{rms}
- ------ 1.4 GHz (Brown & Spoelstra)
- ____ Low-latitude (1.4 GHz – 2.7 GHz)
- _ _ _ Abidin et al. 03 high-latitude (1.4 GHz)

Dust (α=1.7)

- ----- 5% of WMAP ΔTrms
- ___ Prunet et al. 1998
- …... 100μm map + model 8 of Finkbeiner et al. 98

Radio sources: S < 1, 0.2 Jy (Tucci et al. 04)

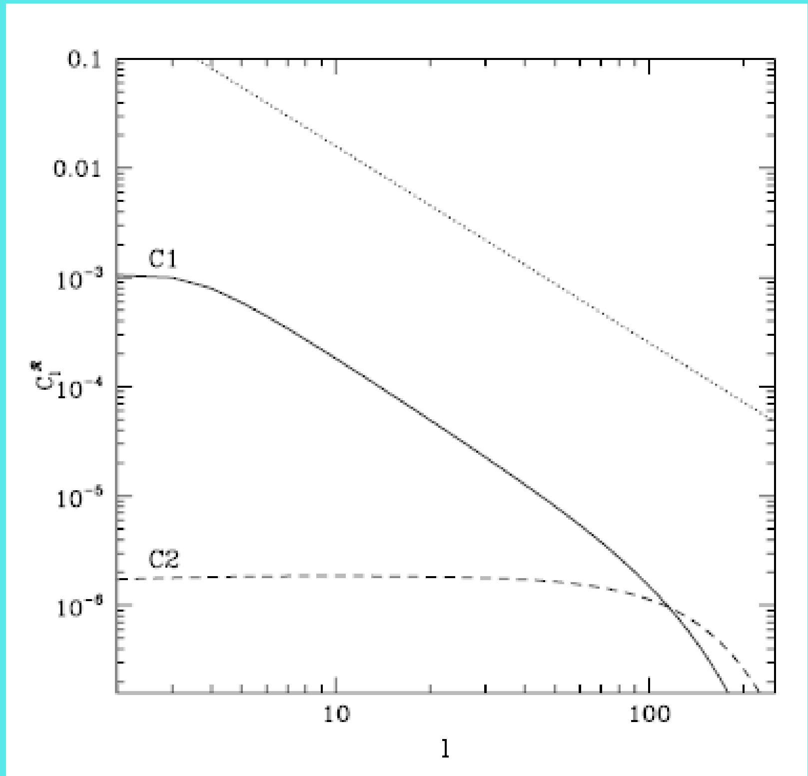
τ=0.1



Residual power spectrum

- The residual foreground is the sum of two terms: foreground polarization error + spectral index uncertainty
- Two extreme cases for spectral index uncertainties: C1) Average spectral index

  C2) Pixel Dependent spectral index

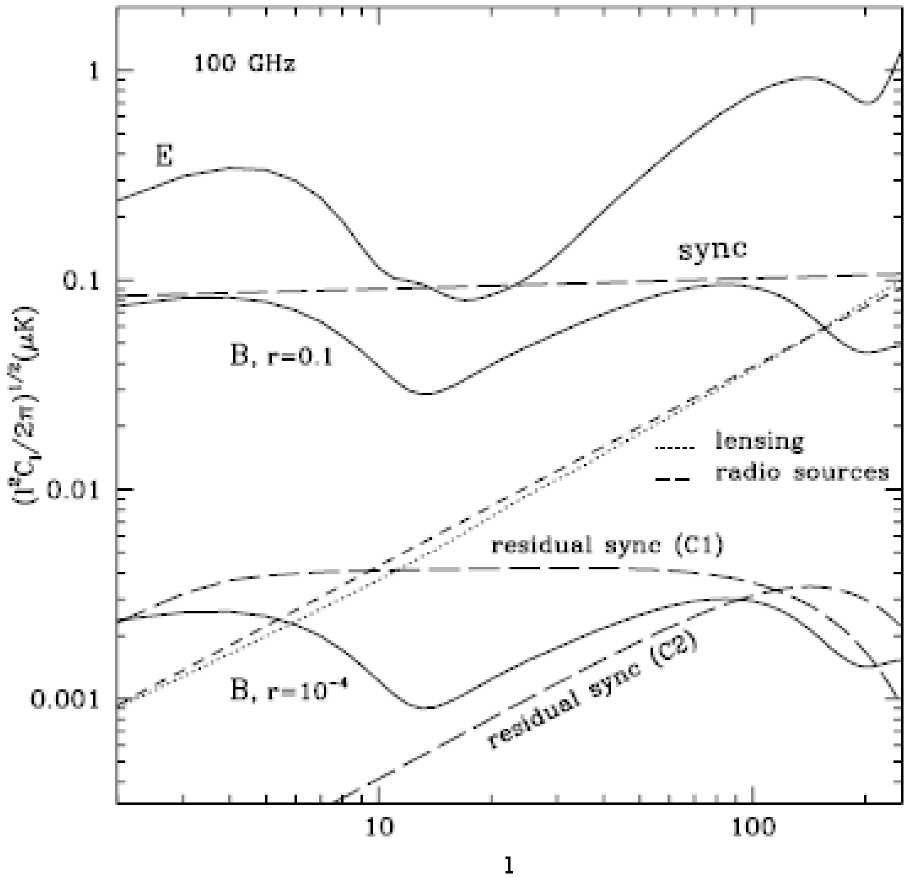


Polarization power spectra at 100 GHz

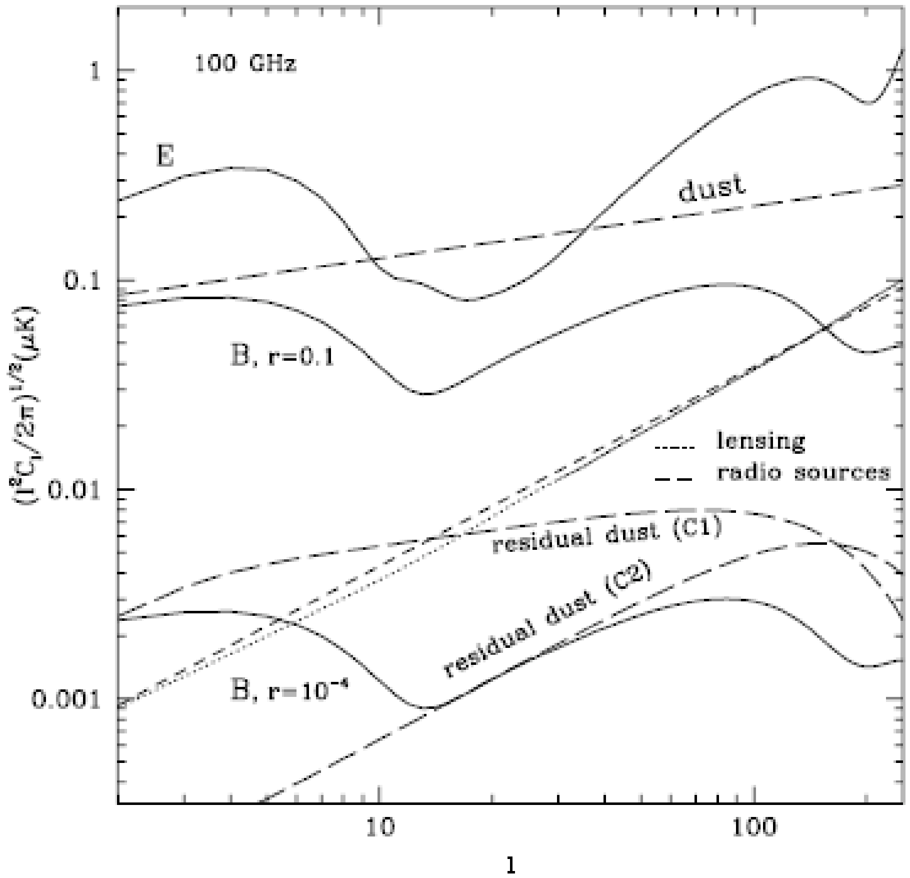
(infinite sensitivity)

- FWHM=1°
- τ = 0.1
- Sources with S < 1 Jy

Synchrotron



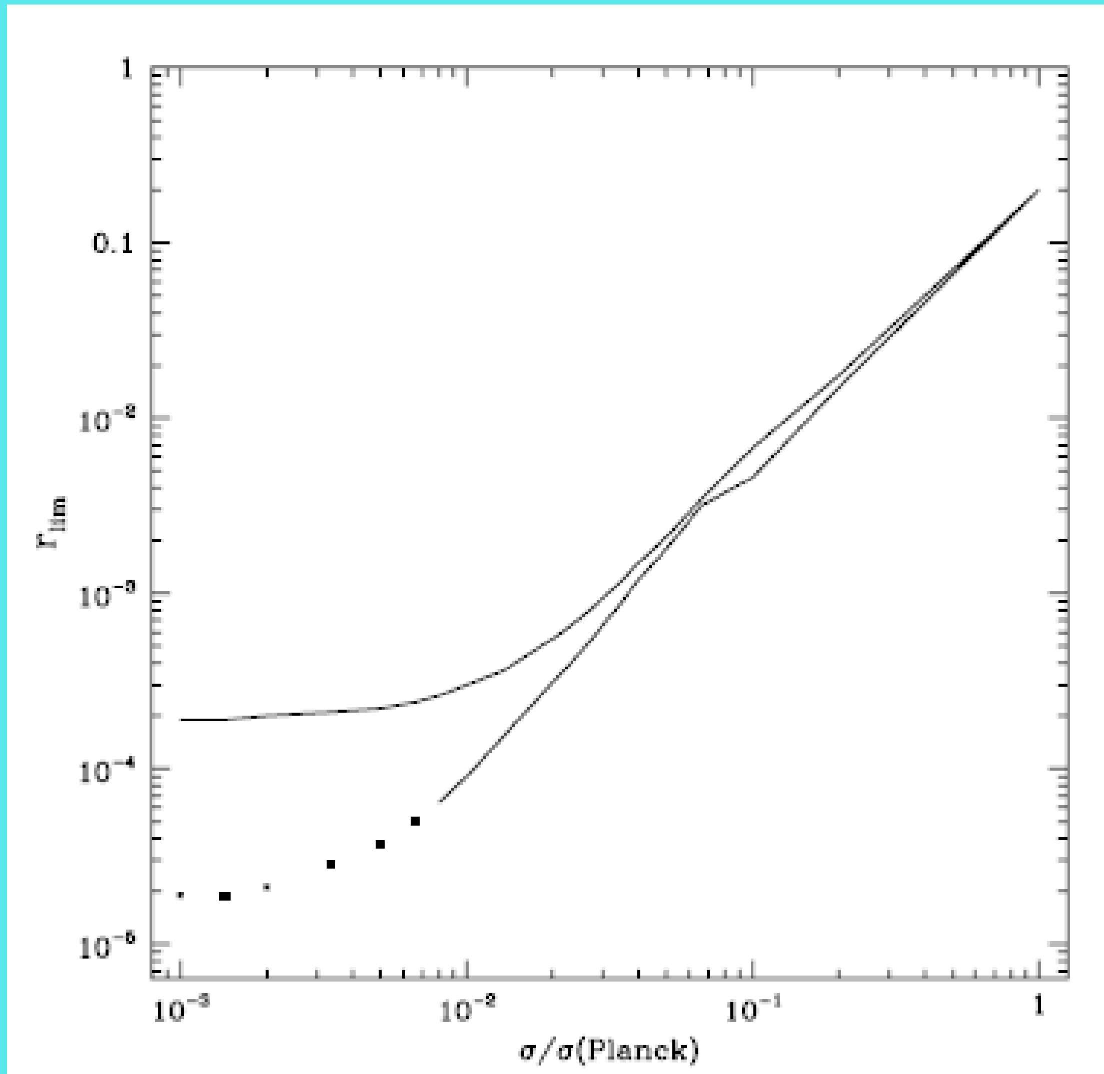
Dust



Assumptions

- For the Fisher matrix only two parameters are considered: r, τ. The rest of the parameters are assumed to be accurately determined.
- Two extreme cases to estimate the Galactic expectral index residual: C1) using the mean value of the spectral index; C2) pixel by pixel.
- $f_{sky} \approx 0.8$
- Extragalactic sources are masked using intensity information up to a 10% lost in number of pixels (for 1° resolution this implies S<150 mJy).

r_{lim} for a Planck-like experiment



Bpol experiment: r_{lim} (3σ)

(FWHM=1°)

Space missions:

- Planck-like mission with 30 times better sensitivity: 1×10^{-3}
- SAMPAN case (100, 143, 217, 353 GHz, 83 nK degree): 8×10^{-3}
  3×10^{-3} (using Planck-LFI)

Ground-based (30x30 degrees):

- Only bolometers (100, 150 GHz, 33 nK degree): 1.5×10^{-2} (using Planck-LFI)
  (5000 bol.)
- Only radiometers (30, 90 GHz, 31 nK, 21 nK degree): 4×10^{-1} (using Planck-HFI)
  (1000 rad. at 30 GHz, 4000 rad. at 90 GHz)

(Note that the definition of r is: $r \equiv Q_T^2 / Q_S^2$ (Tucci et al. 05). The tensor-to-scalar ratio defined as the amplitude of tensor to scalar fluctuations (Leach et al. 02) is 1.78 x r for the concordance model).

Conclusions

- Assuming there is not any anomalous emission, given similar sensitivity high-frequency experiments obtain more stringent constraints on r than low-frequency ones.
- All-sky missions impose more stringent limits on r than ground-based ones with partial sky coverage.
- Radio sources with $S < 1$ Jy and lensing are not significantly changing the results for $r > 10^{-3}$.