Foreground contamination of the CMB anisotropies

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Abstract

- In the early universe photons and matter were coupled by Thompson scattering. As the temperature fell, due to universal expansion, photons and electrons combined to form neutral hydrogen gas, which is transparent. This "recombination epoch" occurred when the temperature was about 3000 K, at a red shift of about 1000. Those photons have since cooled to about 3 K and form the CMB (Cosmic Microwave Background) radiation throughout the universe, discovered by Penzias and Wilson in 1965.
- At radio wavelengths the extra-terrestrial electromagnetic radiation background is dominated by a highly isotropic component CMB, confirmed by COBE satellite the Planck spectrum with temperature (Mather et al. 1994), and also an anisotropy of amplitude on 10 degree angular scale.
- The Galactic and extra-galactic components are identified by multi- frequency observations. The atmospheric (water vapor and possibly oxygen) effects can also be estimated from multi- frequency data and direct meteorological measurements. The atmospheric contribution can be reduced by using interferometer observation. In this paper the properties of these extra-terrestrial confusion signals are discussed in two groups, extra-galactic radio emission and Galactic diffuse emission. Dust will be negligible unless at frequencies greater than 200 GHz.

- **Key words** : Cosmic microwave background, cosmology, observations, large scale structure of universe

Introduction

- Studies of the structure in the CMB radiation provide fundamental information about the galaxy formation, the cosmological models and the origin and the evolution of the universe.
- Radiation from astronomical sources is red-shifted. Such radiation provides snap-shot of the universe as it was at the epoch of recombination at the red shift $Z = 1000 \pm 100$.
- The CMB is an isotropic component of extratresstrial radiation background with a thermal Planck spectrum $T = 2.726 \pm 0.010$

Types of foreground confusion

- Atmospheric emission
- Extragalactic radio discrete sources (PS)
- CMB radiations
- Galactic diffuse emission
  - Dust emission
  - Free-free emission
- Which is the interaction of electrons, of ionized region with the Electric field of the ions for example HII around O and B stars.
  - Synchrotron emission
- Which is the interaction of cosmic ray electrons
- moving relativistically in the Galactic Magnetic
- field for example SNR.
- The quantification of these radiations is important.

Observations and Data

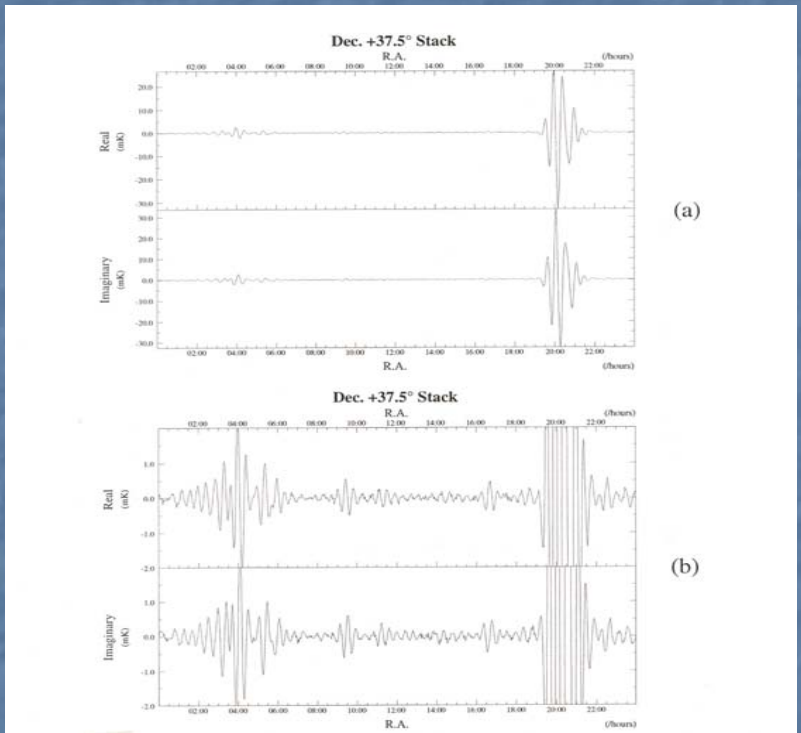

Figure 1 : The stack of all data collected at declination +37?5 in November and December 1995. Each part of this figure is plotted in mK versus 24 hr RA in real and imaginary form. The Galactic plane crossing is evident on both profiles. In part (b) the vertical axes have been expanded to improve clarity. A number of point sources are evident at high Galactic latitude; these will be analysed in the next chapter.

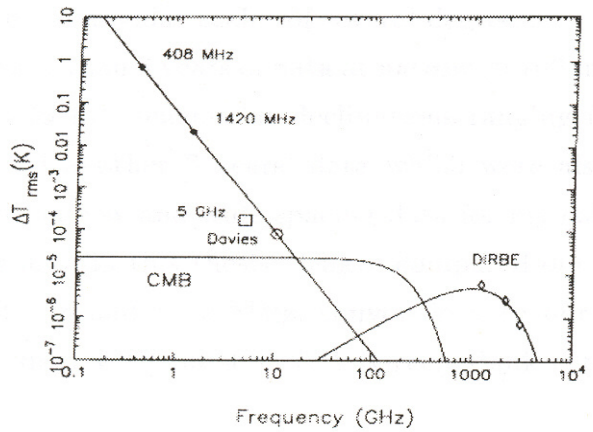

Figure 2: Brightness temperature versus frequency plot of RMS structure in the Galactic emission taken from Davies et al. (1996b). The CMB brightness temperature is also shown. The dust emission which is dominated at higher frequencies is illustrated at the bottom left.

Results

- One can consider the microwave background fluctuation field at 5 GHz to consist of 5 components:
- A fluctuation field contributed by the Poisson statistics of many weak point sources (S<25 mJy) (Franceschini et al.)
- The universal CMB radiation
- Instrumental noise
- Galactic emission; this is a mixture of synchorotron and free-free emission. Dust is negligible in this range.
- A quantitative estimate for the Galactic component after correcting the above observational data is 42 ± 10 μK. See more details in (Asareh, 1997).

References

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