COSMIC FOREGROUND EXPLORER

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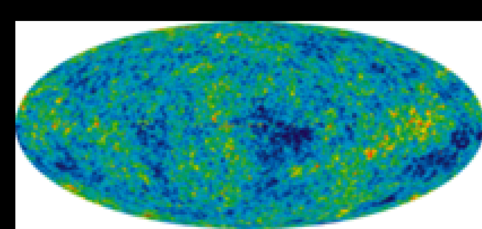
INTRODUCTION TO THE MICROWAVE BACKGROND RADIATION



Picture in Microwave taken by the Cosmic Background Explorer showing temperature variations from space

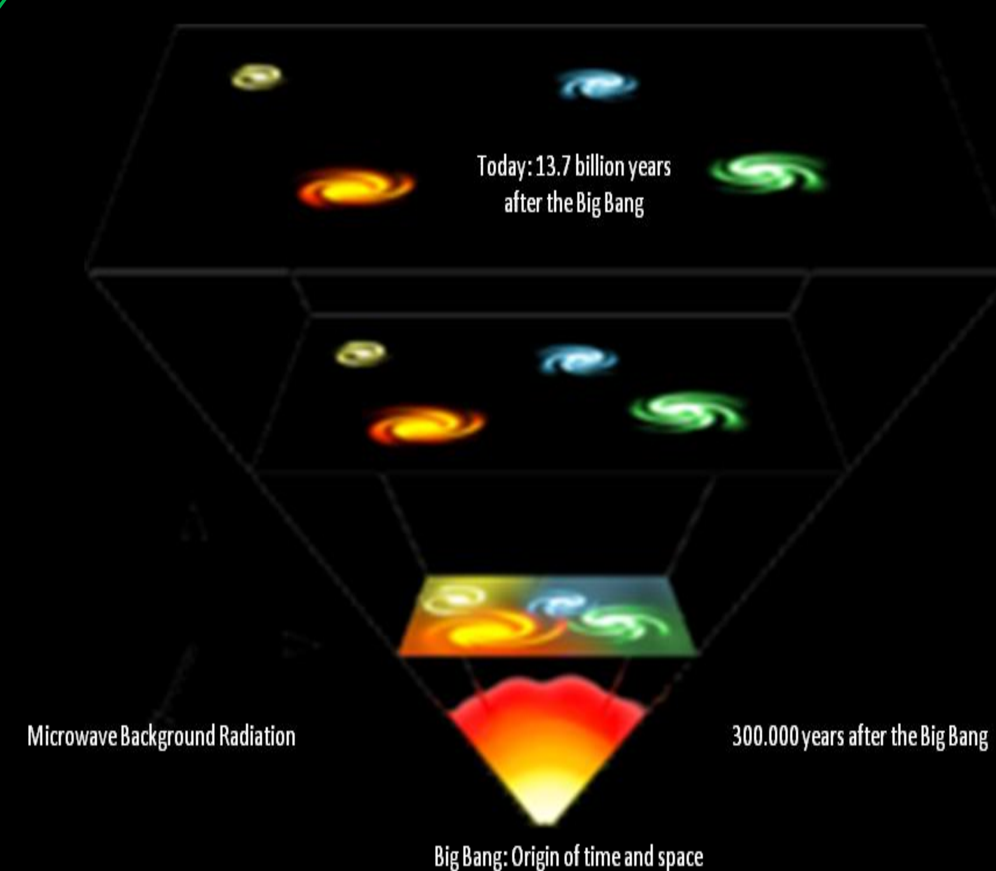
In cosmology the Cosmic Microwave Background Radiation is considered a left over from an early stage in the formation of the universe and therefore the most direct and strongest evidence of the Hot Big Bang Model. This radiation shines primarily in the microwave portion of the electromagnetic spectrum.

This radiation is almost uniform in all directions. Some of the limitations of its measurements are the contamination by electro-magnetic emissions from our galactic plane showing small anisotropies, or irregularities.

PURPOSE

UNDERSTANDING THE MICROWAVE BACKGROUND →

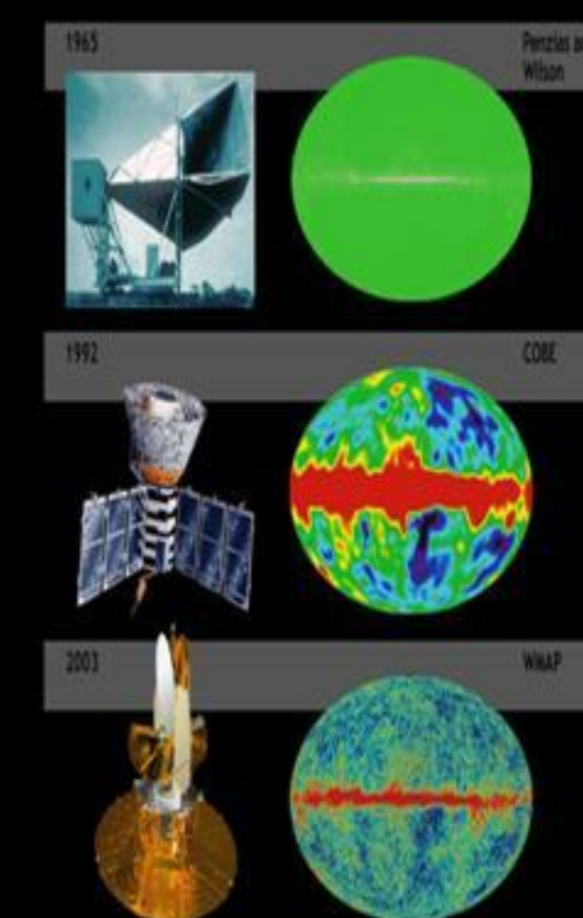
- Development of cosmological scenarios of origin and structure
- Understanding geometry, mass- energy and composition



Microwave Background Temperature → Remnant in Radio Frequency: 2.7Kelvin Temperature (1 Kelvin = -272.15 degrees Celsius)

Isotropy of the Cosmic Microwave Background

Anisotropy of the Cosmic Microwave Background: Frequency Fluctuations, Temperature Fluctuations



A RADIO TELESCOPE AT 100.000 FEET ABOVE SEA LEVEL

Limitations of Measuring the Microwave Background

Contamination by electro-magnetic emissions from our galaxy

Foreground Explorer Expectations

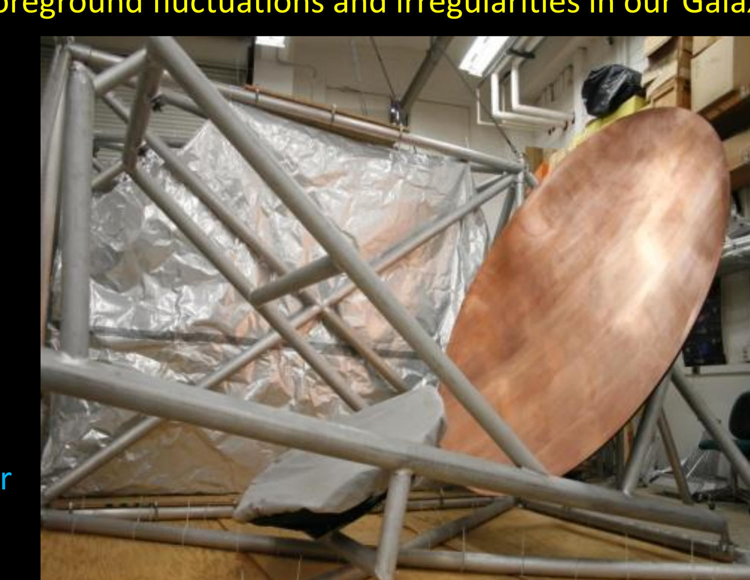
- Gather low frequency fluctuations and measure temperature variations of galactic foreground.
- Short duration balloon flights from Northern and Southern hemispheres at 45 degrees from the horizon reaching approximately 93% of the sky.
- Air time: 12 and or 24 hour flights

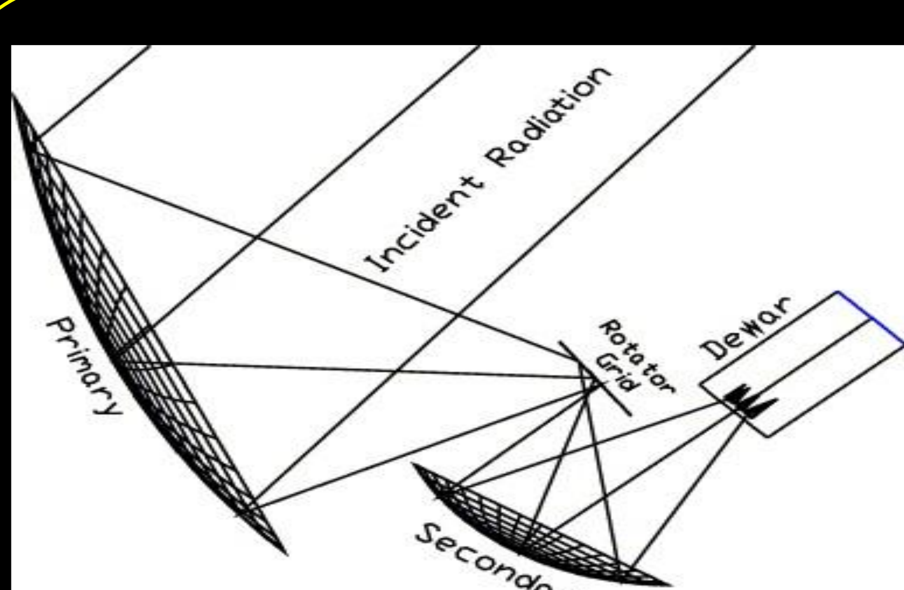
The *Cosmic Foreground Explorer* is a telescope built to measure low frequency foreground fluctuations and irregularities in our Galaxy.

General Specifications:
- Elevation: Last 1% of the atmosphere
- Coverage: 80% of the sky,
- Mount: Balloon-borne design for light carbon fiber optical elements

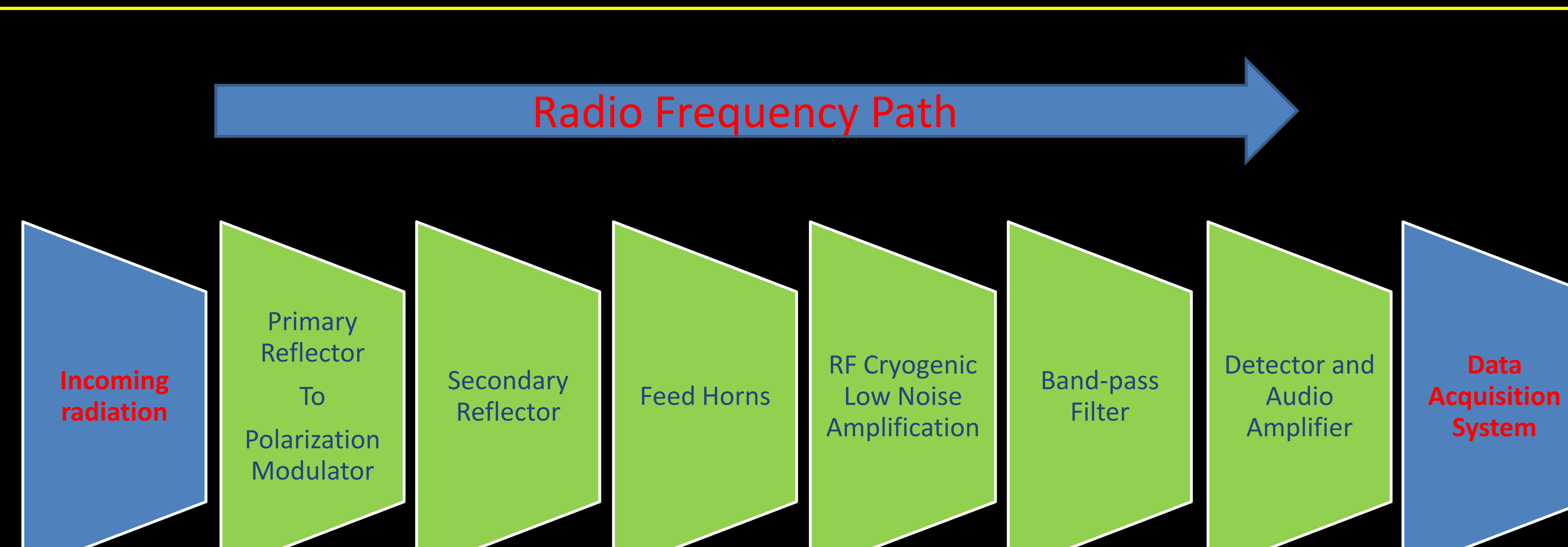
Expected Results:
- Measurement of Galactic Microwave Foreground Polarized Emission

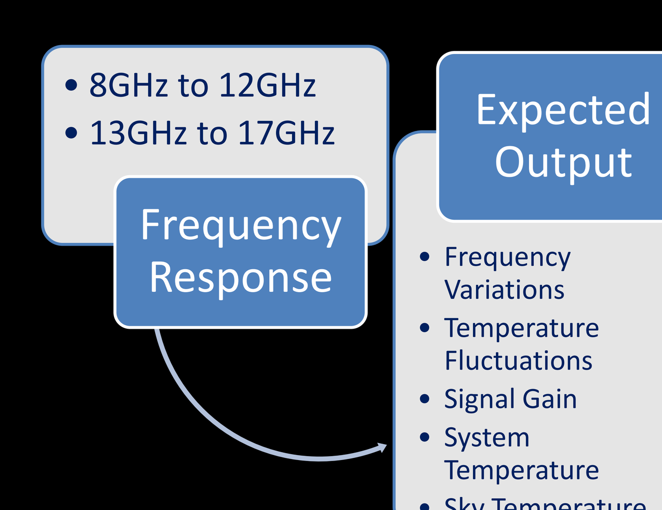
Applications:
- Mapping foreground low frequencies and temperature fluctuations to obtain a better resolution of Microwave Background Radiation

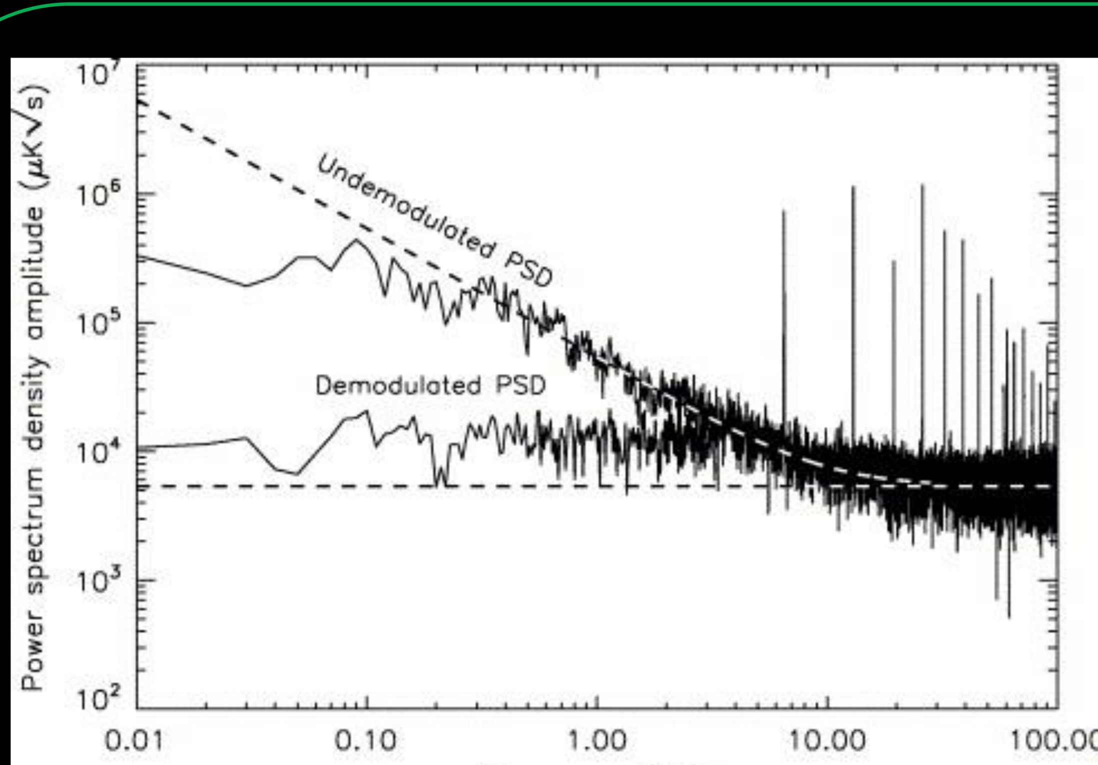




Off-axis Gregorian configuration optimized for minimal cross-polarization contamination. A 2.2 m parabolic reflector primary, a 0.9 m ellipsoidal secondary, and a 0.3 m rotator grid are shown.







Sample data from our room temperature radiometer viewing the sky at 41.5 GHz. The demodulated data have no visible 1/*f* and a white noise level consistent with expectations. The polarization modulator has a broad bandwidth. We achieved 22 dB isolation at 20% bandwidth. The system works for a very wide range of frequency bands.

Instrument Parameters

	COFE		
Central frequency (GHz)	10	15	20
FWHM beam (arcmin)	83	55	42
T_{sys} (K)	8	10	12
T_{sky} (K) at target altitude[a]	2.5	2.4	2.3
Bandwidth (GHz)	4	4	5
Number of receivers	3	6	10
Sensitivity per receiver ($\mu K\sqrt{s}$)	261	308	318

Observations

Receiver bands and Expected Receiver Sensitivity

Receiver sensitivity can be estimated according to the radiometer equation

$$\sigma_T = K\left(\frac{T_{sys}+T_{sky}}{\sqrt{\Delta\nu\cdot\tau}}\right),$$

Where σ_T is the root-mean-square noise, T_{sys} is the system noise temperature, T_{sky} is the sky antenna temperature, $\Delta\nu$ is the bandwidth, τ is the integration time, and K is the sensitivity constant of the receiver.

- System Temperature Noise = 80Kelvin
- Cooled System Temperature Noise = 10 Kelvin
- Gain in signal: 70 Decibels

Conclusions

Balloon-borne telescope will map more than 80% of the sky. Both polarization anisotropy and polarized foregrounds will be measured over several bands.

Our current understanding of the polarization foregrounds limits our ability to make accurate observations of the Cosmic Background Radiation. COFE will enhance current models of foregrounds and future experiments of precise measurements of cosmic background radiation and it's irregularities.