EDGE* Observations of the CIB

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*EDGE: Explorer of Diffuse high-redshift Galactic Emission

The end of the “Dark Ages”

- When does galaxy formation start?
- How does the rate of star formation change with cosmic time?
- How is galaxy formation dependent on the large-scale environment?
The EDGE Measurements

- Detect and characterize the fluctuation power-spectrum of the CIB
  - Angular scales from 5° to 10°
- Measure galaxy weighted mass power spectrum
  - Redshift range from 0.5 to larger than 5
  - Four discrete redshift bins
- Large range of spatial scales
  - > 200 H⁻¹ Mpc
  - < 5 H⁻¹ Mpc
- Prove High-z galaxy luminosity function
Finding the CIB

FIRAS sky spectra binned by
DIRBE sky brightness

Separate spatial and spectral components

\[ S_{kv} = U_v + g_k G_v \]

Spatial part - k
Spectral part - \( \nu \)

Decomposed Spectra


Spectral components corresponding to different template maps

FIRAS color template

Line emission template

DIRBE map templates
140 and 240 \( \mu \)
Best fit CIB spectrum

\[ I_\nu = 1.3 \times 10^{-5} (\nu/\nu_0)^{0.04} B(\nu, T=18.5 \text{ K}) \]

Source Contribution to CIB

\[ \int S(\nu) d\nu = \text{const} \]

Knox et al., astro-ph/0009151
Galaxy flux as a function of $z$

Evolution of galaxy parameters

Dust quantity is proportional to integral of SFR

Dust heating is proportional to SFR

Constants of proportionality found from fit to CIB spectrum


Fluctuations

- Matter fluctuation spectrum is confidently modeled on large scales (>50 Mpc) even at low z.
- Galaxy density must respond to underlying matter fluctuations.
  
  \textit{This property gives an independent handle on how galaxies form.}

- Use this tool to:
  1. Test growth of structure models
  2. Test relationship between density variation and galaxy formation as a function of z.
  3. Search for earliest dust emission - birth of galaxies.

Measure proto-galaxy clustering properties

- If redshifts of all objects is known, about 8000 galaxy positions are needed to determine fluctuations to 5% a broad band near $l=800$. ($dz=0.25$, $z=2$, 8 sq degrees)
- If only sub-mm color redshifts are known the number is $>10^5$

EDGE is a way to get at the large-scale structure information in the proto-galaxies while short-circuiting the need to count many galaxies.
**EDGE Experiment Characteristics**

- >10 day high-altitude balloon flight
- 6 arcminute resolution in 8 bands from 300GHz to 1.5 THz
- Sky coverage > 400 square degrees.
EDGE and other large-scale structure probes

The strength of the EDGE data are greatly enhanced when used in conjunction with other LSS probes.

- Sub-mm source counting experiments - what is making up the fluctuations we see.
- SDSS - same galaxy bias and clustering at low \( z \).
- Lyman \( \alpha \) forest - same spatial scale, different bias.
- Matter distribution from CMB lensing - don’t have to use statistical comparisons - no sample variance.
EDGE Future

- The properties of the CIB fluctuation spectrum is a potent tool to understanding galaxy evolution and LSS at intermediate scales.
- 2 year detector development to enhance the detector complement.
- Possible addition of polarization sensitivity.
  - Learn about the galactic dust.
  - Learn how to remove dust from CMB polarization measurements.
### EDGE Sensitivity and Complementary Missions

1. **Total system sensitivity at a given frequency (all pixels for a particular mission).**
2. **BLIP:** Background Limited Performance (per pixel) in $10^{-18}$ W/Hz$^{0.5}$ including the atmosphere and the telescope emission.
3. **NEP:** Noise Equivalent Power (per pixel) in $10^{-18}$ W/Hz$^{0.5}$.
4. [http://astro.estec.esa.int/SAgeneral/Projects/Planck/](http://astro.estec.esa.int/SAgeneral/Projects/Planck/)
5. [http://sofia.arc.nasa.gov/index.html](http://sofia.arc.nasa.gov/index.html)

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**4 channel prototype FSB Spectrum**

**Relative Response**

**Frequency (GHz)**

**Relative Response**

**Frequency (GHz)**