An introduction to the physics of the Cosmic Microwave Background

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The cosmic microwave background Radiation's "surface of last scatter" is analogous to the light coming through the clouds to our eye on a cloudy day.

We can only see the surface of the cloud where light was last scattered.
Plan of the lectures

I. The CMB in a homogeneous Universe

II. The physics of CMB anisotropies

III. CMB: from observation to constraining cosmology
Useful resources

• Scott Dodelson:  

• Daniel Baumann:  

• Anthony Challinor and Hiranya Peiris:  
CMB frequency spectrum (FIRAS)

![Graph showing CMB frequency spectrum with wavelength in mm on the x-axis and intensity in MJy/sr on the y-axis. The graph includes a blackbody curve at 2.725 K and error bars labeled FIRAS data with 400σ errorbars.]
Planck map of CMB temperature anisotropies
Spherical harmonics
Planck angular power spectrum
Spherical Bessel functions

\[ j_l^2(x) \]

\[ x \]

\[ l = 10 \quad l = 100 \quad l = 500 \]
Individual contributions to the $C_{\ell}\ell$s

$l(l + 1)C_\ell$

$\log(l)$

- **Sachs-Wolfe:** $\Theta_0 + \Psi$
- **Doppler:** $\Theta_1$
- **Late ISW**
- **Early ISW**
- **Potential:** $\Psi$
Diffusion damping