Sunyaev Zel'dovich Effect

- The modification in the Black-Body curve due to the upscattering of CMB photons while propagating through the Inter Cluster Medium. As a consequence, this scattering leads to a reduced number of photons at lower energies, relative to the Planck spectrum, and higher energy photons being added. This effect is called the Sunyaev Zel'dovich effect (SZE).

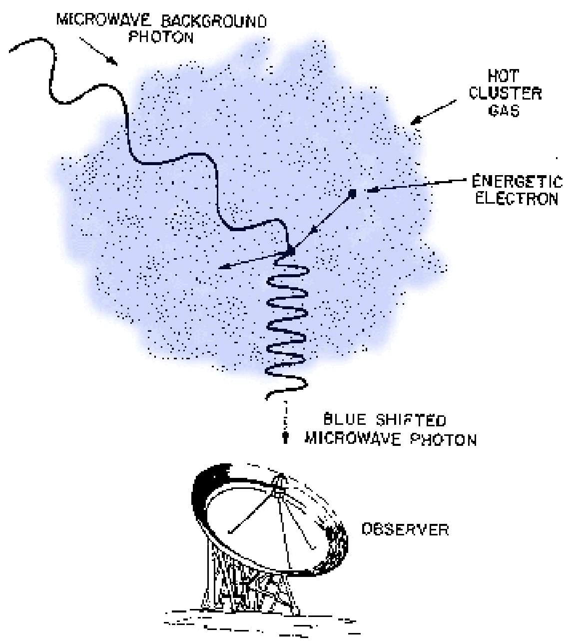

Figure 1: Schematic of the Sunyaev Zel'dovich effect that results in an increase in higher energy (or blue shifted) photons of the cosmic background when seen through the hot gas present in cluster of galaxies. (Adapted from L. Van Speybroeck)

- **Notes:**

  i. The SZE appears as a decrease in the intensity of the CMB at frequencies <218 GHz and as an increase at higher frequencies.

  ii. The CMB spectrum, measured in the direction of a galaxy cluster, deviates from a Planck spectrum.The degree of this deviation depends on the temperature of the cluster gas and on its density.

  iii. SZ effect is independent of the cluster redshift, as long as the change in CMB temperature is spatially resolved.

  iv. The SZ effect was mainly considered a tool for measuring distances to clusters of galaxies(independent of redshift), and from this the Hubble constant.

$$T_{CMB} = T_{o,CMB} \tag{1}$$

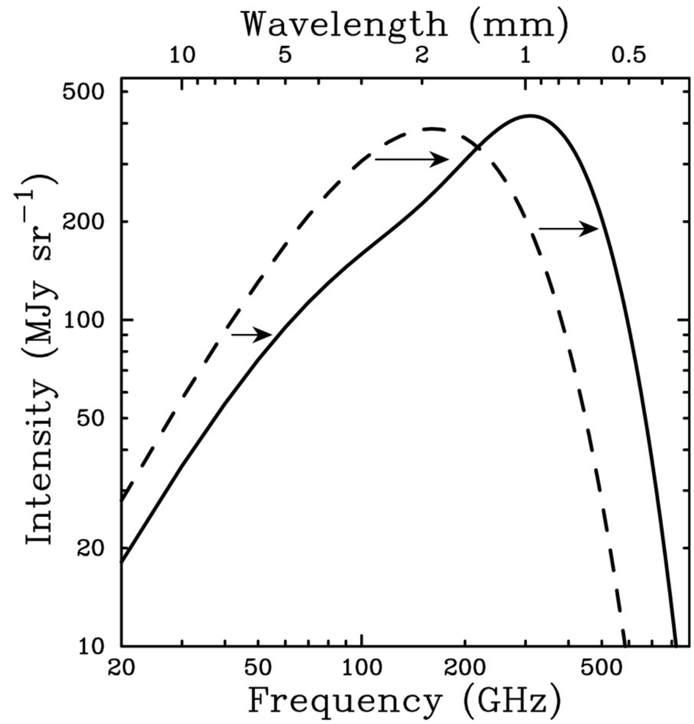

Figure 2: The dashed line represents the intensity of the cosmic microwave background with radio frequency. The solid line is the distorting in the cosmic background intensity due to inverse-Compton scattering of photons through the gas presents in a cluster of galaxies.

$$I_v = \frac{2v^2kT}{c^2} \tag{2}$$

$$\frac{\Delta I_v}{I_v} = -2y \tag{3}$$

$$y = \int \sigma_T n_e \frac{kT}{m_e c^2} dl \tag{4}$$

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Where:

$\sigma_T = \frac{8\pi}{3}(\frac{e^2}{m_e c^2})^2$ is the Thomson cross section.
y is the compton Y-parameter.