

Radiation from the Big Bang—11 April

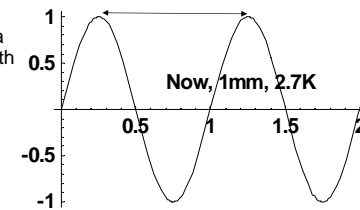
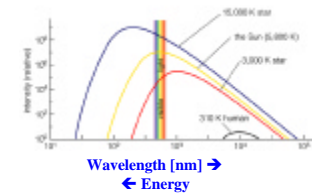
- Penzias & Wilson discover (1965) the temperature of the universe is 2.7K.
 - Big Bang emitted black-body radiation, which is now 2.7 K.
 - Called Cosmic Background Radiation; Cosmic Microwave Background Radiation
- At earlier times this radiation dominated the pressure and mass.



Radiation from the Big Bang

- We see black-body radiation with $T=2.7$ K.
 - Wein's Law (week3)

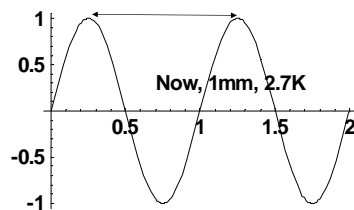
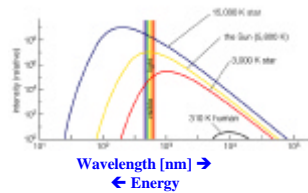
$$I_{\max} = 2.7\text{mm}\cdot\text{K} / T$$
 - Wavelength of radiation stretches as universe expands.
1. When the distance to Coma was 150MLy, the wavelength of the radiation was
 - a. 1mm
 - b. 2mm
 - c. 0.5mm
 - d. Information is insufficient



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$$I_{\max} = 2.7\text{mm}\cdot\text{K} / T$$
 - Wavelength of radiation stretches as universe expands.
2. When the distance to Coma was 150MLy, the temperature of the radiation was
 - a. 2.7 K
 - b. 5.4 K
 - c. 1.35 K
 - d. Information is insufficient

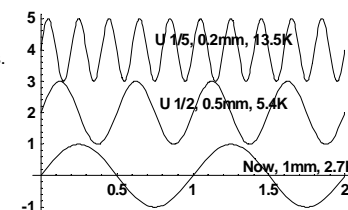
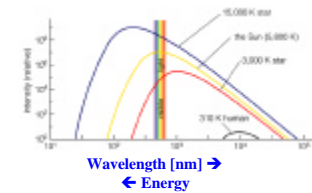


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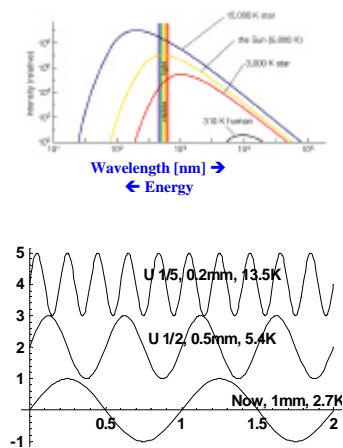
$$I_{\max} = 2.7\text{mm}\cdot\text{K} / T$$
 - Wavelength of radiation stretches as universe expands.
2. When the universe was $\frac{1}{2}$ the present size, the temperature of the radiation was

$$2 \cdot 2.7 \text{ K} = 5.4 \text{ K}.$$
 3. At $T=500\text{K}$ (451F), paper ignites. Will paper ignite when universe was $\frac{1}{10}$ of present size?
 - a. Y
 - b. N



Radiation from the Big Bang

- We see black-body radiation with $T=2.7$ K.
 - Wein's Law (week3)
- $$I_{\max} = 2.7\text{mm}\cdot\text{K} / T$$
- Wavelength of radiation stretches as universe expands.
- When the universe was $\frac{1}{2}$ the present size, the temperature of the radiation was $2 \cdot 2.7 \text{ K} = 5.4 \text{ K}$.
 - At $T=500\text{K}$ (451F), paper ignites. Will paper ignite when universe was $\frac{1}{200}$ of present size?
 - Y
 - N



Penzias & Wilson

- Boss says to Arno Penzias & Robert Wilson, "Go measure the noise of the radio receiver."
 - Receiver used for Echo Satellite.
 - Penzias & Wilson were postdocs at Bell Labs
- P&W wrote a paper

"Measurements of the effective zenith noise temperature of the 20-foot horn-reflector antenna ... at 1080 mc/s have yielded a value about 3.5K higher than expected. This excess temperature is, within the limits of our observations, isotropic, unpolarized, and free from seasonal variations."



Radiation is from the Big Bang

- Isotropic means same intensity in all directions
 - Free from seasonal variations means same intensity in summer and winter.
- Is radiation from the Milky Way isotropic?
 - Y
 - N
 - Is radiation from the horn free of seasonal variations?
 - Y
 - N
- Measurements of the effective zenith noise temperature of the 20-foot horn-reflector antenna ... at 1080 mc/s have yielded a value about 3.5K higher than expected. This excess temperature is, within the limits of our observations, isotropic, unpolarized, and free from seasonal variations.
 - Radiation from Big Bang is isotropic & free from seasonal variations.