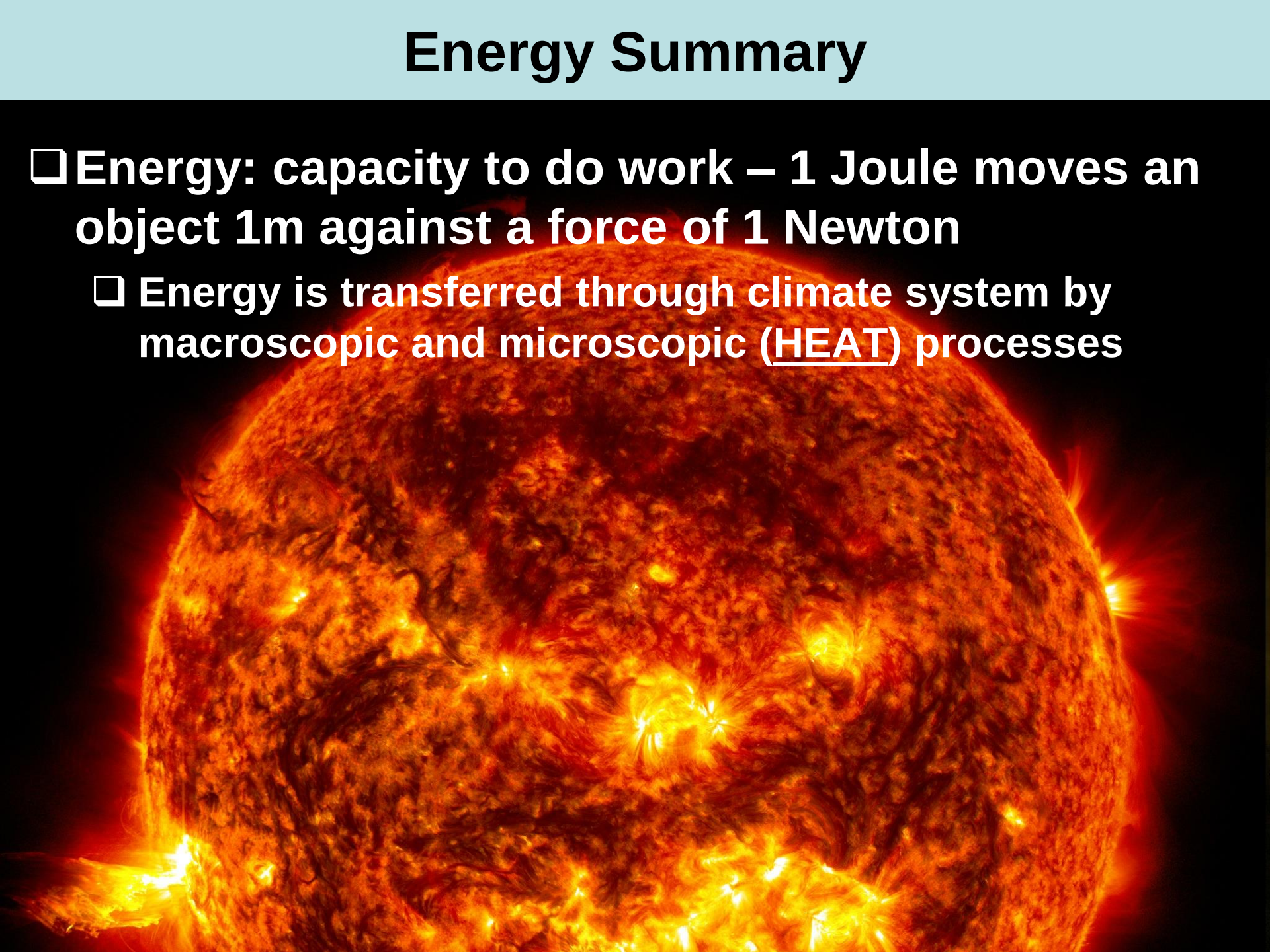
Energy Summary

- Energy: capacity to do work – 1 Joule moves an object 1m against a force of 1 Newton
  - Energy is transferred through climate system by macroscopic and microscopic (HEAT) processes



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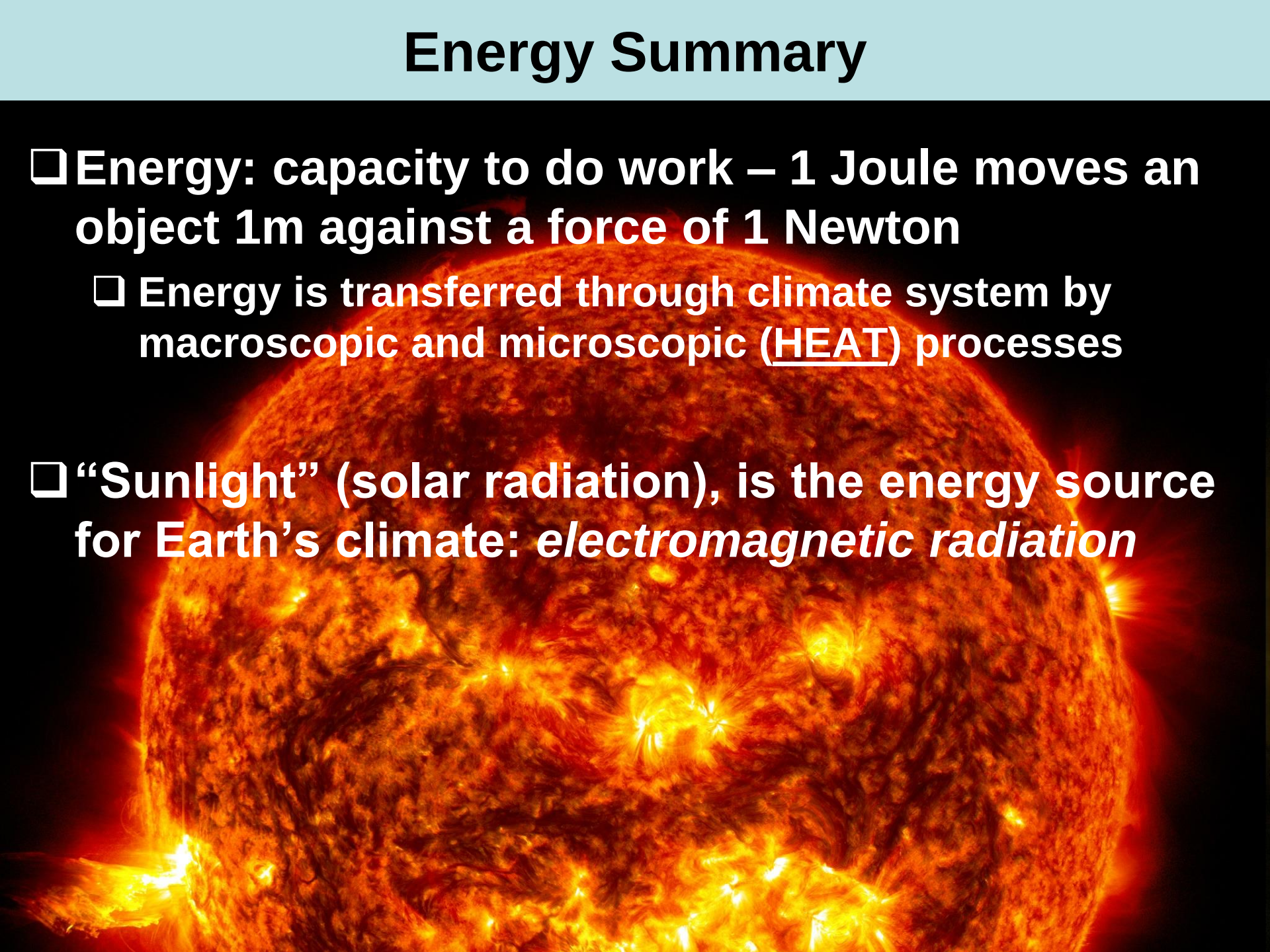
- **"Sunlight" (solar radiation), is the energy source for Earth's climate: *electromagnetic radiation***



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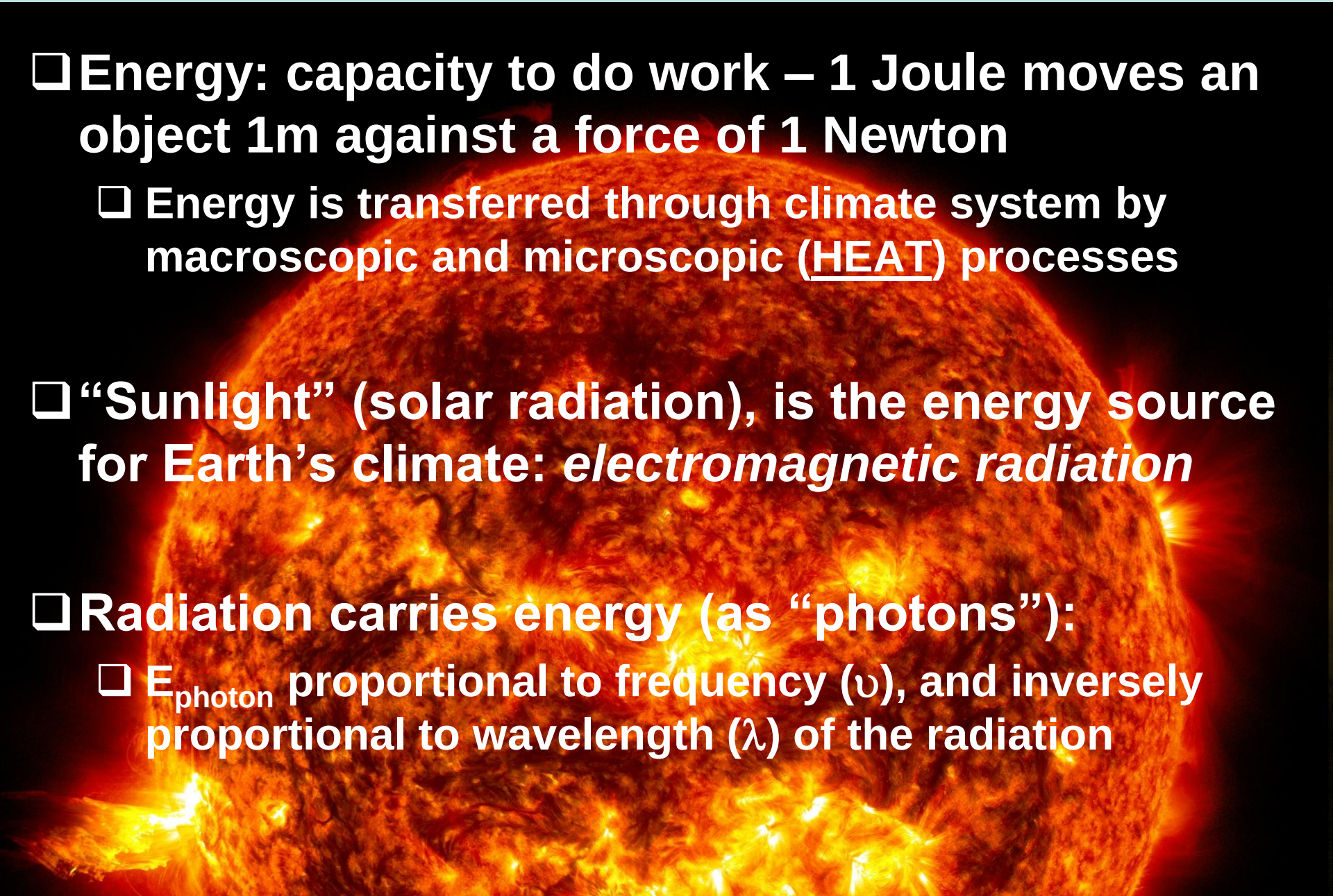

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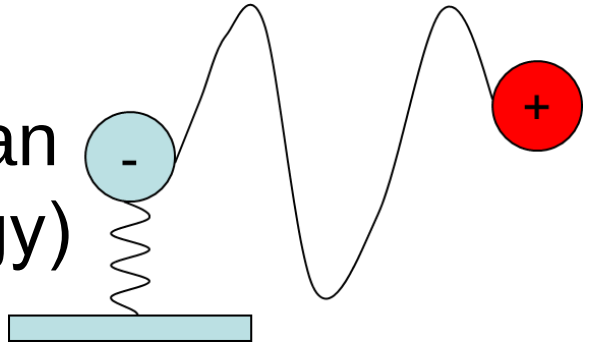
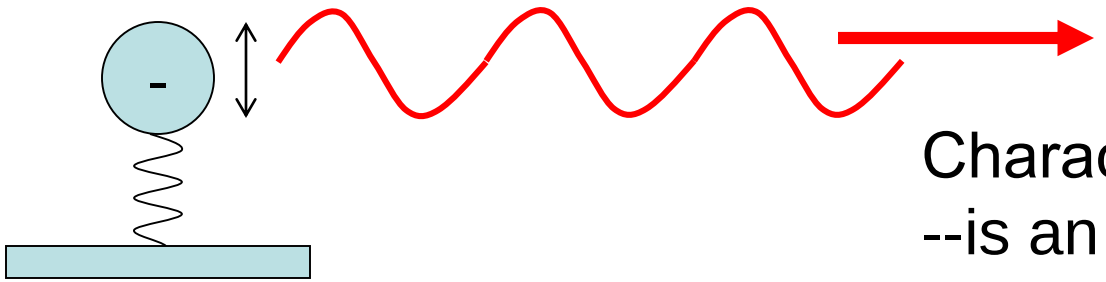
- "Sunlight" (solar radiation), is the energy source for Earth's climate: *electromagnetic radiation*
- Radiation carries energy (as "photons"):
  - E_{photon} proportional to frequency (υ), and inversely proportional to wavelength (λ) of the radiation

Radiation – Matter – Temperature



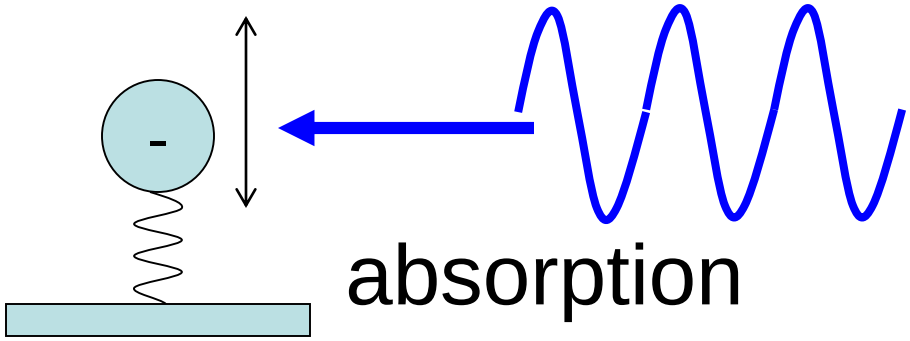
- Charged particle motion related to an object's temperature (internal energy)
- Charged particle motion can be affected by oscillations in the external electric field (i.e. by radiation!)
- All objects that can **absorb** radiation (energy gain), can ***emit*** radiation (energy loss)

Radiation Absorption, Emission, Temperature



emission

Characteristic of a body's T
--is an <u>energy loss</u> mechanism

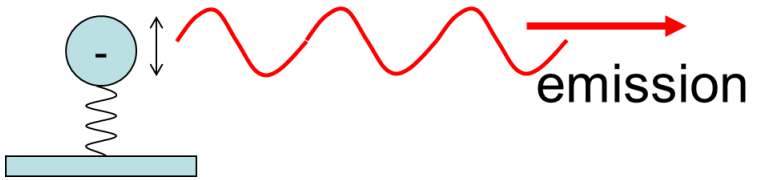


absorption

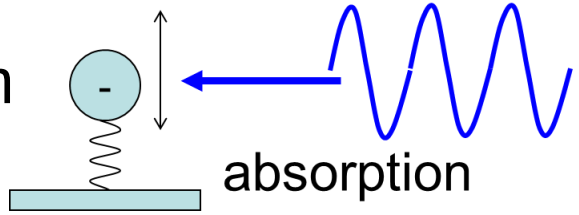
Induces more atomic/molecular motion
→ Increases a body's T
--is an <u>energy gain</u> mechanism

Interactions of Radiation and Matter

1. **Emission**—causes matter to cool



2. **Absorption**—causes matter to warm



3. **Transmission**—no interaction

4. **Scattering**—direction of radiation propagation altered
(like reflection but more general)

All processes happen on Earth and are important in considering the energy balance of the planet.

Temperature and Radiation Emission Spectra

- Amount of radiation emitted by object quantified by the radiation **flux (Watts/m^2)**

$$\frac{\text{amount}}{\text{area} \cdot \text{time}} \rightarrow \frac{\text{Joules}}{m^2 \cdot \text{second}} \rightarrow \frac{\text{WATT}}{m^2}$$

- 3 **Blackbody Radiation Laws** relate object's temperature to amount and **spectrum** of radiation emitted

"distribution"

Which picture shows the larger flux of blu circles

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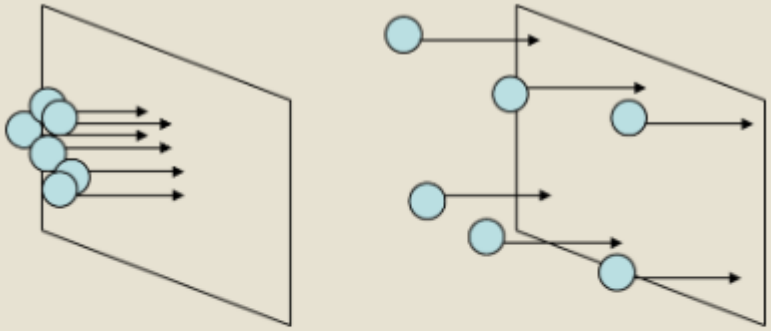

- Left
- Right
- Neither

Visual settings

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W The hotter an object (higher T), the larg the flux of radiation it emits. This is an example of

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a positive
edback

a negative
feedback

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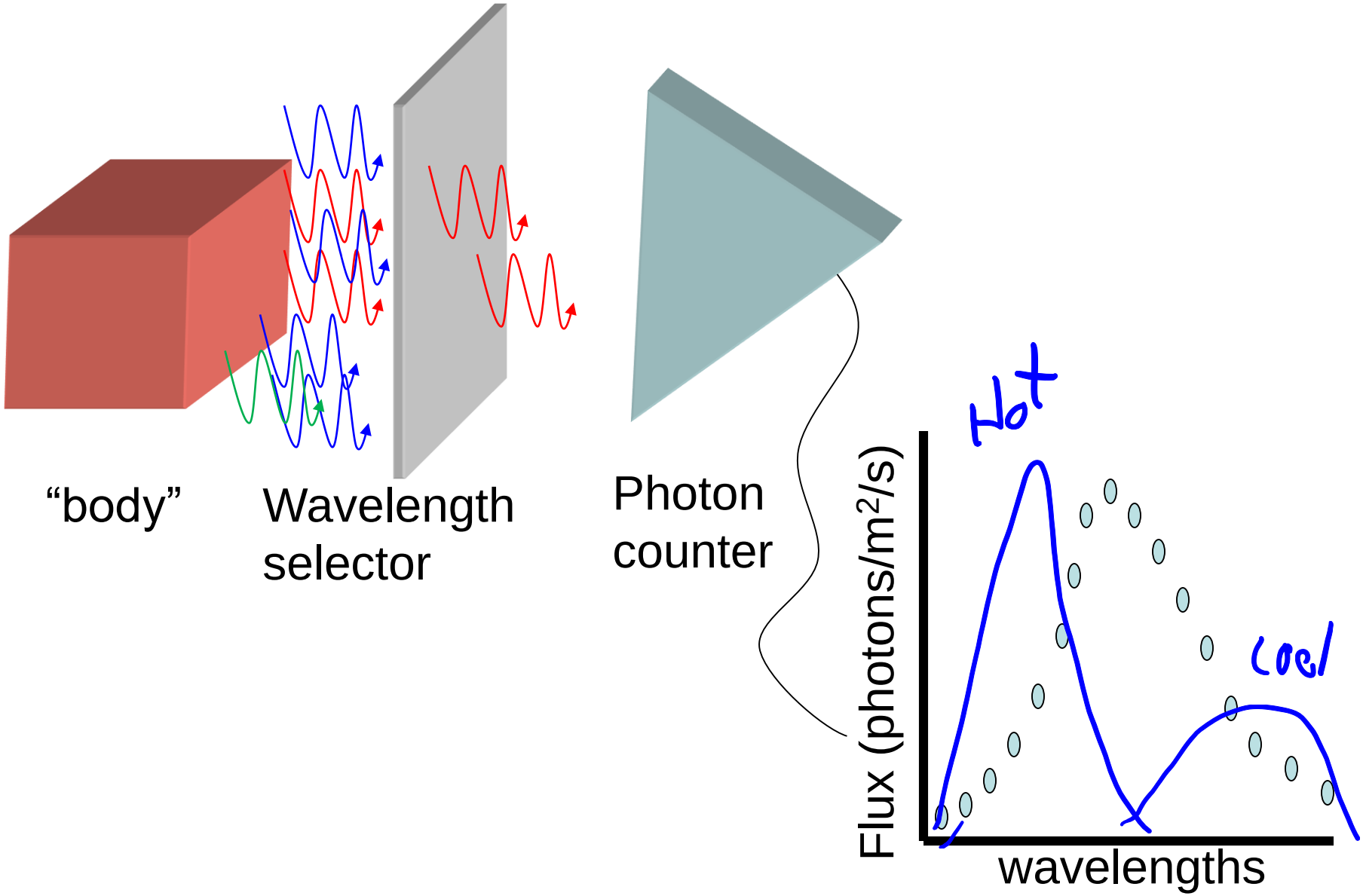
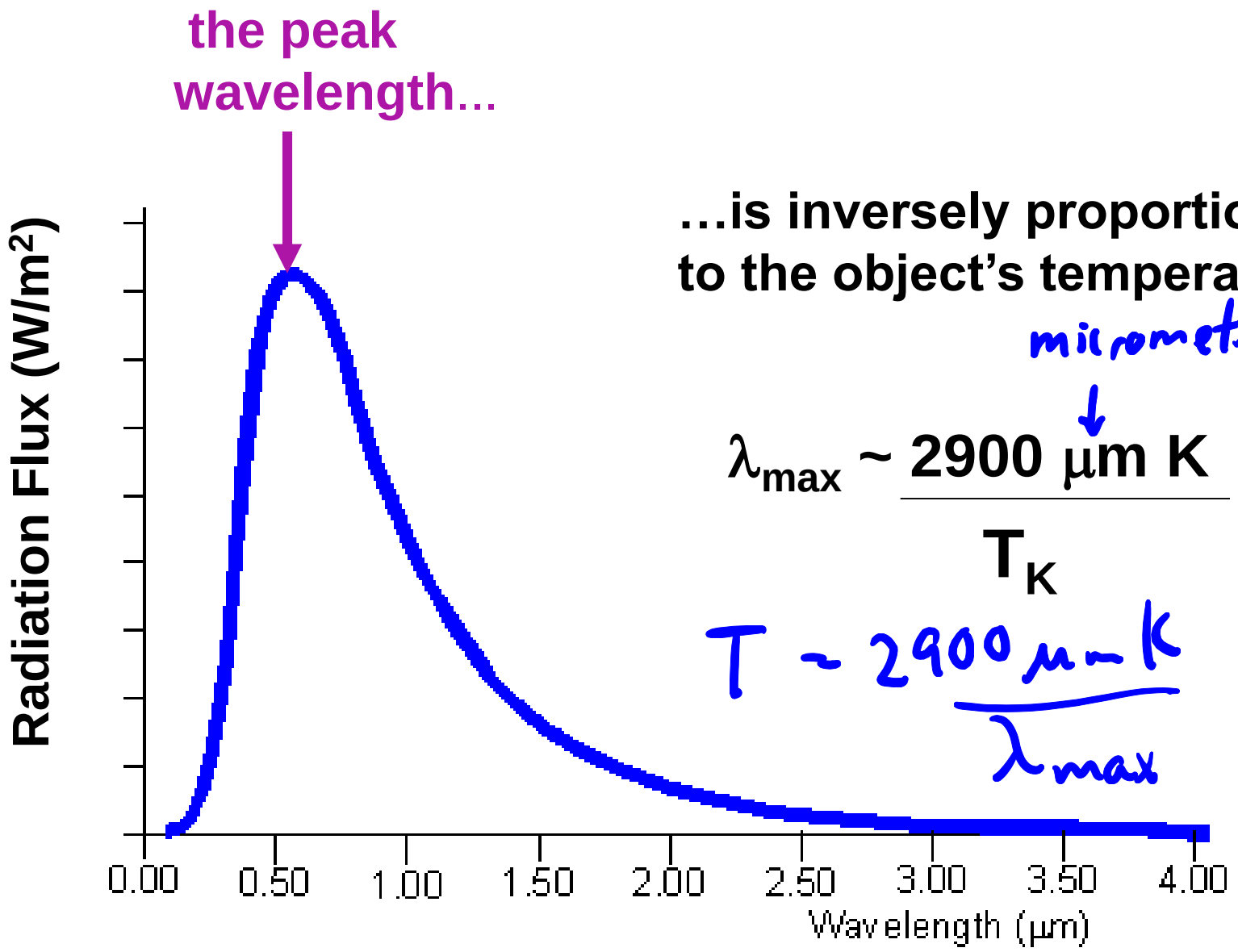
Total Results: 0

Emission Spectrum: energy distribution



Blackbody Radiation: Wien's Law



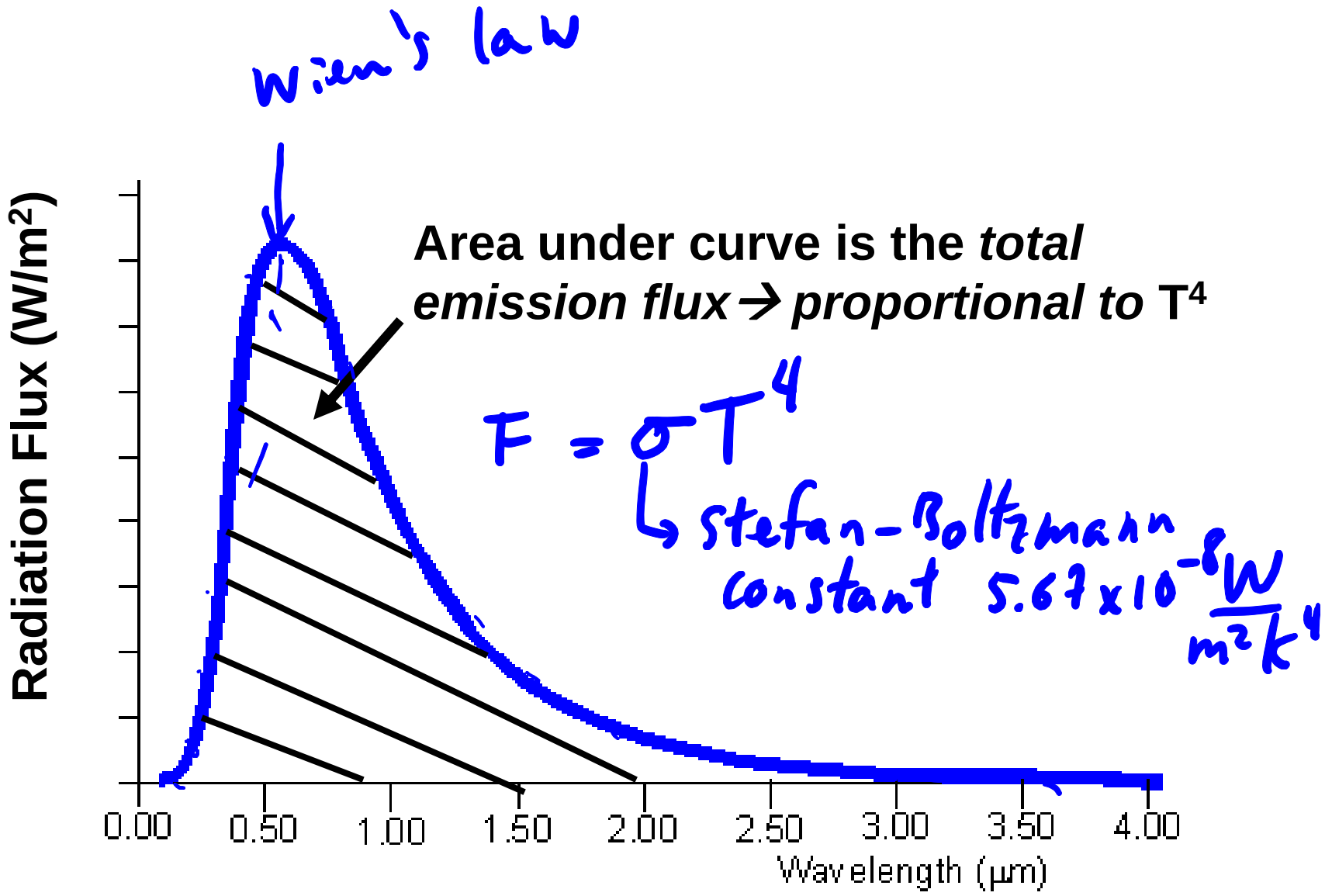
…is inversely proportional to the object's temperature

micrometer

$$\lambda_{max} \sim \frac{2900\ \mu m\ K}{T_K}$$

$$T \sim \frac{2900\ \mu m\ K}{\lambda_{max}}$$

Blackbody Radiation: Stefan-Boltzmann's Law



The global average temperature of Earth's surface is ~ 15 oC. What wavelength carries the most radiant energy emitted by Earth's surface?

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- 0.1 micrometer
- 1 micrometer
- 10 micrometer

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The sun's emission flux maximizes at a wavelength of ~ 0.5 micrometer. The sun's surface temperature is

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- ~ 1500 K
- ~ 6000 K
- ~ 15,000 K

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