**Model of Stars—29 Sep**

- Hertzsprung-Russell diagram
- Spectral Class
  - Oh be a fine girl kiss me.
  - Hottest stars on left
- Absolute magnitude measures brightness with all stars placed at same distance
  - Brightest stars on top
- Model
  - Temperature
  - Size (therefore names dwarfs & giants)

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**The Hot-plate Model of a Star**

- The surface of a star is made of tiles of hot plates.
- How does the energy from the hot-plate get to my hand?
  - Key observation: I can hold my hand much closer to the hot plate when it faces to the side, rather than up.
- Energy moves from the hot plate to my hand by
  - Movement of hot air
  - By radiation (mostly infrared light)

1. How does energy move from the sun to the earth?
   A. By radiation only
   B. By movement of hot air only
   C. Both A & B

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    - For the sun, the radiation is mostly ultraviolet light, visible light, and infrared light.
  - We concentrate on the radiation produced by the hot plate.
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- We concentrate on the radiation produced by the hot plate.
1. What are two ways to make hot plates produce more energy per second? (The same question applies to a star. What are two ways to make a star brighter or more luminous?)

A. Make the plates hotter.
B. Make the plates bigger.
C. None of the above answers.

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- The surface of a star is made of tiles of hot plates.
- The luminosity of a star (the energy produced every second) depends on temperature and size.

1. What can I do to make the same hot-plate at the same setting burn my hand and not burn my hand? (Without modifying the sun, what can I do to make the sun brighter or fainter?)
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   - A. Move my hand closer or farther.
   - B. It is not possible.

Model of a Star: Thermal Radiation

- Thermal radiation, also called black-body radiation
  - Emits by everything
  - Brighter for hotter objects
  - Wavelength changes with temperature
    - $\lambda_{peak} \propto T^{-2.9}\text{mm K}$ (Wien’s Law)
    - For the sun, $T=5700K$ and $\lambda_{peak} = 2.9\text{mm/5700K} = 0.0005\text{mm}=500\text{nm}$
    - For a person, $T=273+37=310K$. $\lambda_{peak} = 2.9\text{mm/310K} < 0.1\text{mm}$ (infrared)
  - Radiation emitted by black objects does not depend on the material.
    - A “black” object absorbs all radiation
  - A star or hot plate emits radiation. Energy emitted per second depends on $A \times T^4$.

Luminosity & Flux of Stars

- Luminosity = amount of energy per second (Watt) produced by the star
  - $L= R^2 T^4$
- Flux = energy per second received by a detector on earth (Watt/m$^2$)
  - $F= L/D^2$
- At greater distances from star, light is spread over larger area. Flux is lower.
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1. Supernova 1987a in the Magellanic Cloud became much, much brighter in one day. What quantity or quantities have changed?
   - A. Flux and luminosity
   - B. Flux only
   - C. Luminosity only
   - D. Neither flux nor luminosity

**Summarizing question**

- Hertzsprung-Russell diagram
- Spectral Class is related to temperature
  - OBeA FmGrlKisM
  - Hottest stars on left
- How can a star at the same temperature and the same distance as the sun be much brighter?