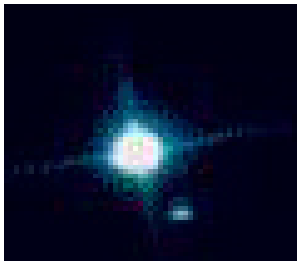
Discovery of White Dwarfs—5 Oct

- Adams' discovery
- Magnitude, apparent & absolute
- Why are white dwarfs much smaller than stars like the sun?
- Normal gas & degenerate gas

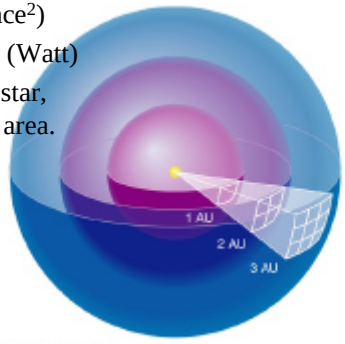


Sirius A & B
http://chandra.harvard.edu/photo/2000/0065/0065_optical.jpg

Flux & Luminosity

Flux = Luminosity/(4πDistance^2)

- Star produces Luminosity (Watt)
- At greater distances from star, light is spread over larger area. Flux (Watt/m^2) is lower.



Apparent & Absolute Magnitude

- Flux=Luminosity/(4πDistance^2)
- Apparent mag is a logarithmetic expression of flux
  - If the app mag changes by -2.5 mag, the flux is brighter by a factor of 10.
  - $f_B/f_A = 10^{(-(m_B-m_A)/2.5)}$
  - $m_B-m_A = -2.5 \log(f_B/f_A)$
- Absolute mag is a logarithmetic expression of luminosity
  - Abs mag of a star is its app mag if the star is moved to a distance of 10 pc.
  - If the abs mag changes by -2.5 mag, the luminosity is brighter by a factor of 10.

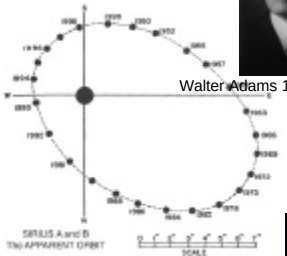
Star	Apparent mag	Flux		Absolute mag	Luminosity		Distance
		[W/m^2]	[f_{Vega}]		[W]	[L_{sun}]	[pc]
Sun	-26.7	1400	5.2×10^{10}	4.8	3.9×10^{26}	1	5×10^{-6}
Vega	0.0	2.7×10^{-8}	1	0.5	2.1×10^{28}	54	8
Sirius	-1.45	1.1×10^{-7}	3.9	1.4	9.0×10^{27}	23	2.7

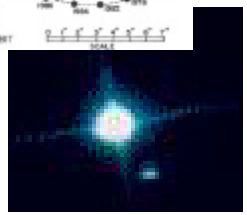
1. As viewed from earth, the sun is the brightest star. Which is the faintest of the three? Which columns contain that information?
2. Which star is the brightest when viewed from a distance of 10 pc? Which columns contain that information?
3. How much brighter or fainter is Sirius compared with Vega? Use the given magnitude to calculate this.

Sirius A and Sirius B

Walter Adams 1876-1956

- Apparent mag of Sirius A is -1.5
- Apparent mag of Sirius B is 8.7
- Sirius A & B orbit each other.
- In 1914, Walter Adams measured the colors of A and B to be about the same. What did he discover?

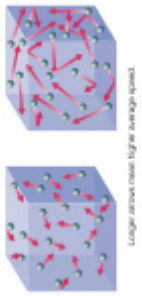




http://chandra.harvard.edu/photo/2000/0065/0065_optical.jpg

White Dwarfs

- A white dwarf is the size of earth, 1/100th radius of sun. New physics!
- A star is a battle between gravity and pressure. If gravity is stronger, star shrinks, temperature increases, and pressure rises to restore balance.
- In normal star, the gas is normal
  - PV=nRT
  - Pressure is caused by gas moving due to temperature.
- In white dwarf, gravity overcame the pressure of the normal gas. A new form of pressure acts. "Degenerate" electrons supply pressure. (S4)
  - Electrons move not because they are hot but because they are confined to a small space.
  - Heisenberg's Uncertainty Principle: momentum×space >h
  - If you confine an electron to 10^{-10}m, it moves at 7000km/s.



Summarizing question

- Why was finding of Sirius B's spectral class crucial to discovery of white dwarfs?