Name ___Solution___

STAR TEMPERATURE AND SIZE

TEMPERATURE FROM THE LINE SPECTRUM: THE SPECTRAL CLASS

If λ_{peak} isn't known, thanks to the work of Cecilia Payne-Gaposchkin (1900-1979), the spectral class can be used to estimate the temperature. This is done by interpolation between the minimum and maximum temperatures of each spectral class:

TEMPERATURE FROM SPECTRAL TYPE $\qquad T = T_{max} - \left\{ (subclass) \times \left(\frac{T_{max} - T_{min}}{10} \right) \right\}$

Here the subclass is the number given with the spectral type (e.g. the 2 in Sol's G2), T_{max} is the highest temperature in the spectral class and T_{min} is the lowest.
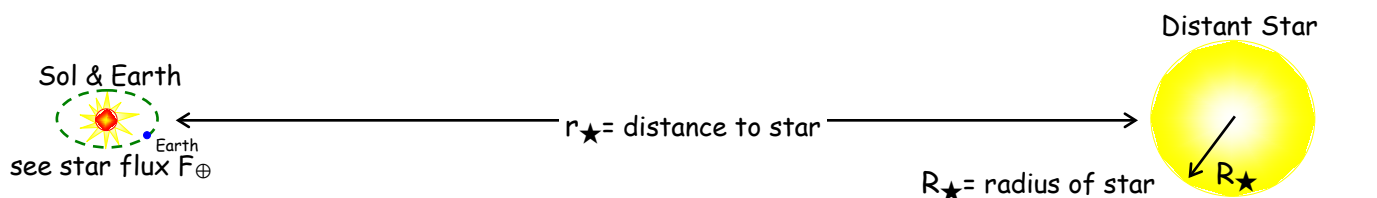
SIZE OF AN OPAQUE, SPHERICAL STAR: THE STEFAN-BOLTZMANN LAW:

The Stefan-Boltzmann law relates the luminosity of a star to its temperature and its emitting surface area ($4\pi R^2$)

RADIUS FROM LUMINOSITY AND TEMPERATURE $\qquad R_\star = \sqrt{\dfrac{L_\star}{4\pi\sigma T^4}}$

where $R_\star$ is the *radius of the star* in m, $\sigma = 5.67 \times 10^{-8}$ W/M²K⁴, $R_\odot = 6.96 \times 10^8$ m, and $r_\oplus = 1.496 \times 10^{11}$ m.

STAR	FIELD GUIDE TO THE STARS AND PLANETS TABLE A2				FG A3	CALCULATED				
						LUMINOSITY		SIZE		
	V	M_V	$r_\star$	Spec.	T	$L_{\star,SOL}$	$L_\star$	$R_\star$	$R_\star/R_\odot$	$R_\star / r_\oplus$
			ly	Type	K	In L_{sol}	In Watts	Billions of m	(number)	%
Polaris (α UMi)	2.0	-4.1	431	F5 I	6,750	3698	1.42×10^{30}	30.9	44.4	20.7
Vega (α Lyr)	0.03	0.6	25	A0 V	11,000	48.8	1.87×10^{28}	1.34	1.92	0.89
Deneb (α Cyg)	1.25	-7.5	1467	A2 I	10,300	84,723	3.24×10^{31}	63.6	91.4	42.5
Altair (α Aql)	0.77	2.1	17	A7 IV	8550	12.2	4.69×10^{27}	1.11	1.59	0.74
Betelgeuse (α Ori)	0.5	-5.0	522	M2 I	3400	8472	3.24×10^{30}	184.5	265	123
Alnitak (ς Ori)	2.05	-5.5	817	O9.5 I	25,750	13,428	5.14×10^{30}	4.05	5.82	2.71

Sol & Earth

see star flux $F_\oplus$

$\longleftarrow$ $r_\star$ = distance to star $\longrightarrow$

Distant Star

$R_\star$ = radius of star

$R_\star$

shines out luminosity $L_\star$

$L_\star = 10^{\left(\frac{M_{Sol} - M_\star}{2.5} \right)} L_{Sol}$ AND $L_{Sol} = 3.83 \times 10^{26}$ Watts

Which star impresses you the most? Why? $\qquad\qquad\qquad$ ← Don't skip this!

Betelgeuse! It's 123% of Earth's orbit! So if it were our star, Earth would be within it!