Level 2 Stars

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Problem Set S.5

The period of radial pulsations of a star in the instability strip can be shown to be approximately,

$$\Pi \approx \sqrt{\frac{3\pi}{2\gamma G\rho}} \, ,$$

where Π is the period, γ is the ratio of the specific heats (and may be assumed to have a value of 5/3) and ρ is the density.

a) What physical model for the period of radial pulsations would allow you to derive the above formula? State what simplifying assumptions you would make.
[3 marks]

b) Beta Doradus is a Cepheid variable star. It has a pulsation period of 16 days, a mass 6.5 times that of the Sun, and a surface temperature of 6000 K. Altair is a Delta Scuti variable star. It has a pulsation period of 2.7 hours, a mass 1.8 times that of the Sun and a surface temperature of 7000K. What is the ratio of the luminosities of the two stars? Note, in your calculation you should use the formula given above. [7 marks]

[$M_\odot = 1.99 \times 10^{30}$ kg; $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}; $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}; $k = 1.38 \times 10^{-23}$ J K^{-1}]