Stellar Structure and Evolution
—Exercises—
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Part 4

1) Stars are acoustic resonators. Their period of oscillation (pulsation) Π is determined by their mean density ($\rho \sim M/R^3$) approximately through the period - density - relation

$$\Pi\sqrt{\rho} = constant$$

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Prove this relation on the basis of order of magnitude estimates: Use the relation between period and wavelength of a sound wave. How big is the maximum wavelength of a standing sound wave in a star (order of magnitude)? The sound speed may be estimated using the condition of hydrostatic equilibrium.

2) The period - luminosity - relation for Cepheids ($\log\Pi \sim \log L$) is of fundamental importance for distance measurements in astrophysics. Show that such a relation exists, if the excitation of Cepheid pulsations is restricted to a narrow strip in the HRD, which is approximately represented by $\log L = \alpha \log T_{eff} + constant$ with constant α.

Hint: Use the period - density - relation together with the mass - luminosity - relation and Stefan - Boltzmann's law.