Stellar Evolution 2016 Q1

Ugeseddel 4 (week 38)

In the lecture on Thursday September 22 Günter will finish the discussion of degeneracy (*Kippenhahn, Weigert & Weiss*, Chapter 15) and consider more general aspects of the equation of state (*Kippenhahn, Weigert & Weiss*, Chapter 16). On Monday 26 September he discusses other aspects of the physics of stellar interiors, i.e., opacity (*Kippenhahn, Weigert & Weiss*, Chapter 17) and energy generation (*Kippenhahn, Weigert & Weiss*, Chapter 18). We largely defer details on electron screening (Section 18.4), neutron-capture nucleosynthesis (Section 18.6) and neutrino energy loss (Section 18.7) to the extension of the course in Q2. On 29 September and 3 October we shall cover the properties of unevolved stars on the so-called zero-age main sequence (*Kippenhahn, Weigert & Weiss*, Chapter 22) and other main sequences (Chapter 23), as well as the Hayashi line (Chapter 24). In addition, we discuss the evolution of the Sun (Chapter 29).

The exercise class on 28 September will consider:

i) Items iv) and v) from Exercise U2.1 on Ugeseddel 2.

ii) *Lecture Notes on Stellar Structure and Evolution*, Exercise 3.5.

iii) Go through the analysis of the properties of polytropic models, which will be useful in the analysis of more physical models. Perhaps not surprisingly I find the presentation in *Lecture Notes on Stellar Structure and Evolution*, Section 4.6 clearer than that given by *Kippenhahn, Weigert & Weiss*, and hence I suggest that you use that.

iv) Solve the Lane-Emden equation numerically for some representative cases of the polytropic index n. This is discussed in *Lecture Notes on Stellar Structure and Evolution*, Exercise 9.1. You can use any programming language and algorithms that you are familiar with to integrate ordinary differential equations. Note that the singularity at the centre requires the use of an expansion around the centre; it would not hurt to derive this expansion.

Corrections to *Kippenhahn, Weigert & Weiss***:**

- **p. 134, Eq. (14.36)**: Here the notation is a little confusing. The partition functions, now called u_r where r labels the ionization state,

obviously also depend on the element that we consider. Thus u_r, u_{r+1} should be replaced by u_i^r, u_i^{r+1}, using a notation consistent with, e.g., χ_i^r.

- **p. 252, l. 7 from bottom of proper text**: add 'which are' after 'Those objects in Fig. 22.2'.

- **p. 260, Eq. (22.4)**: The equation should obviously be

$$\frac{dP_{\rm rad}}{dr} = \frac{4a}{3} T^3 \frac{dT}{dr}$$

The rest of the analysis appears not to be affected by this error, however.

21 September 2016 Jørgen Christensen-Dalsgaard