Assignment 6 — due December 12th [*Revision* : 1.2]

1. Use *EZ Web* to calculate solar-metalicity models with $\log M/M_\odot = -0.4$, -0.2, 0.0, ..., 1.2, 1.4. Set the maximum model number to 100,000, and the maximum model age to 10^{20}; this will ensure that *EZ Web* follows as much of the evolution as possible. You only need to generate summary files; model files are not required. With the data from these calculations, plot the evolutionary tracks of the models in a Hertzsprung-Russell diagram. Your diagram should cover the ranges $\log T_{\rm eff} = [4.6, 3.4]$ and $\log L/L_\odot = [-2, 6]$.

   On your HRD, mark (by hand or using the computer) the following features:

   - The zero-age main sequence (for all tracks)
   - The episode of overall Kelvin-Helmholtz contraction during hydrogen burning (for $\log M/M_\odot \geqslant 0.2$)
   - The point where hydrogen shell burning begins (for all tracks)
   - The point of helium core ignition (for $\log M/M_\odot \geqslant 1.4$)
   - The general location of the Hayashi line
   - The red-giant branch (for $-0.2 \leqslant \log M/M_\odot \leqslant 1.2$)
   - The asymptotic giant branch (for $1.4 \leqslant \log M/M_\odot \leqslant 1.8$)
   - The degenerate cooling curve for $\log M/M_\odot = -0.4$

2. For the models calculated in the previous question, plot the trajectories followed by each model in the $\log \rho_{\rm c}$-$\log T_{\rm c}$ plane (where $\rho_{\rm c}$ is the central density, and $T_{\rm c}$ is the central temperature). On your plot, also show (as a dashed line) the boundary defined by

$$\frac{T_{\rm c}}{\rho_{\rm c}^{2/3}} = 1261\,{\rm K\,m^2\,kg^{-2/3}},$$

   which divides the plane into regions where electron degeneracy is important (low-$T_{\rm c}$, high-$\rho_{\rm c}$) or unimportant (high-$T_{\rm c}$, low-$\rho_{\rm c}$). Moreover, show (as a dotted line) the threshold $T_{\rm c} \approx 10^8\,{\rm K}$ for helium ignition.

   From your diagram, determine which models will undergo a helium flash, and which will never ignite helium. Justify your answers.

3. Fig. 1 shows spectra for four types of supernova: Ia, Ib, Ic and II. Identify which is which, and justify your answers.

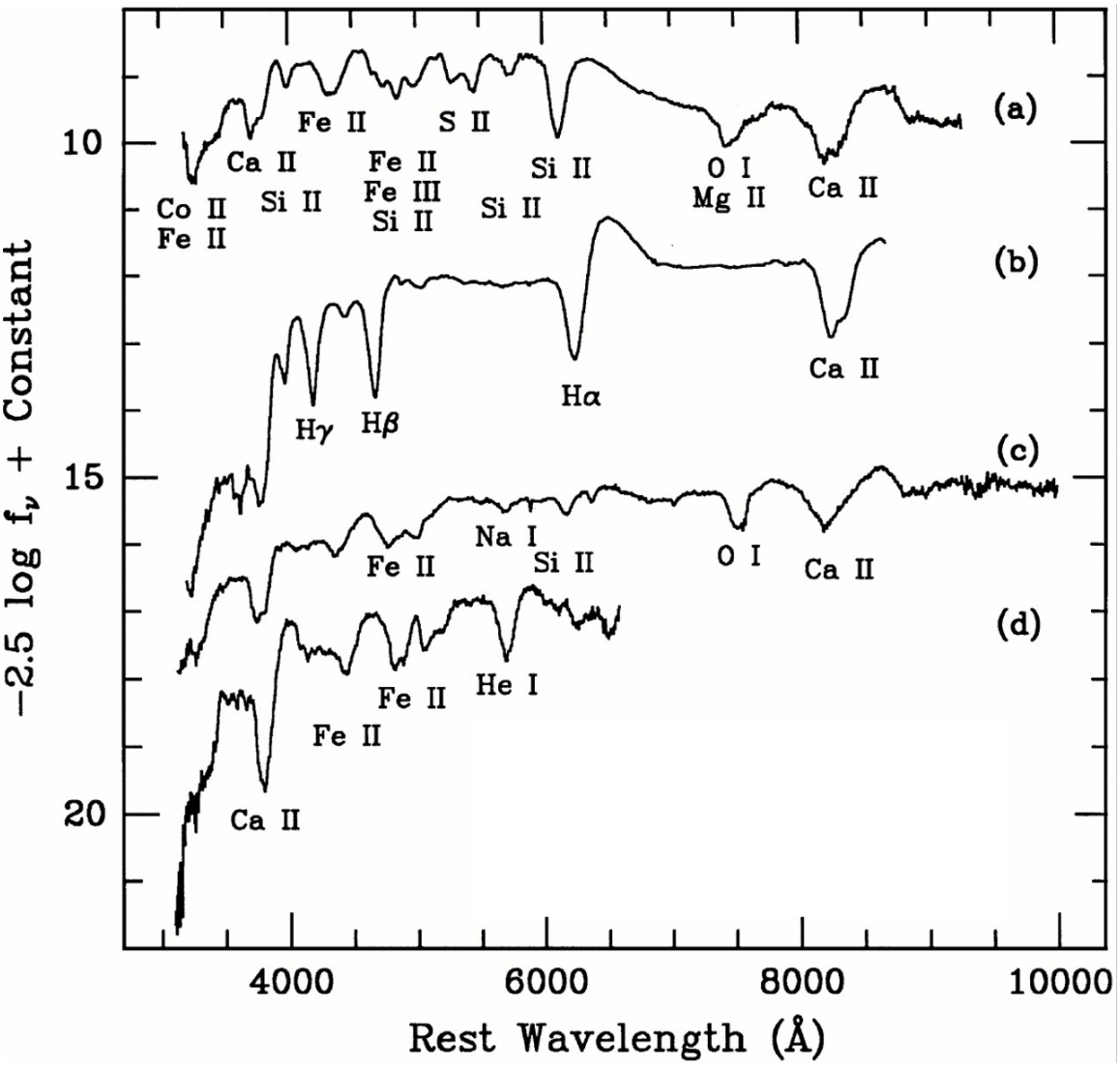

Figure 1: Supernovae spectra for Q3.