2023秋天体物理概论期末（回忆版）

一、选择题

17道单选（略）

二、简答题

1. 地面望远镜和空间望远镜的性能优势和劣势
2. 超新星爆发机制，分Ia型和其他讨论
3. 太阳的一生
4. 恒星结构方程及解释，能量传输分辐射和对流讨论

三、计算题

1. （1）计算旋涡星系边缘的旋转速度

   （2）计算旋涡星系边缘的旋转角速度

2. （1）根据黑体辐射的能流谱密度I_ν证明维恩位移公式

   （2）推导关于ν_{max}的类似公式

   （3）$T_\odot = 5800K$，人眼是I_λ还是I_ν探测器

3. （1）根据Friedmann方程和流体方程推导加速方程

   （2）推导减速因子q的表达式并计算现在值

   （3）计算证明下面两个方程

The behavior of the scale factor R for a flat universe can be found by setting $k = 0$ in the Friedmann equation (Eq. 114). A little algebra and Eqs. (79) and (118) lead to

$$t = \sqrt{\frac{3}{8\pi G}} \int_0^R \frac{R'\,dR'}{\sqrt{\rho_{m,0}R' + \rho_{\mathrm{rel},0} + \rho_{\Lambda,0}R'^4}}. \tag{128}$$

Although this can be integrated numerically, it has no simple analytic solution. Figure 19 displays a numerical solution of Eq. (128) using WMAP values, showing the different behaviors of the scale factor in the radiation, matter, and Λ eras.

To make further progress, we will neglect the reign of relativistic particles during the first 55,000 years or so of the universe by setting $\rho_{\mathrm{rel},0} = 0$. Integrating eventually yields, for $k = 0$,

$$t(R) = \frac{2}{3}\frac{1}{H_0\sqrt{\Omega_{\Lambda,0}}} \ln\left[\sqrt{\left(\frac{\Omega_{\Lambda,0}}{\Omega_{m,0}}\right)R^3} + \sqrt{1 + \left(\frac{\Omega_{\Lambda,0}}{\Omega_{m,0}}\right)R^3}\right]. \tag{129}$$