Astrophysics of interacting binary stars

Problem Set 3

Problem 7

The assumption of a constant effective temperature everywhere in a disk is not fulfilled in reality. In lecture we derived the following expression for the effective temperature *T* as a function of radial distance *R* from the central compact star:

$$T(R)=\left\{\frac{3GM\dot{M}}{8\pi R^3\sigma}\left[1-\left(\frac{R_*}{R}\right)^{1/2}\right]\right\}^{1/4}$$

1) Derive the temperature range for an accretion disk around the following types of accreting sources:
   a) White dwarf: M=0.85 $M_\odot$; $\dot{M} = 10^{-9}$ $M_\odot$ / yr ; $R_* = 7\times10^{8}$ cm
   b) Neutron star: M=1.4 $M_\odot$; $\dot{M} = 10^{-9}$ $M_\odot$ / yr ; $R_* = 1.2\times10^{6}$ cm
   c) a non-rotating Black hole: M=5.0 $M_\odot$; $\dot{M} = 10^{-9}$ $M_\odot$ / yr

2) Let's define by $L(>r)$ the power radiated from the portion of the disk with radius R greater than r. Find an analytic expression for the ratio

$$ratio=\frac{L(>r)}{\frac{GM\dot{M}}{2r}}$$

   Sketch the ratio as a function of *r*. This result demonstrates that the gravitational potential energy, released as the matter migrates inward, does not emerge from the disk locally, but rather is redistributed by the viscous stresses.