Tutorial 3

- For a sphere falling into a black hole (Mass $M_\bullet$) with a constant accretion rate $\dot{m}$, calculate the density ρ at radius R
- Estimate the temperature T of the gas assuming that all the kinetic energy is dissipated into heat; i.e.

$$kT = \frac{1}{2} m v_{ff}^2 \tag{1}$$

- free-free emission (or brehmstrahlung) is emission from charged particles due to acceleration when passing *other* charged particles. The emissivity (i.e. energy radiated in unit time, in unit frequency interval and in unit volume) is :

$$\epsilon_\nu^{ff} = \frac{dW}{dV\ dt\ d\nu} = \frac{2^5 \pi e^6}{3mc^2} \left(\frac{2\pi}{3km} \right)^{1/2} T^{-1/2} Z^2 n_e n_i e^{-h\nu/kT} \bar{g}_{ff} \tag{2}$$

  First calculate the spectrum of an *onion shell* at radius R with density $\rho(R)$ and temperature $T(R)$ and then calculate the integrated spectrum for a sphere around the black hole (from $R = R_{in}$ to $R = R_{out}$).
  Vary the accretion rate to see the effect on the spectrum. Compare this spectrum with the spectrum from the accretion disk (of course for the same black hole mass and accretion rate).

  ! Equation (2) is -still- in CGS system.