(PHY/AST 564; Blackman; Fall 2003 Problem Set 2

1. For Massive X-ray Binaries with O,B type companion stars, accretion onto the neutron star usually occurs via graviational capture from a supersonic stellar wind.

a) Calculate the ratio $\dot{M}_{ac}/\dot{M}_{wind}$, the accretion rate into the neturon star disk, over the spherical wind mass loss rate. Your result should be a function of two ratios: M_{ns}/M_{comp}, the ratio of the binary component masses, and v_{rel}^2/v_w^2, the ratio of the velocity (squared) of NS and the wind over the wind velocity (squared).

Hint: Think about what inequality must be satisfied for material from the wind to be gravitationally trapped the NS as opposed to escaping and recall what we did for Galactic Center.

b)For wind velocity of 1000km/s, $M_{comp} = 17M_{\odot}$, $M_{NS} = M_{\odot}$ and orbit period 30 days, caculuate the ratio explicitly.

2.

a) Calculate and sketch the accretion disk spectrum (flux as function of frequency ν) for two optically thick accretion disks: One with R_{out} =50 R_{in} and one with $R_{out} = 5000R_{in}$. Explain the difference between the two spectra. In each case, show the approximate frequency dependices of the flux for the regimes $\nu << kT(R_{out}/h$, $\nu >> kT(R_{in}/h$, and $kT(R_{out}/h << \nu << kT(R_{in}/h$.

b) Estimate the peak temperatures for WD and NS disks. Why don't we need the actual disk outer radius to make this approximate estimate?

3. Suppose that a thin accretion disk orbits a compact object in a binary system and the conditions are favorable to produce emission lines. (For example in a cataclysmic variable, optical-UV spectra show emission lines hydrodgen and helium.) Suppose that the system is an eclipsing binary, and is such that during maximum eclipse, the low mass companion covers exactly 1/2 of the disk around the star and that the binary inclination angle (angle between normal to binary and line of sight) is $> 60^o$. Sketch how a given emission line profile would evolve over the period (e.g. usually of order a day or so) as the accreting white dwarf passes in and out of eclipse.

Hint: Assume you have the spectral resolution to resolve detailed features of the line profile and think about the line profile emitted by material in a keplerian disk. This problem can be done mathematically precisely, but a qualitative discussion based on physical intuition should suffice.

(PHY/AST 564; Blackman; Fall 2001) Problem Set 3 Due

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2.

3.