PHYSICS OF ACTIVE GALACTIC NUCLEI *Fall 2015*

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PROBLEM SET 2

Problem 1

Consider a perfectly flat, blackbody disk encircling a blackbody star. The star has a radius R_* and effective temperature T_*. The disk begins at a radius far from the star, i.e., the inner disk radius is $r_\mathrm{i} >> R_*$. The disk extends to infinity.

(a). Explain why a measure νF_ν is a measure of the "flux radiated by an object per logarithmic interval in frequency." Here F_ν is the flux density [units of energy per time per area per frequency], and ν is the frequency of radiation.

Can you explain why νF_ν, and not F_ν, is a quantity of interest to those who wish to understand the overall energetics of an object? It is called the "broadband spectral energy distribution," or "broadband SED," or "SED" for short.

(b). Is νF_ν equal to λF_λ, where λ is the wavelength of the radiation, and F_λ is per wavelength rather than per frequency? Show why or why not.

(c). Write down an expression for νF_ν for the blackbody disk. That is, write down the formula for the spectrum of the disk as measured by an observer for whom the disk is a point source.

Recall that the disk has a temperature $T(r)$ at every radius, r. The inner radius of the disk is r_i and the outer radius is r_o. The disk is a distance D away from the observer, and is inclined by an angle i ($i = 0$ corresponds to a face-on disk). Your expression should take the form of an integral.

(d). OPTIONAL: Sketch (no heroics necessary, but get the orders of magnitude right and label the axes correctly!) νF_ν versus ν. If the spectrum exhibits power-law behavior, give the slope of the power law (i.e., $d\ln(\nu F_\nu)/d\ln\nu$). Overlay on your sketch the SED of the central stellar blackbody. Log-log space is best.