ASTRONOMY 8400 – SPRING 2024
Midterm
Due Thursday, 3/7/24, at 10:00 am

1. (10 pts) Describe three techniques for detecting AGN. Give the waveband used and the selection effects that might prevent one from obtaining a complete sample for each technique.

2. (10 pts)
   a) Describe three ways of determining the masses of SMBHs in AGN directly. What are the advantages and disadvantages of each?
   b) Give a way to determine the masses of SMBHs in AGN indirectly and the relationship that this is based on. What are the causes and magnitudes of these uncertainties?

3. (10 pts)
   Describe the main similarities and differences between Seyfert 1 and Seyfert 2 spectra in the following wavelength regimes.
   a) Optical (visible)
   b) UV
   c) Infrared
   d) X-ray
   e) Radio

4. (10 pts)
   a) For an isothermal accretion disk, what is its luminosity in terms of mass and accretion rate and in terms of temperature? Derive an expression that gives the temperature of the disk as a function of mass, accretion rate, and size.
   b) What is the dependence of temperature on mass and Eddington ratio? In what region of the electromagnetic spectrum does the accretion disk emission peak for stellar black holes and for supermassive black holes?

5. (10 pts)
   a) Given the expressions for radiative acceleration and gravitational deceleration in the NLR of an AGN, assume the mass is dominated by the SMBH. What value (in terms of L/L_{Edd}) does the force multipler need to exceed in order to radiatively accelerate the gas?
   b) For a force multiplier of 1000, what type of AGN would you expect to NOT show radiatively driven gas?

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6. Give a **brief** answer, description, or explanation of the following (include an equation if necessary) (2 pts each):
   a) Sloan Digital Sky Survey
   b) Unified model
   c) Range of supermassive black hole masses
   d) Percentage of AGN that are radio-loud
   e) FR I vs. FR II galaxy
   f) Blazar properties
   g) Bolometric luminosities of Seyfert galaxies and those of quasars
   h) Blazar SED
   i) LINER
   j) Vera C. Rubin Observatory
   k) Transfer function
   l) Fe Kα emission
   m) ADAF
   n) Compton hump
   o) Satellite that performed an all-sky hard X-ray survey
   p) FIRST
   q) Warm absorbers
   r) AGN feedback
   s) BAL Quasars
   t) Two sources of absorption-line variability
   u) NLS1 X-ray properties
   v) Baldwin effect
   w) IFU
   x) BPT diagram
   y) Force multiplier