

ASTRONOMY 8400 – Spring 2024
Homework Set 2, Due 2/20/24 at 10:30 AM

1. a) Derive an expression for relative accretion rate (\dot{M}/M) as a function of Eddington ratio (L/L_E) for an accreting supermassive black hole (SMBH).
b) How long does it take for a $10^6 M_\odot$ SMBH to grow to $10^8 M_\odot$ if it grows at the Eddington rate?

2. Suppose you observe the C IV $\lambda 1550$ line in a quasar with the peak of the line at 5500 \AA . The far blue wing of the emission line extends to 5200 \AA .
 - a) What is the redshift and systemic radial velocity of the quasar
 - b) Approximately how old is the quasar if it formed just after the Big Bang?
 - c) In the rest frame of the quasar, what is the radial velocity of the material emitting C IV in the far blue wing?

3. Given: $F_\nu \propto \nu^{-\alpha_\nu}$, $F_\lambda \propto \lambda^{-\alpha_\lambda}$, $F_{\text{ph}} \propto E^{-\Gamma}$
Show that $\alpha_\lambda = 2 - \alpha_\nu$ and $\Gamma = \alpha_\nu + 1$

4. For a Seyfert galaxy at a redshift of $z = 0.03$ and a specific flux of $F_\lambda(5100\text{\AA}) = 5.0 \times 10^{-15} \text{ ergs s}^{-1} \text{ cm}^{-2} \text{ \AA}^{-1}$, what is its total (bolometric) luminosity and its ionizing luminosity (at $h\nu > 13.6\text{eV}$)? Specify the SED that you used.