Dai? / Leighly?

PROBLEM 4

(1) Define the Eddington luminosity. (2pts)

(2) Derive the Eddington luminosity by balancing the radiation force and gravity for an electron. (3pts) gas?

(3) What is the Eddington luminosity for a $10^8 M_\odot$ AGN? (3pts)

(4) An AGN is observed to emit at a super-Eddington rate. What are the possible explanations? (2pts)

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Astro #4

a) The Eddington Luminosity is the maximal luminosity an object can have while remaining in hydrostatic equilibrium.

b) * For an electron gas in HSE:

$$\left|\frac{dP_{rad}}{dr}\right| < \left|\frac{dP}{dr}\right|$$

$P_{rad} = \frac{1}{3}aT^4$ $\quad \frac{dr}{dm} = \frac{1}{4\pi r^2 \rho}$, $\quad \frac{dP}{dm} = \frac{-Gm}{4\pi r^4}$, $\quad \frac{dT}{dm} = \frac{-GmT}{4\pi r^4 P}\nabla$

$\nabla = \frac{-3\kappa l P}{16\pi acGmT^4}$

$$\frac{dP_{rad}}{dr} = \frac{4}{3}aT^3\frac{dT}{dr}$$

$$= \frac{4}{3}aT^3\frac{dT}{dm}\cdot\frac{dm}{dr}$$

$$= \frac{4}{3}aT^3\left(\frac{-GmT}{4\pi r^4 P}\cdot\frac{-3\kappa l P}{16\pi acGmT^4}\right)\cdot 4\pi r^2\rho$$

$$= \frac{\kappa l \rho}{4\pi r^2 c}$$

$$\frac{dP}{dm}\cdot\frac{dm}{dr} = \frac{-Gm}{4\pi r^4}\cdot 4\pi r^2\rho$$

$$= \frac{-Gm\rho}{r^2}$$

$$\Rightarrow \quad \frac{\kappa l \rho}{4\pi r^2 c} < \frac{+Gm\rho}{r^2}$$

$$l < \frac{4\pi cGm}{\kappa}$$

c) $$l < \frac{4\cdot\pi\cdot 3\cdot 10^{10}\frac{cm}{s}\cdot 6.67\cdot 10^{-8}\frac{cm^3}{g\,s^2}\cdot 2\cdot 10^{41}g}{\kappa}$$

$$l < \frac{5.03\cdot 10^{45}\frac{cm^4}{s}}{\kappa}$$?

d) ?