Astrophysik II: Galaxien und Kosmologie
WS17/18
Übungsblatt 6

06.12.2017

Aufgabe 1. *Active Galactic Nuclei*

(a) What different observational classes of AGN exist. Sketch the structure of an AGN, explaining the different components and how they relate to the observed classes.

(b) For some source of mass M, radiating with luminosity L, the radiant flux is (assuming spherical symmetry);

$$S = \frac{L}{4\pi r^2}\left[\frac{erg}{cm^2 s}\right] \tag{1}$$

Assuming a gas of ionized hydrogen, with Thompson scattering dominating. find an expression for the maximum radiative luminosity possible while still maintaining hydrostatic equilibrium. hint: radiation pressure vs. gravity

(c) Assuming a $10^8 M_\odot$ blackhole is accreting at this limit (the Eddington limit), converting 10% of the rest mass of the in-falling material into radiation. What is the maximum luminosity generated. The maximum accretion rate?

(d) The variability of AGN can used to place limits on the physical size of the emission region. An astronomer has estimated an emission region no larger than $d = 10^{-3} pc$. How many type O stars (assuming a typical mass $M_* = 50 M_\odot$) would be needed to produce the same luminosity determined above? What would their density be?

(e) a bright supernova might have $L = 10^{10} L_\odot$, how many supernova would need to be going off constantly to produced the luminosity from above? What are some reasons that make such a scenario implausible?

Aufgabe 2. *Gravitational Lensing*
The angular deviation of photon passing at a distance ξ from a point mass M is given by;

$$\hat{\alpha} = \frac{4GM}{\xi c^2} \tag{2}$$

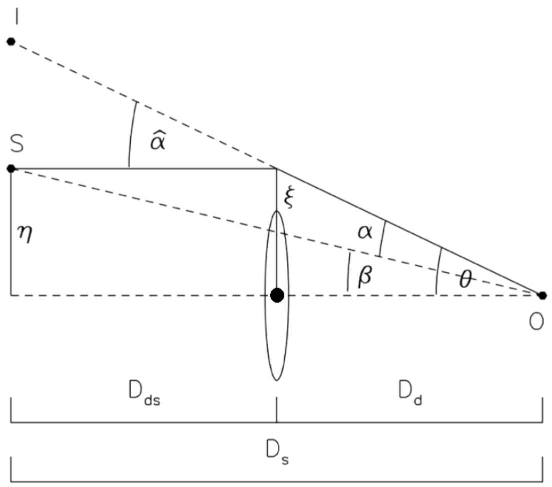

Abbildung 1: The photon is emitted by a source S and deflected on its way to the observer O, such that the observed image appears to be located at I. All angles involved are *small*, at just fractions of a degree.

(a) Show that the angle θ between the lensing mass and the image of the source must satisfy;

$$\theta^2 - \beta\theta - \frac{4GM}{c^2}\left(\frac{D_s - D_d}{D_s D_d}\right) = 0 \tag{3}$$

What observational implications of an equation of this form?

(b) What occurs in the special case where $\beta = 0$?

(c) A multiply imaged quasar is observed at $\theta_1 = 5.35$" and $\theta_2 = -0.8$" relative to galaxy acting as a gravitational lens. The quasar is observed at a redshift $z_s = 1.41$ and the lensing galaxy is observed at redshift $z_d = 0.36$. Approximate the mass of the lensing galaxy.

(d) This problem is a crude approximation, what must be considered in a more physical example. What are some other observational implications (qualitatively)?