Selection of Homework Questions

Topic 14 : Galaxy Nuclei & Black Holes

(1) Deriving M/L(r) in Galaxy Nuclei :

Key observations which help ascertain the presence of a black hole in galactic nuclei are the radial dependences of mean rotation, $< V_{rot} >$, velocity dispersion, σ and surface brightness, μ.

a. How can one use these measurements to estimate M/L(r). Include both observational and theoretical details.
b. What values and form for M/L(r) would suggest the presence of a black hole.
c. How might your approach differ for
   - a kinematically cold stellar disk;
   - a low luminosity elliptical or bulge;
   - a high luminosity elliptical;
   - a high luminosity elliptical with small gas disk.
d. Why does $V_{rot}(r)$ provide a less ambiguous constraint on M/L than $\sigma(r)$?

(2) Black Hole Influence :

Over time, a nuclear black hole and a galaxy nucleus can influence one-another:

a. How can the presence of a central black hole effect the distribution of stars in a galactic nucleus?
b. What factors affect the black hole consumption rate both of stars and, separately, gas.
c. When a black hole ingests a star, what determines whether this meal is visible or invisible to us?

(3) Black Holes Demographics :

Although only ~1% of local galaxies are classified as Seyferts (ie classically active), observations of near-nuclear star and gas dynamics suggests that most galaxies harbor nuclear black holes.

a. Prior to these direct observations, what other lines of evidence already suggested that most galaxy nuclei might harbor nuclear black holes?
b. On what other properties of the galaxy does the black hole mass seem to depend, and how might such dependencies have arisen?
