

# Cosmology 1

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## Proposed problem, lecture 4

Topic: Photon capture radius.

The two black holes imaged by the Event Horizon Telescope (EHT) collaboration are M87\* and SgrA\*. The first is at a distance  $D = 16.8$  Mpc, and has a mass  $M = 6.5 \times 10^9 M_\odot$ , while SgrA\* is at  $D = 8.1$  kpc and has a mass  $M = 4.1 \times 10^6 M_\odot$ . Both black holes are inactive, the little gas that is falling into them has a weak radio emission that has allowed EHT to image them at a resolution of  $20 \mu\text{arcsec}$ . Compute for these two sources:

- (a) the gravitational and Schwarzschild radii, in AU ( $1 \text{ AU} = 1.50 \times 10^{11} \text{ m}$ );
- (b) the angle  $\theta_{\text{flat}}$  subtended by a rod of length equal to the diameter of the event horizon ( $4GM$ ) at their distance in a flat geometry, in  $\mu\text{arcsec}$ ;
- (c) the angle  $\theta_{\text{pcr}}$  subtended by twice the photon capture radius at the same distance, in  $\mu\text{arcsec}$ ;
- (d) the dynamical time  $GM/c^3$ , in minutes or seconds.