Homework 10

Due **November 19 by 10:45am via Canvas upload**
Please show all work, writing solutions/explanations clearly, or no credit will be given. You are encouraged to work together, but everyone must turn in independent solutions; do not copy from others or from any other sources.

1. Suppose the Milky Way consisted of 2.7×10^{11} stars, each of solar luminosity $M_{\rm B} = 4.7$. What would the absolute magnitude of the whole Galaxy be?

2. The star Rigel has a radial velocity $v_r = 20.7$ km s^{-1}, parallax $\pi'' = 4.22$ milliarcseconds (mas), and proper motion components $\mu_\alpha = 1.67$ mas yr^{-1} in right ascension and $\mu_\delta = 0.56$ mas yr^{-1} in declination. What are its total proper motion, tangential velocity, and space motion (total magnitude of its velocity)?

3. The star S2 orbits the supermassive black hole at the center of the Galaxy on an orbit with semimajor axis $a = 920$ AU and eccentricity $e = 0.867$.

   (a) What is the star's distance from the black hole at the perigee of its orbit?

   (b) How much closer would the star need to get to be tidally disrupted?

4. The Eddington limit isn't just for black holes—it also applies to luminous objects, such as stars, and influences how massive they can be. Using the mass-luminosity relationship for higher-mass stars (see the lecture notes or Section 13.6 of the textbook), determine the maximum mass a star can have while remaining stable against disruption by radiation pressure. Express your answer in solar masses.