Homework 9

Due **November 5 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. (a) If the Sun collapsed down to the size of a white dwarf ($R_{\rm WD} \approx 6000$ km) without losing any angular momentum, what would its rotation period be? (Assume the Sun rotates as rigid body, so that its moment of inertia $I = \frac{2}{5}MR^2$.)

   (b) How fast can this white dwarf-sized Sun rotate before it breaks up? (Break-up speed is reached when the centrifugal acceleration at its equator equals the surface gravity g. Assume the star's shape remains spherical, although this will definitely not be the case in reality.)

   (c) Based on your answer, could a white dwarf be the object behind what we observe as pulsars? Why or why not?

2. Consider a neutron star with a mass of 1.5 $M_\odot$.

   (a) What is its radius, expressed as a fraction of its Schwarzschild radius?

   (b) What is its mean density? How does it compare to the mean density of a carbon nucleus, which has a radius $r \approx 3 \times 10^{-15}$ m.

   (c) If this neutron star collapsed to form a black hole, how close could you get to it before being ripped apart? Assume the human body can withstand 1.4×10^5 N of extending force before tearing apart. Explain the difference between this "ripping radius" and the event horizon of a black hole.

3. Following the timeline given on the class page describing your Communicating Science Projects, submit a paragraph (at least 4–5 sentences) describing the final project: what presentation method was chosen, why, how it will be executed, and a timeline of steps towards completion. You may receive feedback from me and/or a request for more information on this step as well.