Astronomy 102 - Recitation #7

Prof. Kelly Douglass

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Review of lecture 13 and Ch. 6.

Formation of stellar-mass black holes

- If the stellar core mass of a dying star is greater than $2.2M_{\odot}$ (the maximum limit for neutron degeneracy pressure), then the core will collapse into a black hole.
- After collapse, any light coming from the horizon of the new black hole will be infinitely redshifted the "star" (black hole) will appear black.
- Outside the radius of the original star, spacetime is no different. The extreme warping of spacetime around a black hole only takes affect in the space within the original star's radius.
- Within the radius of the original star, space is stretched and time is dilated (slowed).
- Orbital speed at $1.5C_S$ is equal to the speed of light, so no stable orbits exist within $1.5C_S$ of a black hole's horizon.
- The only information about the original star that is retained by the new black hole is mass, spin, and electric charge.
- Because time is infinitely dilated and all geodesics terminate at the horizon of a black hole, time and space appear to be "stuck" to the black hole.

Spinning black holes

- Space is dragged with the edge of a rotating black hole, causing it to twist around the hole. Space appears to move faster the closer one gets to the black hole's horizon.
- The ergosphere is defined to be the region around a spinning black hole within which the orbital speed is greater than the speed of light.

In-class problems

- 1. Black holes
 - (a) Is it possible to extract energy from the ergosphere outside the horizon of a rotating black hole? Why or why not?
 - (b) Describe how time appears to run in the vicinity of a black hole to a distant observer.
- 2. You are very far from a $6M_{\odot}$ star that has collapsed into a black hole. Describe how my meter stick appears relative to yours, if I am standing (a) next to you, (b) where the surface of the star used to be, and (c) just above the horizon of the new black hole. How does my meter stick appear to me in each of these locations?