Monday March 28

Syllabus and class notes are at: www.as.utexas.edu

Reading for this week: Chapter 12

The test this Friday will cover chapters 7-11.

We will have a review session for the test Thursday 6:00-8:00 in RLM 15.216B.

I have a meeting today at 2:00, but will be available at 3:00 in RLM 16.332. The rest of the week my office hours will be at 2:00.
Topics for this week

Describe the Milky Way Galaxy
Describe the Standard Candle method of determining distances and how Cepheid variable stars are used as standard candles.
Describe how astronomers measure the distribution of mass in the Milky Way and what they find.
Explain why we might expect the spiral arms in the Milky Way to become more tightly wrapped and how density wave theory solves this problem.
Orbital speed around a neutron star

We can use Newton’s version of Kepler’s 3\textsuperscript{rd} law to calculate the speed that an object would have when orbiting just above the surface of a neutron star.

The formula is:

\[ \nu_{\text{orbit}} = \sqrt{\frac{GM_{\text{star}}}{a}} \]

For a mass of 2 M\textsubscript{sun} and an orbital radius of 10 km, the orbital speed is about 100,000 km/sec. This is 1/3 the speed of light.
Escape speed

To leave Earth orbit and go to the Moon, the Apollo astronauts had to fire their rockets to increase their speed to about 1.4 times the orbital speed.

$$v_{\text{escape}} = \sqrt{\frac{2GM_{\text{star}}}{R}}$$

For a neutron star with $M = 2\ M_{\text{sun}}$, $v_{\text{escape}} \approx 0.45\ c$

If a neutron star had a mass of about 4 $M_{\text{sun}}$, its gravity would make it smaller than 10 km, and its escape speed would be greater than the speed of light.
Black Holes

In fact, if an object is dense enough that escape speed from its surface is greater than the speed of light, light will not be able to escape from the object. This is a black hole.

The theory of General Relativity says that if a mass \( M \) is inside of a radius \( R \) with \[
\frac{2GM}{R} = c^2
\]
the mass will all fall to the center, and not even light will ever get out.
It’s not so bad

Although you need to use General Relativity to calculate the paths of objects near a black hole, farther away you can still use Newton’s laws.

If the Sun collapsed into a radius of 3 km it would be a black hole.

But the Earth would still orbit it just like it does now.

General Relativity give the same predictions as Newton’s laws is long as you are far enough from an object that the orbital speed is much less than the speed of light.
Weekly Quiz
The Milky Way

A hazy band of light across the sky
Latin: Via Lactea, or Milky Road
Astronomy: Galaxy

Galileo saw that it was made of many stars.
The stars form a band across the sky because they are in a flat distribution, like people in this room.
Could you determine the distribution of people in this room, and your position in that distribution from observations without leaving your seat?
Groups of four

Form a group of four students.
Choose one student as the discussion leader and one as the scribe.

Answer two questions:
1. What method could you use to map out the distribution of people in this room? You can invent measurement devices, but you cannot leave your seats.
2. What difficulties or biases in your results would you encounter?

I will ask several groups to report on their methods and expected difficulties.
Spiral Galaxy NGC 4414