

Wednesday, March 30, 2016

*Exam back Wednesday, key posted.*

*Exam 4, Skywatch 4, Friday, April 15.*

Chapter 8 Neutron Stars - Sections 8.1, 8.2, 8.5, 8.6, 8.10

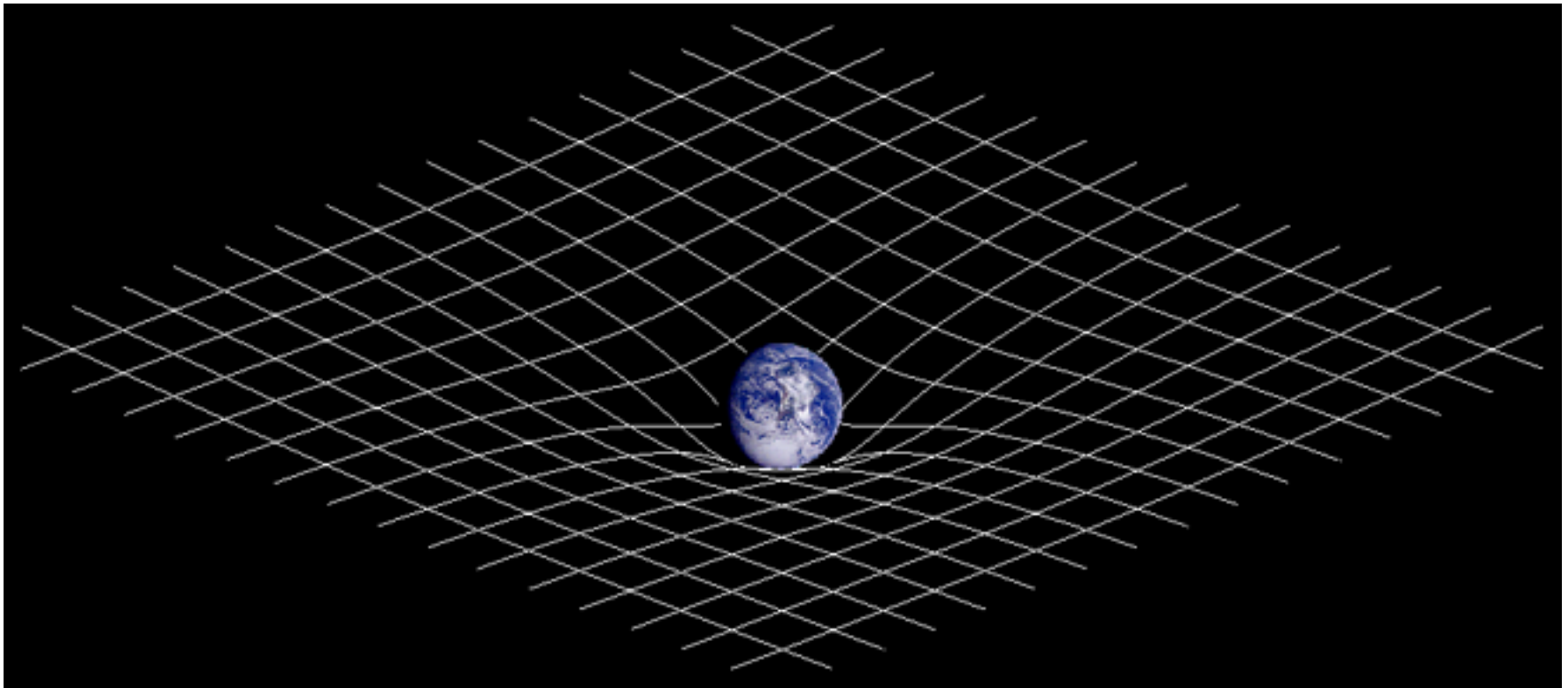
Chapter 9 Theory of Black Holes: 9.1 to 9.5 (update at end of week)



Astronomy in the news

Argyre basin on Mars has characteristics to support life.  
Dirt on top of ice. Dripping water.

What's wrong with this picture?



## One Minute Exam

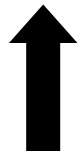
An astronomer fires two laser beams so they will pass near a distant black hole. The beams are initially parallel. An astronaut on the far side of the black hole tracks the two beams and finds that they are diverging, but that they never crossed. This means that:



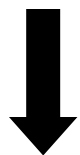
one of the beams entered the black hole



the beams passed on opposite sides of the black hole



the beams passed on the same side of the black hole

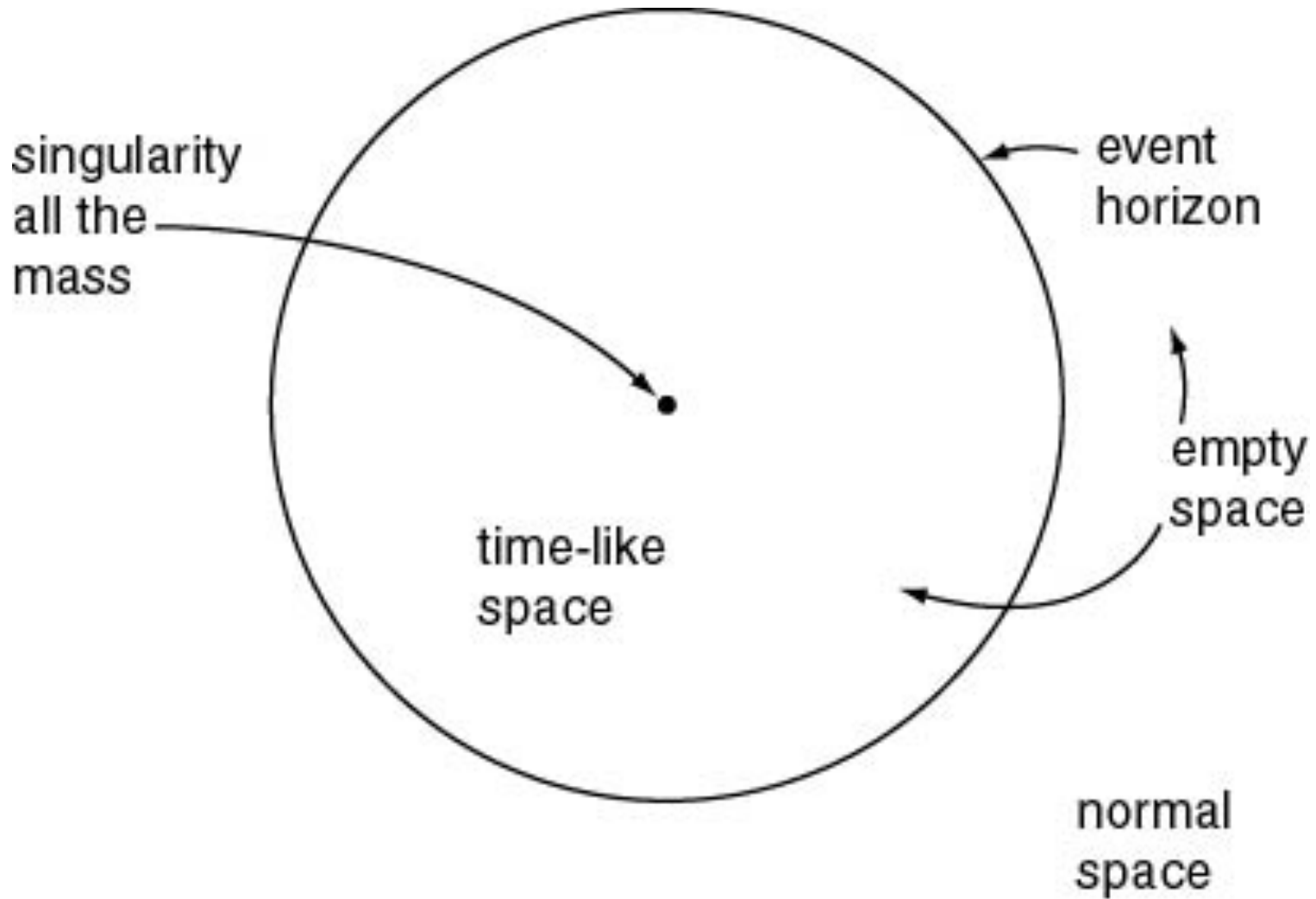


one of the beams had more energy than the other

Goal:

To understand the basic features of a black hole

# Figure 9.1



Basic properties of a (non-rotating) black hole

In Einstein's theory of gravity, black holes are predicted to have an *event horizon* and a *singularity*

**Event horizon:** the surface within which nothing travelling at or less than the speed of light can get out.

=> No event within the event horizon can be witnessed from outside

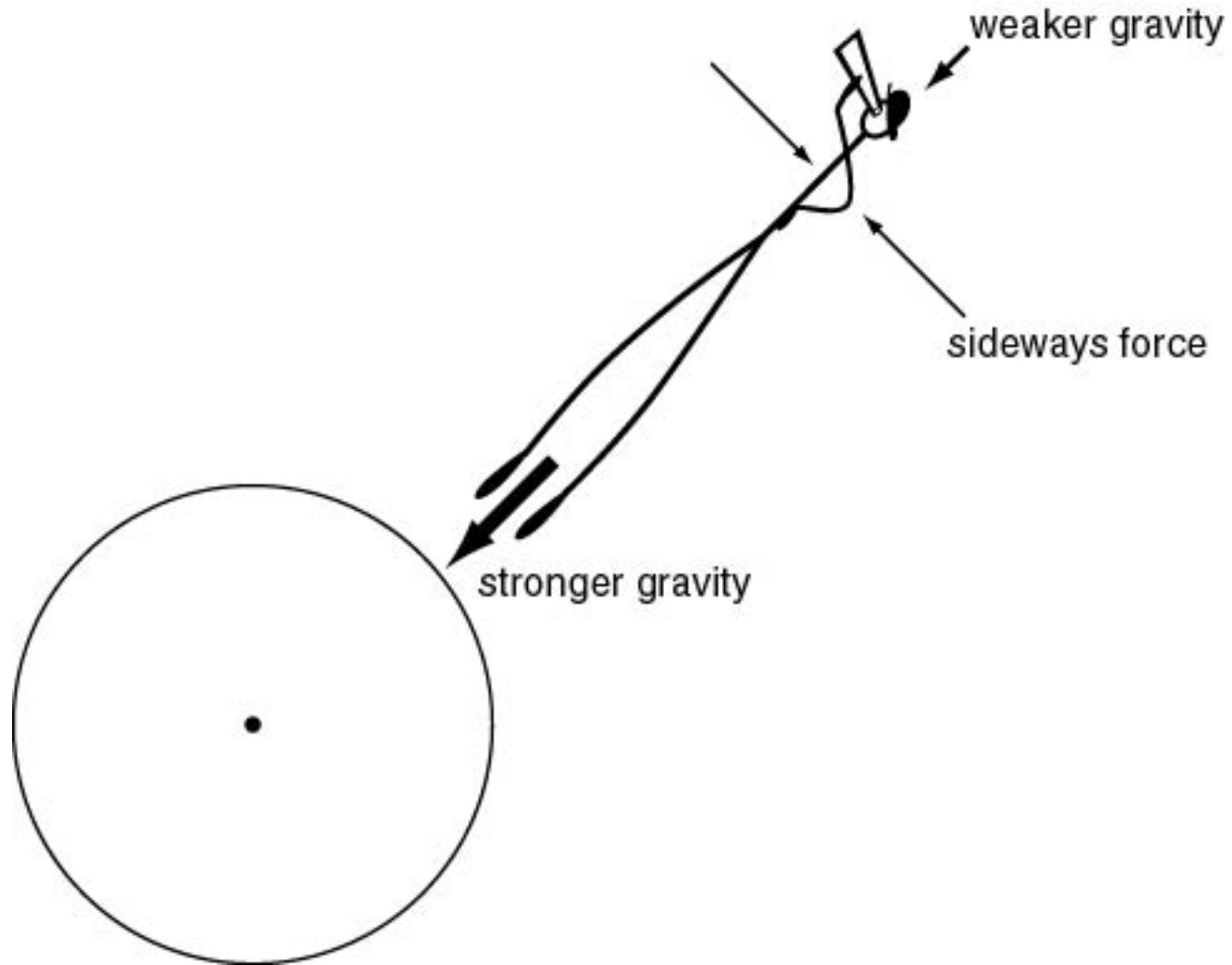
**Singularity:** Finite mass, zero radius, zero volume

=> infinite density, infinite tidal forces, the end of space and time.

Goal:

To understand what it is like to die falling into a black hole.

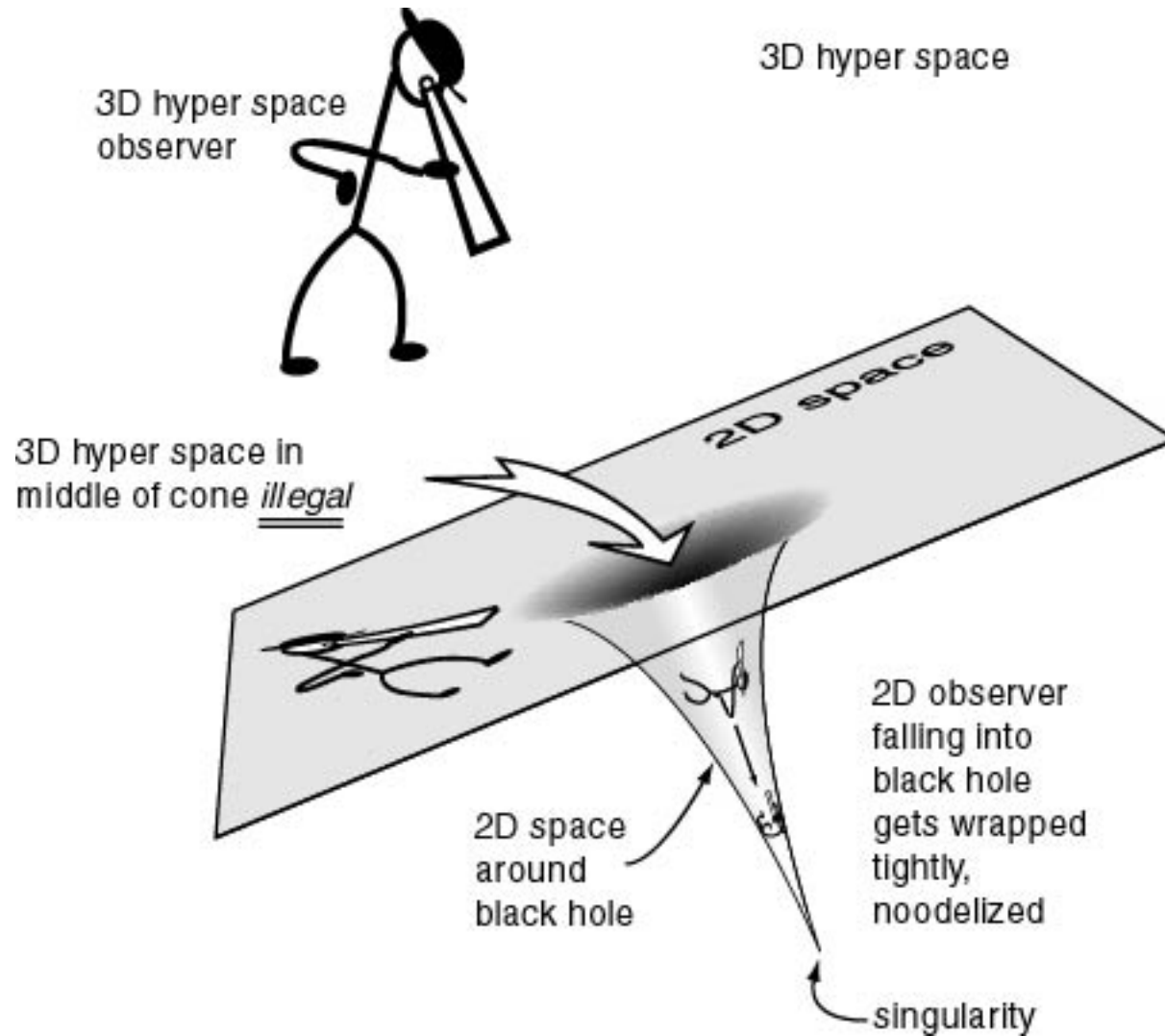
# Figure 9.2



Tidal Forces – Death by Noodle-ization



# Figure 9.3



2D embedding diagram of 3D curved space around a black hole

Goal:

To understand how time works in curved space and near black holes.

## Black holes and Time (Section 9.5.2)

What does it mean to fall? Rather deep and strange phenomenon!

Drop things, fall at same rate...

Falling involves the passage through time as well as space.

# Falling According to Einstein

According to Einstein - curved space around gravitating objects “flows” inward - *inward escalator*. Necessary to truly understand orbits.

If an object floats with *no force* in space (free fall), it will move toward the center of gravitation

⇒ falling - all objects respond to the same curvature, have the same acceleration

Like water down a drain - sit still in the water, but go down the drain.

Must exert a force to resist, to avoid free fall, to avoid the flow of space inward toward the center of the gravitating object.

**Freely falling object has no force on it. You, sitting there, do.**