Friday, April 10, 2015

4th Exam, Skywatch, Week from today, Friday, April 17

Reading:

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 (Note Revision)

Astronomy in the news?

Goal:

To understand the "real" curved space of a gravitating object in three dimensions

3 D gravitating space is not a "cone;" that is just an artifact of the 2 D embedding diagram.

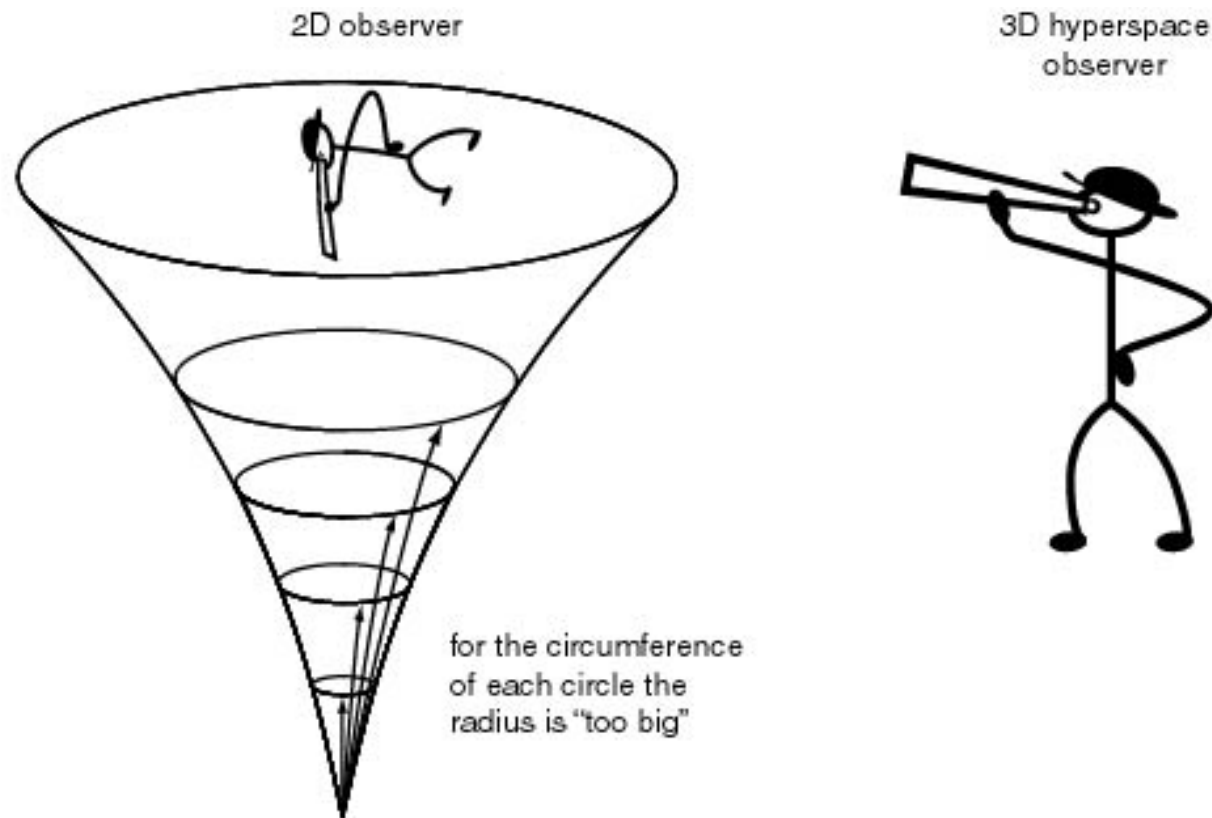Real 3 D space around gravitating objects has the properties:
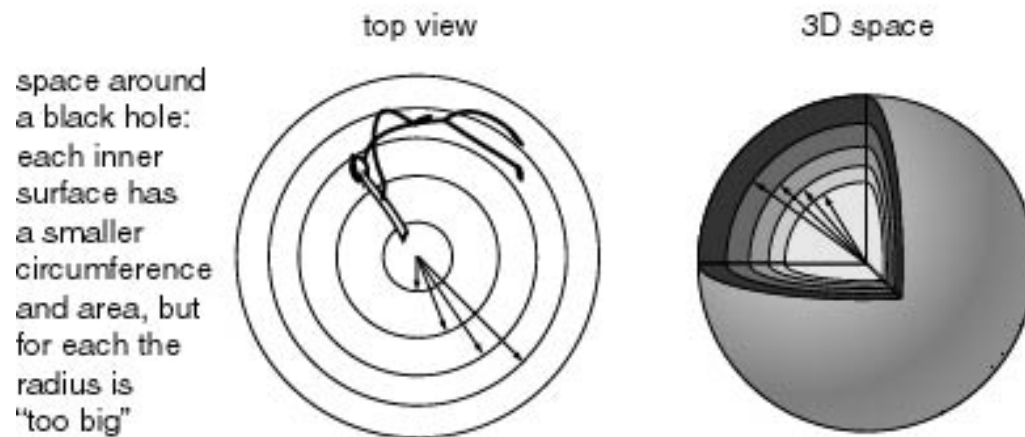
$C < 2\pi R$

Δ not equal 180°

// lines cross or diverge

light is deflected (this one has been experimentally verified)

Fig 9.6

2D observer

3D hyperspace observer

for the circumference
of each circle the
radius is "too big"

Curved 3D space

space around
a black hole:
each inner
surface has
a smaller
circumference
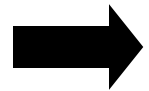and area, but
for each the
radius is
"too big"

top view

3D space

First edition book cover…

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
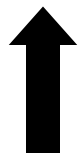
↑ the beams passed on the same side of the black hole
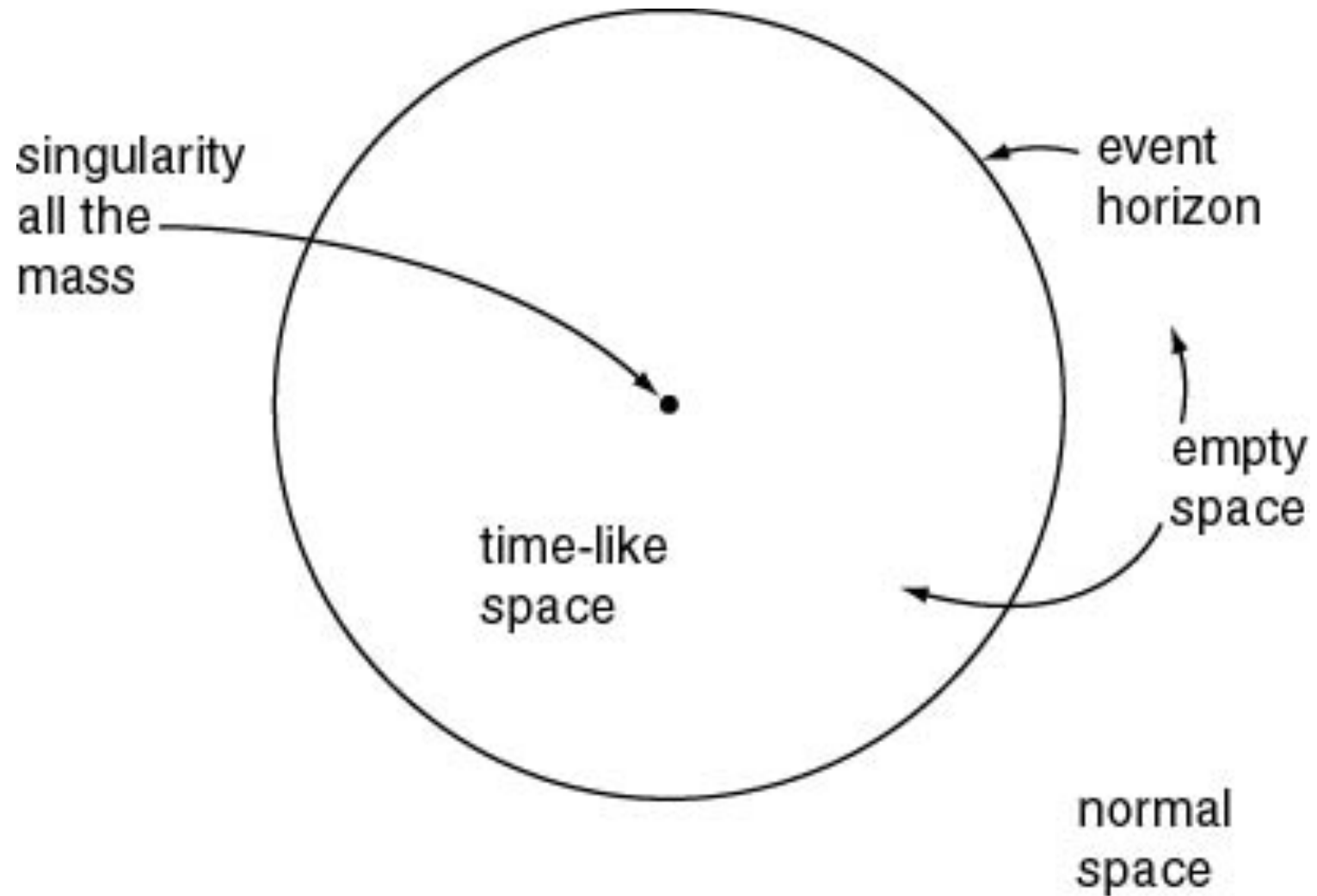
↓ one of the beams had more energy than the other

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.

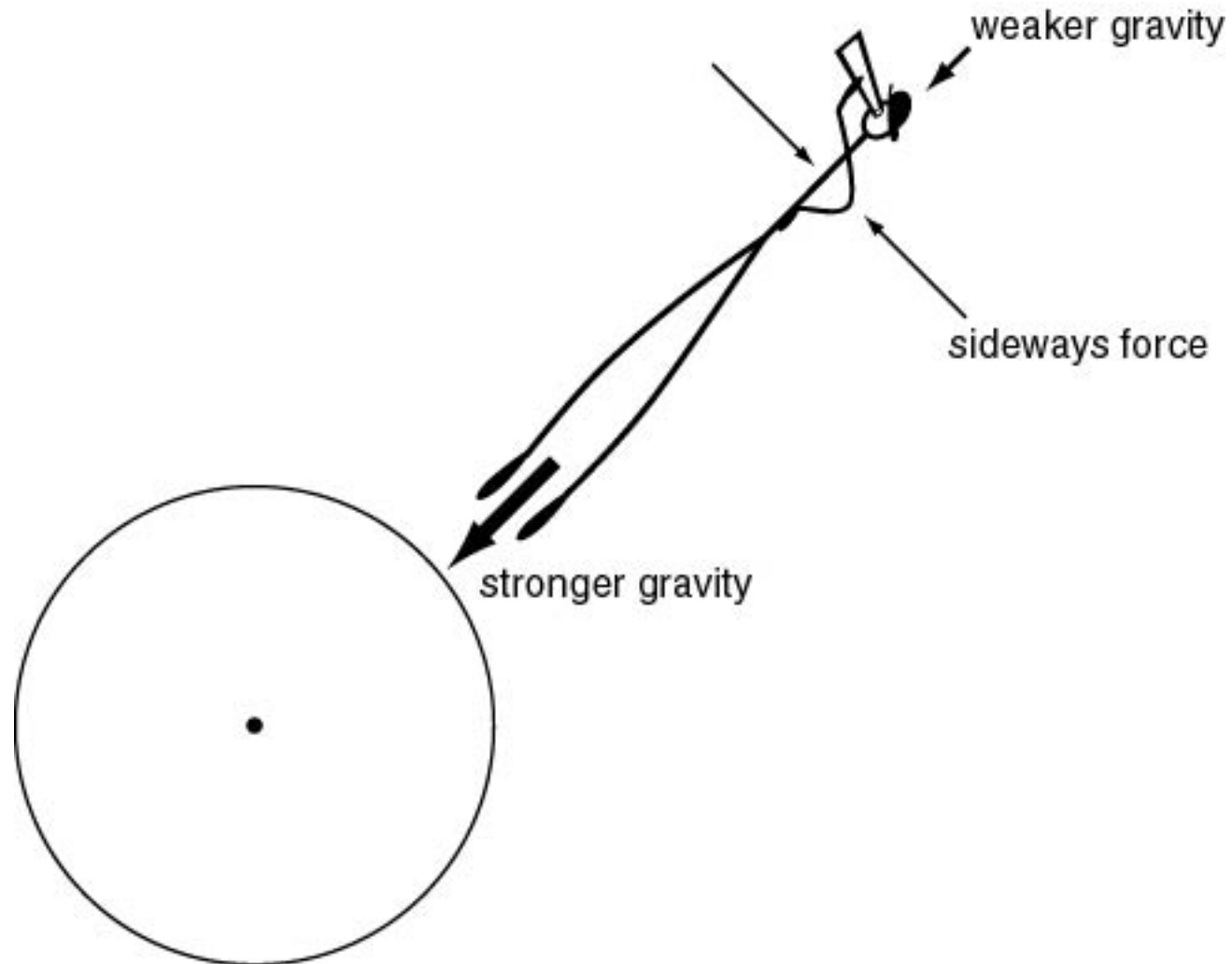=> No event within the event horizon can be witnessed from outside

Singularity: Finite mass, zero radius, zero volume

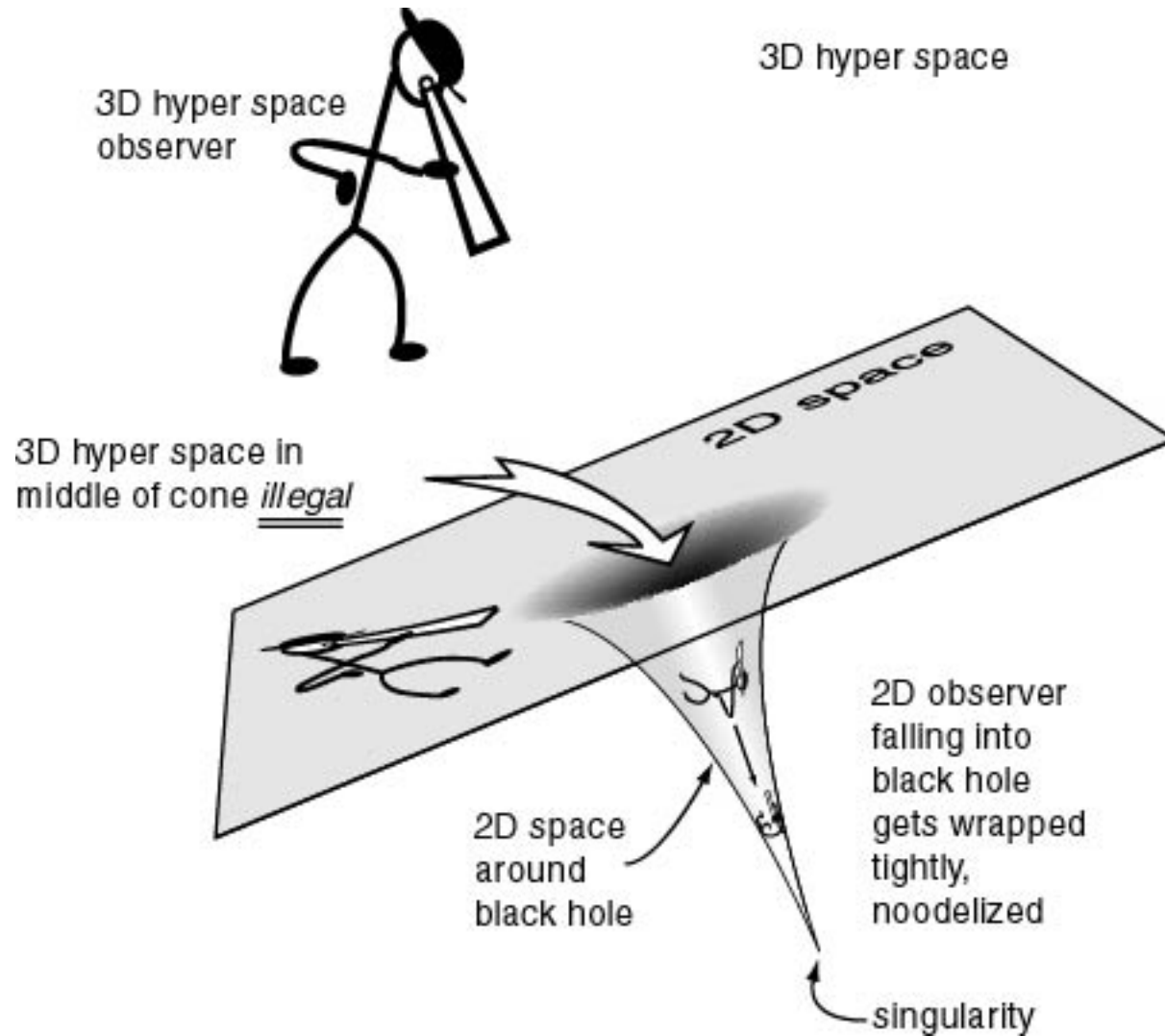=> infinite density, infinite tidal forces, the end of space and time.

Goal:

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

Figure 9.2

weaker gravity

sideways force

stronger gravity

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

$\Rightarrow$ 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.