Monday, April 10, 2017

Change of travel plans, Wheeler here all next week.

Exam 4, Skywatch 4, Friday, April 21.

Reading for Exam 4:

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, 9.8

Astronomy in the news?

April 6 was the 100th anniversary of the declaration of war on Germany by the U. S. Working on the front lines during that war, Karl Schwarzschild wrote down the first mathematical representation of a black hole using Einstein's equations of gravity.

Goal:

To understand the nature of time-like space inside a black hole.

Figure 9.1
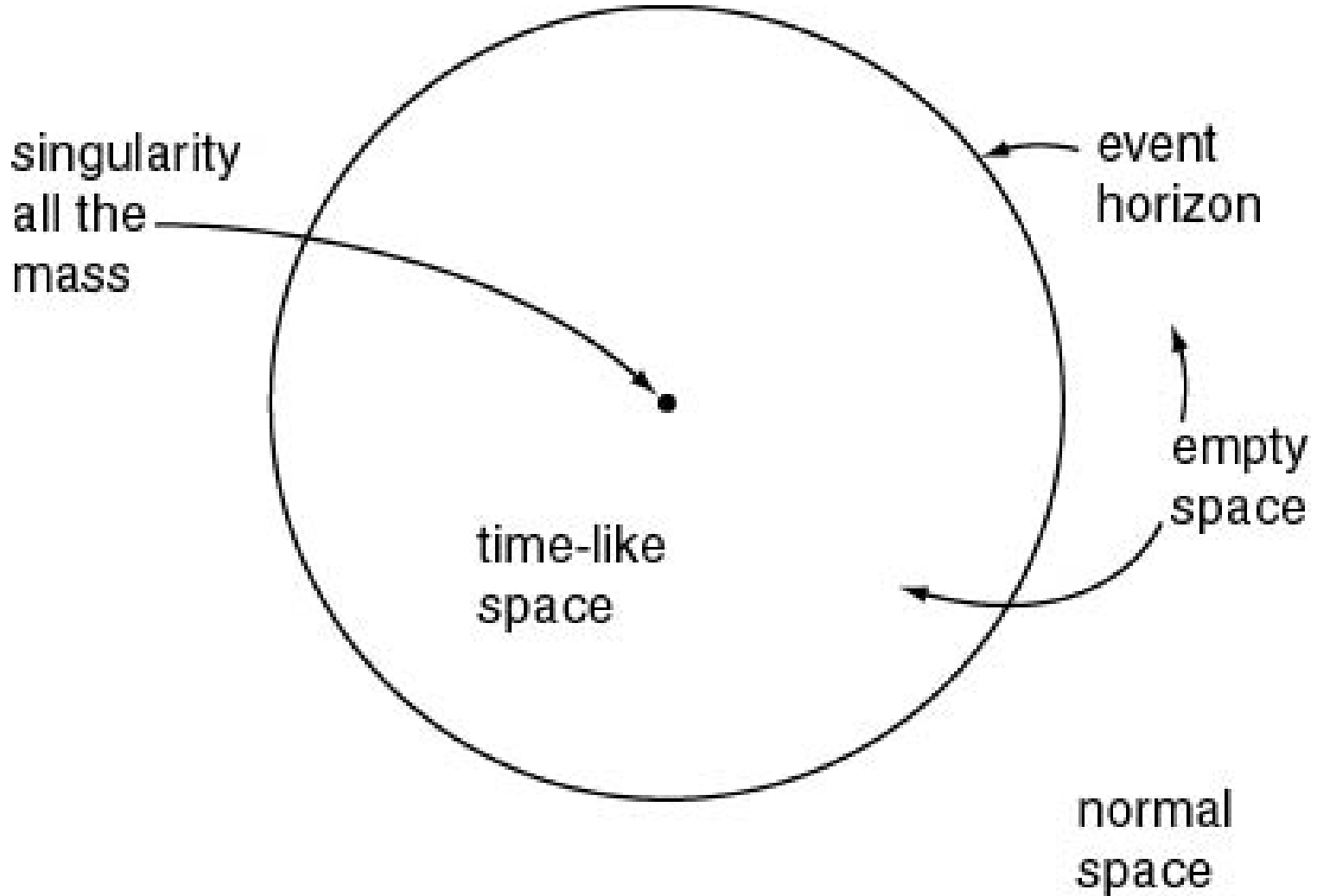
Basic properties of a (non-rotating) black hole

Normal 3D space – space you can move around in and return to the place you started.

Time only flows onward, one way, you cannot return to the time you started.

Time-like 3D space – space acts like time, you can wiggle back and forth a bit, but as time passes, you are forced by the flow of space to move in one direction, just as time flows in only one direction.

The event horizon of a black hole separates normal from time-like space. Inside the event horizon, you are in time-like space, everything, including light, is forced to move inward by the inward flow of space.

The real reason black holes are black.

Goal:

To understand the full space-time associated with non-rotating black holes.
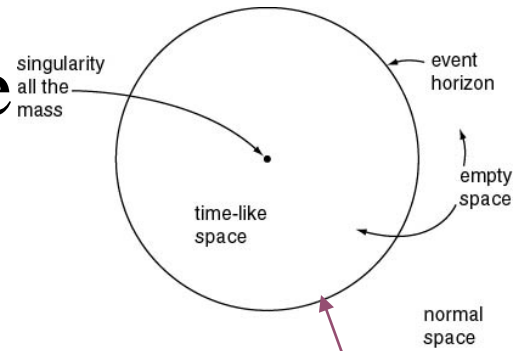
Non-rotating Schwarzschild Black Hole

singularity
all the
mass

event
horizon

empty
space

time-like
space

normal
space

Event horizon is also surface of infinite redshift

Mass, but no spin, no electrical charge

Assume all mass is in the singularity, no mass anywhere else (assumption necessary to solve equations)
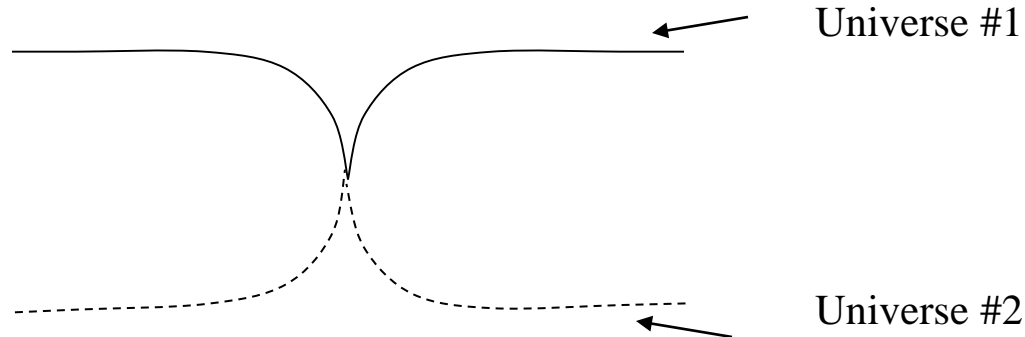
Find two Universes, each of infinite space, connected at one instant by the singularity.

Cannot pass from one to the other if travel at less than the speed of light.

Universe #1

Slice of embedding diagram

Universe #2

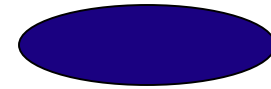Somewhere else in hyperspace

Goal:

To understand the full space-time associated with rotating black holes.

Rotating Kerr Black Hole

Mass and spin, but no electrical charge

Assume all mass is in the singularity, no mass anywhere else
(assumption necessary to solve equations)

Find **singularity is a ring** (not a point)

0 thickness, ∞ density, still infinite tidal forces

Infinite Universes!

(implicitly spread through hyperspace)

Cross-sectional view of rotating Kerr black hole

Event horizons
(one-way membranes)

Surface of infinite redshift

INWARD time-like
space

Ring singularity

Highly curved
normal space

Another space through the ring

Fly in, never to return

Ergosphere
highly curved
rotating
normal space
tap rotational energy