10/27/04

Test 3, Chapters 8, 9 Friday, October 29.

Review sheet posted.

Review session TODAY RLM 15.216B 5 - 6 PM

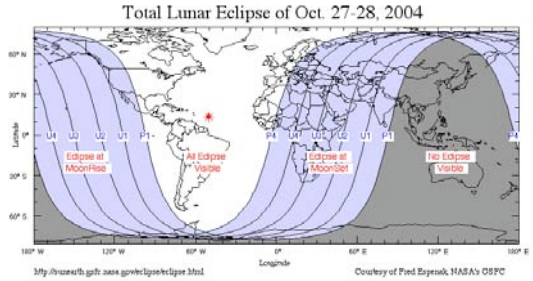
Wheeler gone Wednesday after 3.

News?

Eclipse tonight, start 8 PM darkest about 9:30 - 10:30

Burt Rutan (SpaceShip1) 10am Friday, October 29, in the LBJ Auditorium. www.me.utexas.edu/rutan

Pic of the day: Lunar eclipse



Hawking Radiation

Loss of energy is not arbitrary, it comes out in a very precise form…

Black Holes radiate Hawking radiation as if they had a temperature that depends (inversely) on the mass.

Black holes are not totally black

Given enough time, black holes will evaporate!

Hawking Radiation

If the black hole has the mass of a star, the time to evaporate will be ***much*** longer than the age of the Universe, so unimportant.

If the black hole has the mass of a mountain or asteroid (The Krone Experiment), it can evaporate in the age of the Universe (13.7 billion years).

As mass $\downarrow$ T $\uparrow$ with energy loss, less mass, hotter, more radiation.

Small mass black holes can explode, disappear within the age of Universe.

Theories that mini-black holes might be created in the Big Bang (no hint in any observation).

Hawking Radiation

Information Loss??

Deep issue.

What happens to the ***information*** about all the stuff that fell into the black hole?

Quantum theory insists there must be no loss of information.

Maybe it is in the radiation (Hawking) or maybe it is still somehow in the singularity (string theory).

Does the singularity disappear? Don't know in absence of theory of ***Quantum Gravity***

§ 7 Fundamental Properties of Black Holes

The fundamental properties of black holes are electrical charge (usually taken to be zero), mass, and spin (angular momentum).

All other properties, radius of event horizon, Hawking temperature come from that.

No other properties like mountains, structure, DNA,

Not even number of protons, electrons and neutrons that fell in (profound information loss).

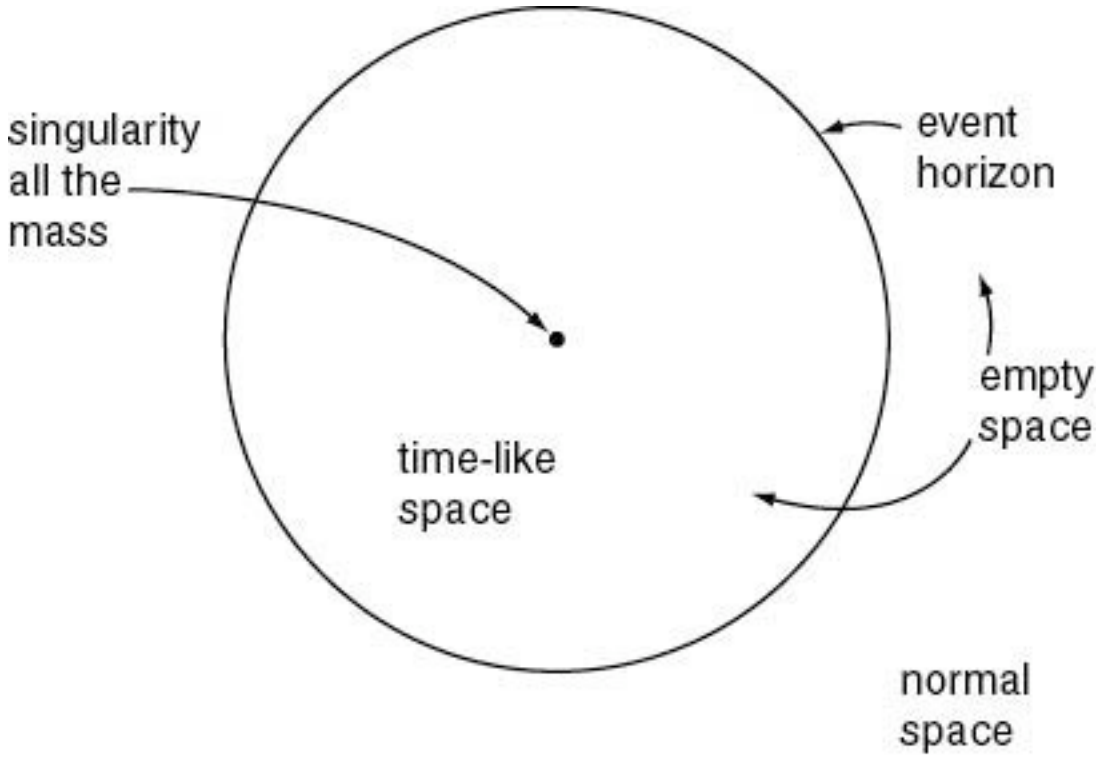
Thought experiment: one neutron star, one anti-neutron star.

$$n + \bar{n} \longrightarrow \text{explosion}$$

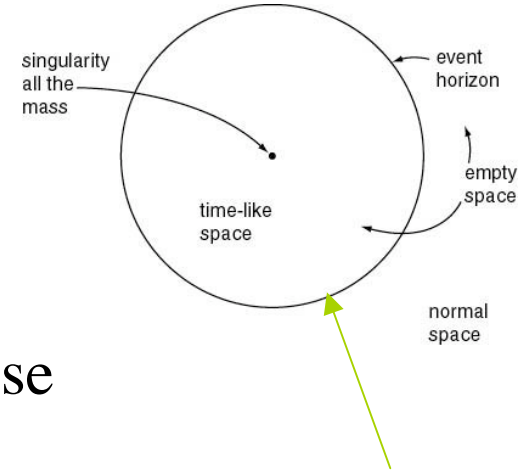
$$\searrow \text{2 BH -> One large Black Hole}$$

Black holes transcend ordinary physics of matter/anti-matter

§ 8 Time-like space
Figure 9.1



Non-rotating Schwarzschild Black Hole



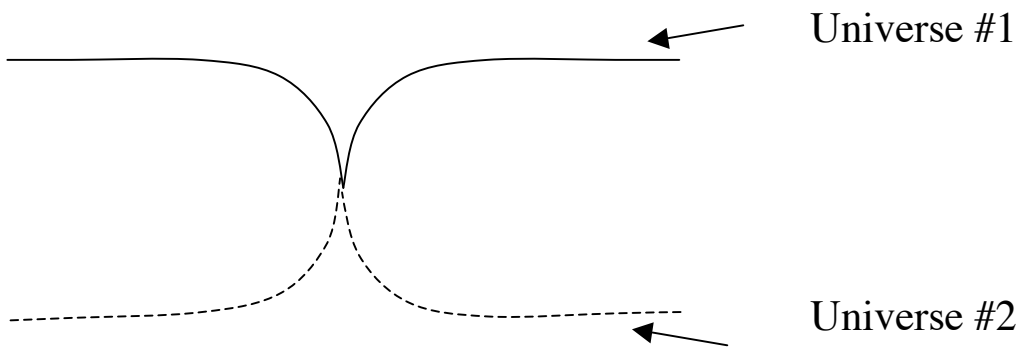
Mass, but no spin, no electrical charge

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

Find two Universes, each of infinite space, connected at one instant by singularity.

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

Event horizon is also surface of infinite redshift

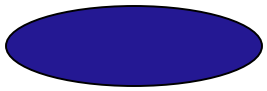


Rotating Kerr Black Hole

Mass and spin, but no electrical charge

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

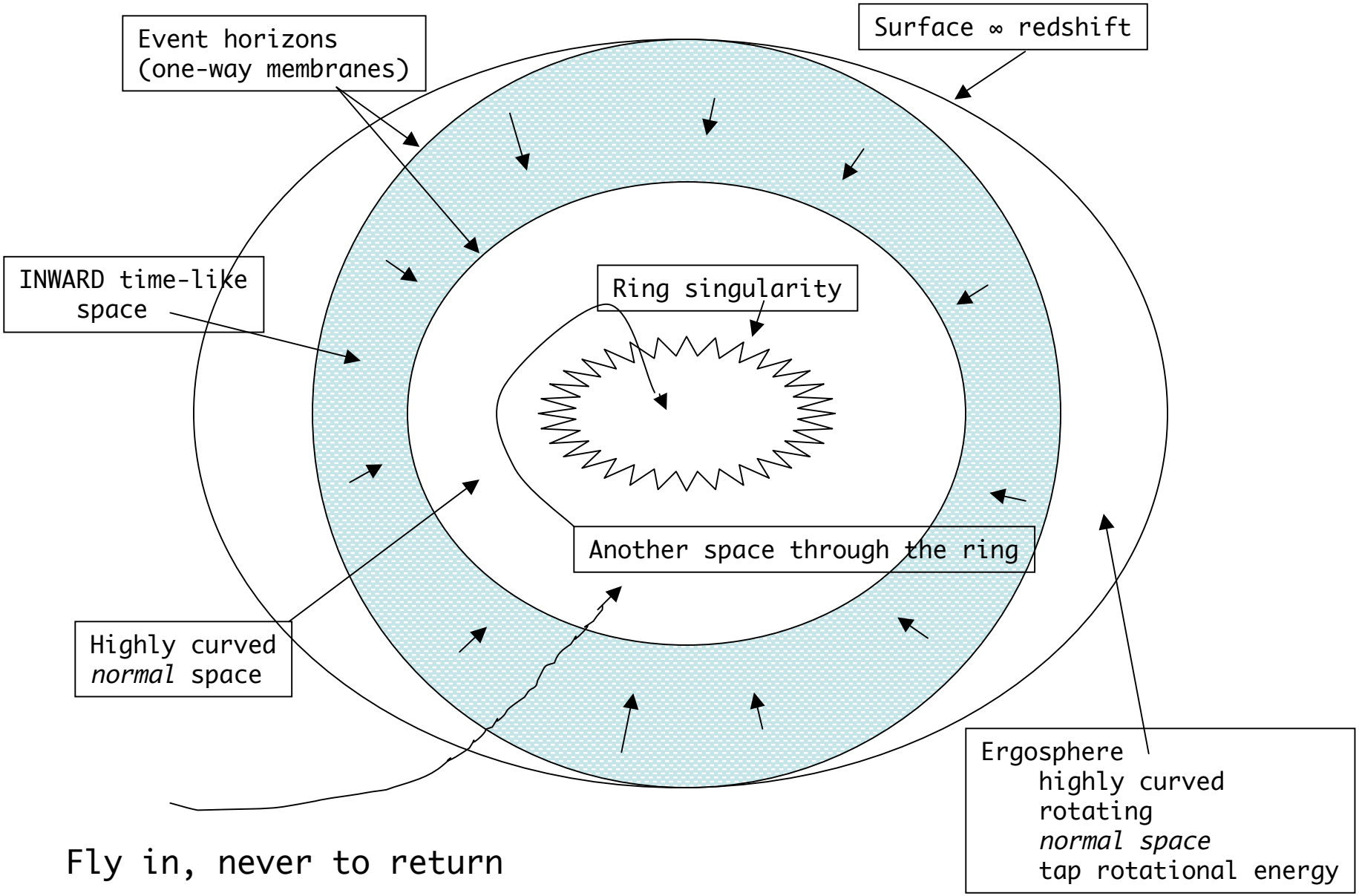
Find ***singularity is a ring*** (not a point)



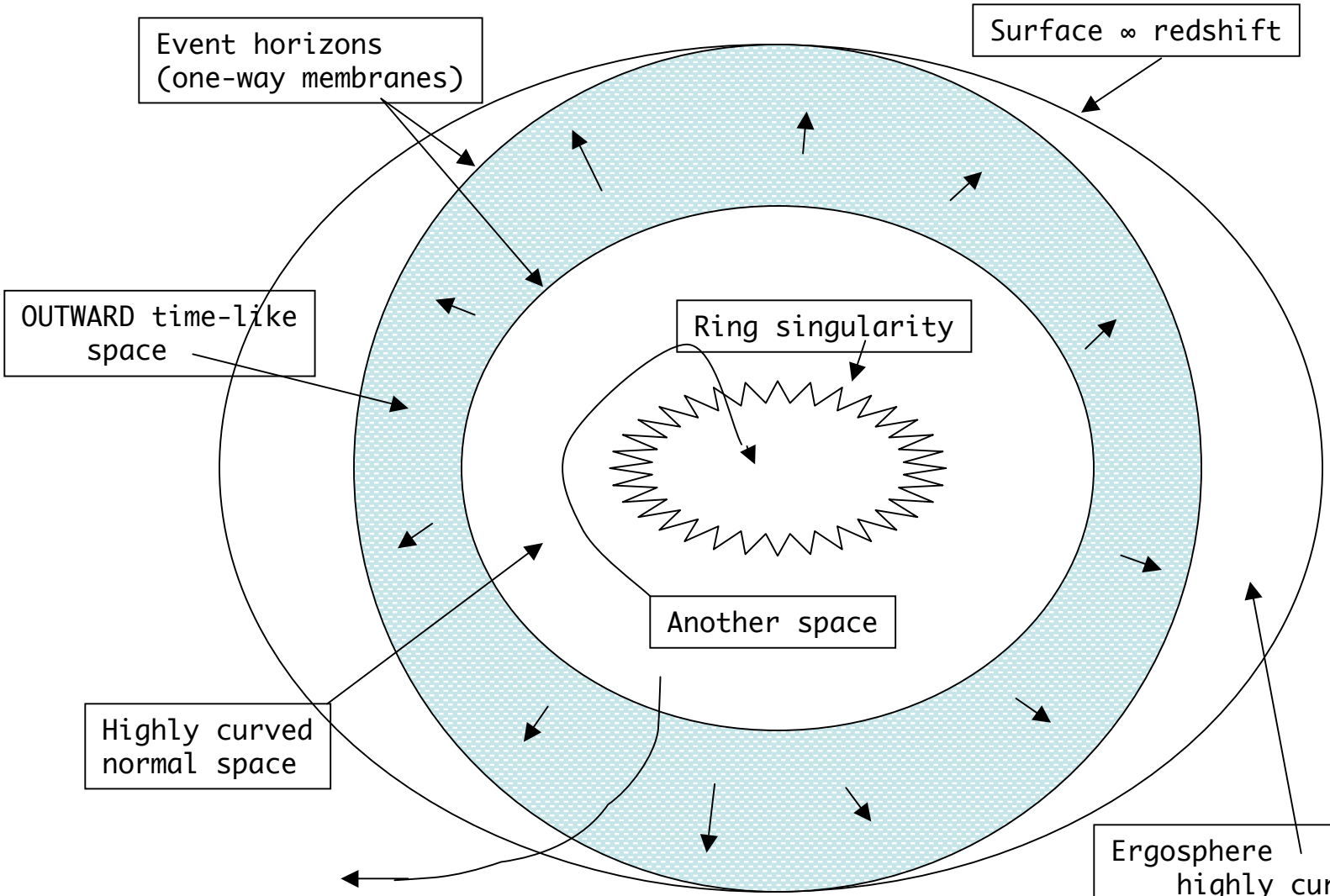
0 thickness, ∞ density, still uncertainty problem

Infinite Universes!

Cross-sectional view of rotating Kerr black hole



In future



Access to Universe different
than original one

Are Different Universes Real?

In Real Universe:

Light falls in

Accelerated to higher energy: Bluesheet

warp space

change mathematical, hence physical solution

So, probably not in this case, but stay tuned…