10/31/07

Astronomy in the News - trouble with solar panels on the International Space Station

Pic of the day - Ghost Head Nebula

Check out

Dr. Quantum in Flatland

Right in spirit, wrong in some essential details. See if you can figure out what those are.

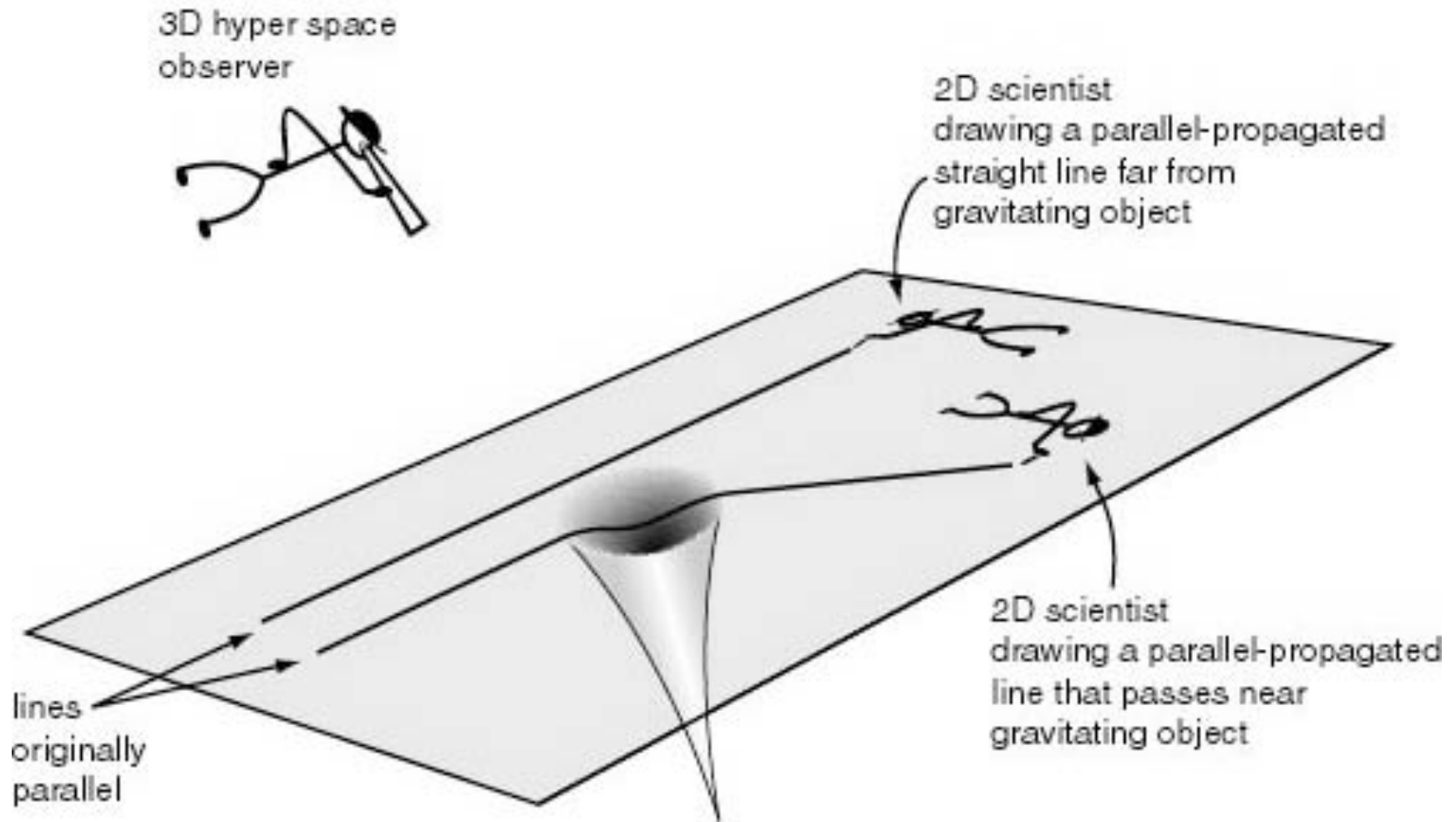http://youtube.com/watch?v=KhbGYn7aAUk

Embedding diagram:

Real Space   -> Embedding Diagram Space

Volume (3D) ->   Surface (2D)

Surface (2D)   ->   Line (1D)

Line (1D)   ->   Point (0D)

Figure 9.4

3D hyper space
observer

2D scientist
drawing a parallel-propagated
straight line far from
gravitating object

lines
originally
parallel

2D scientist
drawing a parallel-propagated
line that passes near
gravitating object

Straight lines in the 2D embedding diagram of curved, gravitating space.
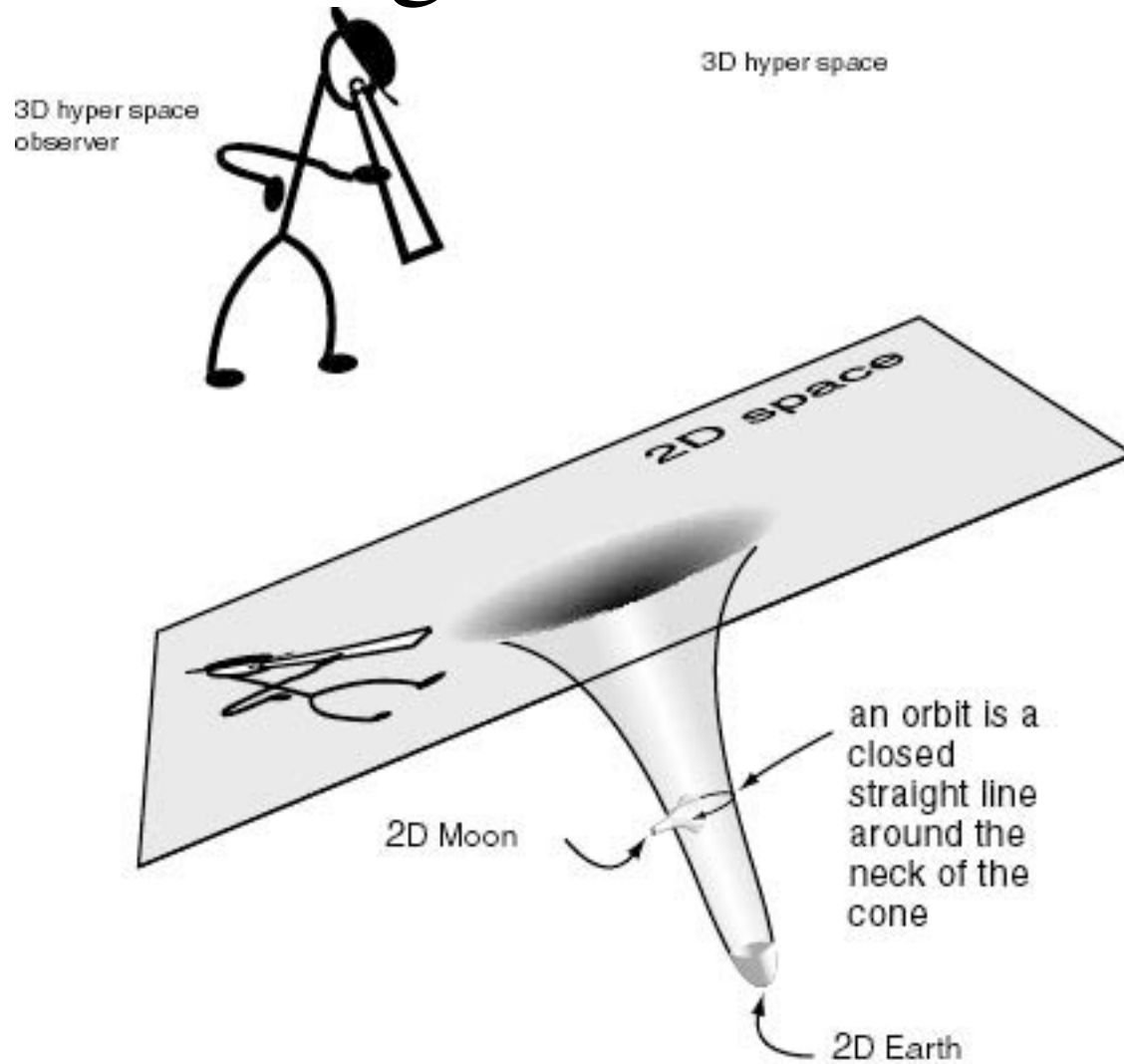
Orbit - circle around "cone"

Moon is going as straight as it can in curved space around the Earth

This is how gravity works for Einstein - no Newtonian Force -

Gravitating objects curve the space around them - nearby objects move in that curved space

The parallel-propagated straight lines of their force-free motion are warped by the curved space.

Figure 9.5

3D hyper space observer

3D hyper space

2D space

an orbit is a closed straight line around the neck of the cone

2D Moon

2D Earth

Orbits in curved 2D embedding diagram of gravitating space

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

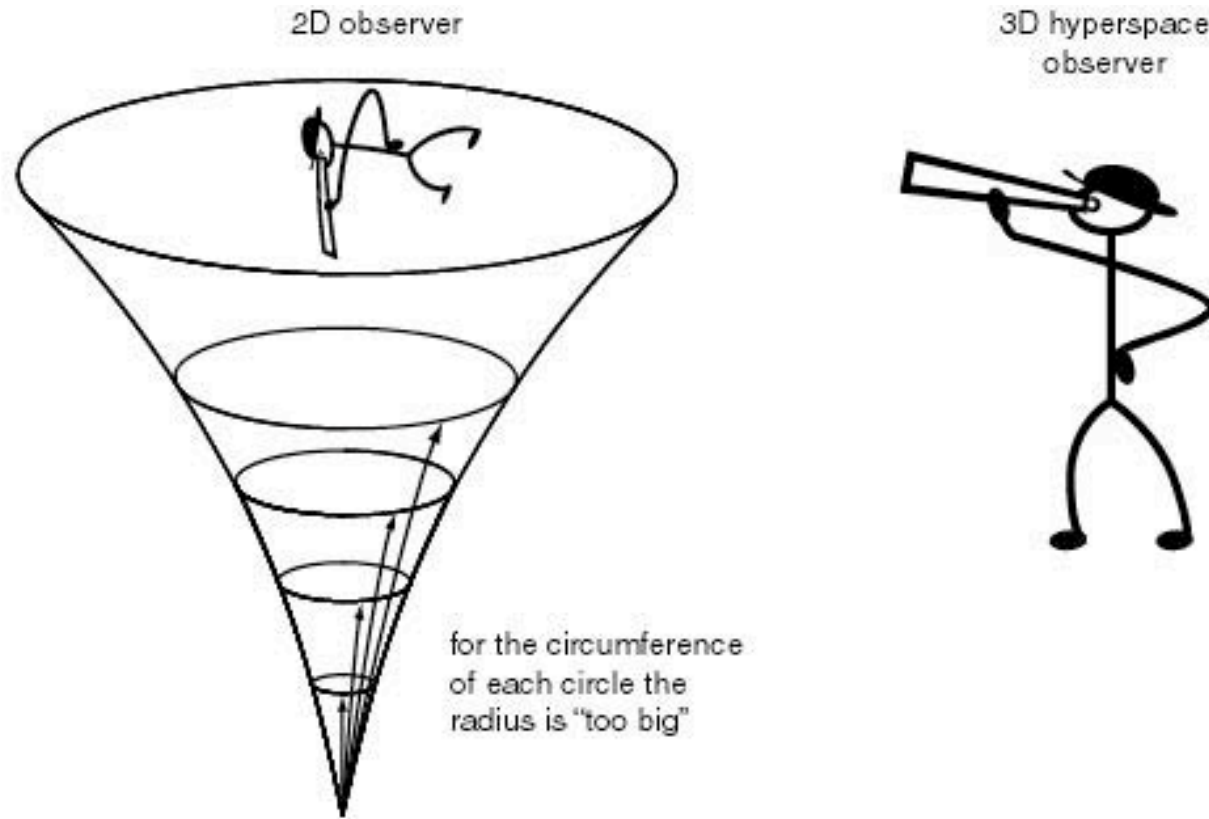Real 3 D space around gravitating objects has the properties:
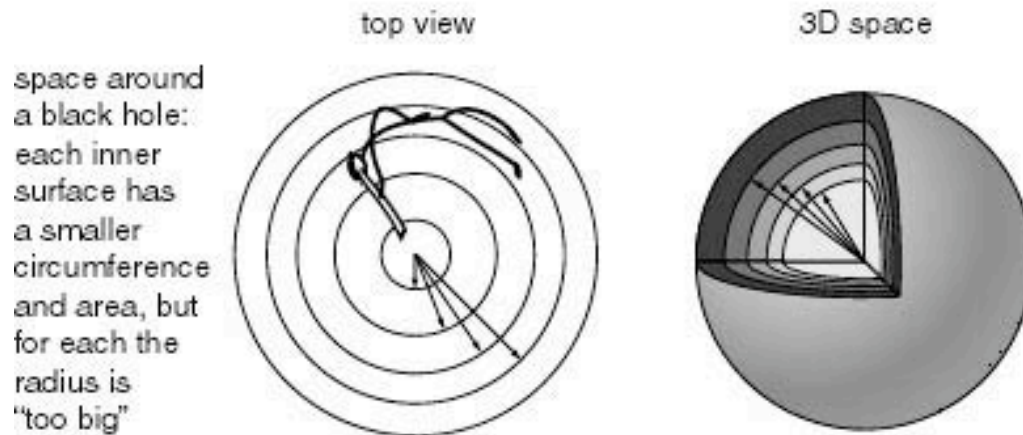
$C < 2\pi R$

Δ not equal 180°

// lines cross

light is deflected (this one has been experimentally verified)

Fig 9.6

2D observer

3D hyperspace observer

Curved 3D space

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

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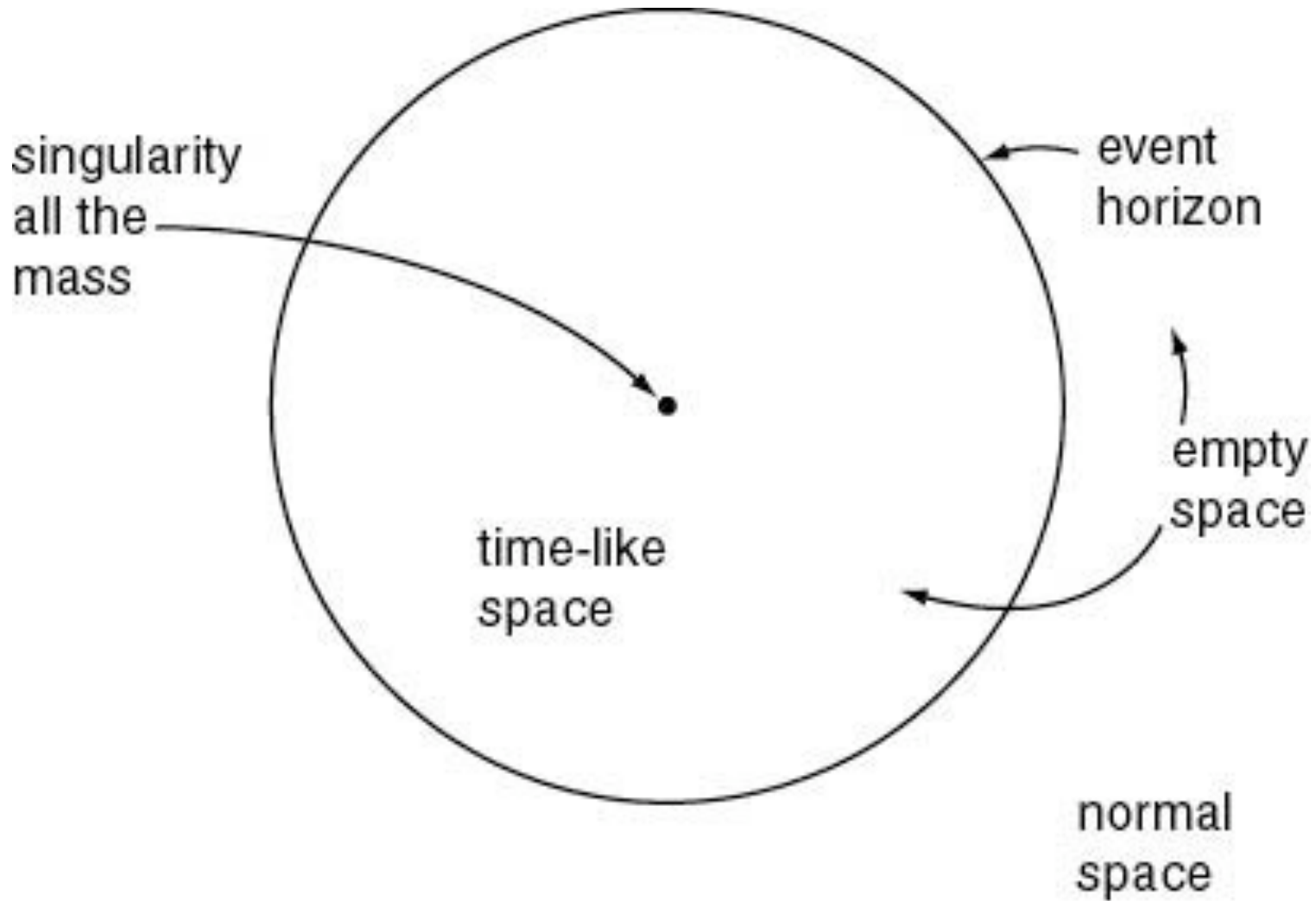
top view

3D space

One Minute Exam

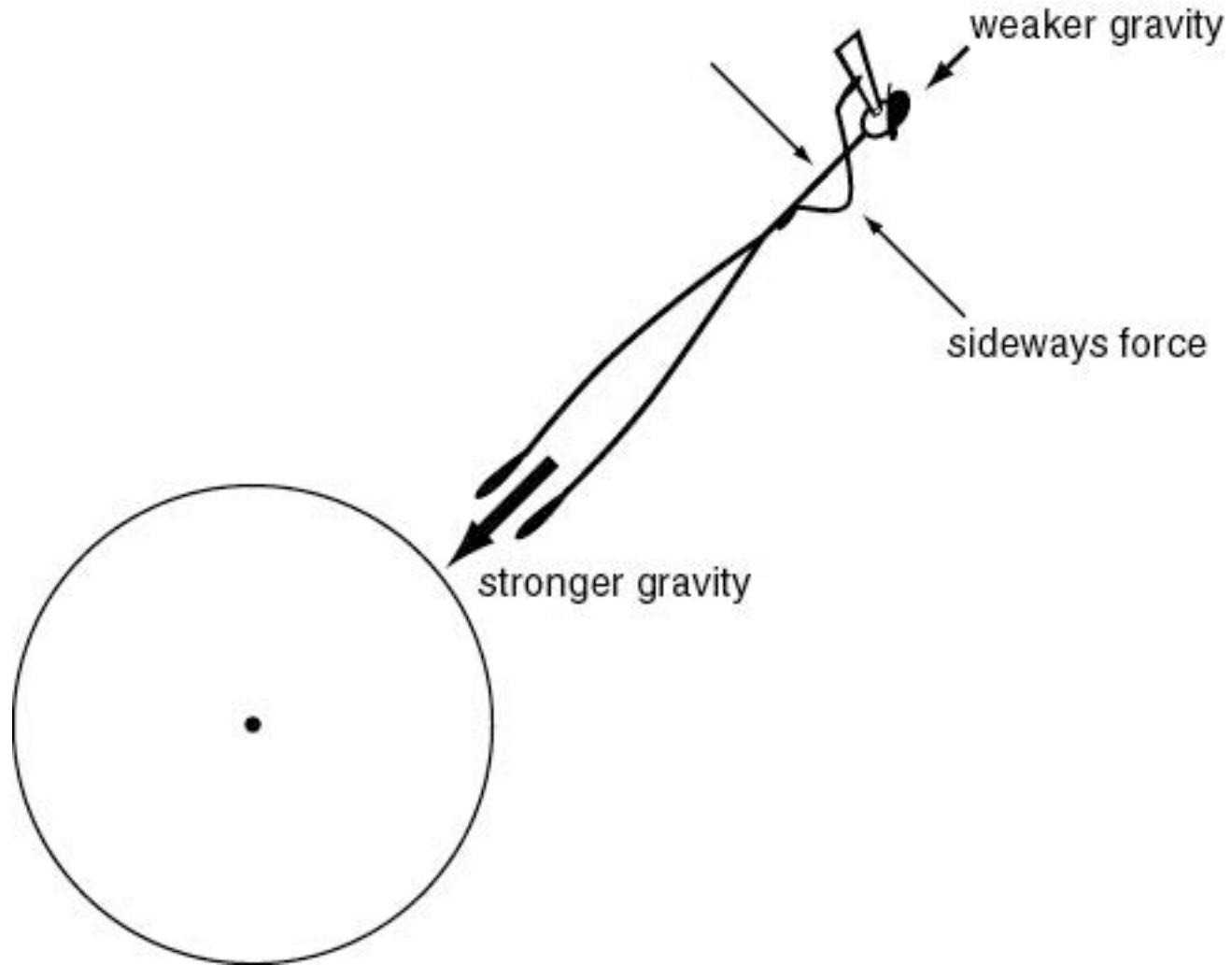Compared to the two-dimensional surface of a balloon, the inside is:

A) A two-dimensional hyperspace

B) A three-dimensional hyperspace

C) A four-dimensional hyperspace

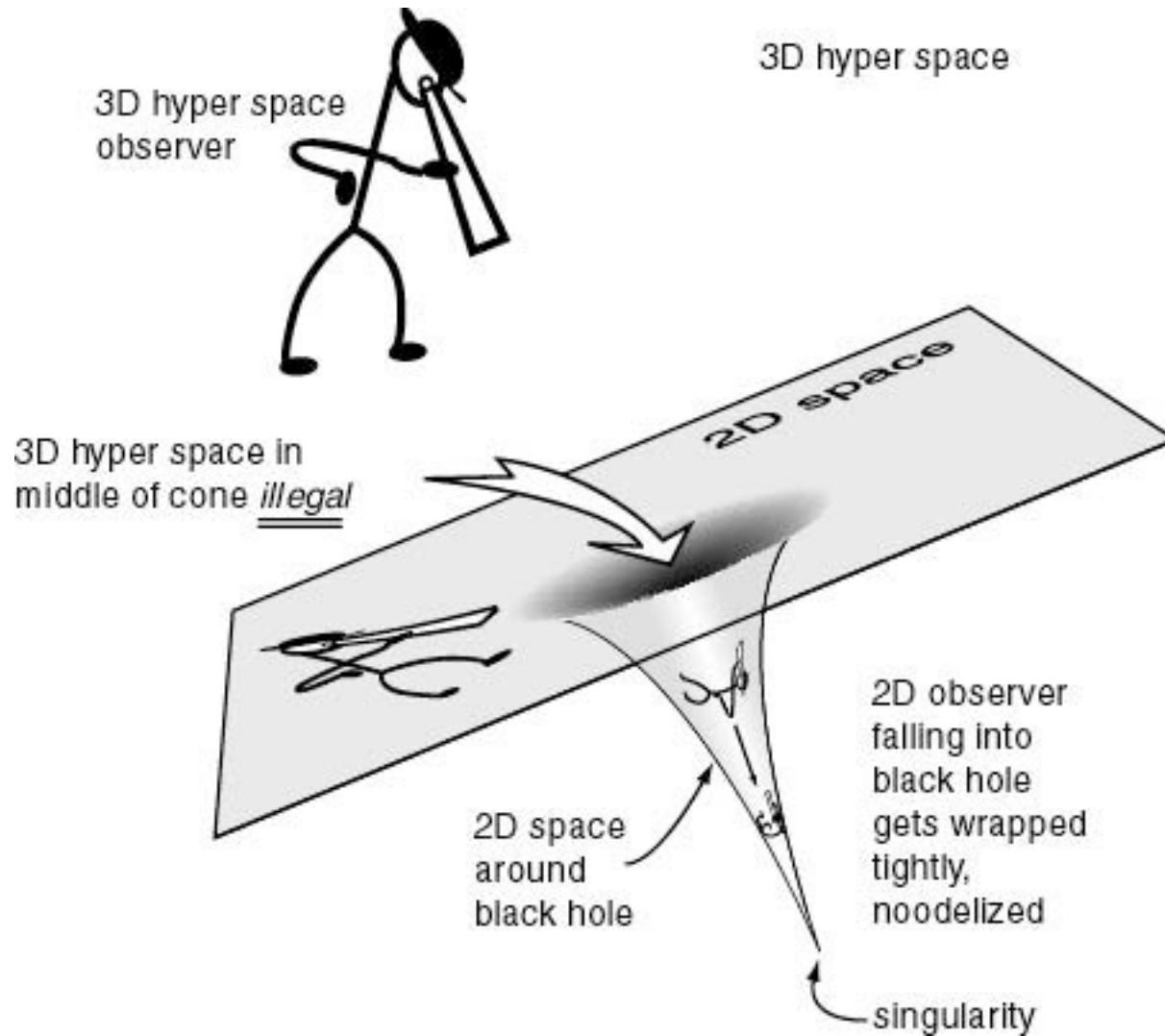D) Accessible to a two-dimensional creature

Figure 9.1

Basic properties of a (non-rotating) black hole

Figure 9.2

weaker gravity

sideways force

stronger gravity

Tidal Forces

Figure 9.3

3D hyper space observer

3D hyper space

3D hyper space

2D space

3D hyper space in middle of cone *illegal*

2D observer falling into black hole gets wrapped tightly, noodelized

2D space around black hole

singularity

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

Black holes and Time (Section 5.2)

If a clock moves away from an observer it ticks more slowly.

If a clock is deep in a gravity well it ticks more slowly according to an observer at large distance where gravity is absent.

Get both effects if you drop a "clock" into a black hole and watch it fall in from a safe distance where gravity is weak (flat 3D space).

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

Drop things, fall at same rate…