November 22, 2010

Reading: Chapter 12, 13, 14

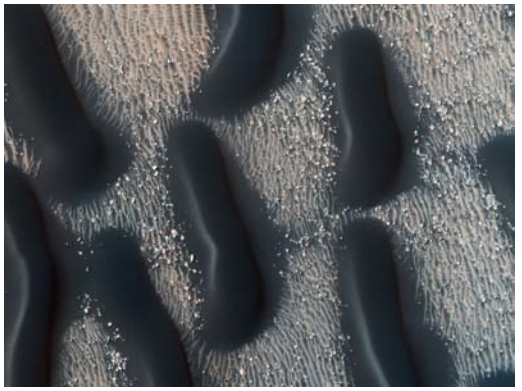
Electronic Course Instructor Survey, now until 12/3/10.

https://utdirect.utexas.edu/ctl/ecis/.

Please do a survey on me, Jacob, and Manos. Written comments are especially valuable as feedback.

Astronomy in the News?

Pic of the Day – sand dunes on Mars



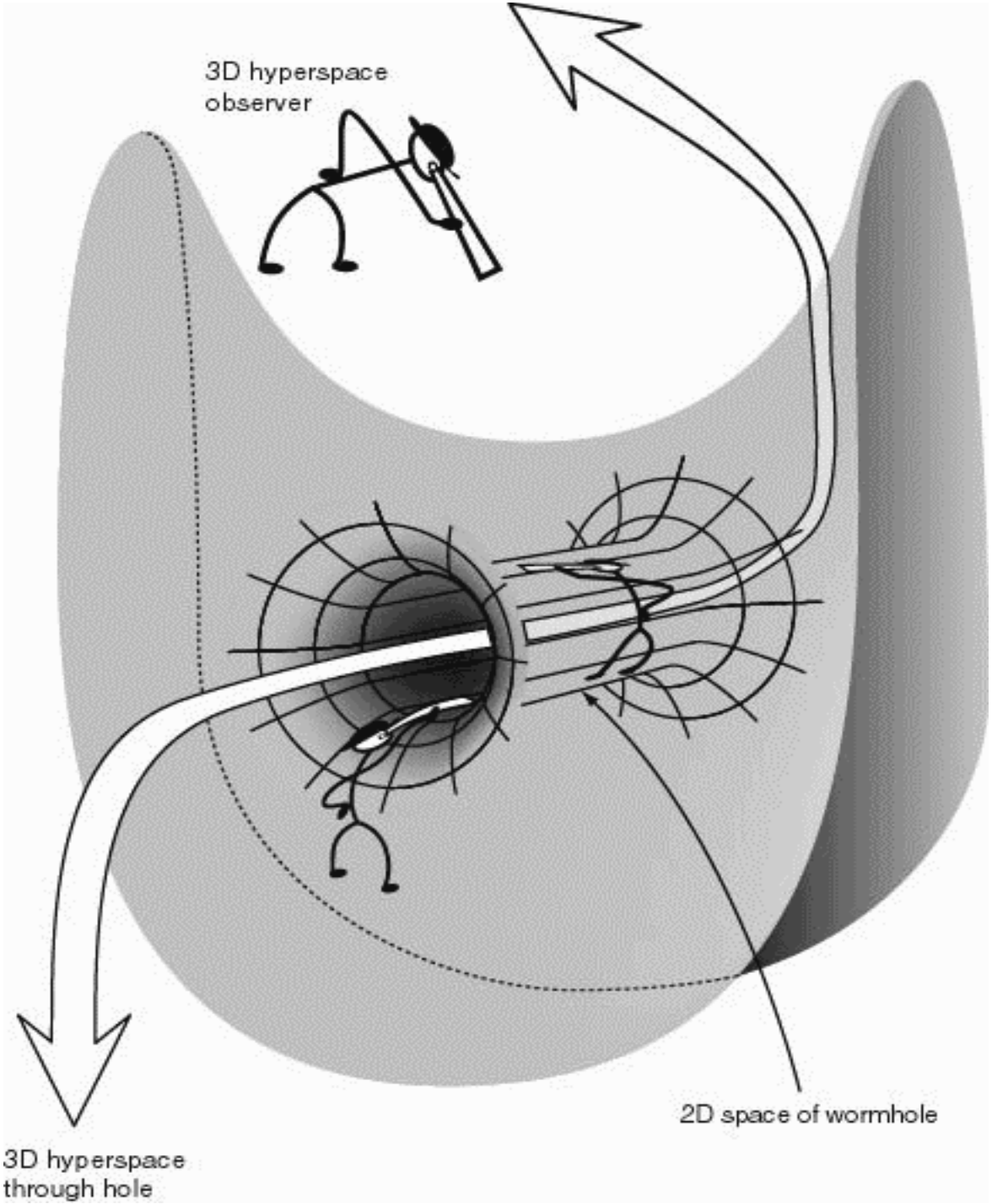
Goal:

To understand how Einstein's theory predicts worm holes and time machines and how we need a theory of quantum gravity to understand if those are really possible.

Discussion Point:

What would it look like to go into a worm hole?

Fig 13.2



2D Analogy - Embedding Diagram

Can go "through" wormhole, but also once deep inside can turn "sideways," parallel propagate - return to point of origin

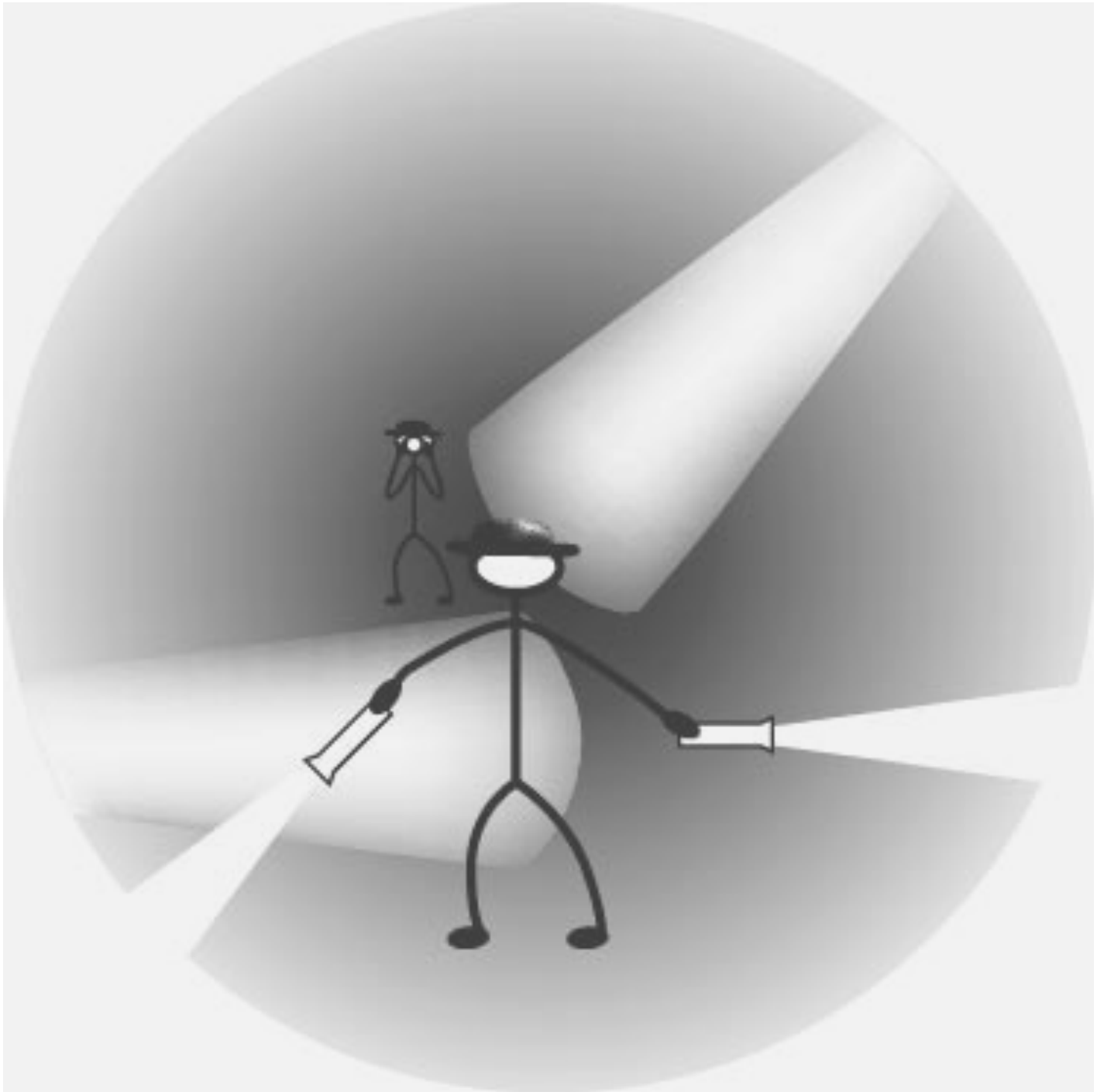


Figure 13.1

In principle, a light beam would travel “around” the interior of a worm hole. You could also see through the wormhole.

One Minute Exam

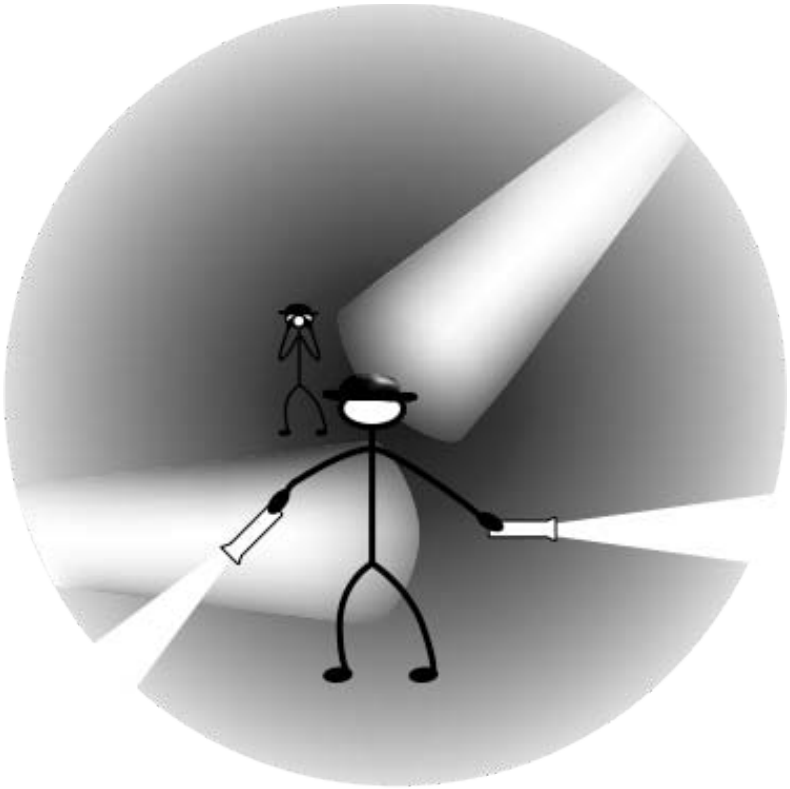
If I flew straight into a worm hole and once inside turned at 90 degrees and kept flying as straight as I could, I would

 Emerge from the other mouth of the worm hole

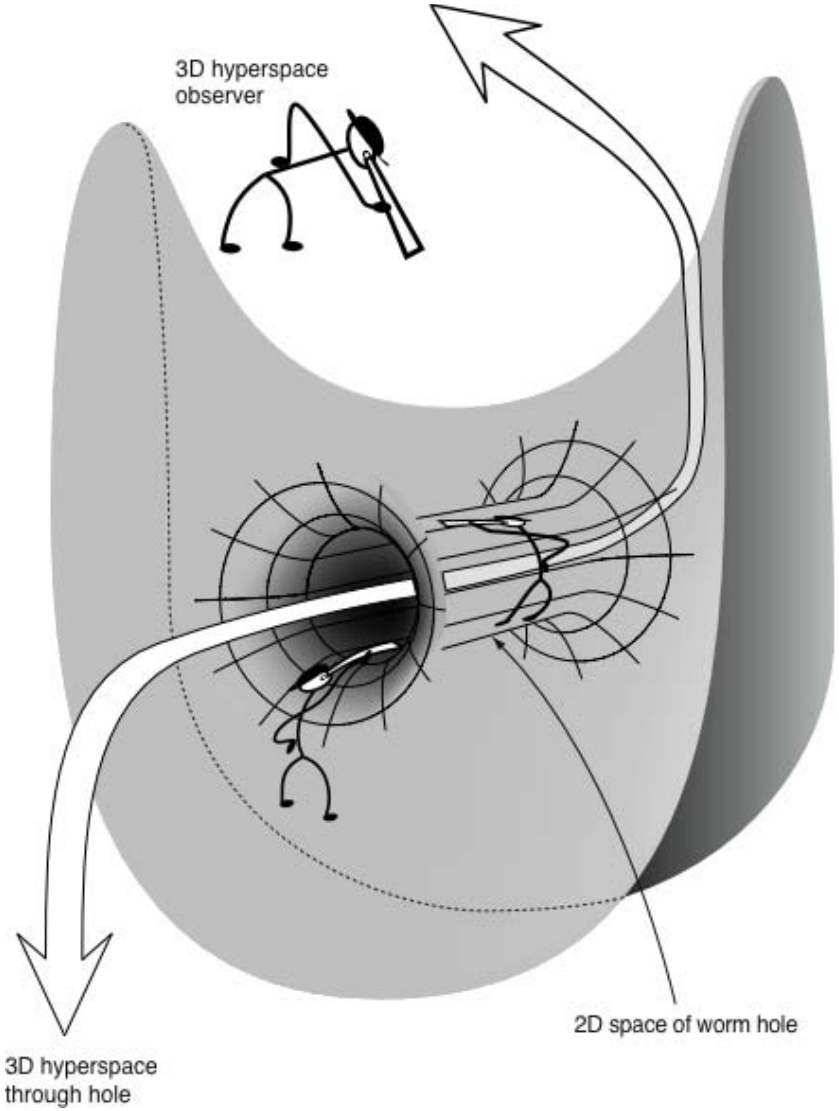
 Run into myself

 Be in hyperspace

 return to the point where I made the turn



The mouth of a worm hole would be a 3D “object,” the space inside highly curved.



Embedding diagram of a worm hole in an “open” universe

Do not confuse the “tunnel” through the middle of an embedding diagram representation of a worm hole (that is hyperspace!) with the tunnel-like aspect of the real three dimensional space.

Stargate - two dimensional “opening” not “realistic”

Goal:

To understand how Einstein's theory predicts worm hole time machines.

Thorne went on to study worm holes (Thorne - Black Holes and Time Warps: Einstein's Outrageous Legacy)

Worm holes are automatically time machines!

Igor Novikov elaborated (Novikov - The River of Time)

Twin paradox - twin who accelerates out and back in space will be younger than the twin who stays behind (special relativity).

Do this (conceptually) with one mouth of a worm hole or lower one mouth into strong gravity where time runs slower.

Time "connects" differently through the wormhole and in the surrounding space - one mouth is "younger"

Thorne video

Discussion Point:

What happens when you go into a worm hole time machine?

Can, in principle, travel back in time (but not before the time the machine is constructed)

Go in one mouth, come out in the past, go around in normal space, meet yourself before you go in.

Time travel paradoxes - Grandfather Paradox, Self-suicide

Pool Ball Paradox (purely mechanical, get people, intention, and will out of the analysis) - fire pool ball through time machine to deflect itself before it went in so could not have deflected

Novikov - there is no paradox - Physics always works out so that a paradox is avoided

Pool ball just nicks, Grandfather ducks.

With time machines, the future is already “there” in space-time

Premise of many famous time travel movies is undone, cannot change the future by tinkering in the past.

Implication - no free will

We just live through time with impression we are making choices

Novikov - I exert my free will to fly around the room or to walk through solid walls

Physics says I cannot - what’s the big deal?

Likewise - I cannot will a time travel parodox, physics says “no.”

Hawking TV program - seems to accept paradoxes as problem, no nod to Novikov.