

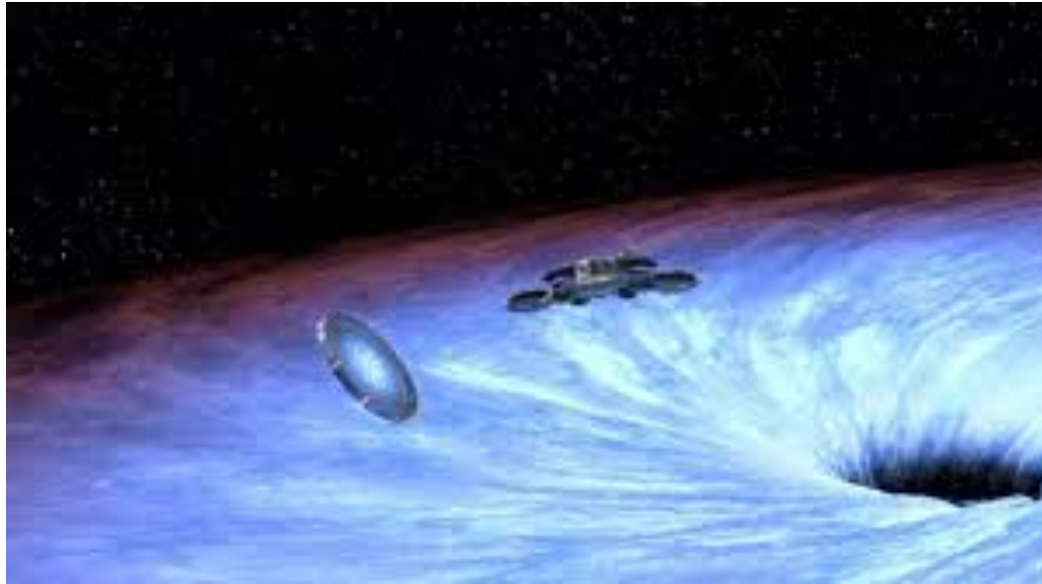
Wednesday, November 27, 2013

Reading: Chapter 13 – all; Chapter 14 - all

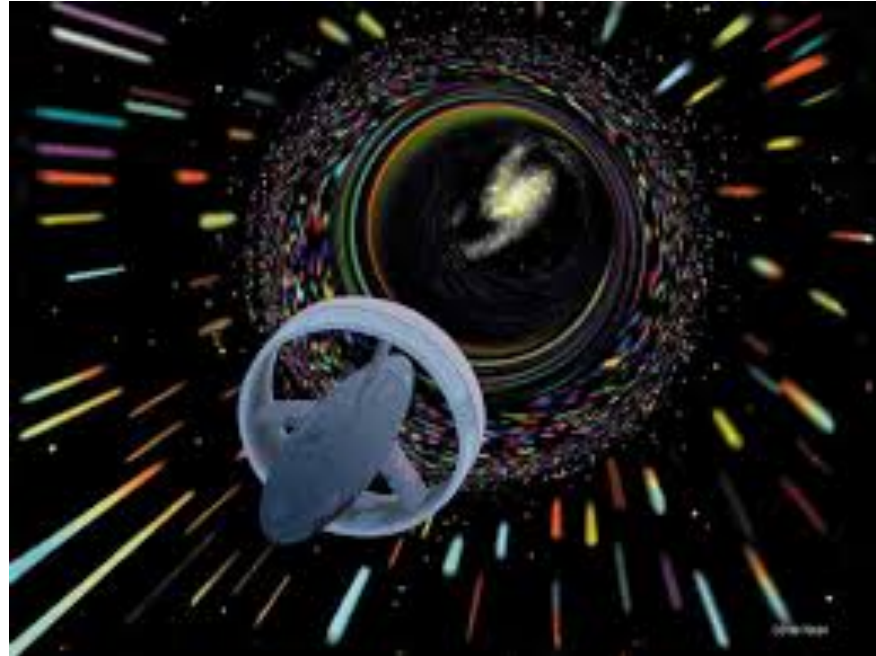
Astronomy in the news?

Comet ISON may be destroyed by close passage to Sun, but may survive to be visible in early December.

What's wrong with these pictures of a wormhole?



What about these?



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”

## 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. [Thorne video]

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 paradox, physics says “no.”



*Novikov Consistency Conjecture*: physics will arrange itself so that there is no time-travel paradox - you cannot travel back in time and kill yourself before you enter the worm hole/time machine.

Back to the Future films

Terminator films

Consistent or not with the Novikov Consistency Conjecture?

Is Donnie Darko about split universes or time travel?  
If time travel, is it consistent with the Novikov  
Consistency Conjecture?

Ultimate resolution - will not know if worm holes can be constructed, even in principle, without a theory of *quantum gravity*.

To make a worm hole, space must be ripped apart and re-stitched, how does that work? Need quantum gravity to understand.

Hawking - vacuum fluctuation energy (from uncertainty principle applied to vacuum) can go into wormhole, come out in past, pile up at mouth where began, quickly build up huge energy density, curve space, slam worm hole shut.

Maybe, but cannot actually compute that process without a theory of quantum gravity to handle the change in the “connectivity” of space time - must space time be smooth, or can it be laced with “tunnels” in space and time?