

Wednesday, November 23, 2011

Reading: Chapter 12, Chapter 13, **Chapter 14**

Astronomy in the news? Soyuz capsule returns safely from the International Space Station. Mars Science Lab may launch on Saturday.

The Fabric of the Cosmos, last installment, Universe or Multiverse, Wednesday, Tonight, PBS (KLRU) 8 PM (re-runs <http://www.klr.org/schedule/viewProgram.php?id=246736>).



Pic of the day: New ALMA submillimeter array in Chilean Andes

Goal:

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

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?

Rumor - Thorne talking to Spielberg...

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*.

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?

One Minute Exam

The Novikov Consistency Conjecture says:

-  Worm holes cannot lead to the future
-  Worm holes cannot lead to the past
-  Worm holes cannot exist
-  Worm holes cannot lead to time travel paradoxes

Need quantum gravity theory of singularity, quantum foam, worm holes

The best current candidate for a theory of Quantum Gravity is String Theory

See Brian Greene - The Elegant Universe

(<http://www.pbs.org/wgbh/nova/elegant/>)

Read ***The Universe on a String*** editorial by Brian Greene posted under links -> string theory

Hyperspace is an intrinsic aspect of string theory - 10 dimensions of space, plus time.

Background - pre-Einstein late 19th, early 20th Century

Where does space curve to?

Riemann (1826 -1866), Lobachevsky (1792 - 1856)

Theory of curved space, non-Euclidian geometry

Notions of 4D hyperspace affected art/culture turn of 20th century

Flatland - Edward Abbott

Tesseract - 4D hypercube (Elegant Universe link)

3D “unfolding” of tesseract in Salvadore Dali’s

Crucifixion (Corpus Hypercubas)



Notions of seeing from different directions at once

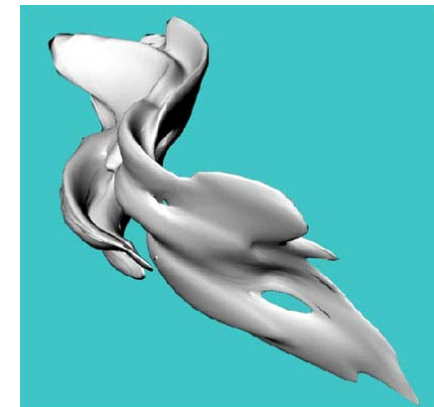
Perspective of Cubism

Picasso - Les Demoiselles d'Avignon



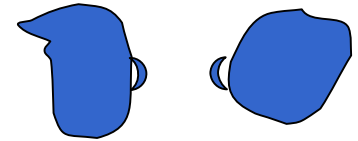
Deschamps - *Nude Descending A Staircase*

Contemporary Brazilian artist Marcos Novak -
3D projections of 4D objects



Hyperspace Perspectives (reflected in cubism?)

2D creature - another 2D creature sees the front



From 3D, we see front, back and *inside* simultaneously

In our 3D space we see the front of another 3D creature

A being living in a 4D hyperspace would see all of our surface, front and back, and our insides, all at once!

A 3D creature passing through a 2D Universe would start as a point, grow to a finite *area*, then decrease to a point and disappear.

A 4D creature passing through our 3D Universe would start as a point, grow to a finite *volume*, then decrease to a point and disappear.

Sagan YouTube

Living and perceiving different dimensions

<http://www.youtube.com/watch?v=Y9KT4M7kiSw>


Nota Bene: even if hyperspace exists, that does not mean it is populated with living creatures, that notion is just to help us gain perspective.

One Minute Exam

A five-dimensional creature intruding into our space would appear to us to be

 One-dimensional

 Two-dimensional

 Three-dimensional

 Four-dimensional

Goal:

To understand how string theory represents the current best candidate to be the needed theory of quantum gravity

Classic Quantum Theory

Particles are points (electrons) or are made up of point-like particles (three quarks in a proton or neutron), that also have wave-like properties.

Quantum view of forces - the quantum theory (mathematically) views all forces as resulting from an exchange of particles, with different exchange particles representing different forces.

Photons are the exchange particles for the electromagnetic force, other exchange particles account for the weak and strong nuclear forces.

String Theory

Best current candidate for a quantum gravity “theory of everything.”

Particles like e^- , p , n are not “points” but strings, loops of energy that vibrate in different modes

The different modes of vibrations give all the well-known particles and *more*

String Theory

History - in 1960's physicists recognized that the equations corresponding to the strong nuclear force also described entities that could stretch and wiggle - strings

Space in which strings vibrate has *10 space dimensions* + time

Shape of wrapped-up space determines how strings vibrate, what particles they represent.