Physics 102 - April 13, 2011

- Recitation 9 Makeup
  Thursday 4:30 pm  B+L 208
  If can't make that -> quick coverage after normal recitation this wk

- No Recitations Next week

- Exam 2 - in 1 week (Apr. 20)
  3x5 index card
  Calculator
  Recitations 5-10
  de Broglie -> inflation
  Feb 16 Apr 11 (no strings)

- Exam Q&A Monday Apr. 18 in class
String Theory

or

versus

Particle spectrum consists of different excitations of fundamental string-like objects

point-like particles in quantum field theory
Excitement about String theory

Small distance behavior better

Quantum gravity seems practical

Oyikes!
Supersymmetry

Can provide mechanism to solve Higgs problem in Standard model

Can help theorists greatly with cancellation of radiative corrections.

Sort of a natural symmetry to expect.
String theory
Bosons only
misbehaves (ghost particles)
unless done in 26 dimensions mathematically

Not like the real world

Extra Dimensions

Yikes!
Must concoct ways for those extra dimensions to exist in the theory but be imperceptible.

\[ \Rightarrow \text{compactification} \]

limit where particles can go

\[ \Rightarrow \text{compactification} \]

\[ 2d \]

\[ 3d \]

\[ \text{Let } R \rightarrow \text{small} \]
"Strings" are a special case

Structures in String Theory

P-Branes

0-Brane
1-Brane
2-Brane
3-Brane
...
9-Brane

D-Brane (Dai, Leigh Polchinski; + indep by Horava)

P-Brane where one end of an open string is attached.
Limit where particles can go

Image from http://abyss.uoregon.edu/~js/qc/qc.html
Ekpyrotic Multiverse
(Time Separated, cyclic)

3 branes

Move Together

Ekpyrotic Universe
(cyclic)

Move Apart

Bulk

Looks like Now

wrinkles in space

Smooth out

Collide everywhere locally looks like Big Bang everywhere

Paul Steinhardt
Niel Turok
The Cosmic Landscape

In String Theory -

Laws of Physics
Particle Spectrum
Nature of forces

Shades of the Ancient Greeks!

Geometry

dictated by
Shape + Size of Extra dimensions

depends on details of the compactification
Vacuum "potential energy" depends on the details of the configuration of the different dimensions.

Springs and Potential energy

uncompressed spring

PE = 0

compressed spring

PE > 0
Gravitational Potential Energy

increased gravitational Potential Energy

↓

Earth
Different compactification schemes involve different degrees of potential energy stored in the "vacuum".
The string theorist's fantasy:

There is a single, particular model of compactification that leads to a minimum in the total energy of the system ... corresponds to the particle spectrum, cosmological constant, forces we see → The Theory of Everything!!
But…

Expect a huge # of compactification schemes to lie at local minima of the "potential energy" function. → should be quasi-stable or stable