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

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

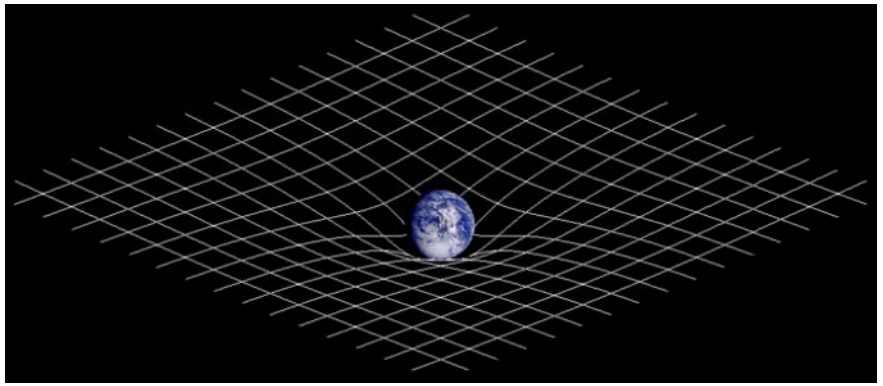
vs.

point-like particles in quantum field theory

Excitement about String theory

Small distance Behavior Better

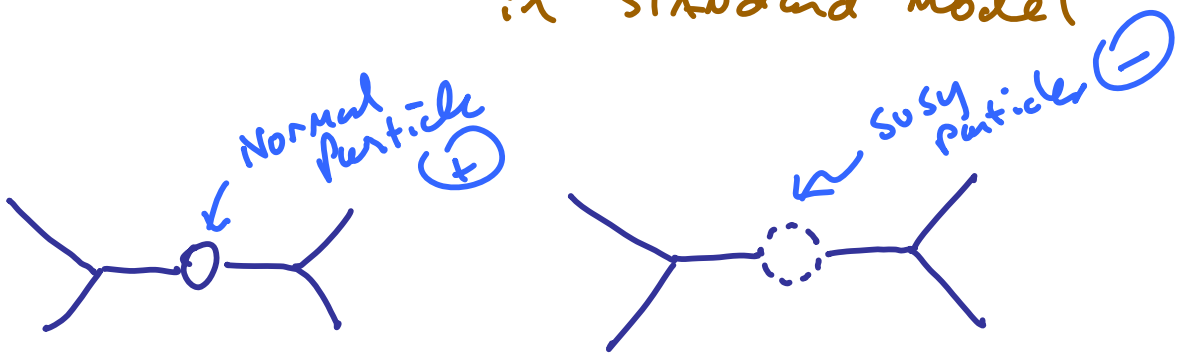
Quantum Gravity Seems Practical



	Spin		Spin
e^-	$\frac{1}{2}$	$\tilde{e}^-$	0
ν_e	$\frac{1}{2}$	$\tilde{\nu}_e$	0
u	$\frac{1}{2}$	$\tilde{u}$	0
d	$\frac{1}{2}$	$\tilde{d}$	0
γ	1	$\tilde{\gamma}$	$\frac{1}{2}$

Supersymmetry Natural

→ Can provide mechanism to solve Missing Higgs problem in Standard model



→ can Help theorists greatly w/ 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

String theory
Bosons + Fermions
misbehaves
(ghost particles)
unless done in
10 dimensions mathematically
plus
Supersymmetry

like real world?
Maybe

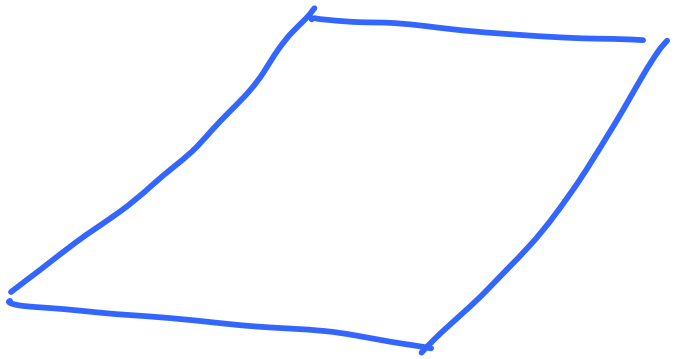
Extra Dimensions
yikes!

Must concoct ways for those Extra Dimensions to exist in the theory But be imperceptible

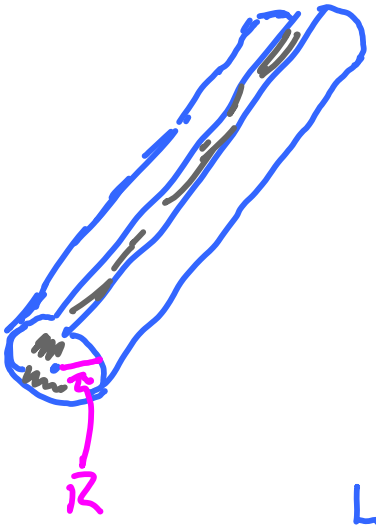
→ Compactification

→ limit where particles can go

Compactification

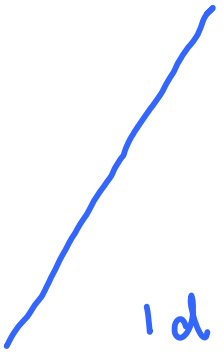


2d



R

3d



1d

Let R → small

"Strings" are a special case

Structures in String theory

P-Branes

0-Brane	Point
1-Brane	String
2-Brane	Membrane
3-Brane	
⋮	
9-Bran	

D-Brane (Dai, Leigh, Polchinski + indep by Horava)
1989

P-Brane where on end of an open string is attached.

Limit where particles can go

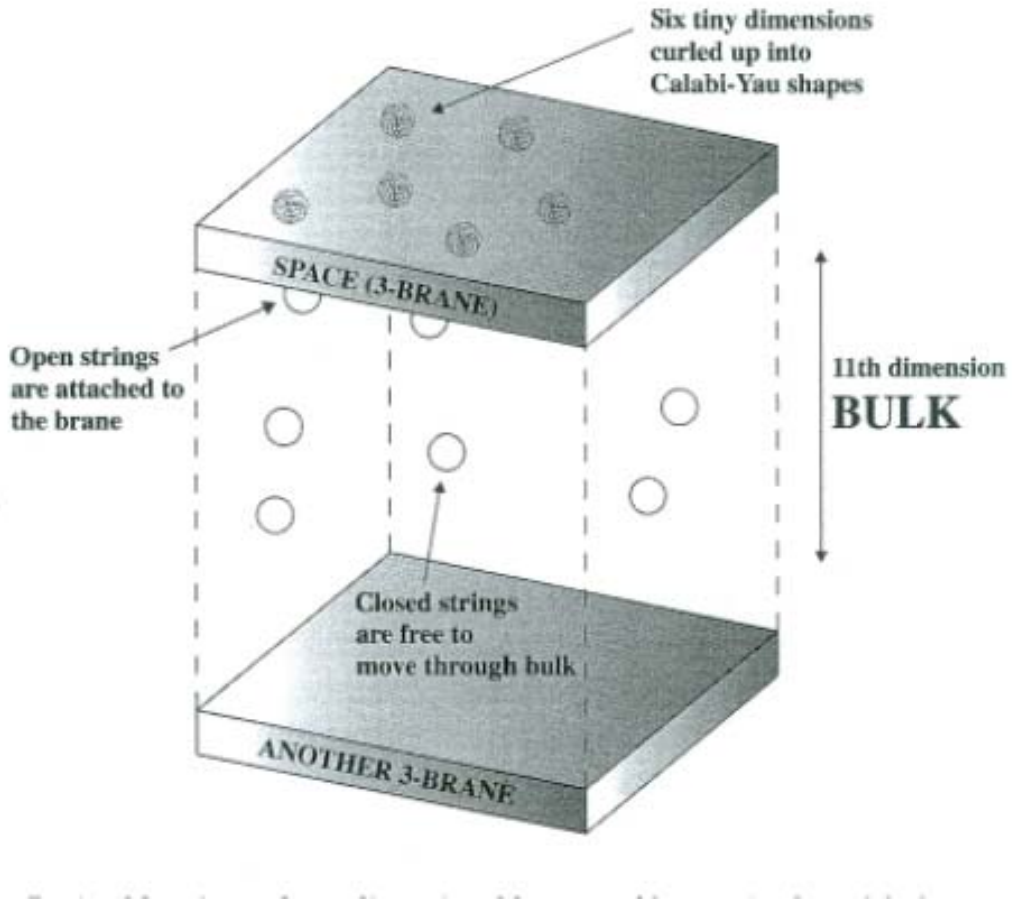
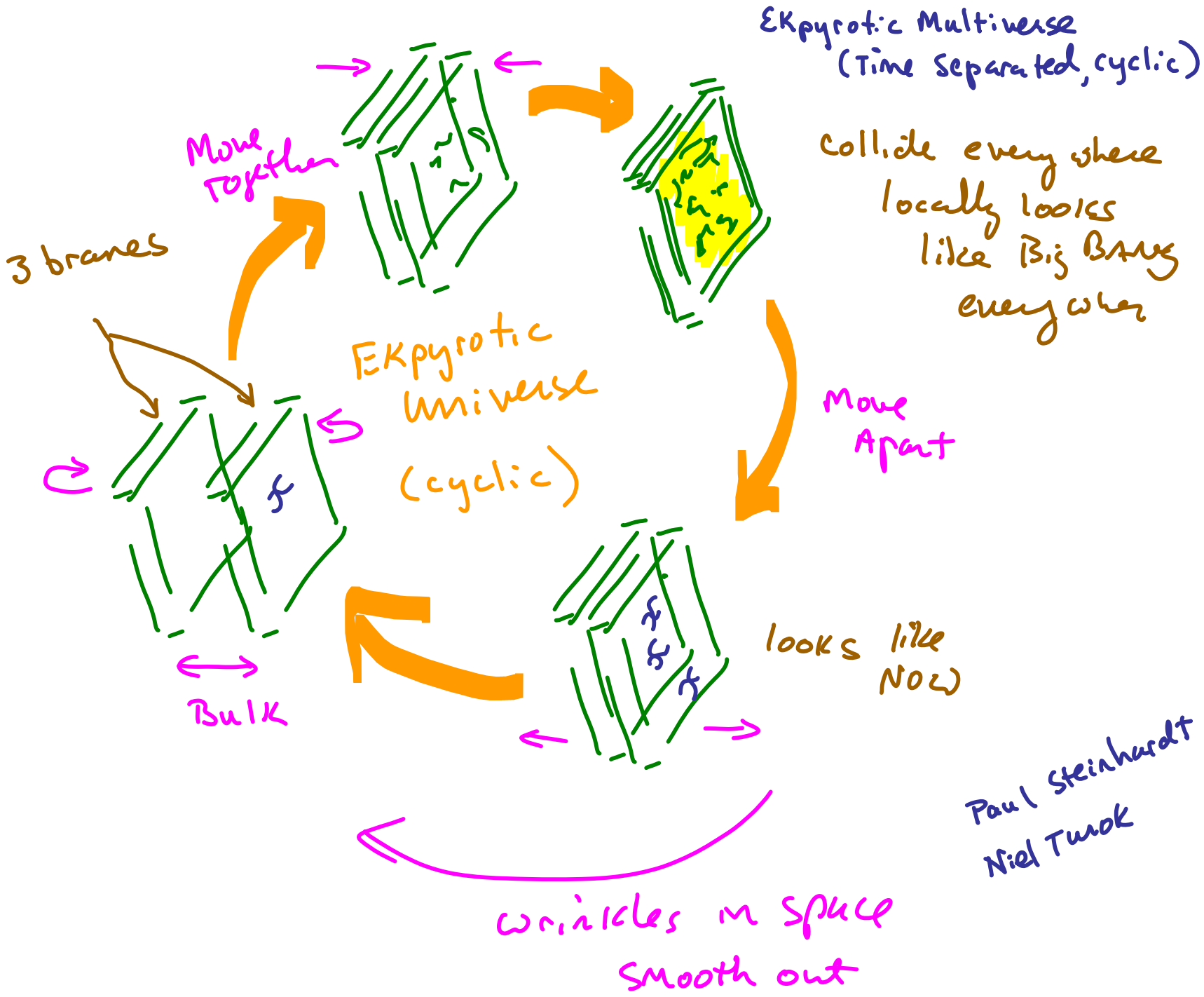


image from http://abyss.uoregon.edu/~js/qc/qc.html


Ekpyrotic Multiverse
(Time separated, cyclic)
Collide everywhere
locally looks
like Big Bang
everywhere
Move
Apart
looks like
Now
wrinkles in space
smooth out
Move
Together
3 branes
Ekpyrotic
Universe
(cyclic)
Bulk
Paul Steinhardt
Neil Turok

The Cosmic Landscape

In String theory –

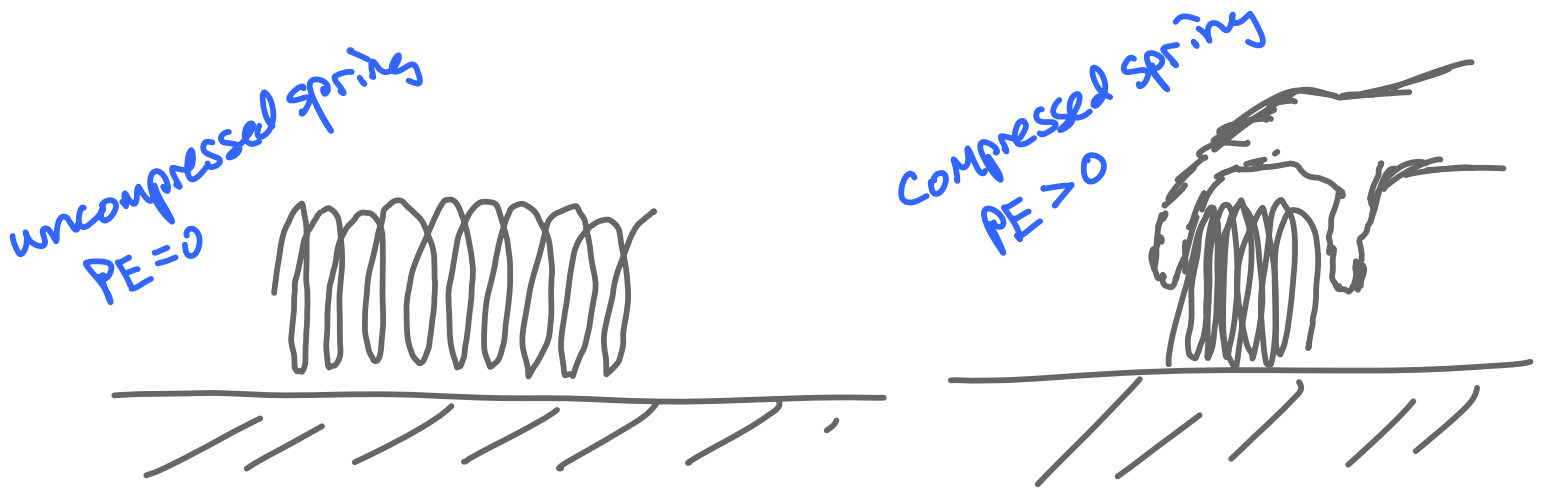
Laws of Physics
Particle spectrum
Nature of forces

} dictated by Shape + Size of Extra dimensions

Shades of the Ancient Greeks! geometry

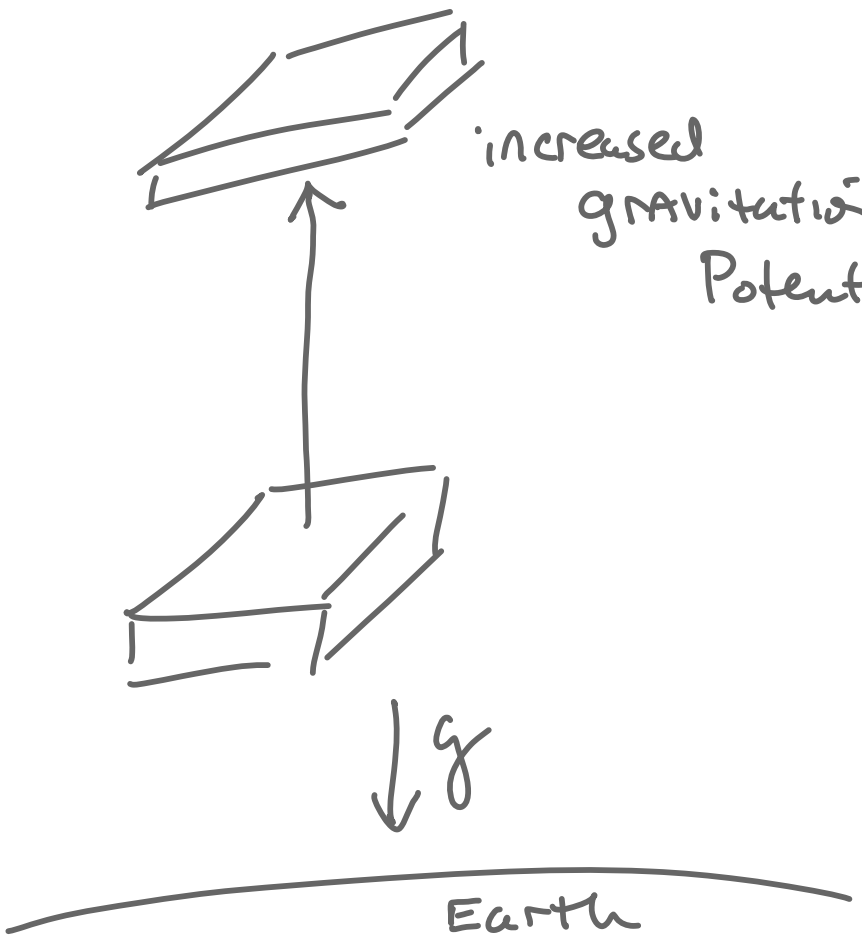
Depends on details of the compactification

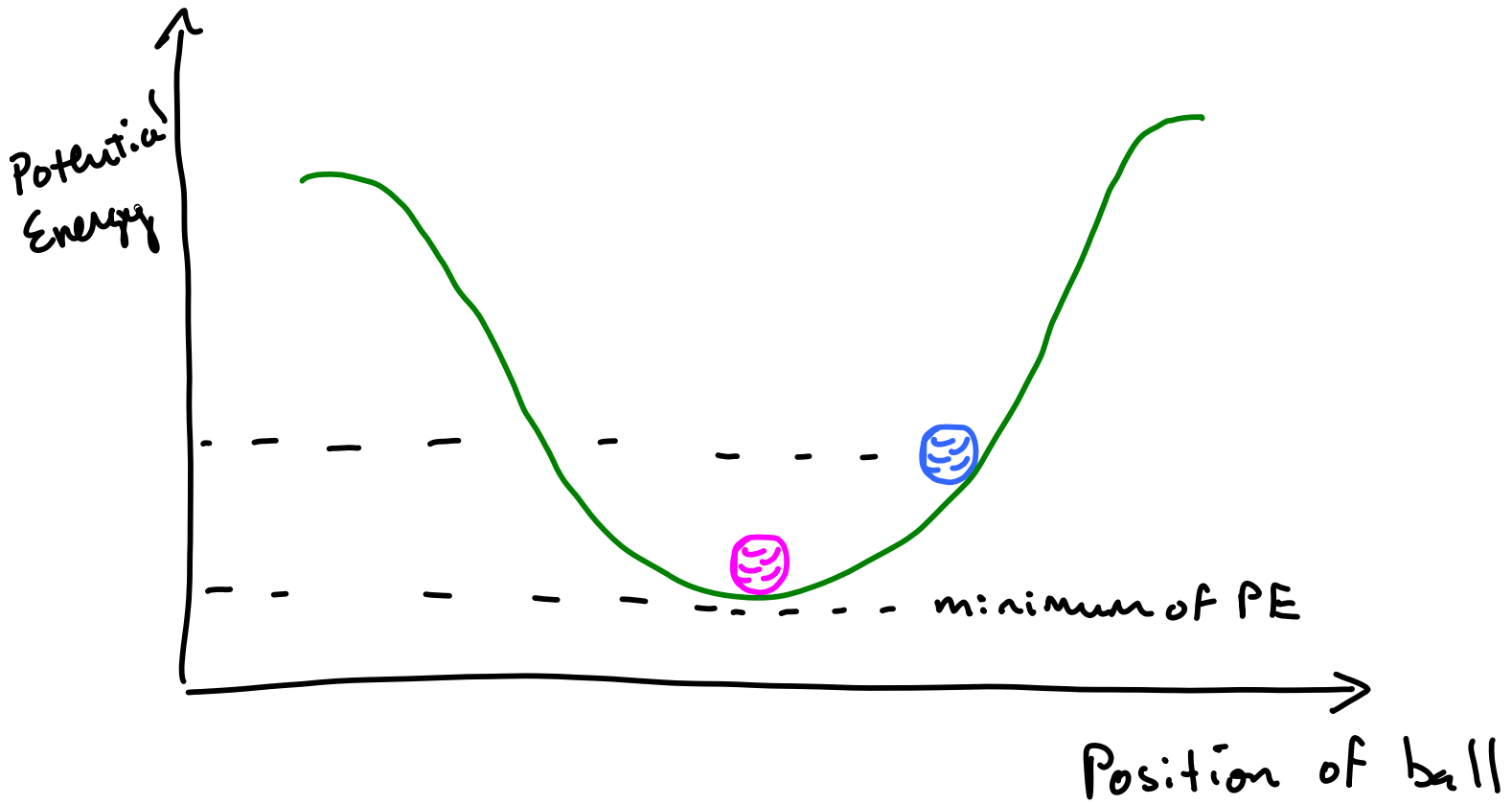
Vacuum "potential energy" depends on the details of the configuration of the different dimensions



Springs and Potential energy

gravitational Potential Energy



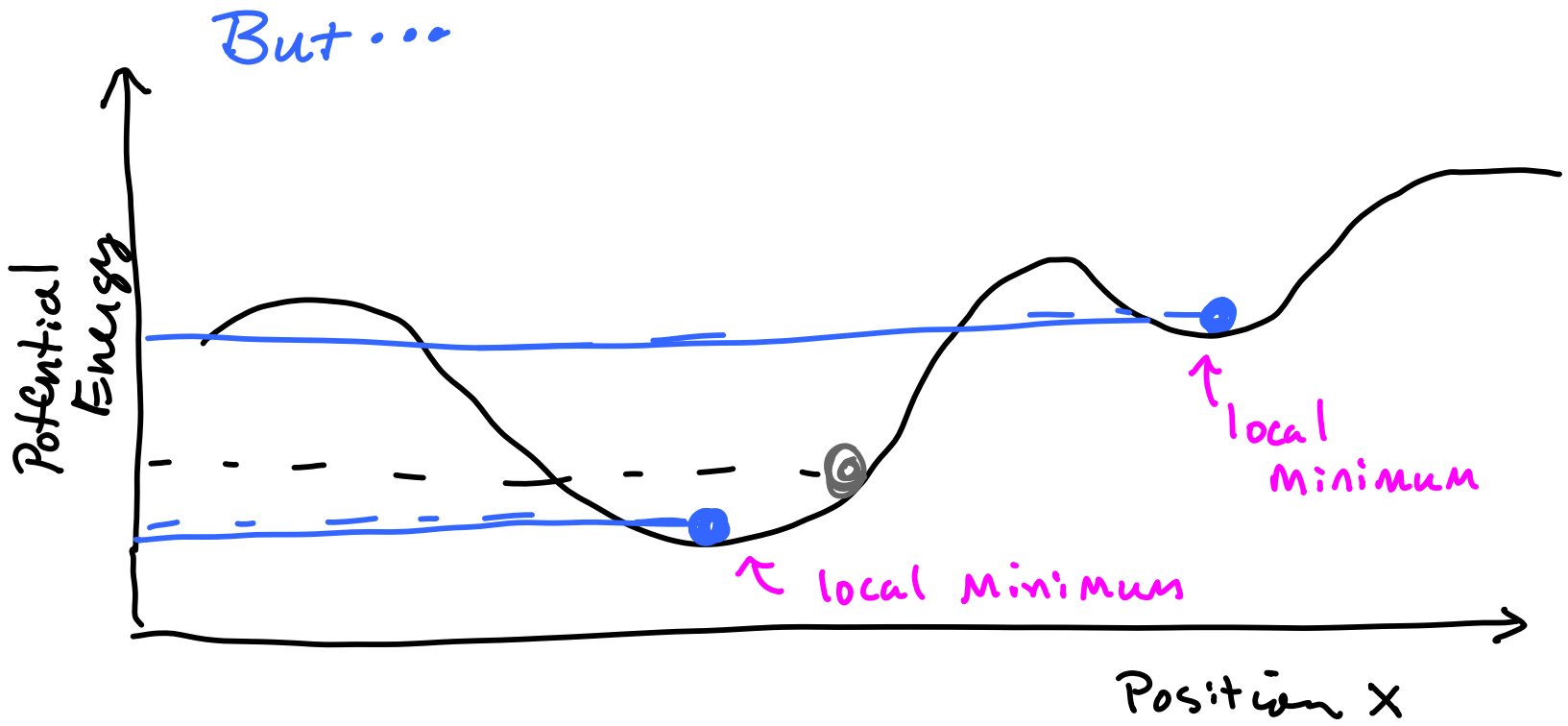


Different compactification schemes involve different degrees of potential energy stored in the "vacuum"

The String theorist's fantasy:

There is a single, particular Model 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!!



Expect a huge # of compactification schemes to lie at local minima of the "potential energy" function

→ should be quasi stable or stable