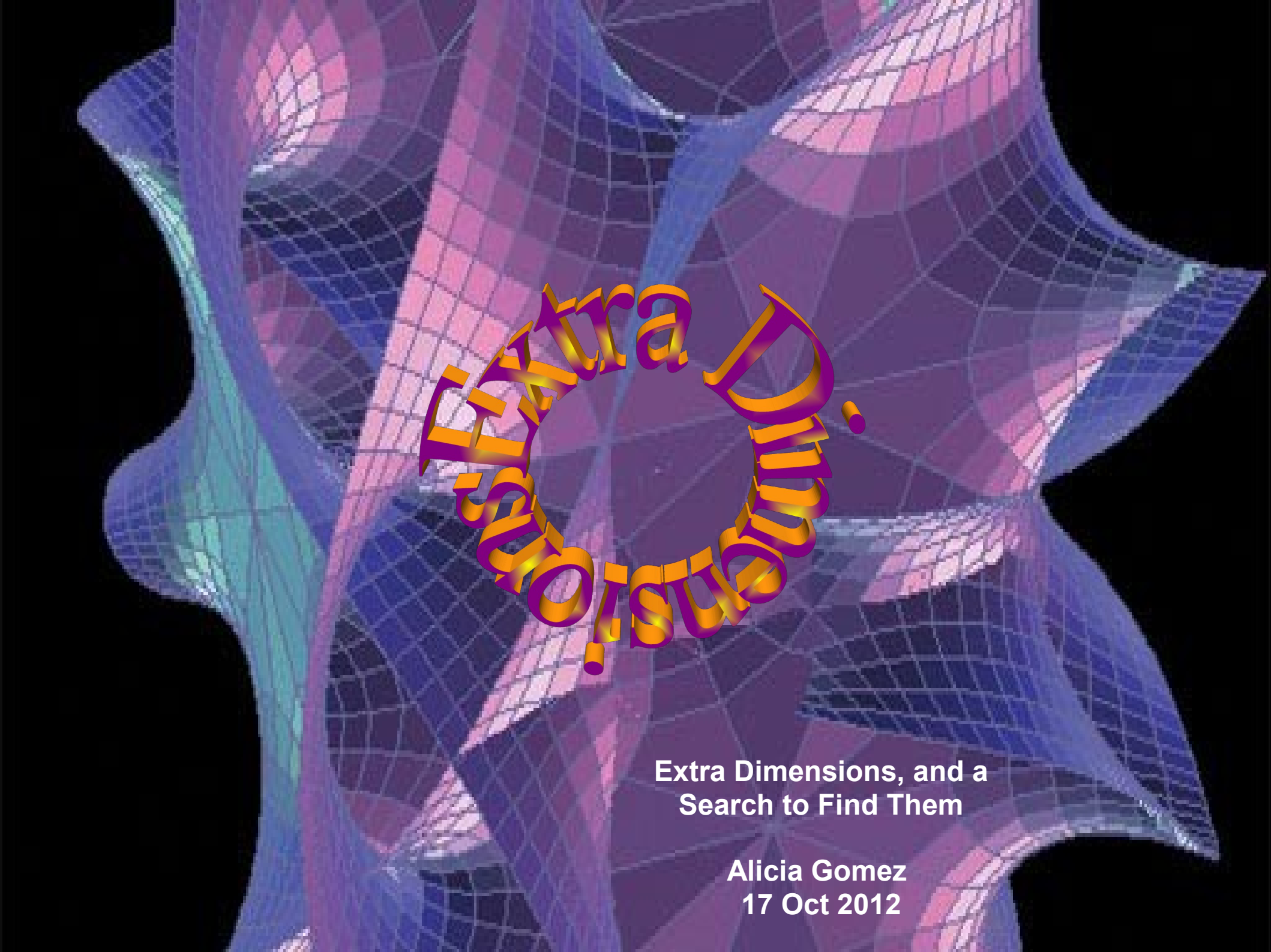

Extra Dimensions, and a
Search to Find Them

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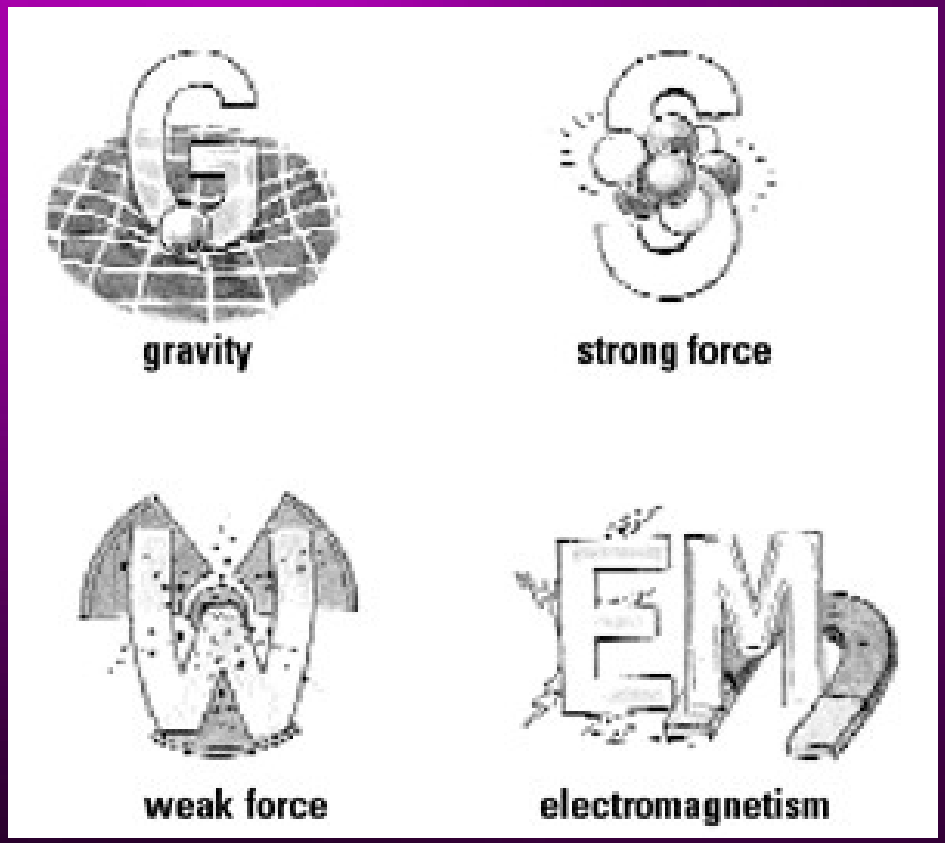
Outline

- Hierarchy Problem
- Intro to Extra Dimensions
- Branes, the bulk, and the megaverse
- Geometry of extra dimensions
- ADD model
- A search to look for them

Hierarchy Problem

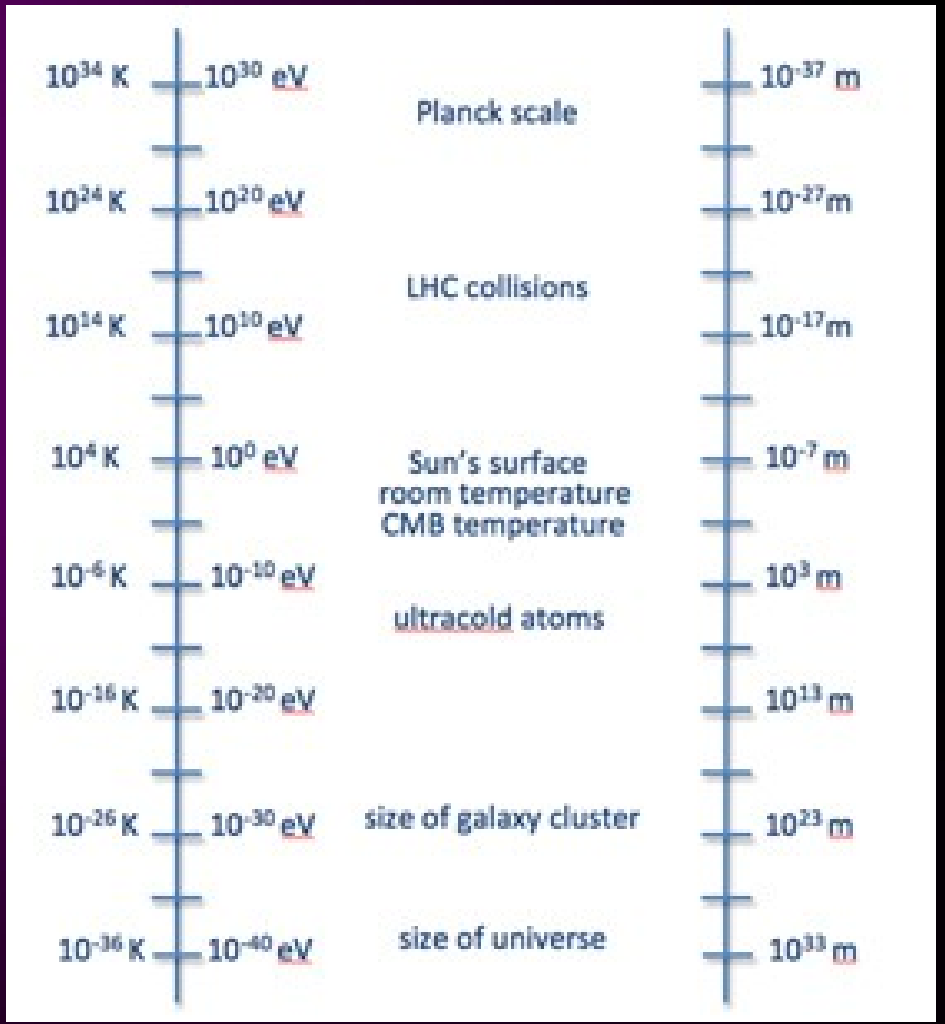


The four fundamental forces.

- Strong ~ 1
- Electromagnetic ~ 10^{-2}
- Weak ~ 10^{-6}
- Gravitational ~ 10^{-39}

Comparison of Scales

- Two (at least) fundamental energy scales.
- Planck scale
  - 10^{18} GeV
- Electroweak scale
  - 10^{3} GeV

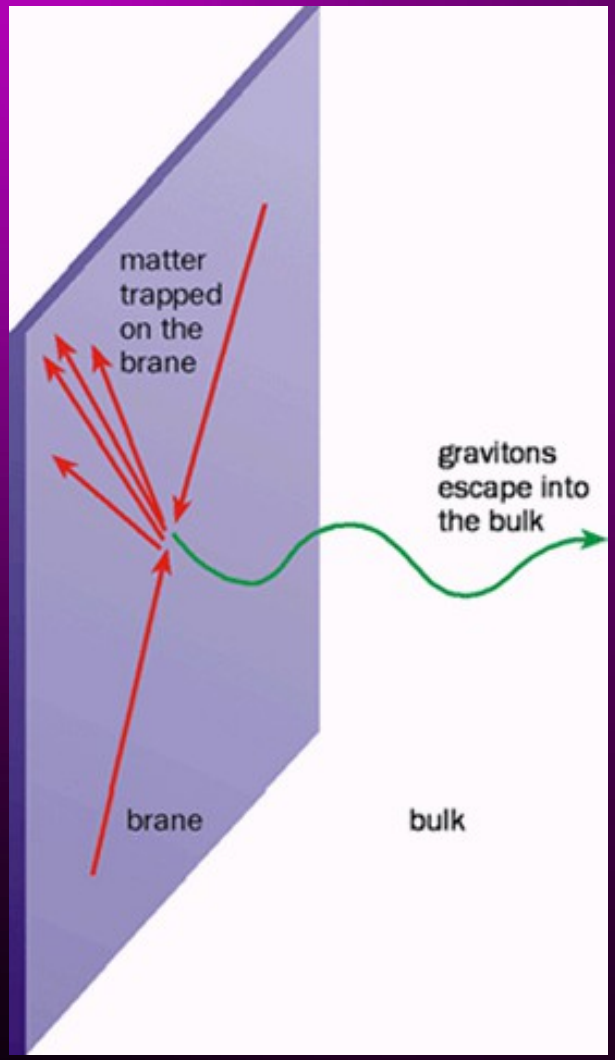


Energies and distances scale. LHC collisions is comparable to electroweak scale.

A Possible Solution: Extra Dimensions

- We live in a 3 + 1 dimensional world (3 spacial dimensions, 1 time).
- Side Note: Extra dimensions are mathematically needed in string theory to provide a self-consistent theory of quantum gravity.
- One theory is that the gravitational force is diluted into a higher dimensional world.

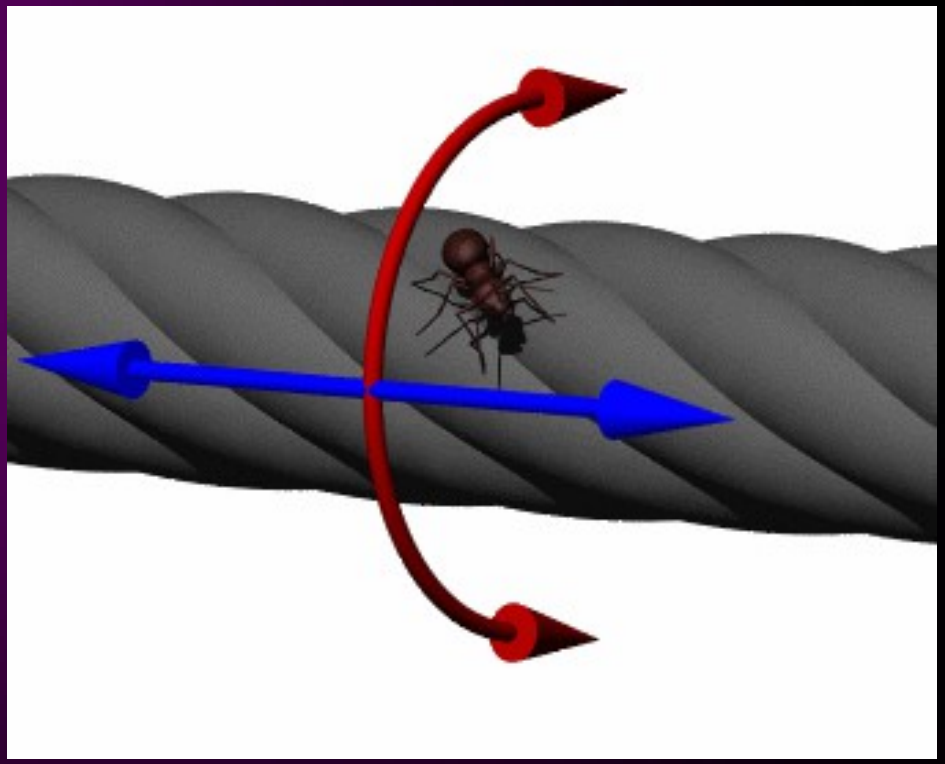
The Brane and the Bulk



- Brane – a lower dimensional subspace in a higher dimensional space.
- Bulk – the higher dimensional space.
- Multiple branes in a Megaverse

How can we Experience Extra Dimensions?

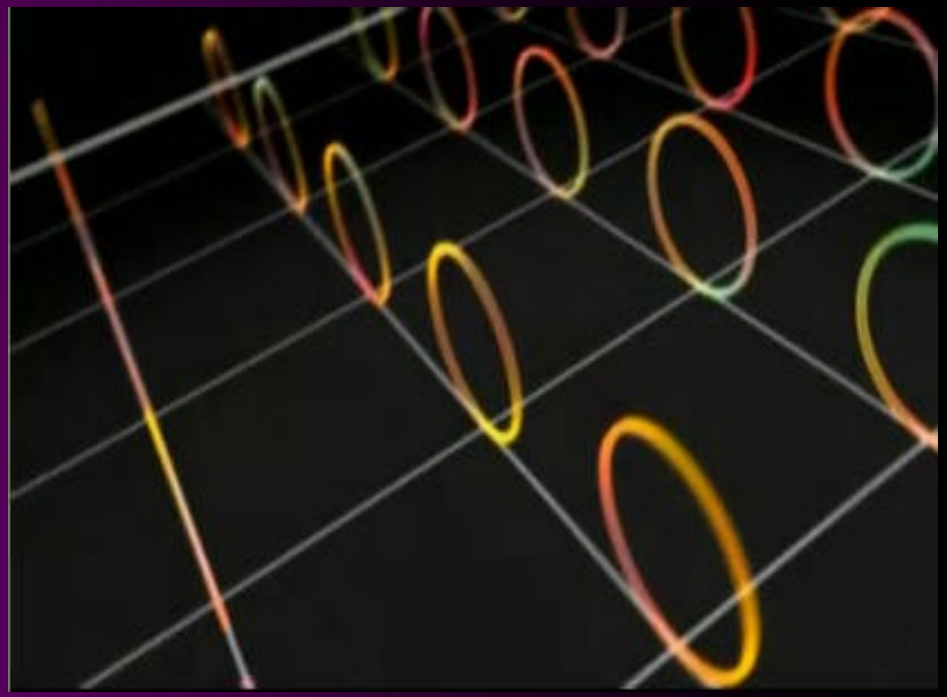
A large body experiences 1 dimension



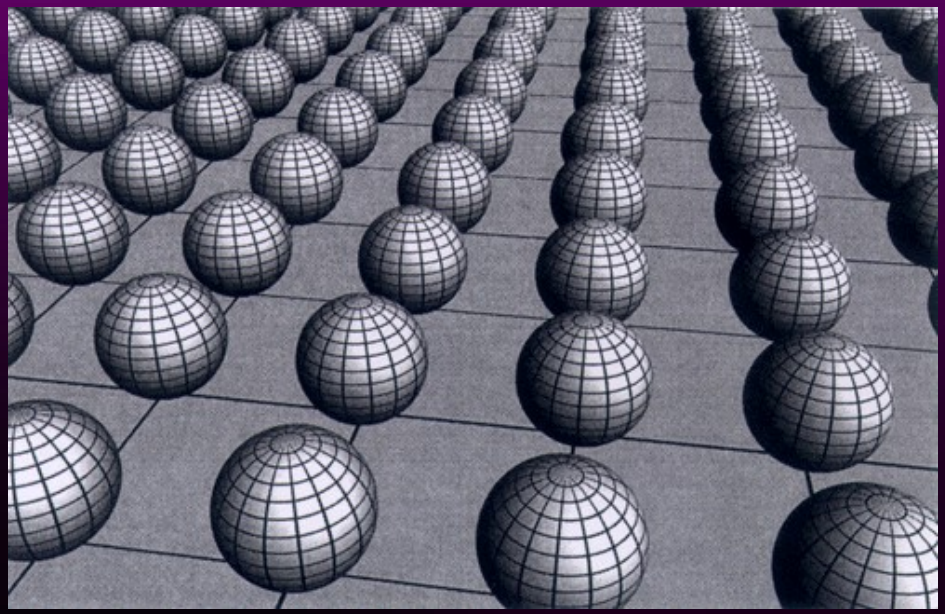
A small body experiences 2 dimensions

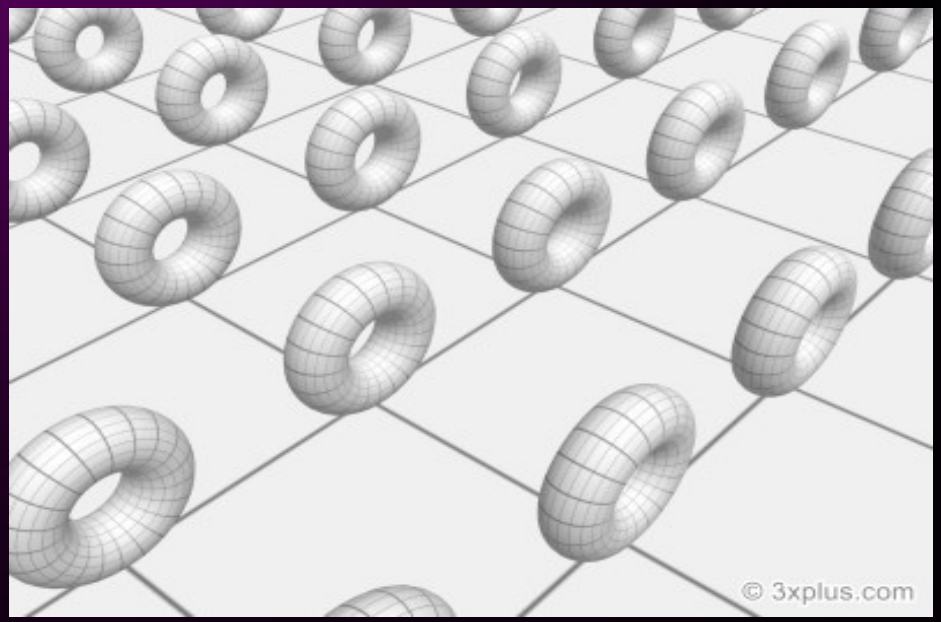
Compactification – extra dimension(s) curled up at every point in space time.

1 extra dimension



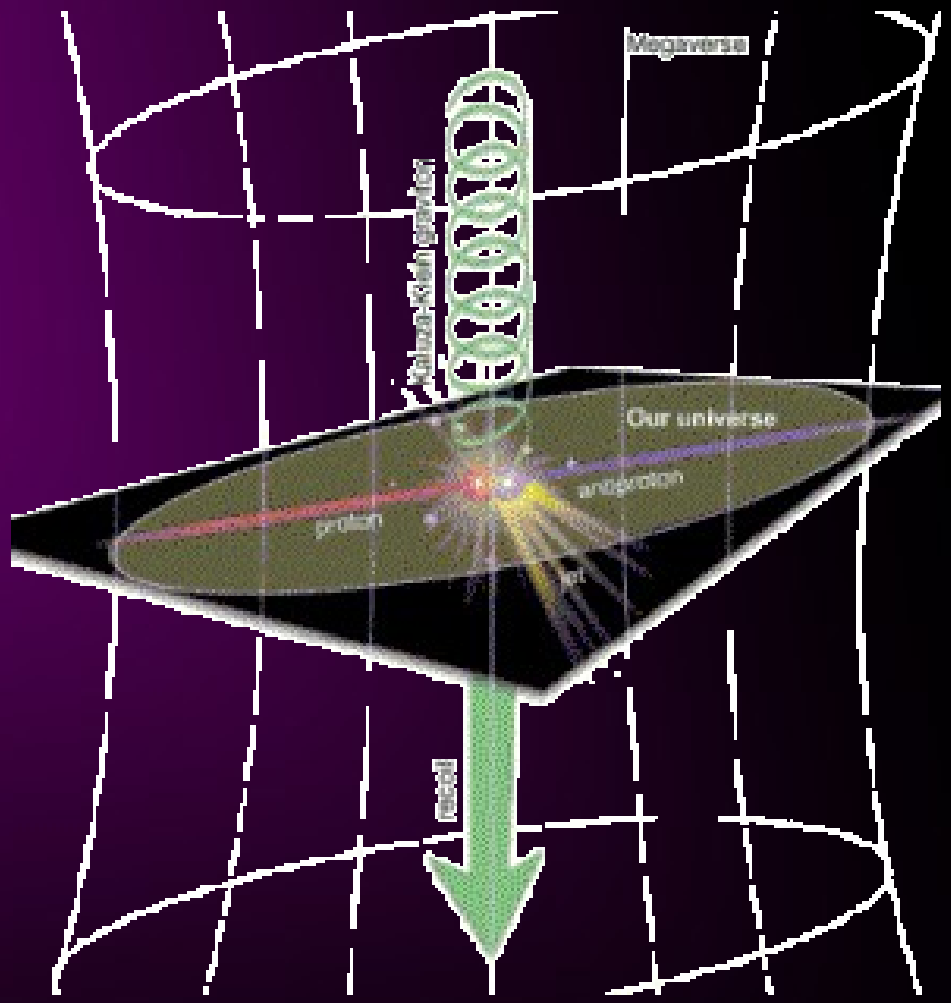
2 extra dimensions





ADD Model

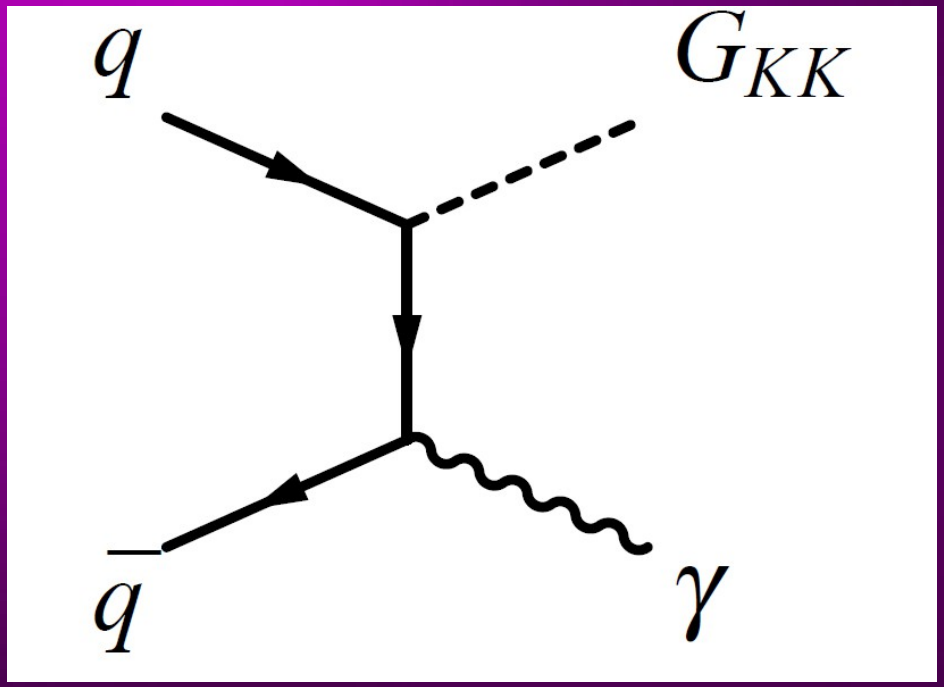
- Arkani-Hamad, Dimopoulos, Dvali, 1998.
- Propose existence of n > 1 large extra spatial dimensions.
- Suggest that Standard Model particles can be “kicked off our 4D manifold” into the extra dimensions.



A Search for Large Extra Dimensions

- ADD model presents a formula which relates the size of the compactified extra space, the effective Planck scale in 4D spacetime, and the fundamental Plank scale in the 4 + n dimensional spacetime.
- I am finding limits on the fundamental Planck scale if there were higher dimensions.

My Research



Feynman Diagram

- I look at quark antiquark collisions that result in a photon and missing energy.
- Preliminary results... no sign of extra dimensions.

Conclusion

- Extra Dimensions are a possible solution as to why gravity is much weaker than the other forces.
- These extra dimensions can be compactified at every point in spacetime.
- The ADD model presents a specific framework in which experimentalists can look for large extra dimensions.
- So far, no evidence of extra dimensions has been observed.

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Any Questions?