

BRANEWORLD

BEYOND 4 DIMENSIONS
(SPECULATIONS IN COSMOLOGY I)

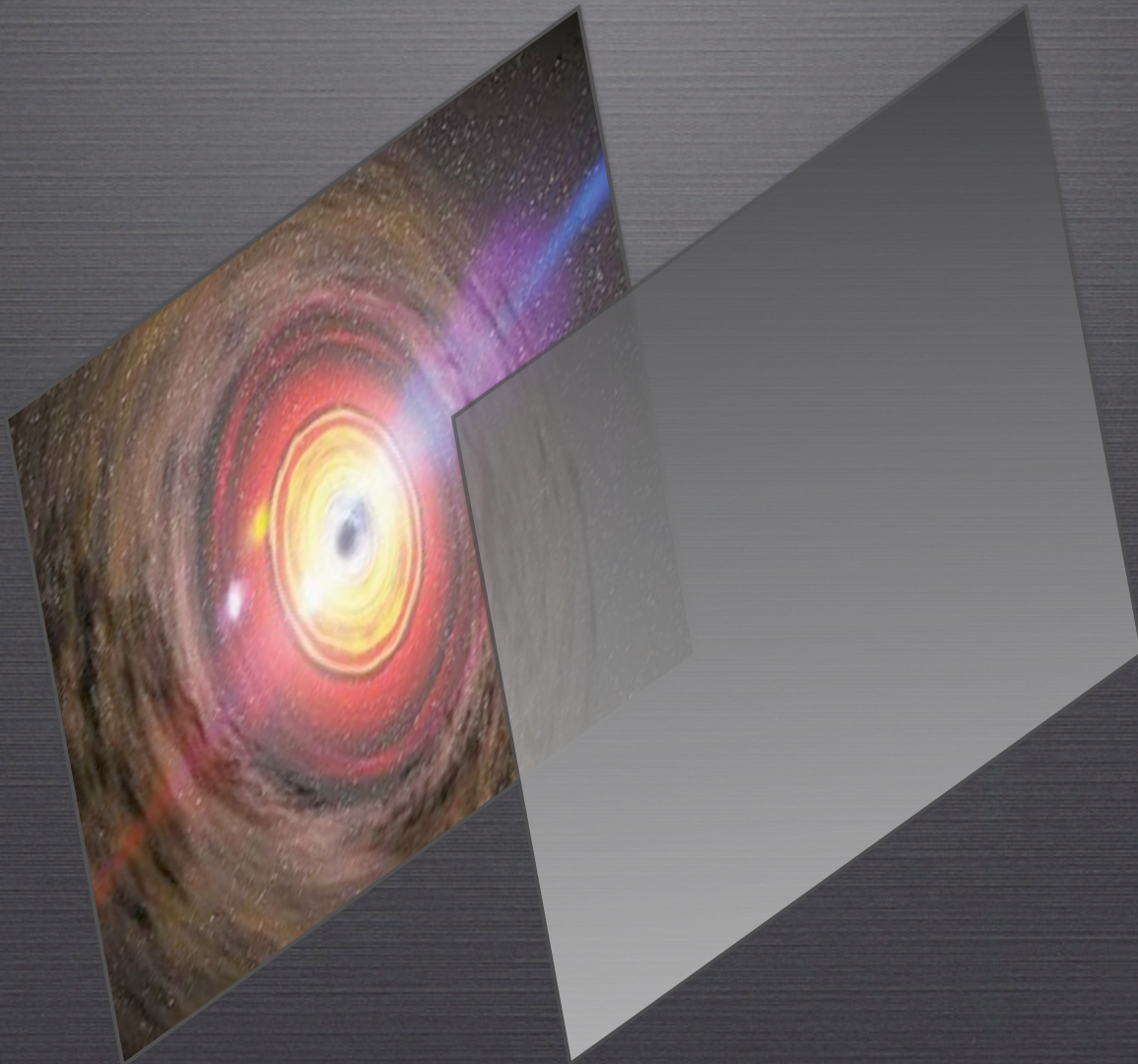
MARK WYMAN

74TH COMPTON LECTURE SERIES

SOME BUSINESS

- Lecture next week!
- No lectures: Nov. 26th or Dec. 3rd
- Physics with a Bang! Dec. 3rd, 11am - 4pm
- Last lecture - with luncheon, Dec. 10th
(see handouts)

WHAT DO I MEAN BY EXTRA DIMENSIONS?

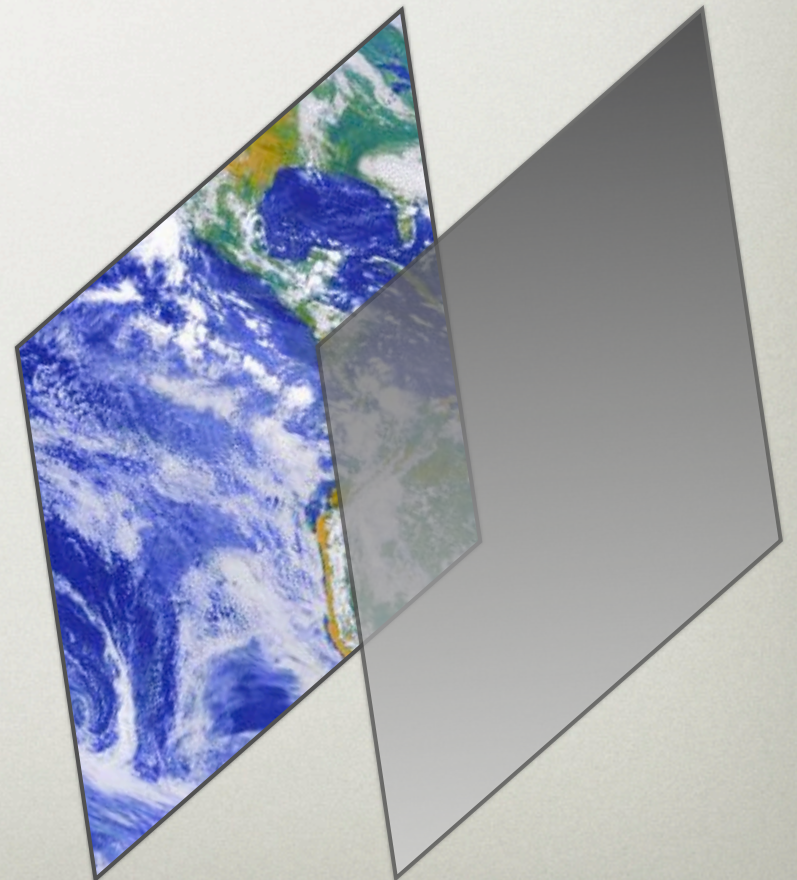
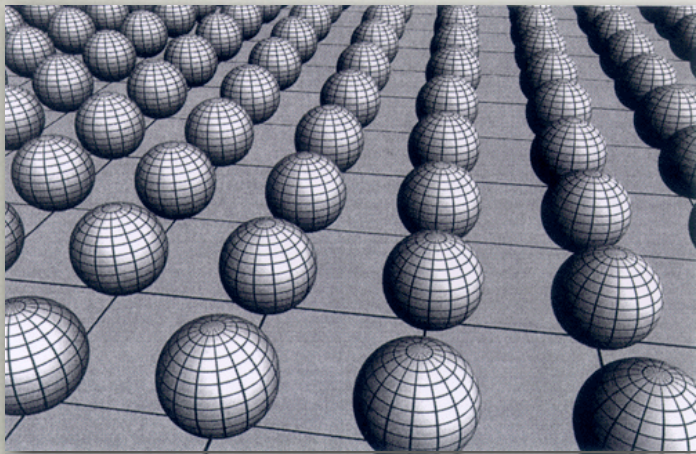


THREE KINDS OF EXTRA DIMENSIONS

tiny ones

“medium” ones

big ones



TINY EXTRA
DIMENSIONS:

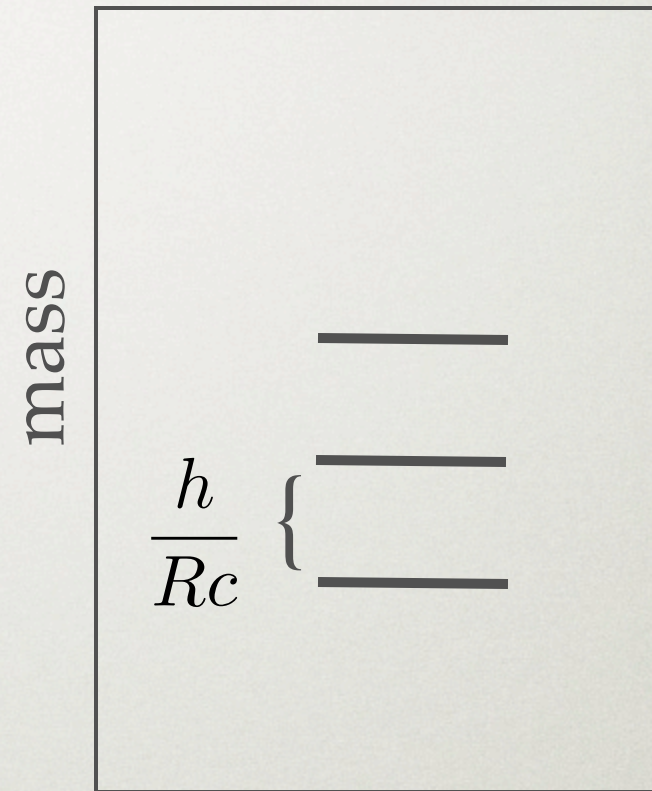
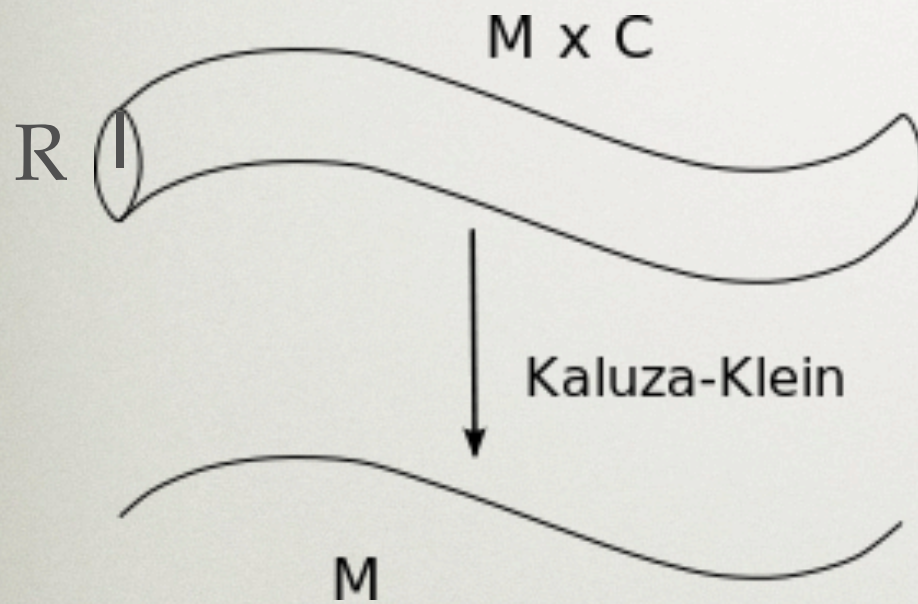
COMPACTIFICATION

KALUZA-KLEIN THEORY

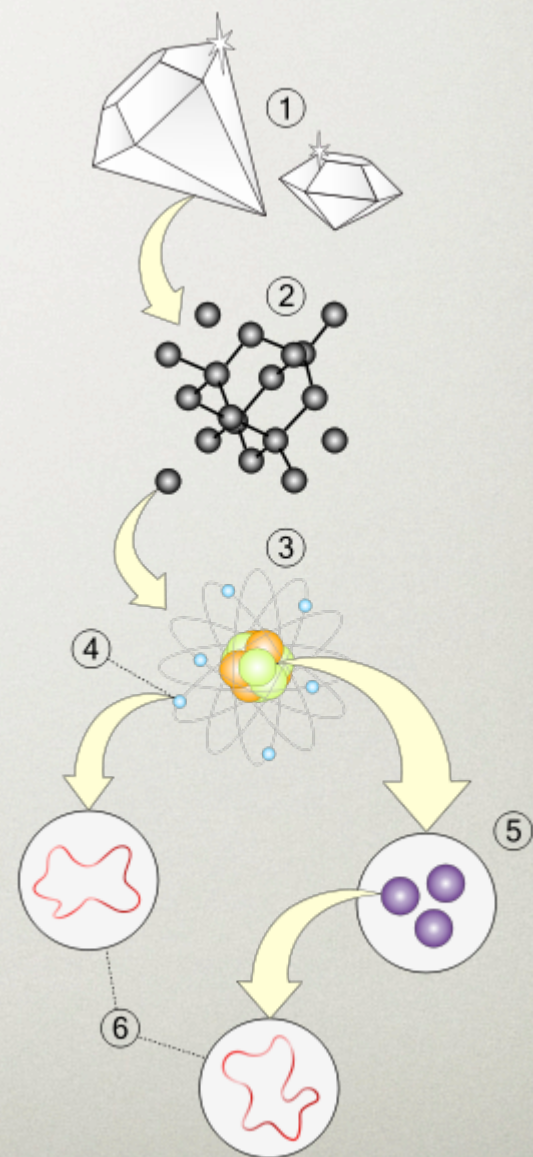
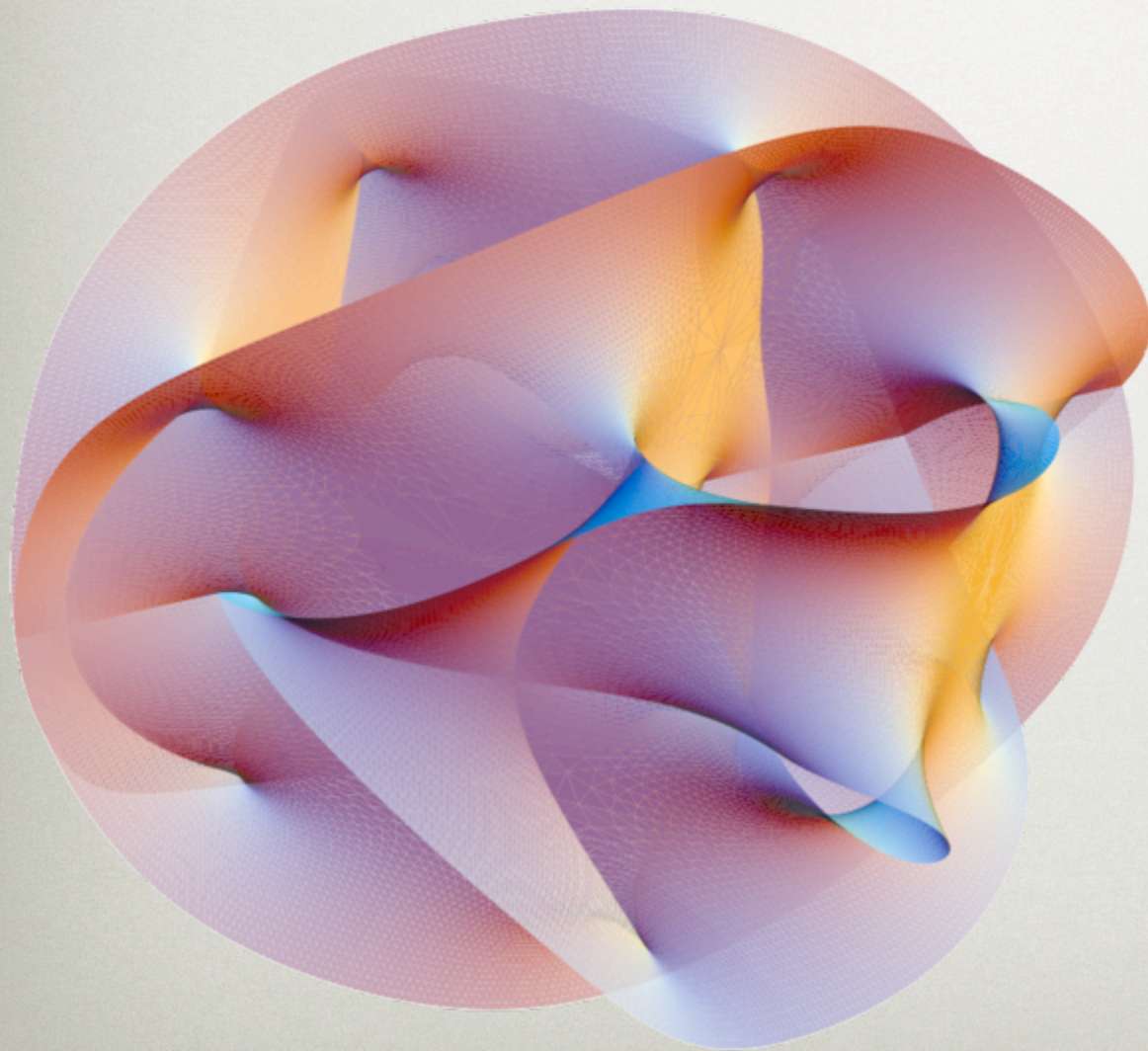


1920s!

MASS “TOWER”

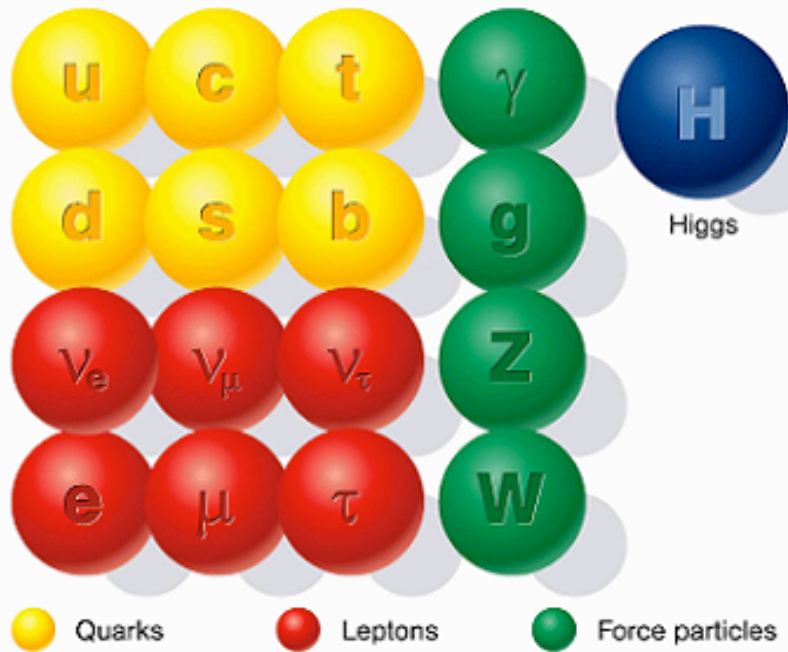


STRING THEORY!

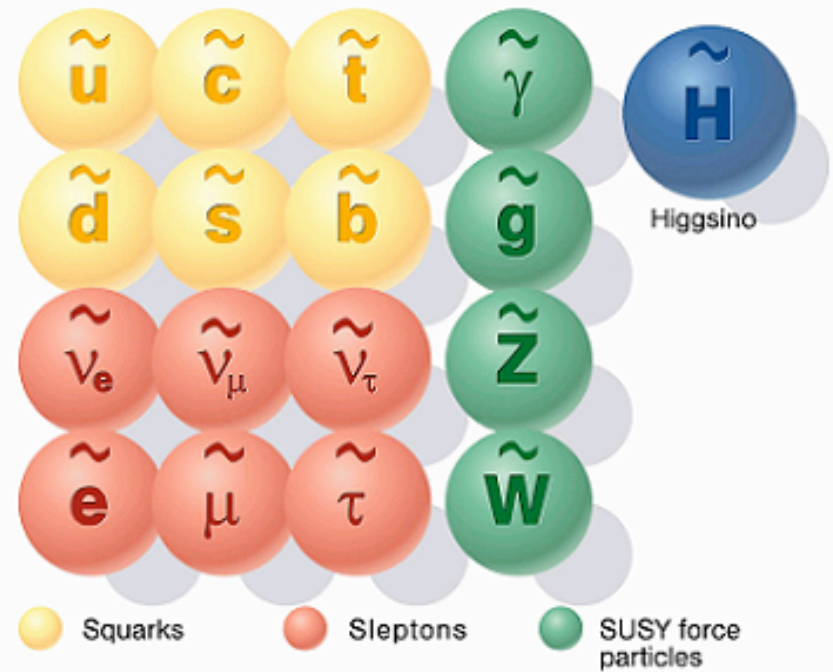


SUPERSYMMETRY

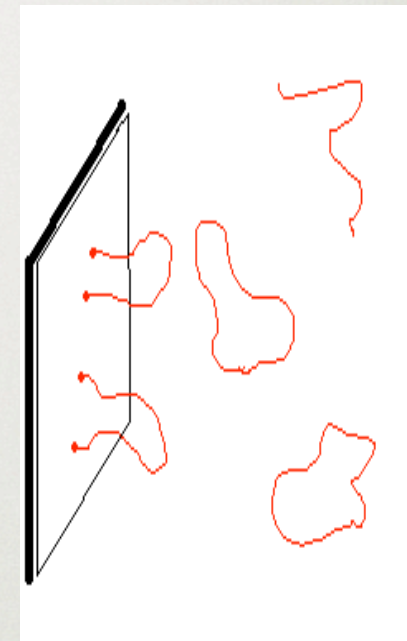
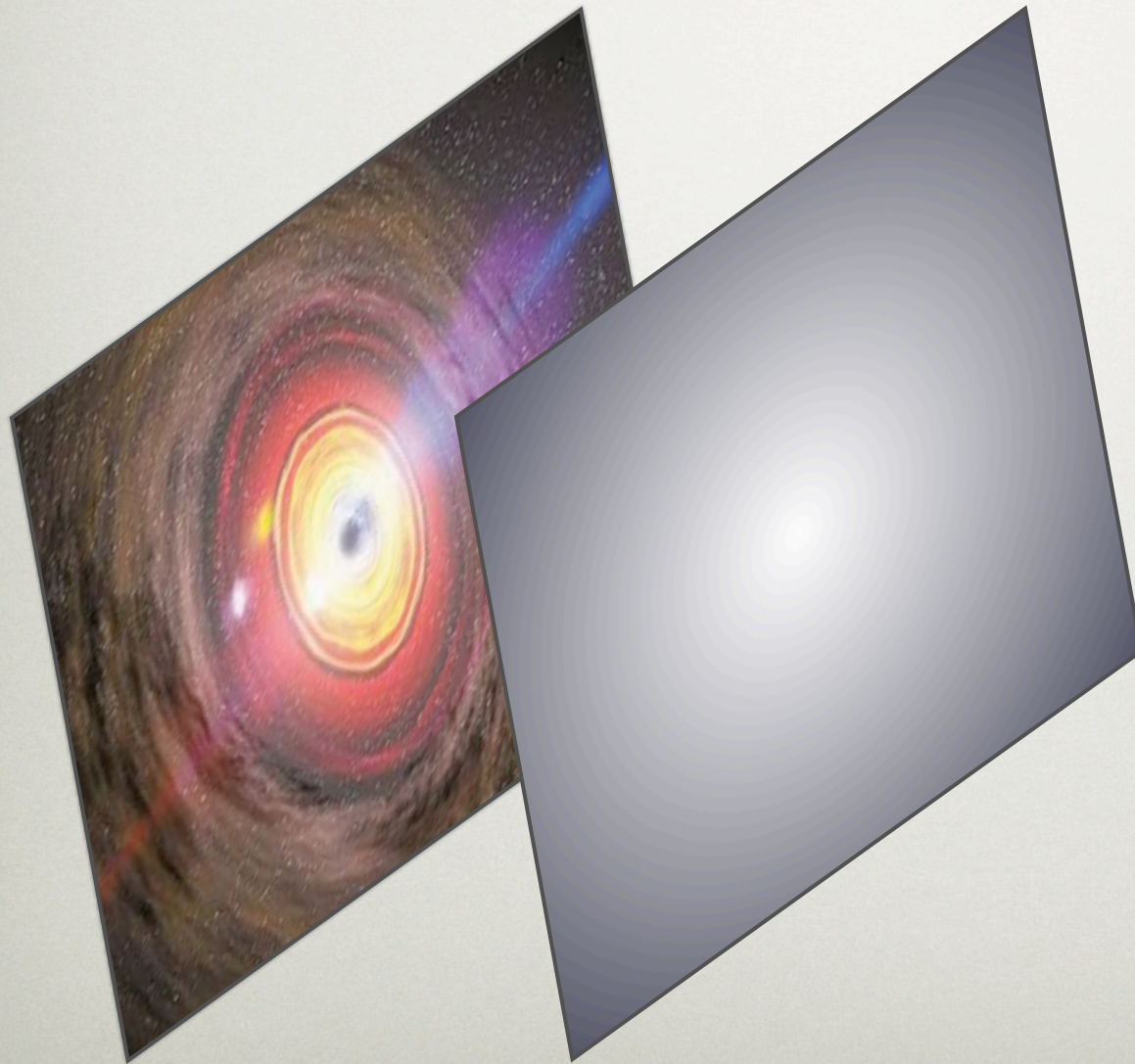
Standard particles



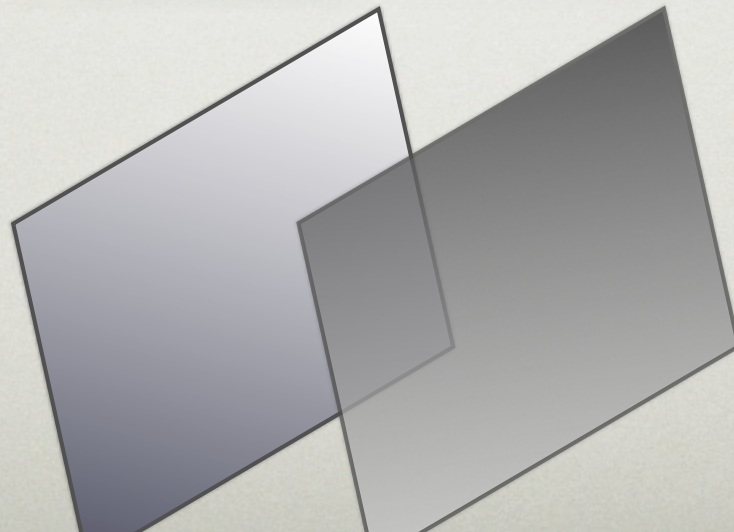
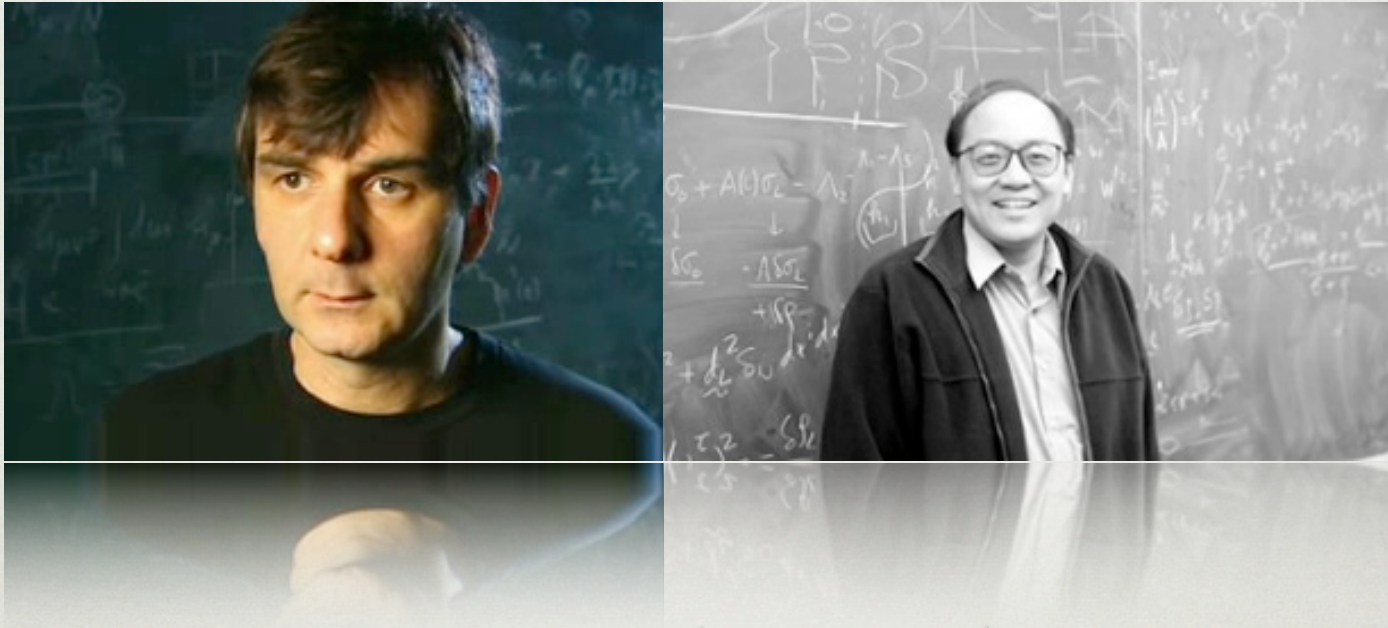
SUSY particles



DIRICHLET MEMBRANES, OR “BRANES”



BRANE INFLATION?



LARGE EXTRA DIMENSIONS

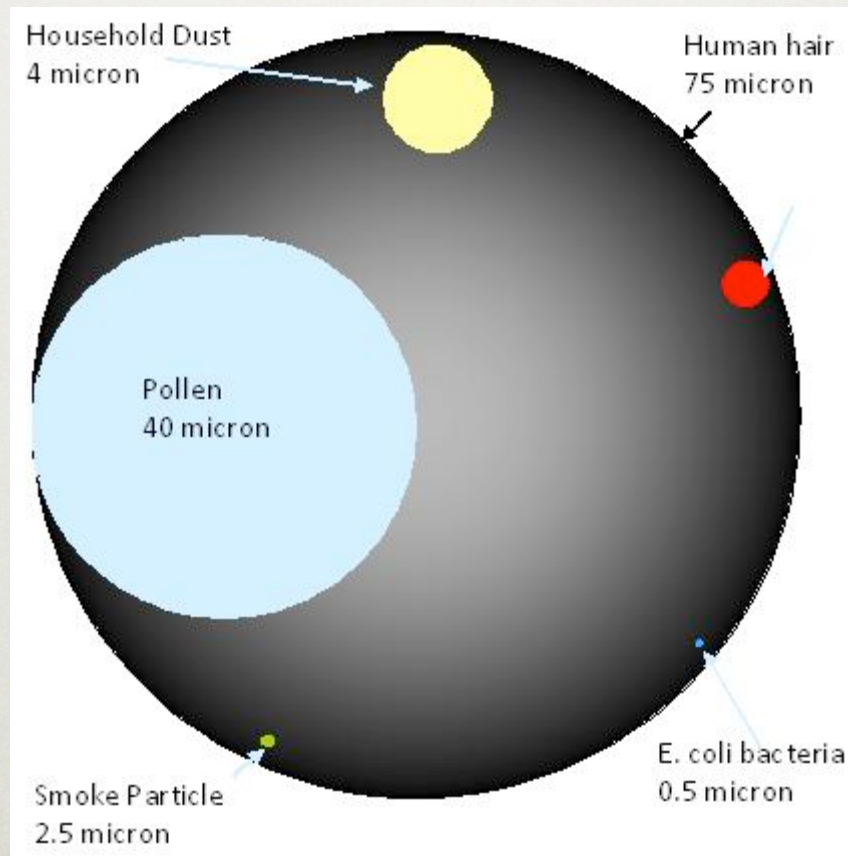
WHY LARGE EXTRA DIMENSIONS?

Gravity is *weak*

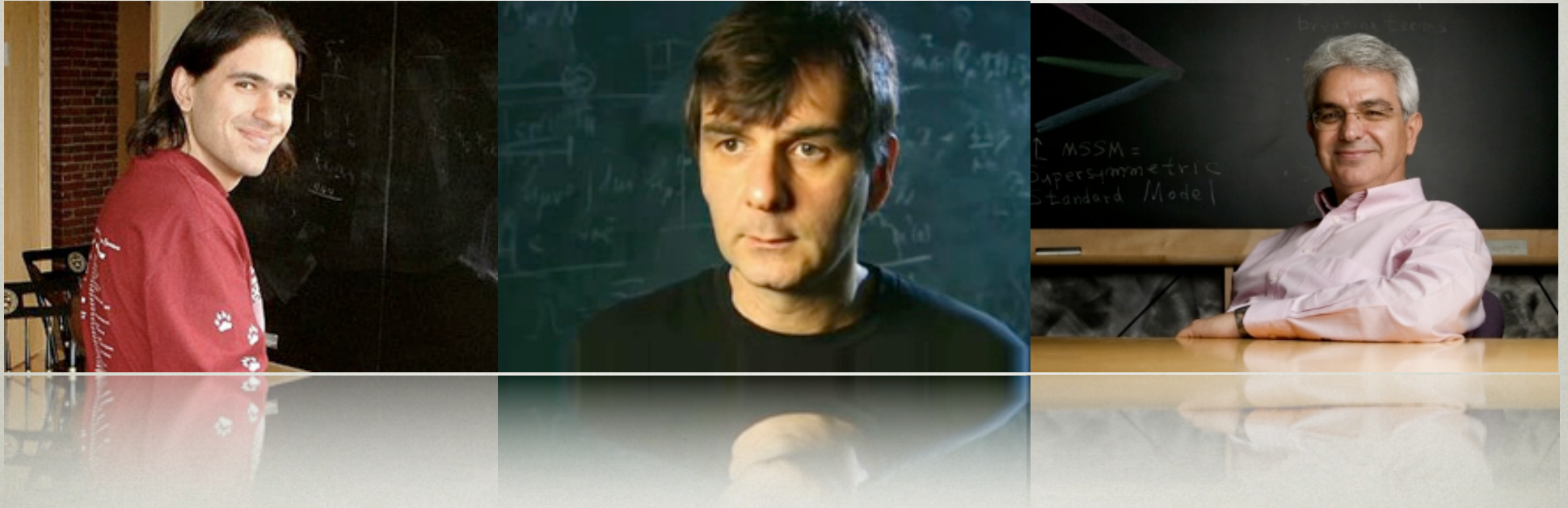
$$\frac{\text{Electromagnetism}}{\text{Gravity}} \sim 10^{32}$$

Idea: gravity is diluted by extra dimensions!

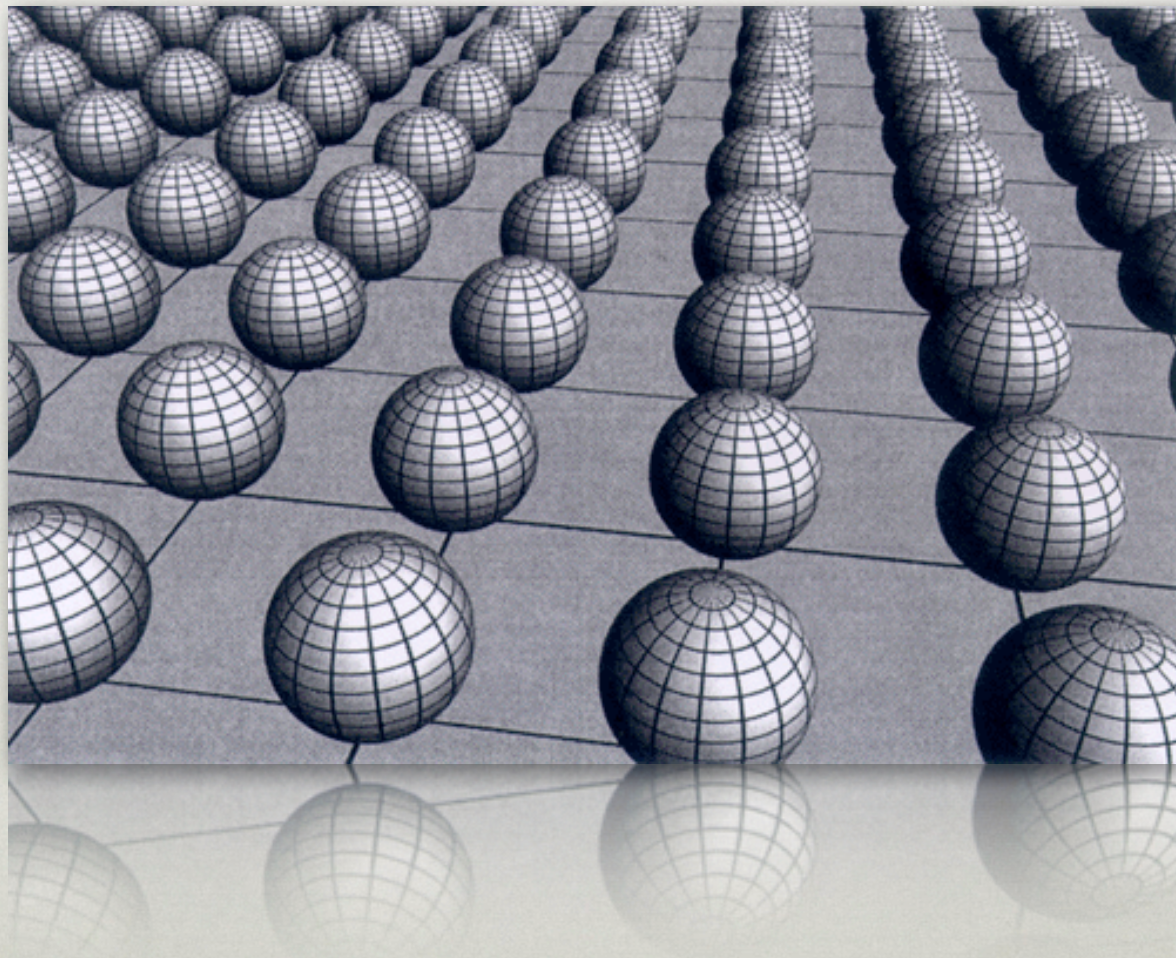
“LARGE” IS STILL SMALL



THE ADD MODEL



THE ADD MODEL



MORE DIMENSIONS, WEAKER GRAVITY

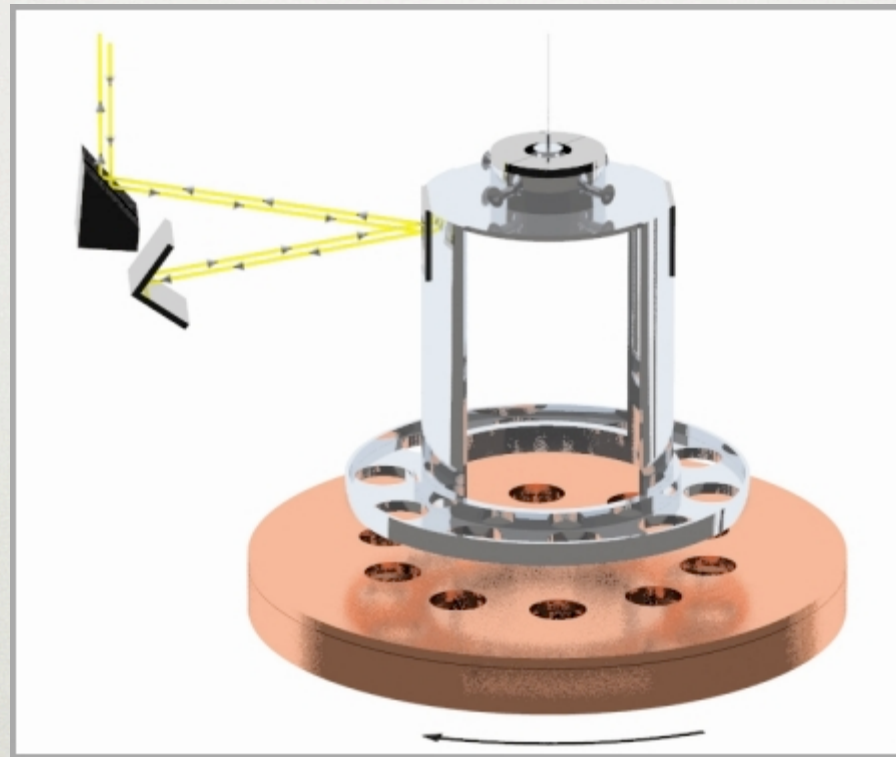
$$\frac{1}{R^2} \rightarrow \frac{1}{R^3} \quad 1 \text{ extra dimension}$$

MORE DIMENSIONS, WEAKER GRAVITY

$$\frac{1}{R^2} \rightarrow \frac{1}{R^3} \quad \text{1 extra dimension}$$

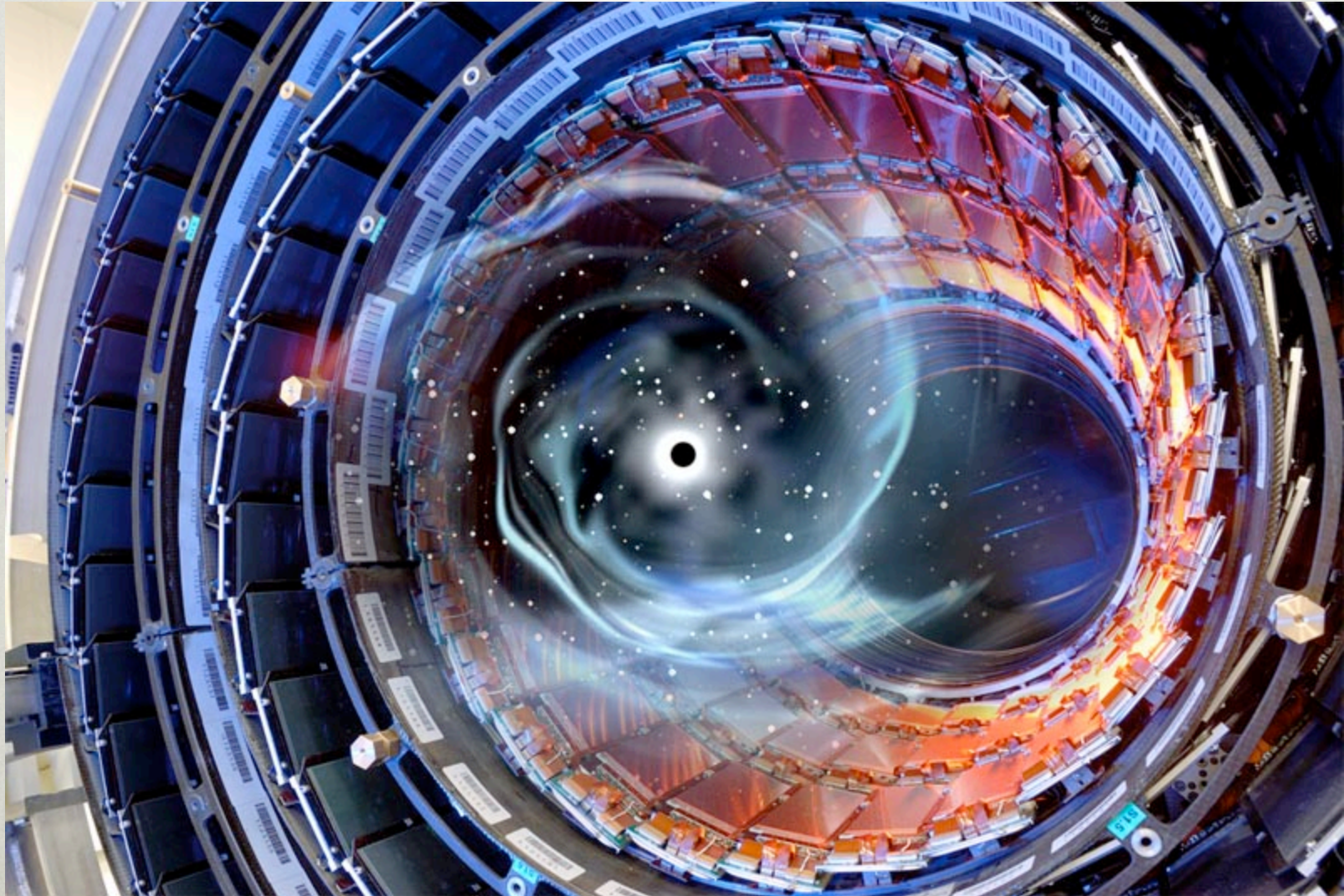
$$\frac{1}{R^2} \rightarrow \frac{1}{R^{D-1}} \quad \text{D total dimensions}$$

WE CAN LOOK FOR CHANGES IN GRAVITY ON SMALL SCALES

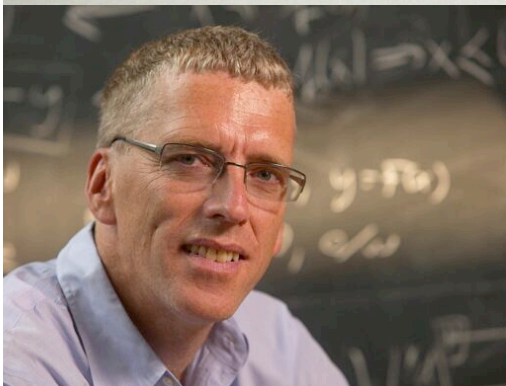
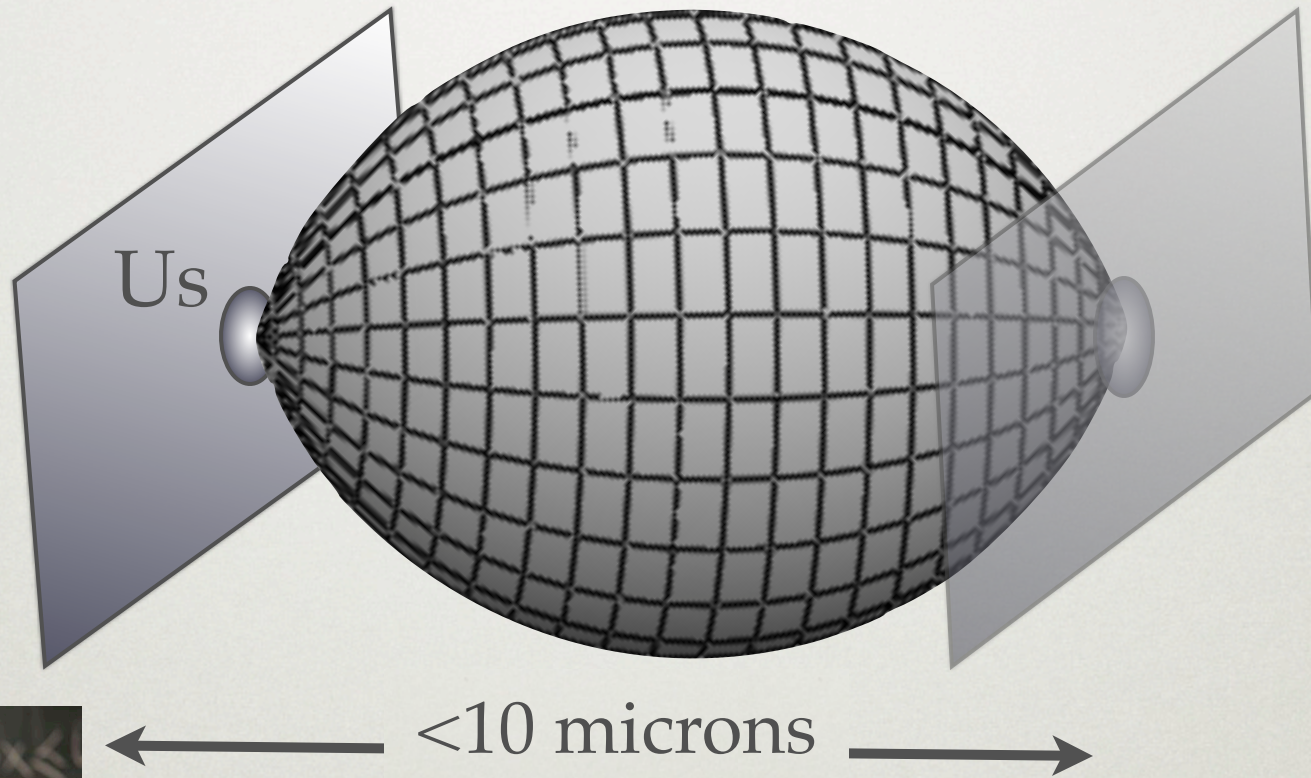


<1mm

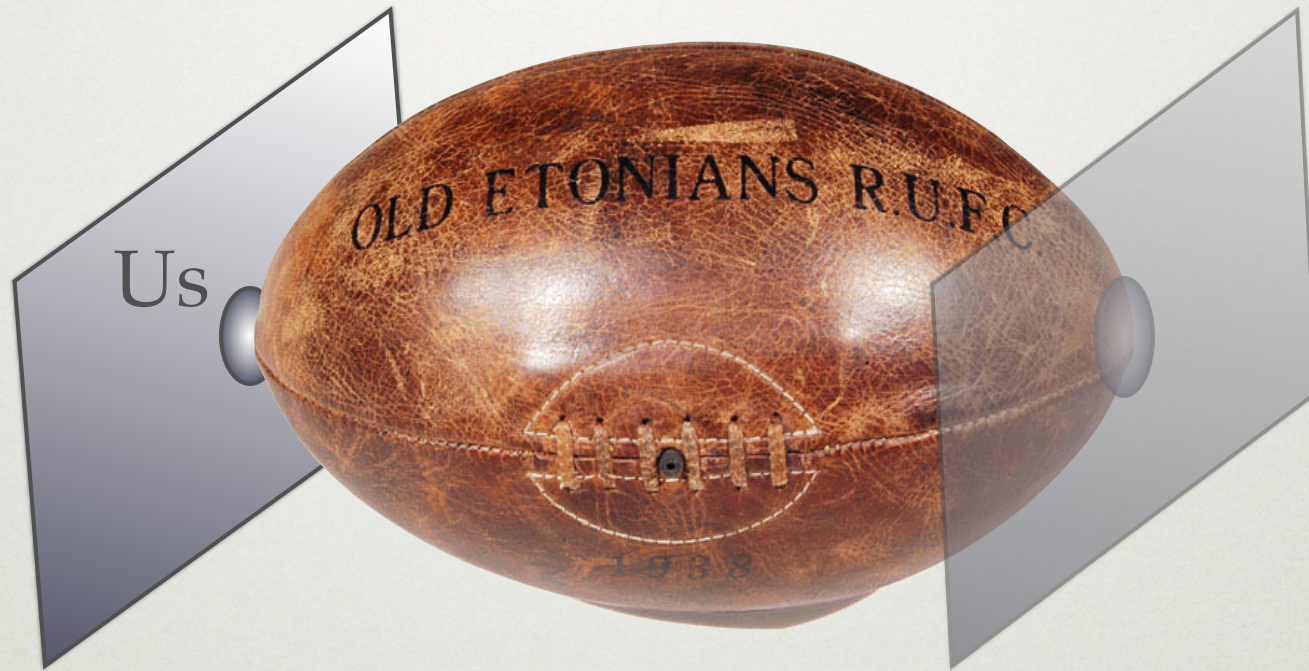
**BLACK HOLES ARE EASIER TO
MAKE WITH WEAKER GRAVITY!**



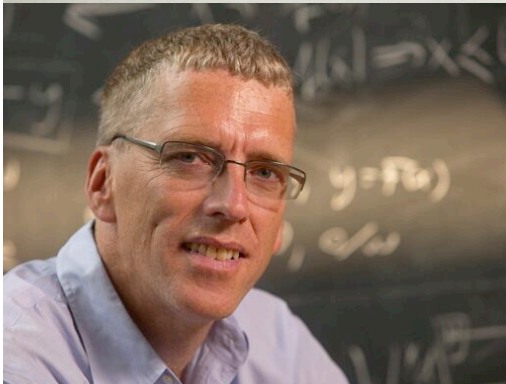
STRING THEORY, TAKE 2: SLED



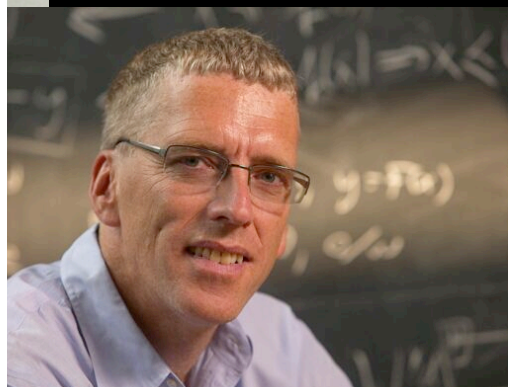
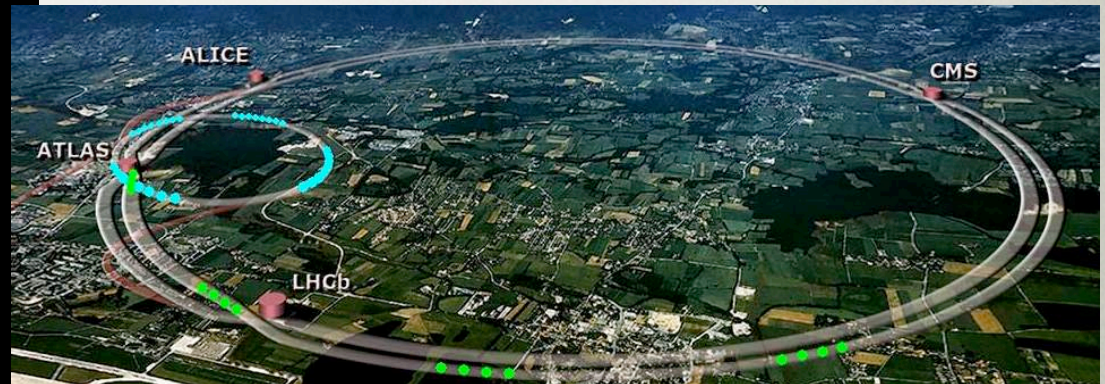
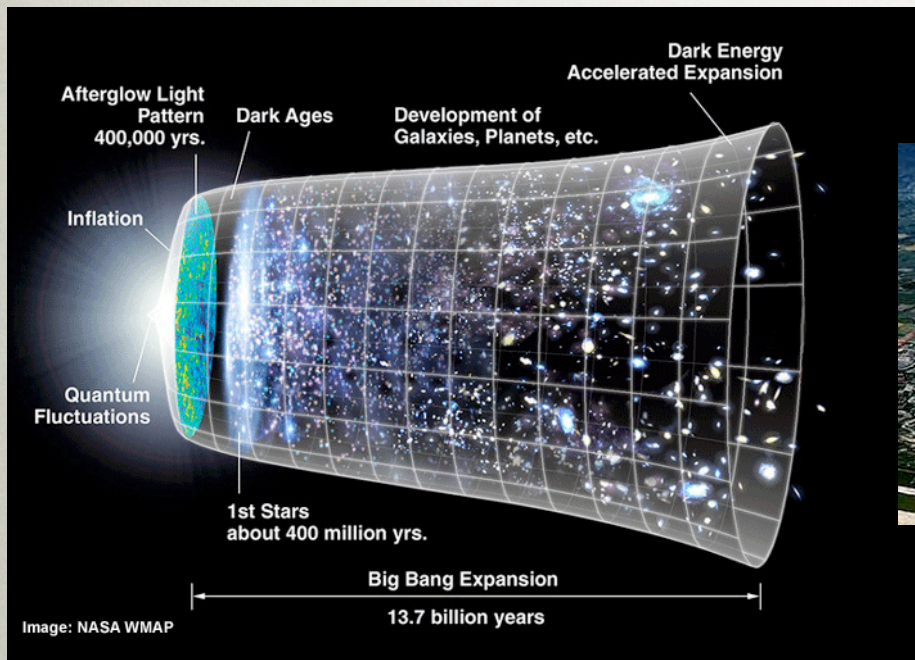
STRING THEORY, TAKE 2: SLED



← <10 microns →



STRING THEORY, TAKE 2: SLED

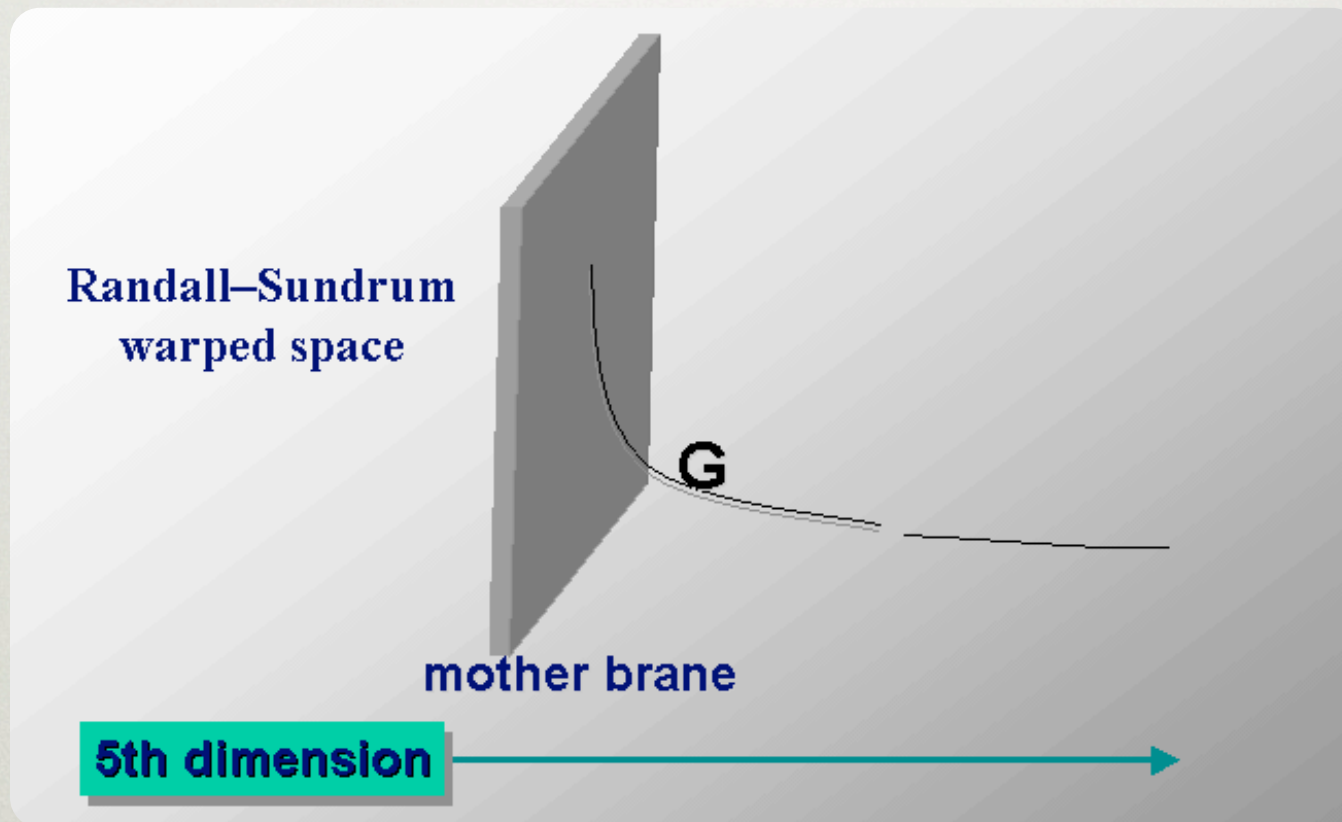


tested: soon!

RANDALL-SUNDRUM

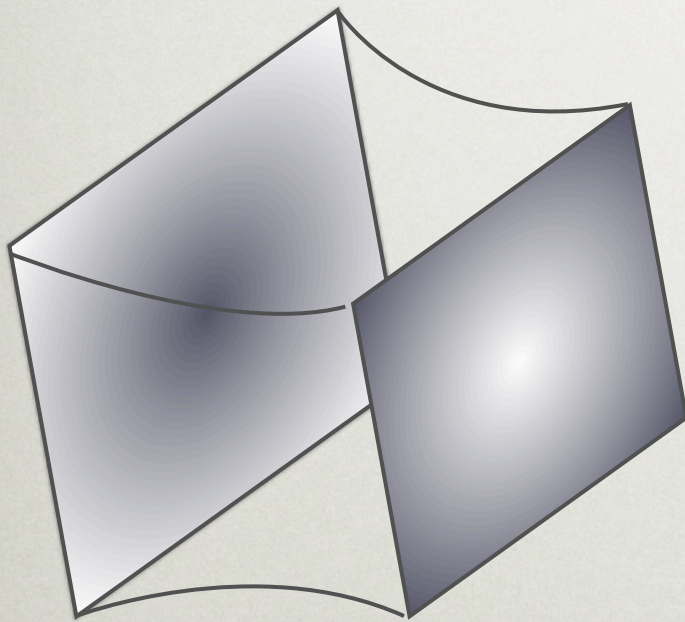


WARPING THE EXTRA DIMENSION(S)



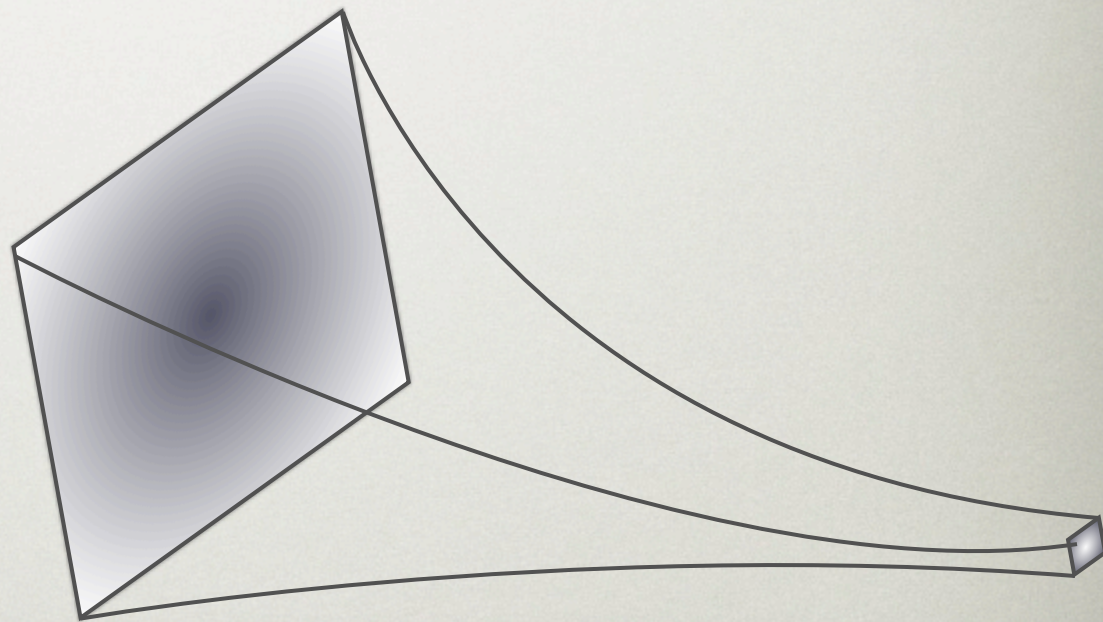
TWO VERSIONS:

two branes



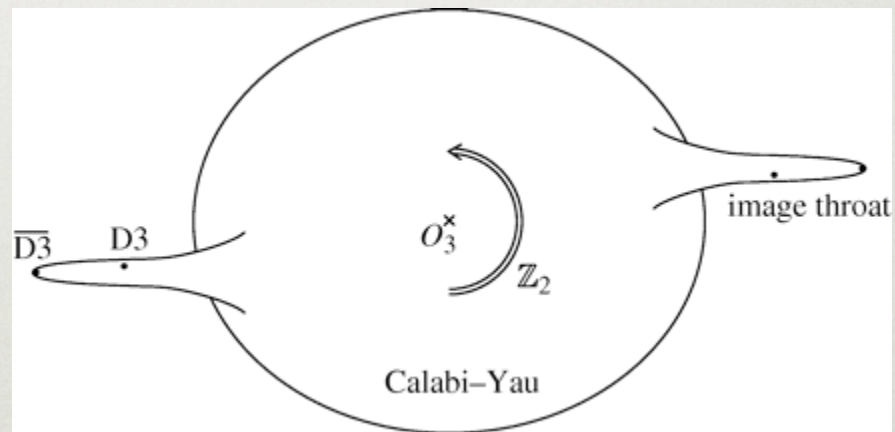
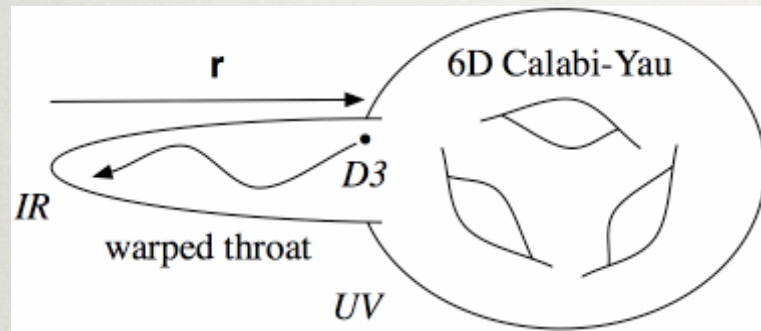
(a small
extra dimension)

one brane
(the other at infinity)

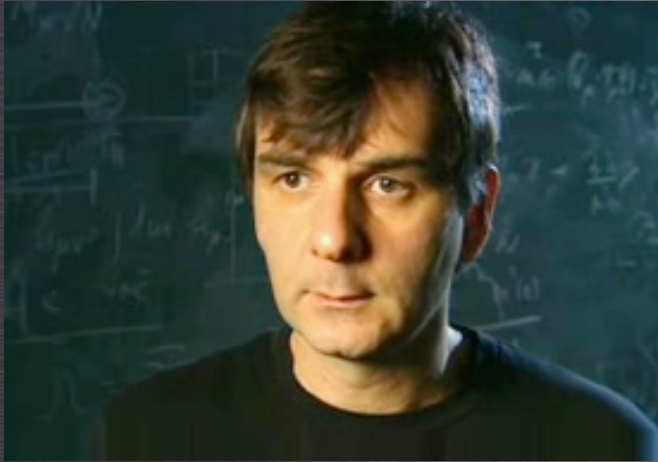


(a huge
extra dimension)

WARPING CHANGED STRING THEORY!



**EXTRA-LARGE
EXTRA DIMENSIONS!**

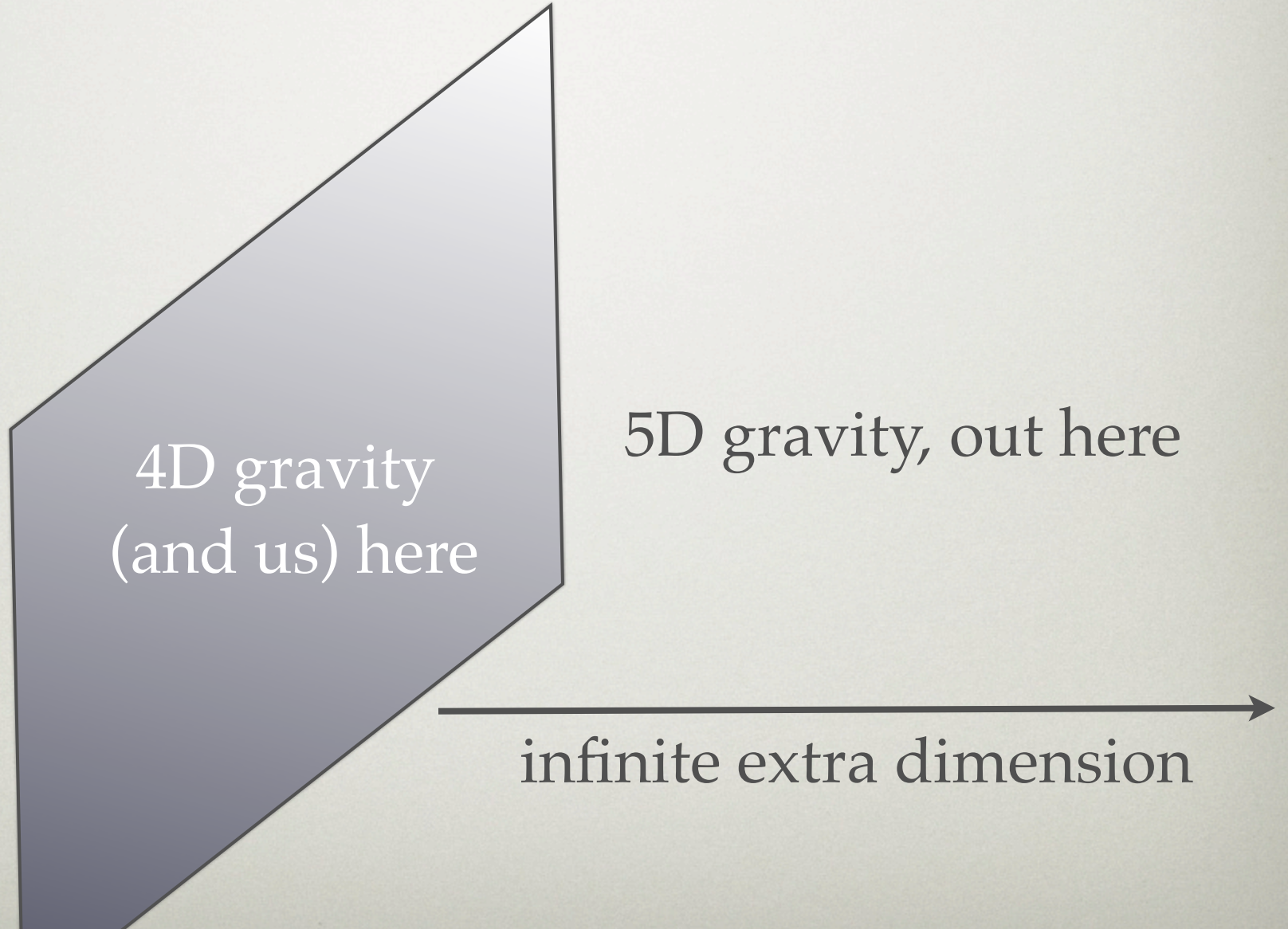


D

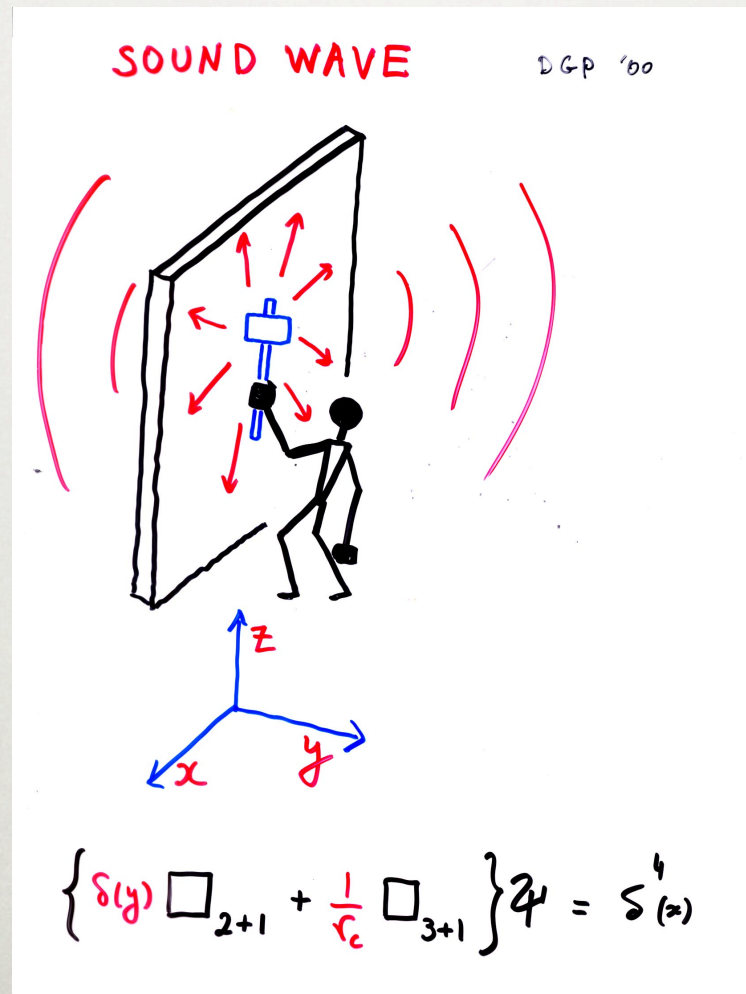
G

P

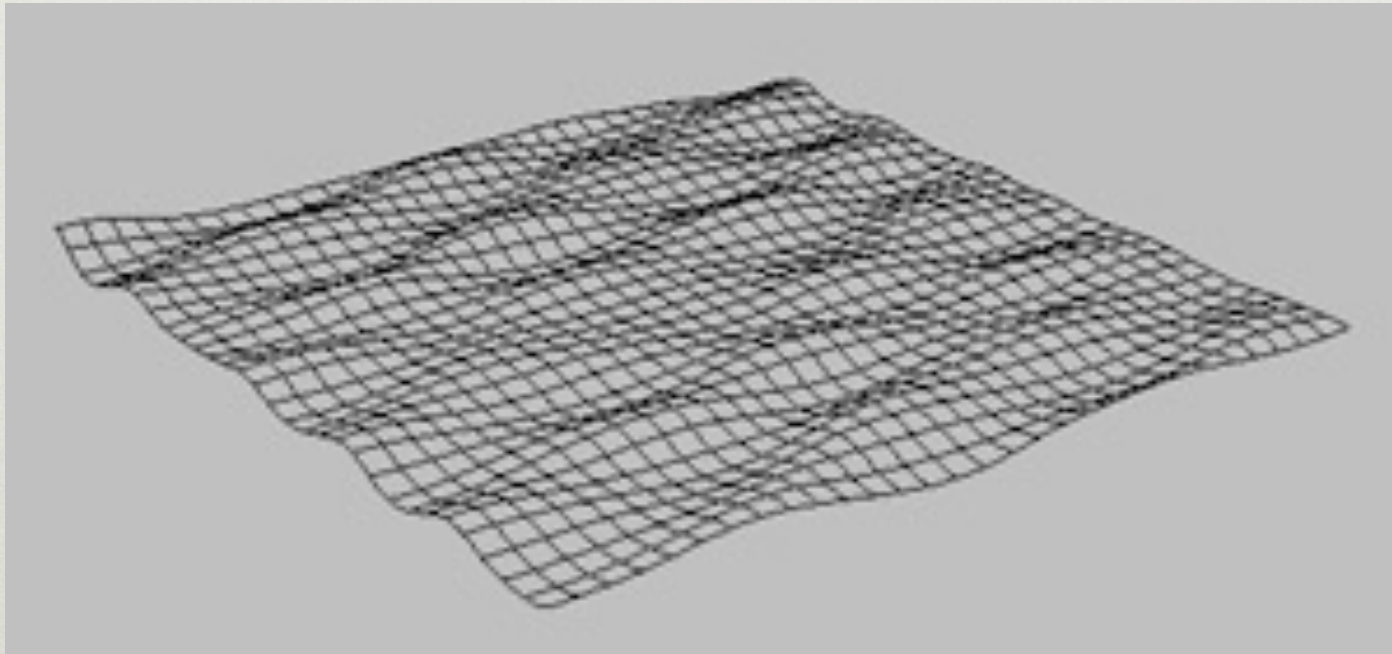
THE DGP IDEA:



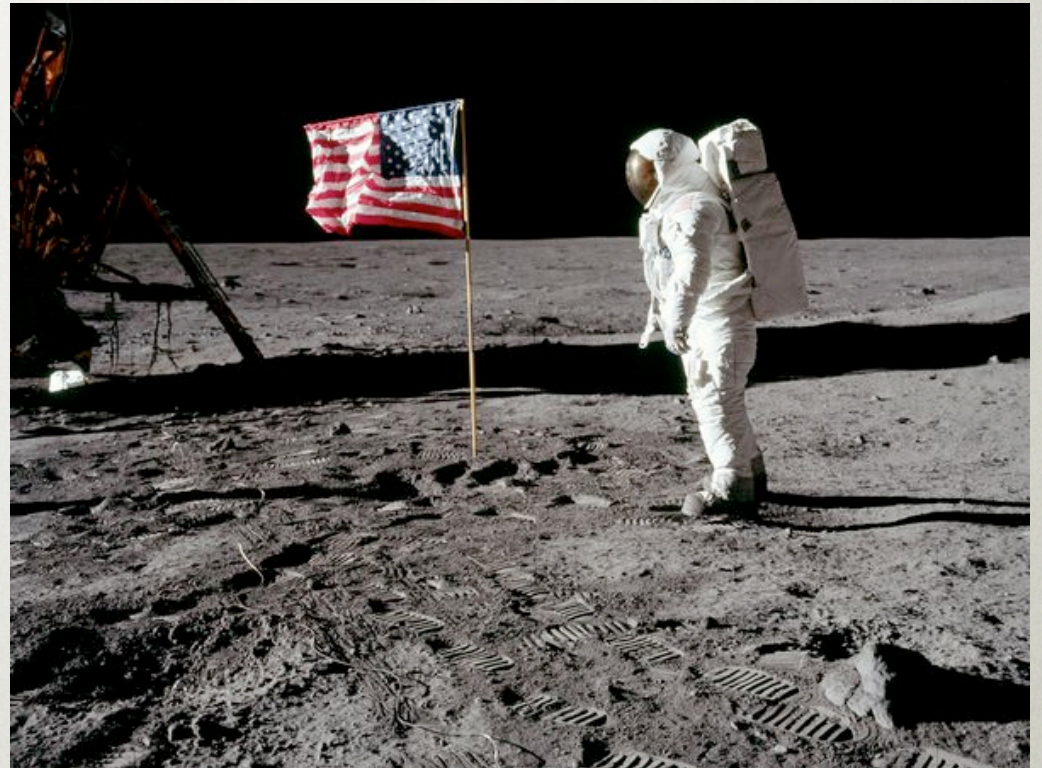
SELF-ACCELERATION FROM “GRAVITY LEAKAGE”?



“BRANE BENDING”



TEST: THE MOON!



TEST: THE MOON!

