5/4/05

Test 4 results

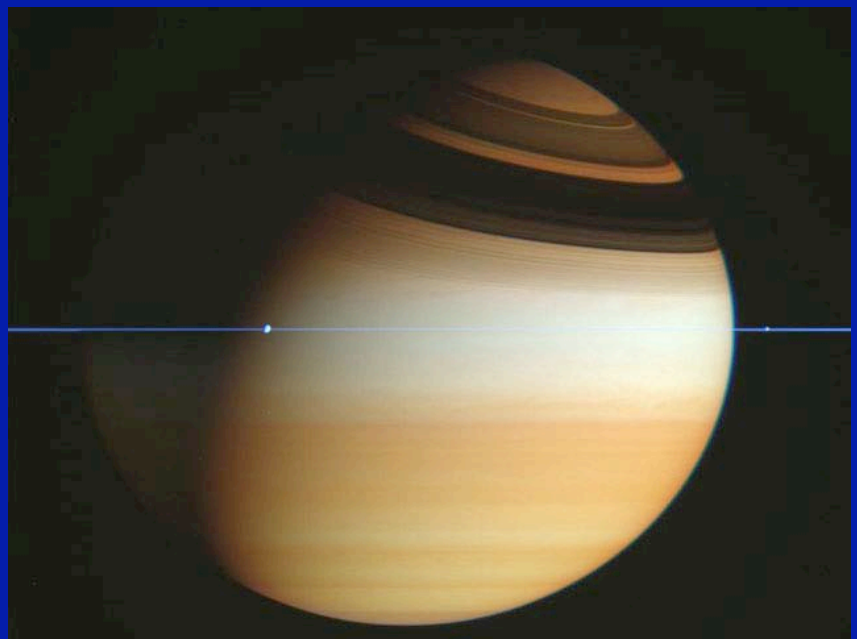
Final Review Sheet - this week's material plus a review of some term-spanning themes, posted today.

Chapter 12 - Omit worm hole, time machines Sections 1, 2, some new material - Braneworlds in higher dimensional space

News:

Pic of the day:

Saturn's rings edge on



Comprehensive Final

100 multiple choice questions,

Wednesday, May 11, 2 - 5 PM here in Welch 3.502.

Extra credit sky-watch reports are due by 5 PM on Friday, May 6.

Brief descriptions of what you saw, under what circumstances, with what relevance to course.

Special Office Hours: RLM 15.216B

Tuesday, May 10 4 - 6 PM

Jen: 4 - 5

Wheeler: 5 - 6

Or make appointment with either of us.

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 (mathematicaslly) 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 for the weak and strong nuclear forces.

String Theory

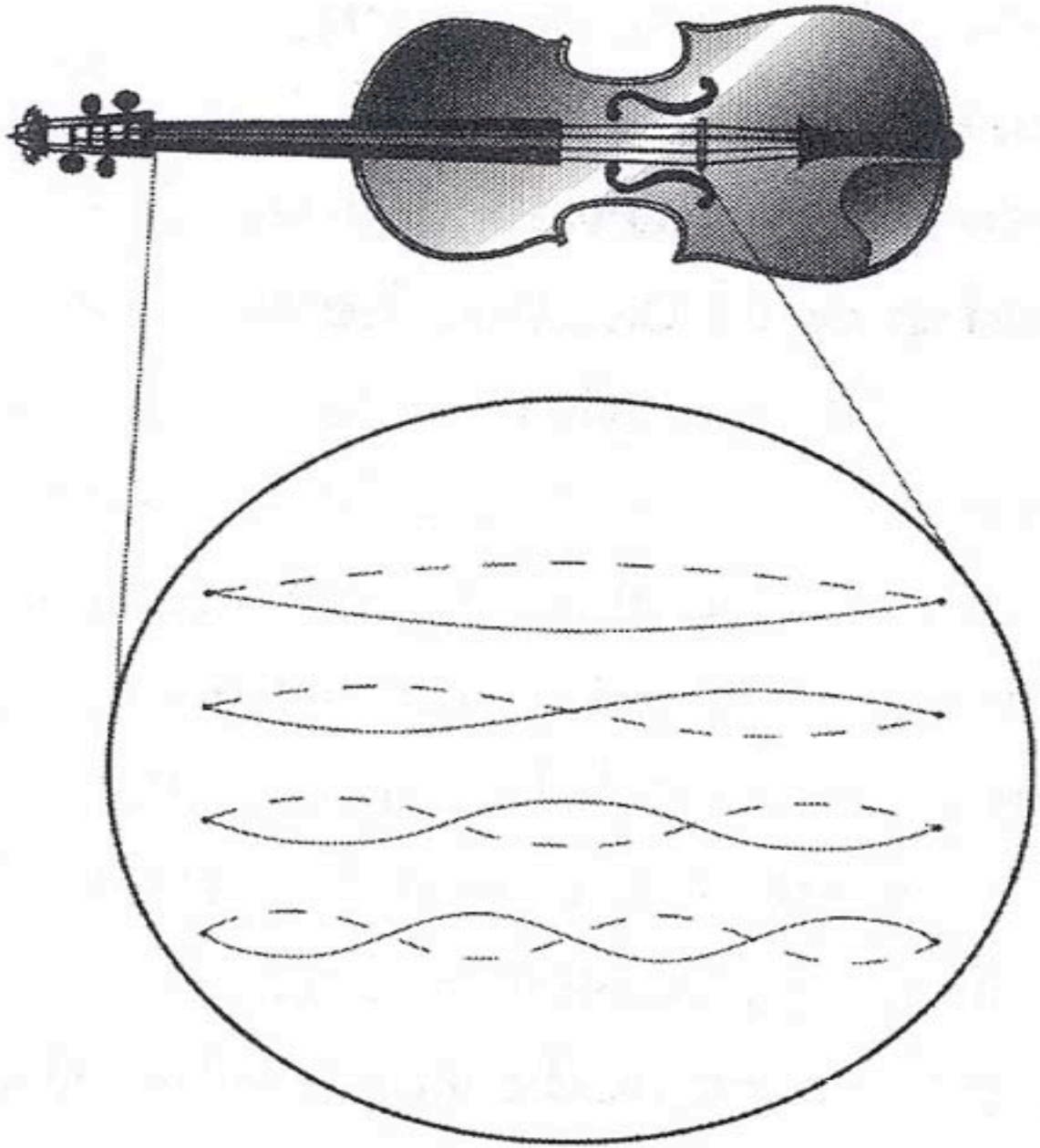
Best current candidate for a quantum gravity "theory of everything."

Particles like e-, p, n are not "points" but strings, loops that vibrate in different modes

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

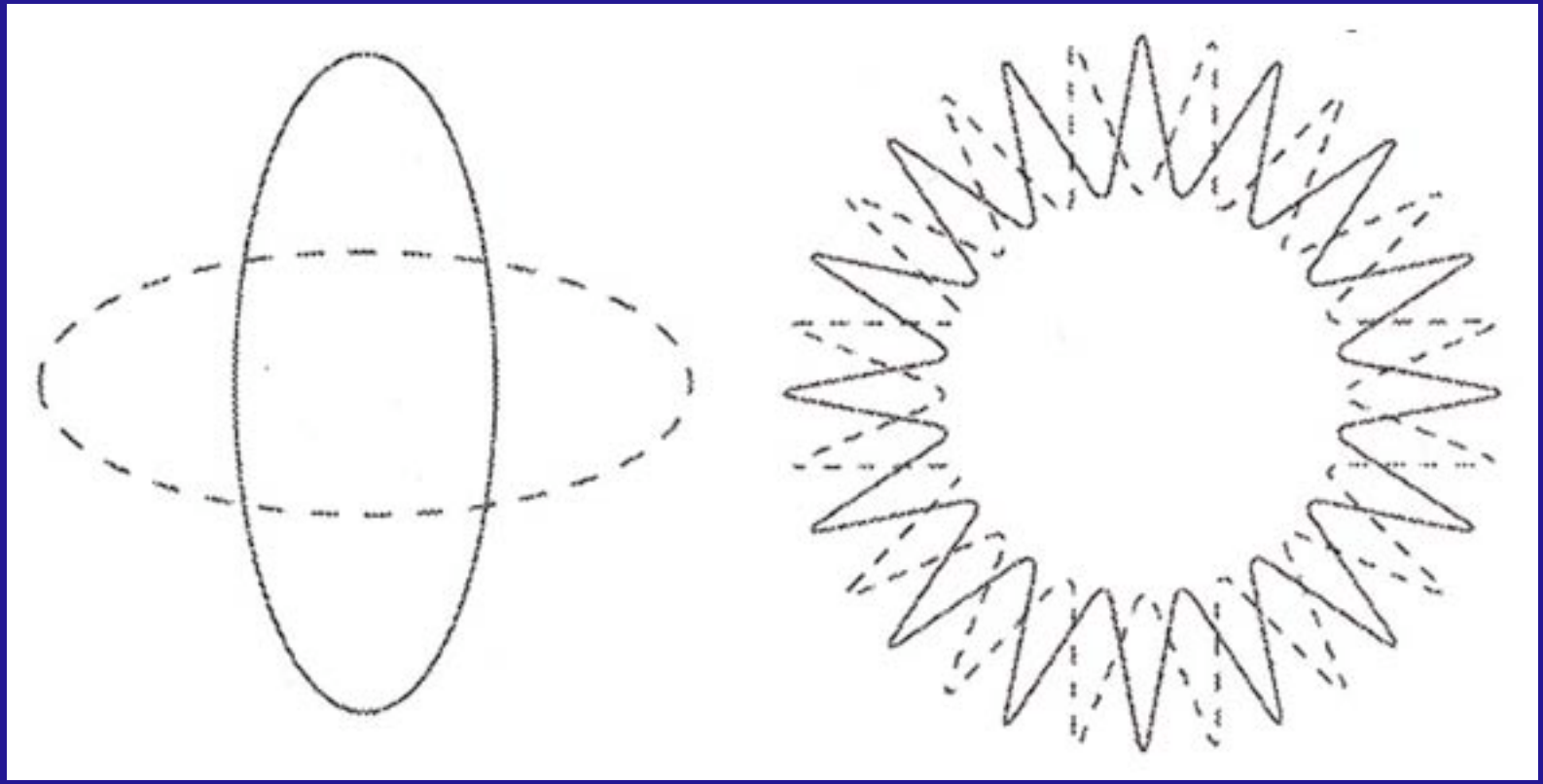
Can't make notes with grains of sand, but with strings, you have Mozart

From Brian Green - The Elegant Universe



One particle

A different particle



Same fundamental loop of string

From Brian Green - The Elegant Universe

To be mathematically self-consistent

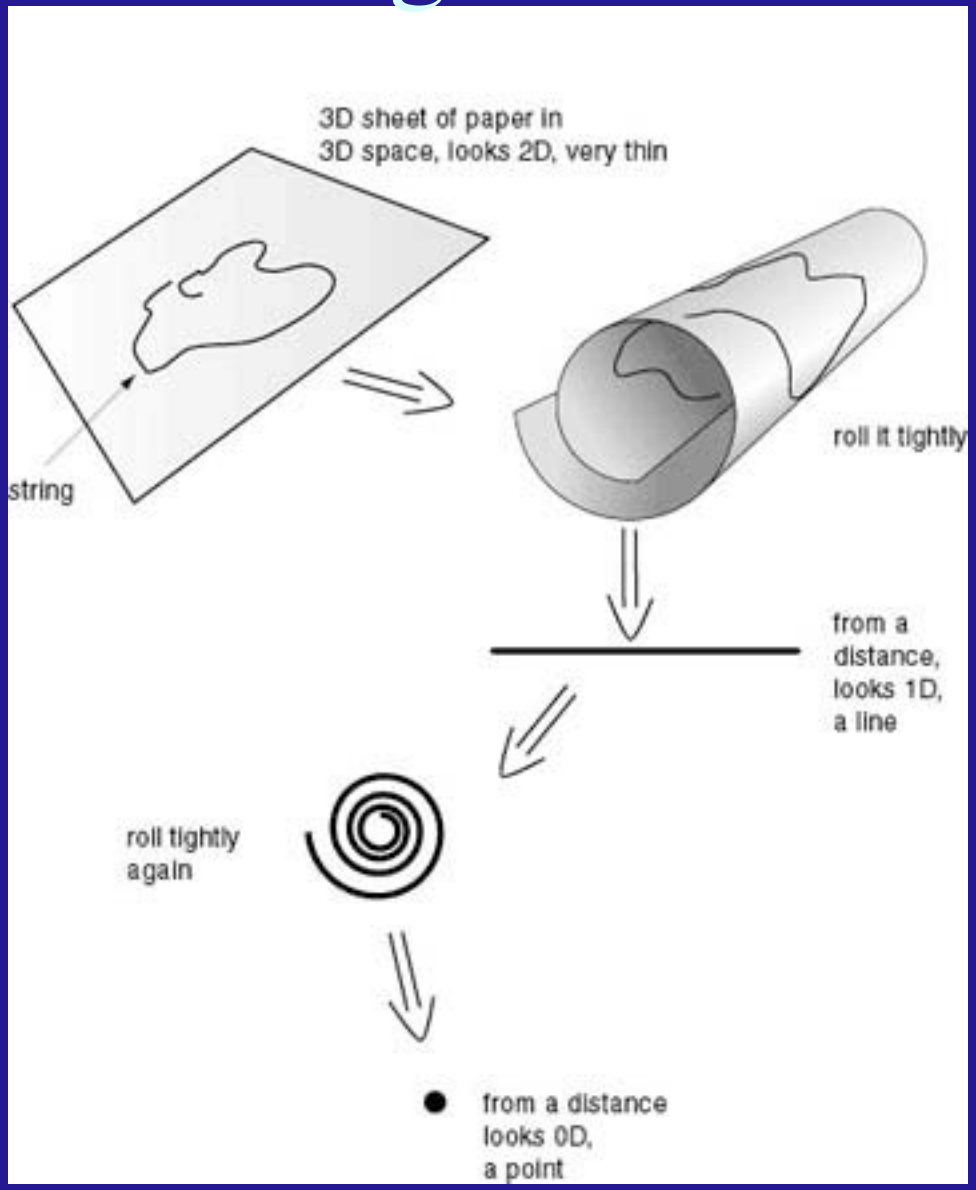
Space in which strings vibrate has ***10 space dimensions*** + time

First notions:
3 big space dimensions + time

Other 7 dimensions "wrapped up" on "string length scale," not known precisely, somewhat larger than the Planck scale, but very tiny so we cannot easily "see."

Rubber band - 1D, paper - 2D (wrap rubber band in paper, make 1D, 0D spaces still containing the rubber band)

Fig 12.3


3D sheet of paper in
3D space, looks 2D, very thin
string
roll it tightly
from a
distance,
looks 1D,
a line
roll tightly
again
from a distance
looks 0D,
a point

String Theory

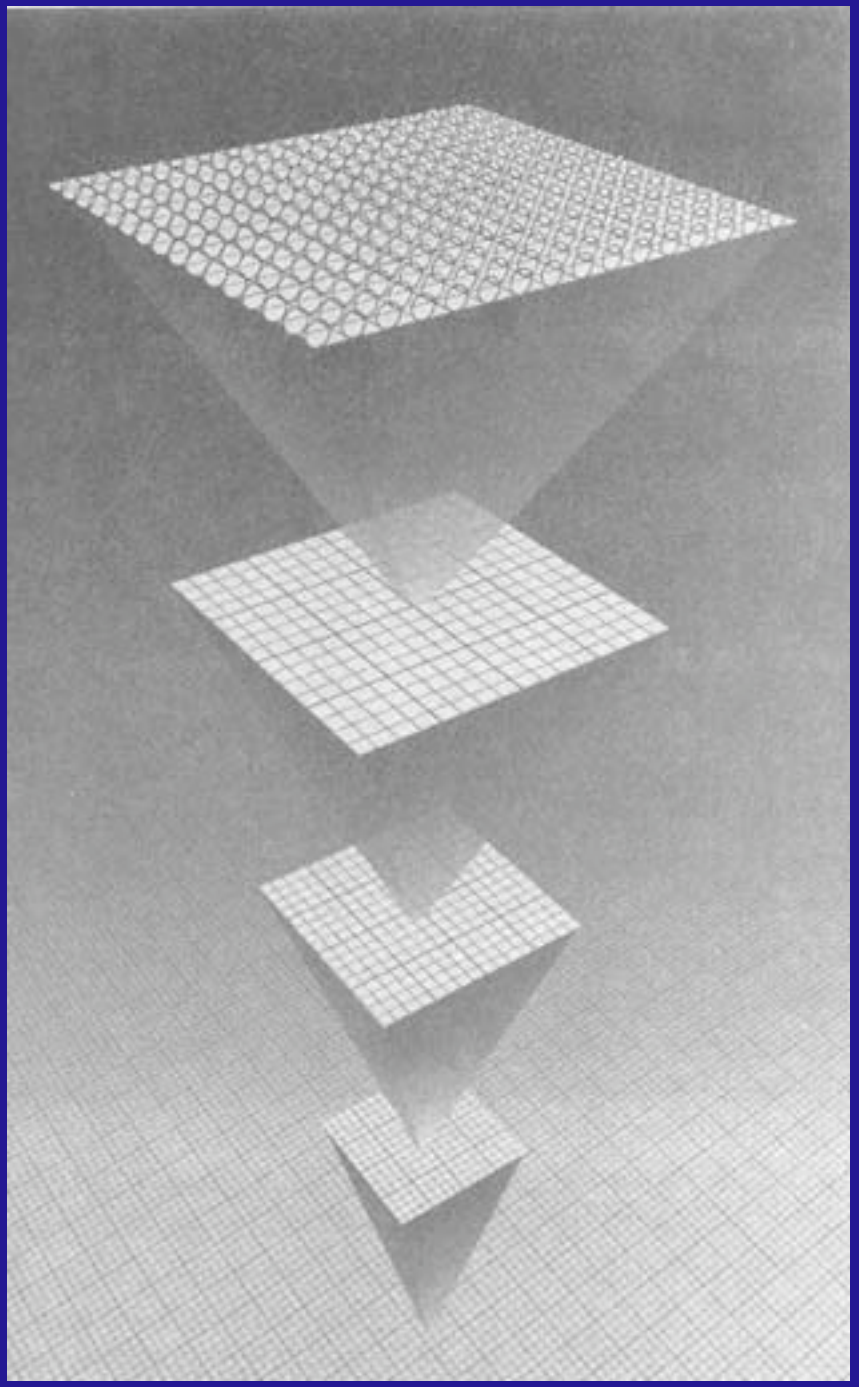
History - in 1960's physicists recognized that the equations corresponding to the strong nuclear force also described entities that could stretch and wiggle - strings

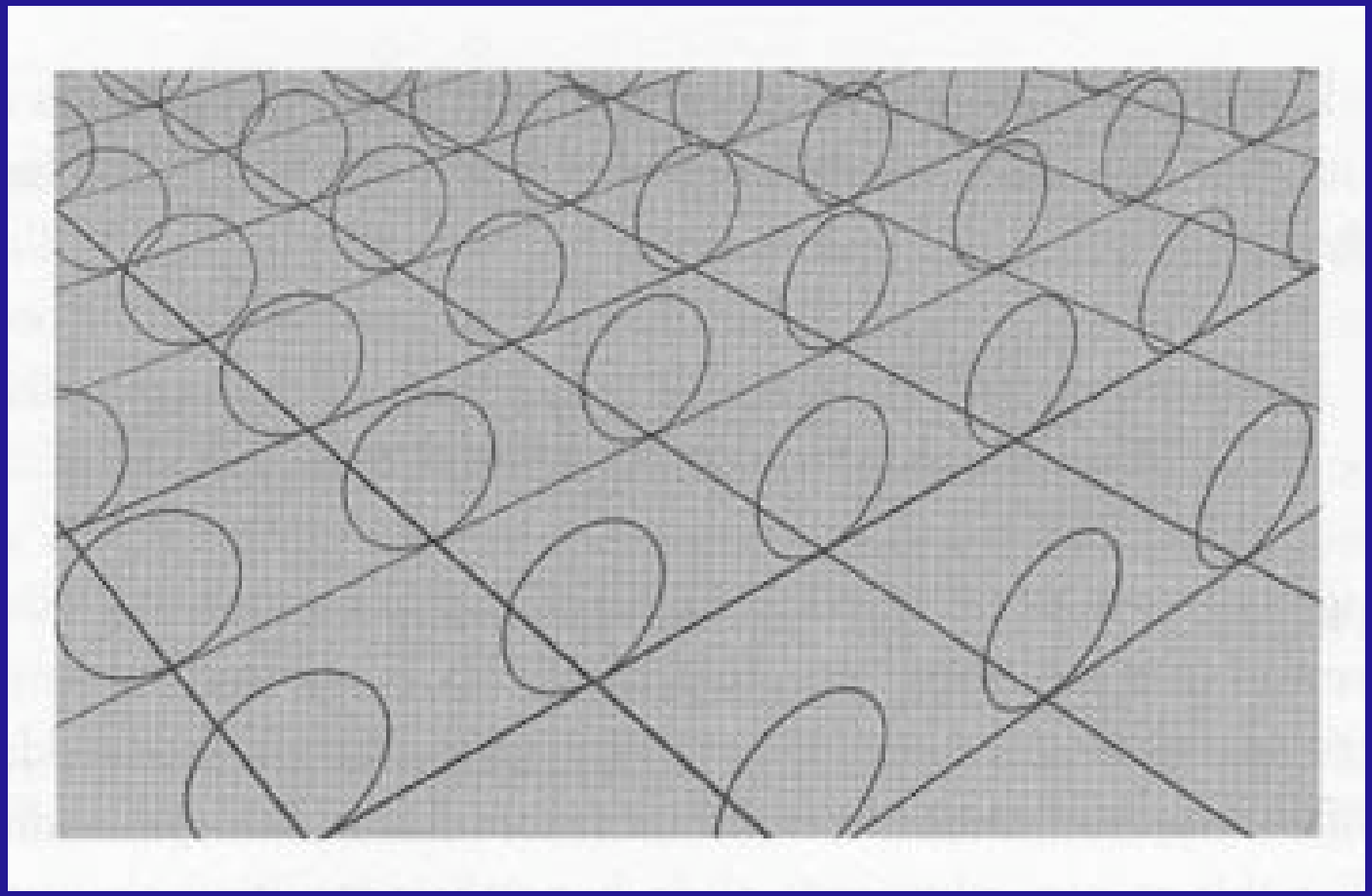
Space in which strings vibrate has ***10 space dimensions*** + time

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

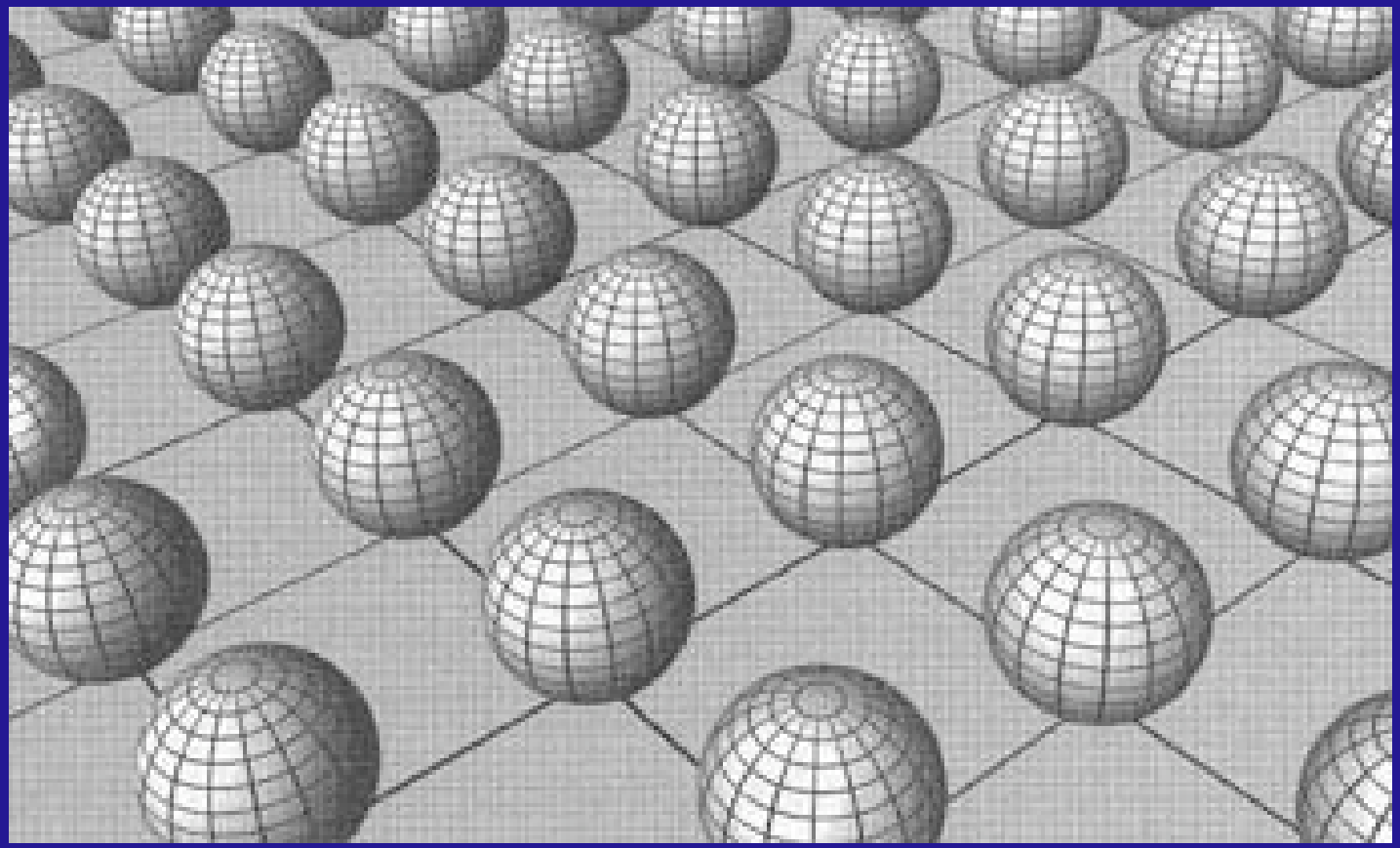
Schematic illustrations of how tiny “wrapped up” extra dimensions could be associated with our 3D space - something like an embedding diagram of the higher dimensional space, so our 3D space is reduced to 2D and the higher dimensional wrapped spaces are reduced to 3D.

From Brian Green - The Elegant Universe

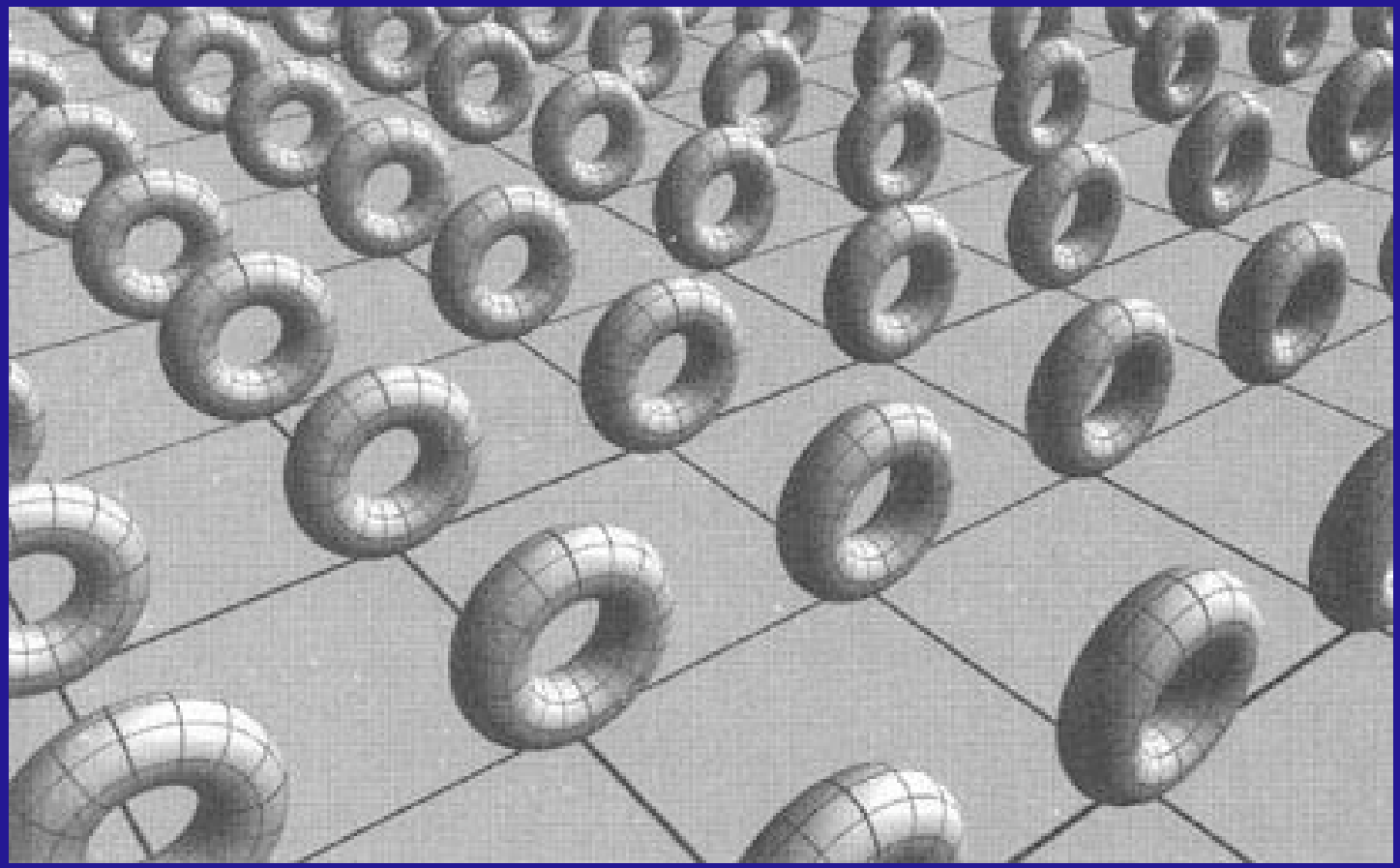




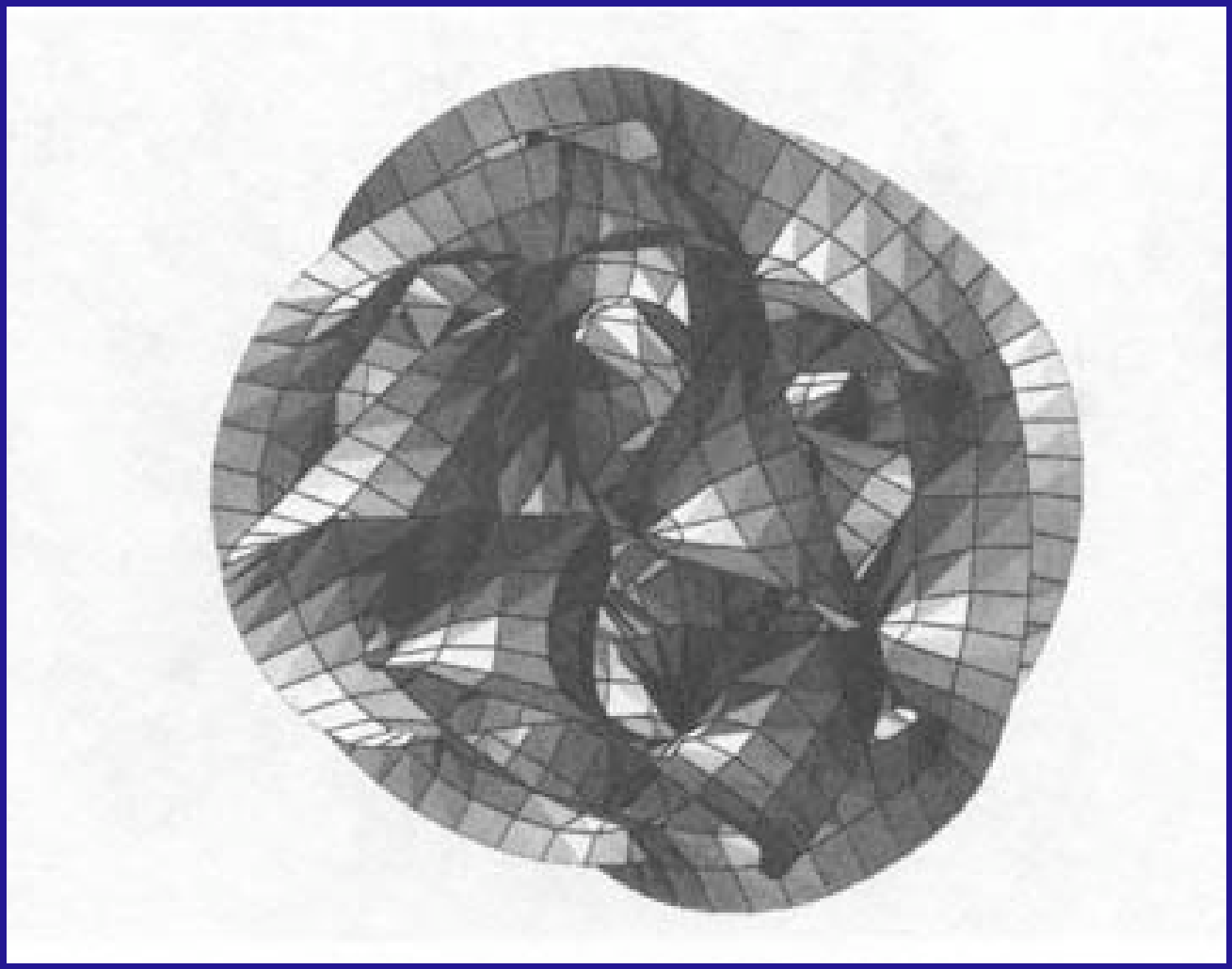
At each point in the 2D space (not just at the intersections of grid lines), there is a little 1D loop of one wrapped up extra dimension.



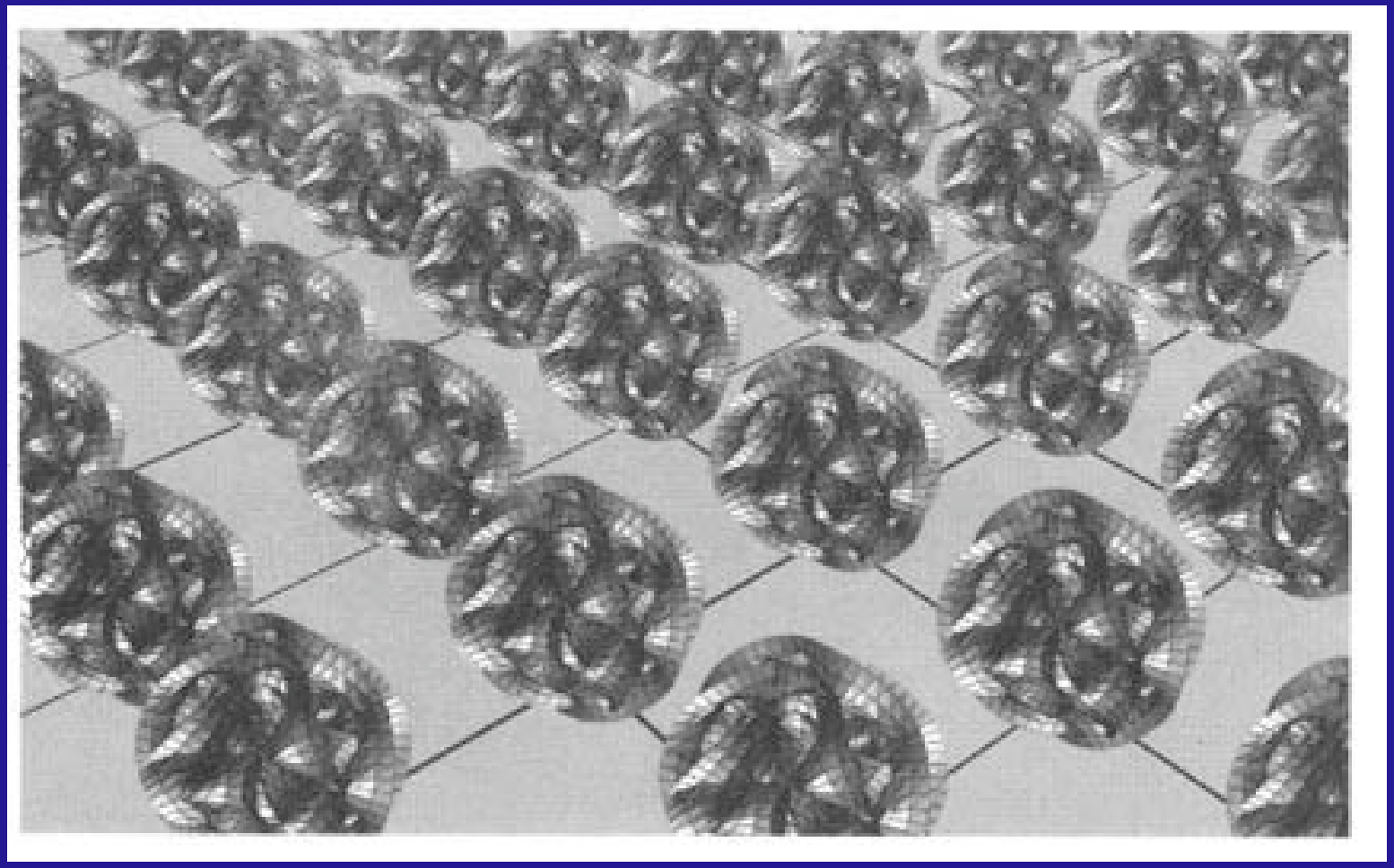
At each point in the 2D space (not just at the intersections of grid lines), there is a little 2D “sphere” of two wrapped-up extra dimensions.



At each point in the 2D space (not just at the intersections of grid lines), there is a little 2D “torus” of two wrapped-up extra dimensions. A torus has a distinctly different “topology” or “connectedness” than a sphere.



Representation of a Calabi-Yau space, with 6 wrapped-up extra dimensions



At each point in the 2D space (not just at the intersections of grid lines), there is a little 6D Calibi-Yau space of six wrapped-up extra dimensions.