Physics 102 - January 19, 2011

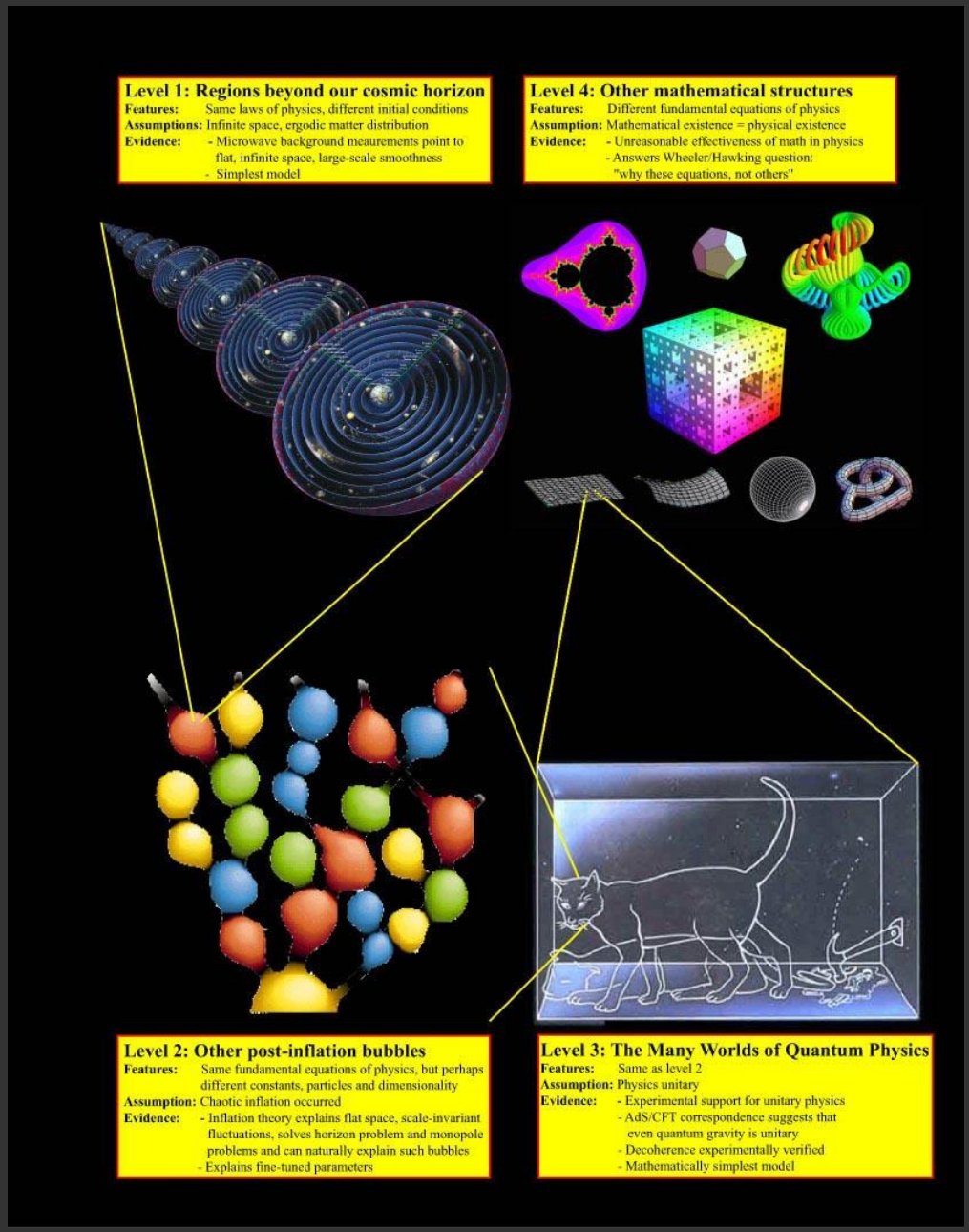
- Recitations begin next week
- Jury Duty - class next week
- Questions abt course

What is a universe?

Max Tegmark's multiverse taxonomy

Classified by level of abstraction/complexity

Cosmologist at MIT



My populist taxonomy – classified according to primary form of separation of the universes

Space-time separated

Dimensionally separated

Faith-based

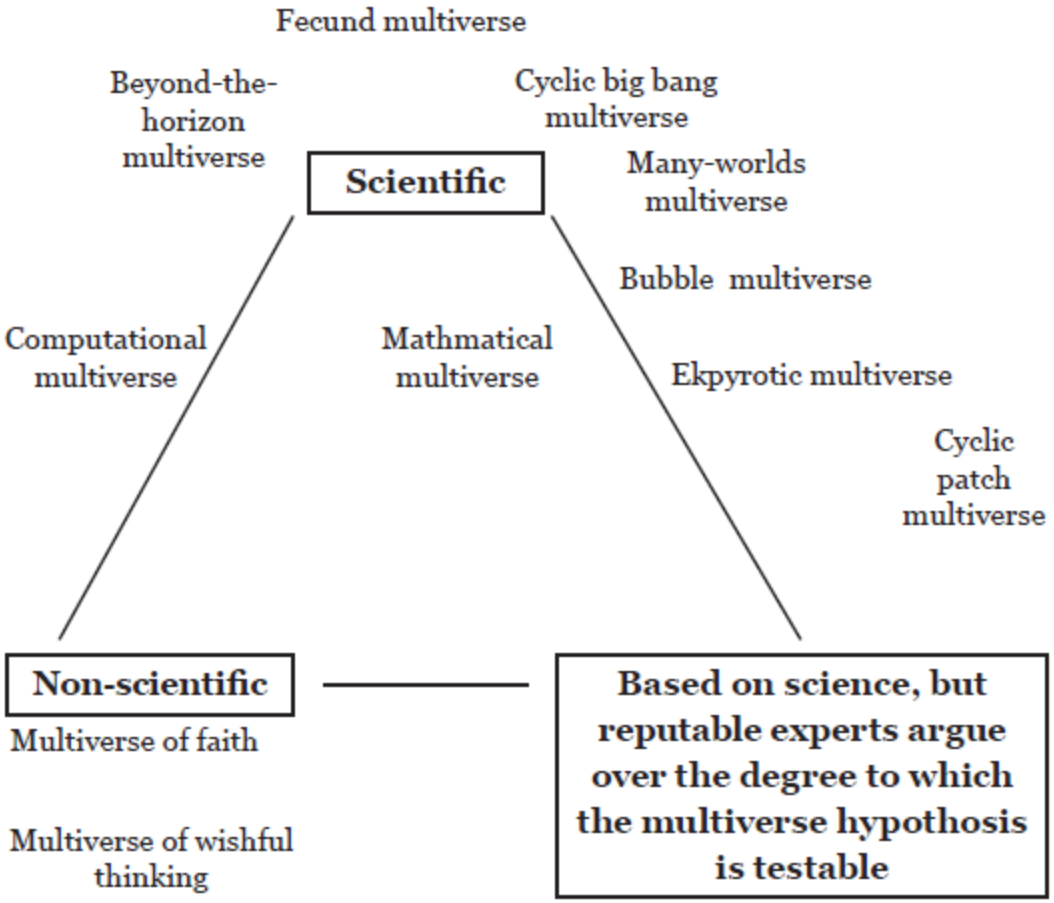


Figure 1.1: Relative degrees to which different multiverse concepts are scientific.

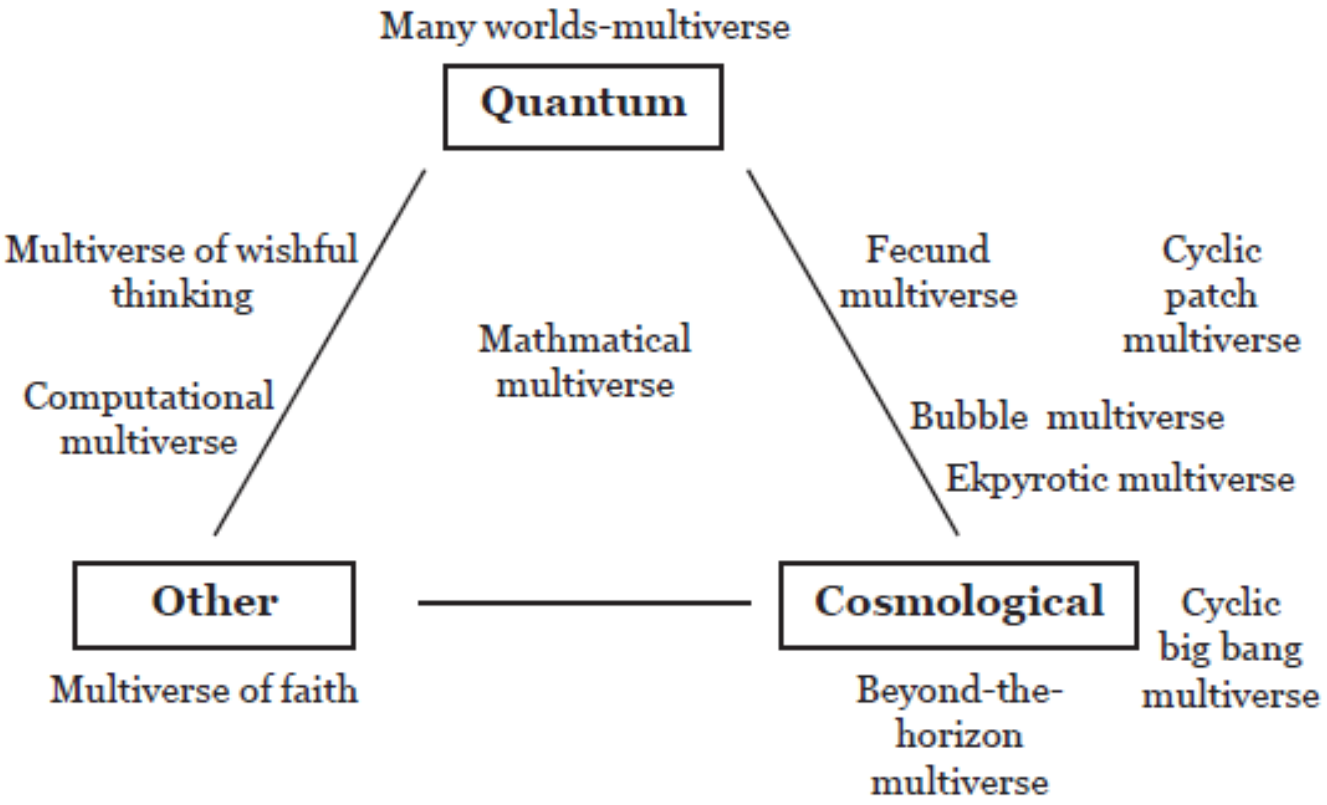


Figure 1.2: Relative degree of quantum versus cosmological character for different multiverse concepts.

The Human Experience

Time ~ .001s — 2000 years

Distance ~ 100 microns — 10000's of miles

Mass ~ milligrams —> many tons

Scientific Notation

1

$10 = 1 \times 10^{1}$

$100 = 1 \times 10^{2} = 10^{2}$

$1{,}000{,}000 = 1 \times 10^{6} = 10^{6}$

$0.1 = 1 \times 10^{-1} = 10^{-1}$

$.0000001 = 10^{-7}$

See java applet at

http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

Length:

Distance	Length (m)
Radius of visible universe	1×10^{26}
To Andromeda Galaxy	2×10^{22}
To nearest star	4×10^{16}
Earth to Sun	1.5×10^{11}
Radius of Earth	6.4×10^{6}
Sears Tower	4.5×10^{2}
Football field	1.0×10^{2}
Tall person	2×10^{0}
Thickness of paper	1×10^{-4}
Wavelength of blue light	4×10^{-7}
Diameter of hydrogen atom	1×10^{-10}
Diameter of proton	1×10^{-15}

Time:

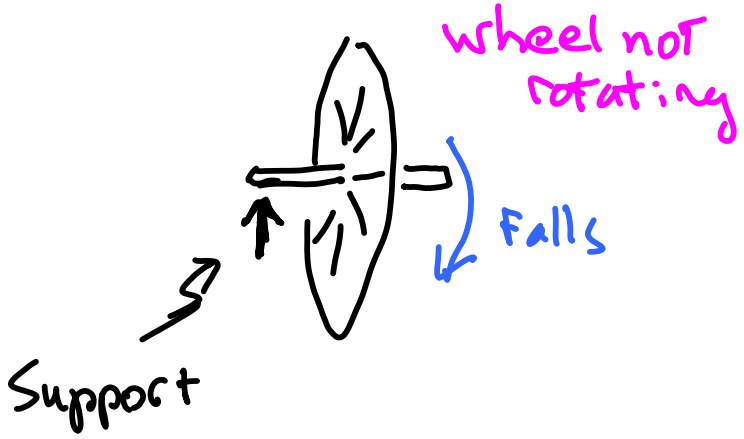
Interval	Time (s)
Age of universe	5×10^{17}
Age of Grand Canyon	3×10^{14}
32 years	1×10^{9}
One year	3.2×10^{7}
One hour	3.6×10^{3}
Light travel from Earth to Moon	1.3×10^{0}
One cycle of guitar A string	2×10^{-3}
One cycle of FM radio wave	6×10^{-8}
Lifetime of neutral pi meson	1×10^{-16}
Lifetime of top quark	4×10^{-25}

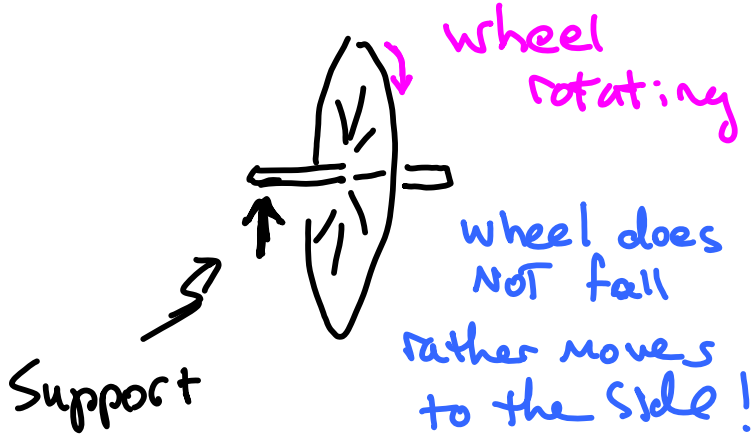
Mass:

Object	Mass (kg)
Milky Way Galaxy	4×10^{41}
Sun	2×10^{30}
Earth	6×10^{24}
Boeing 747	4×10^{5}
Car	1×10^{3}
Student	7×10^{1}
Dust particle	1×10^{-9}
Top quark	3×10^{-25}
Proton	2×10^{-27}
Electron	9×10^{-31}
Neutrino	1×10^{-38}

However if you do careful observations ... even at "human" scales nature has some surprises

bicycle wheel demo





Surprise!

How are (Art / Science / Religion) the same?

How are " different?