

Physics 102 - December 9, 2009

■ Projects due Friday

■ Final EXAM - Wed., Dec. 16, 4pm

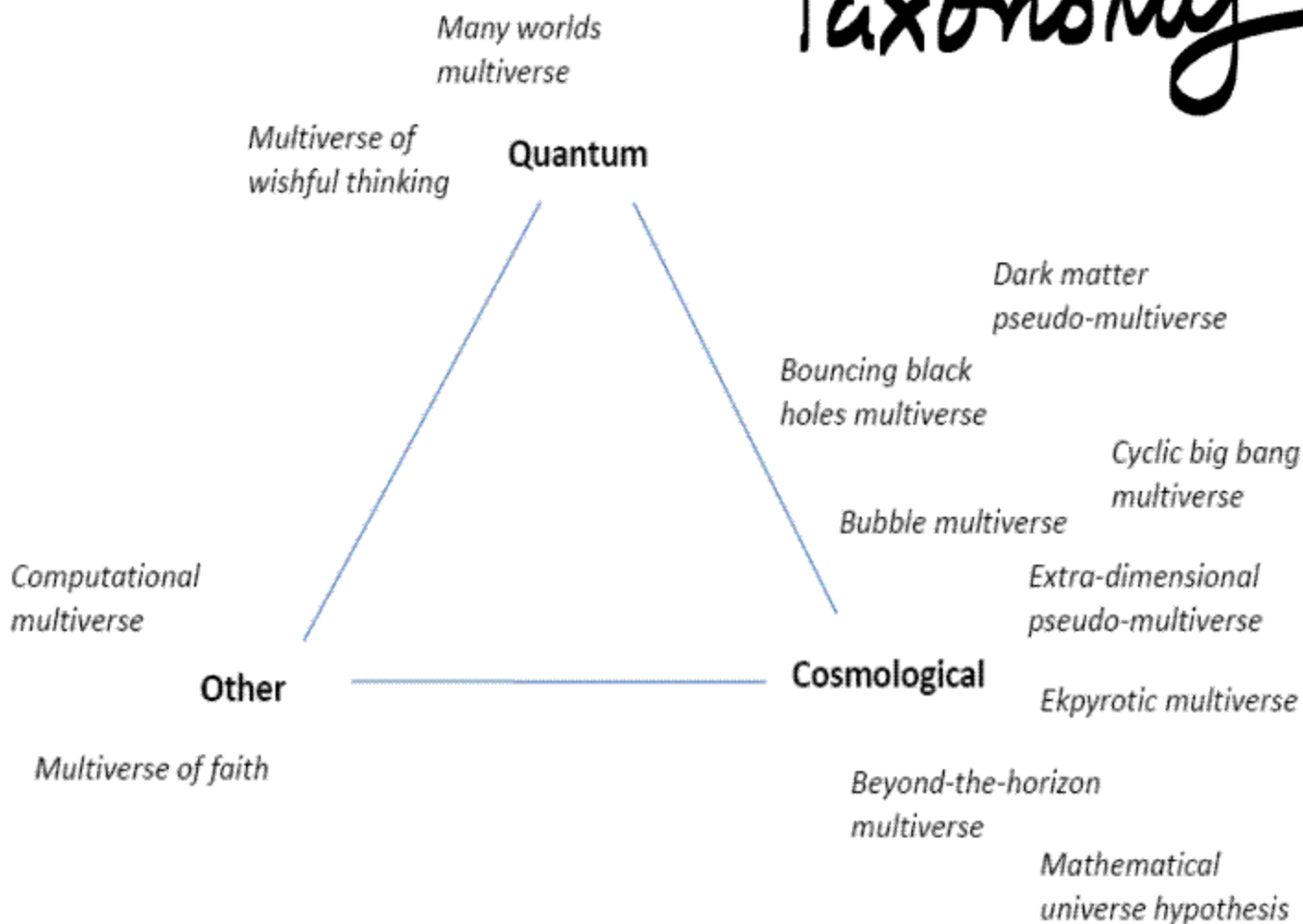
B+L 109

index card okay
cumulative

■ Pre EXAM Q+A session

B+L 208 Tuesday, Dec. 15 1:30-3:00 pm

Return to the Multiverse Taxonomy



*Beyond-the-horizon
multiverse*

*Dark matter
pseudo-multiverse*

*Many worlds
multiverse*

*Bouncing black
holes multiverse*

scientific

*Cyclic big bang
multiverse*

*Extra-dimensional
pseudo-multiverse*

**Based on science but reputable experts
argue over the degree to which the
multiverse hypothesis is testable**

nonscientific

Multiverse of faith

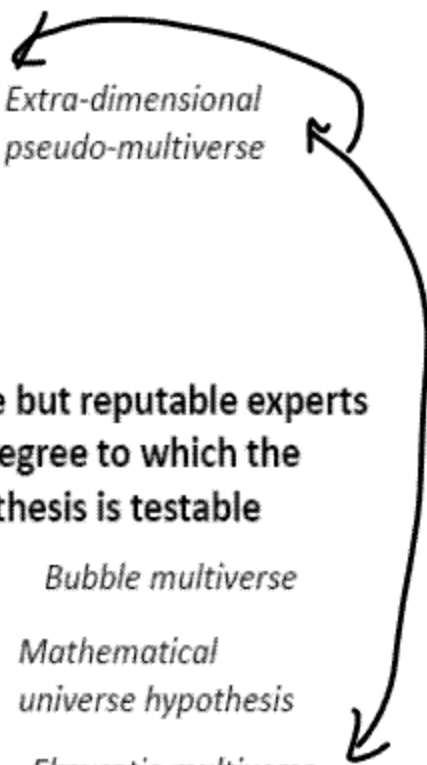
*Computational
multiverse*

Bubble multiverse

*Multiverse of
wishful thinking*

*Mathematical
universe hypothesis*

Ekpyrotic multiverse



These multiverse concepts
are NOT mutually exclusive

Could be we ...

Live in a universe with Dark matter and QM. many worlds

With a Beyond the horizon multiverse in a

Bubble Multiverse which is

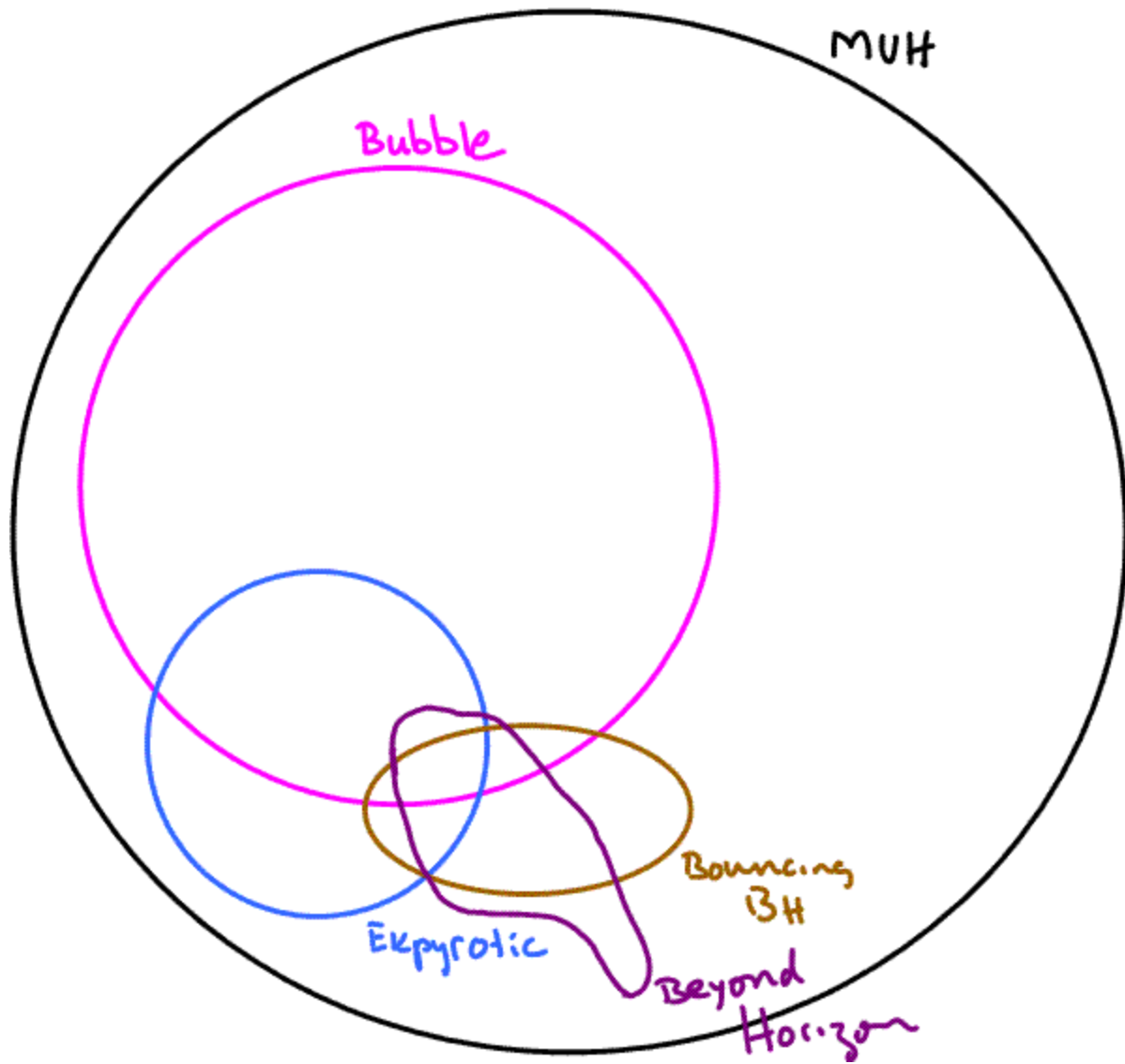
Part of Cosmic landscape

Under a particular Mathematical
Structure in Math. Univ.

... all of which is simulated

... by God?

Tongue in cheek
... but you get
the idea.

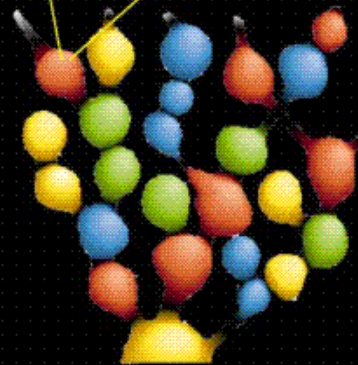
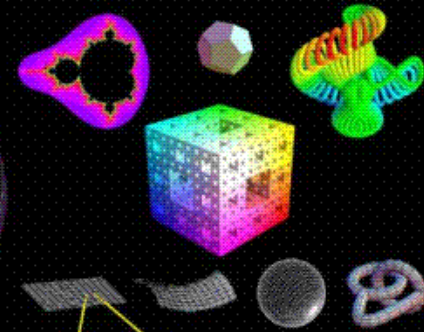
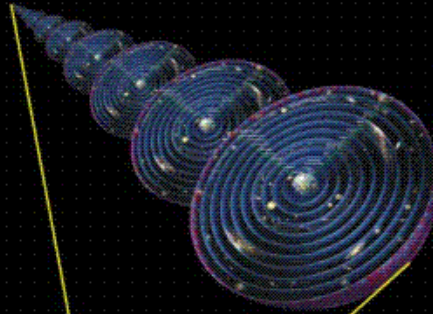


Level 1: Regions beyond our cosmic horizon

Features: Same laws of physics, different initial conditions
Assumptions: Infinite space, ergodic matter distribution
Evidence:
- Microwave background measurements point to flat, infinite space, large-scale smoothness
- Simplest model

Level 4: Other mathematical structures

Features: Different fundamental equations of physics
Assumption: Mathematical existence \rightarrow physical existence
Evidence:
- Unreasonable effectiveness of math in physics
- Answers Wheeler-Hawking question: "why these equations, not others?"



Level 2: Other post-inflation bubbles

Features: Same fundamental equations of physics, but perhaps different constants, particles, and dimensionality.
Assumption: Chaotic inflation occurred
Evidence:
- Inflation theory explains flat space, scale-invariant fluctuations, solves horizon problem and monopole problems and can naturally explain such bubbles
- Explains fine-tuned parameters

Level 3: The Many Worlds of Quantum Physics

Features: Same as level 2
Assumption: Physics unitary
Evidence:
- Experimental support for unitary physics
- AdS/CFT correspondence suggests that even quantum gravity is unitary
- Decoherence experimentally verified
- Mathematically simplest model

From
M. Tegmark

Perhaps the question is Not so much

Do we live in a multiverse?

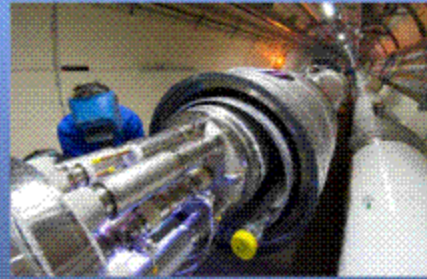
But rather

In how many different
types of Multiverses
do we live?

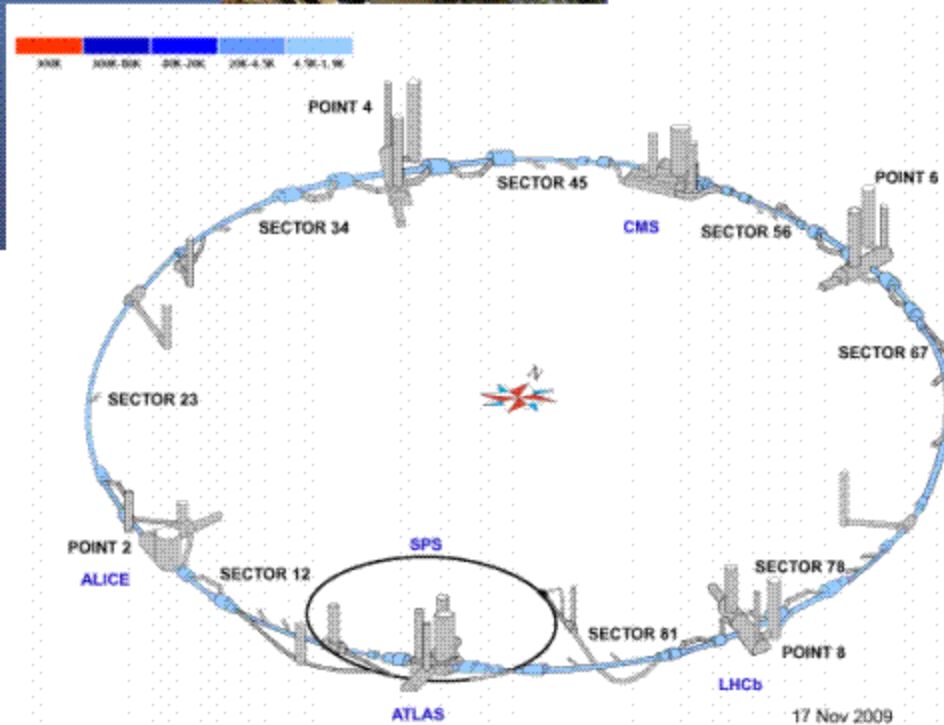
The future of our
concept(s) of the
Multiverse



Underground



The Large
Hadron
Collider



What does what the Higgs does?

Supersymmetry?

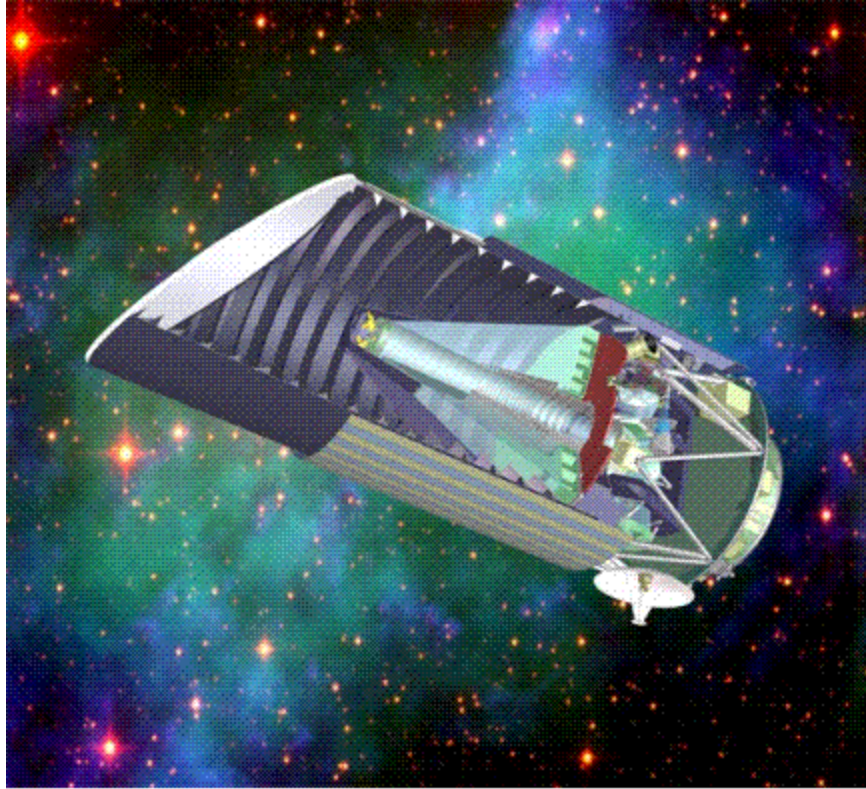
Dark Matter candidate?

New Physics?

If discovered -
good for string
theory



Brilliant
Theorist discovers
There is a natural
"best" solution in the
string theory landscape
and it is the TOE
or something entirely new!



SNAP

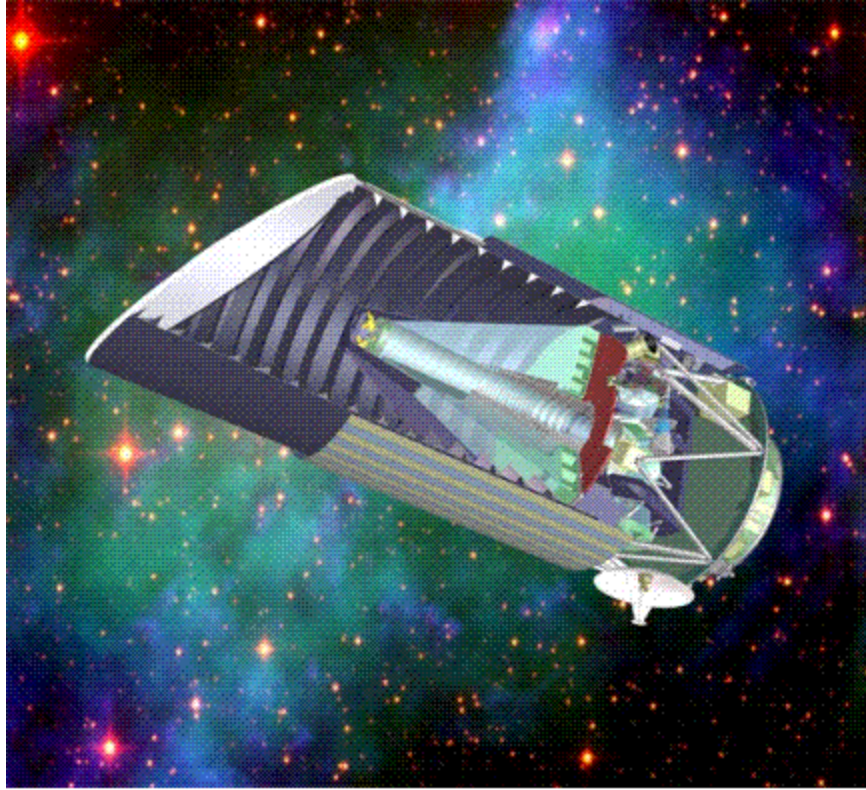
Supernova Acceleration
Probe

Type IA Supernovae
+
Redshifts

To measure Expansion rate of univ w/ time

Weak gravitational lensing

Probes Nature of
dark energy



SNAP

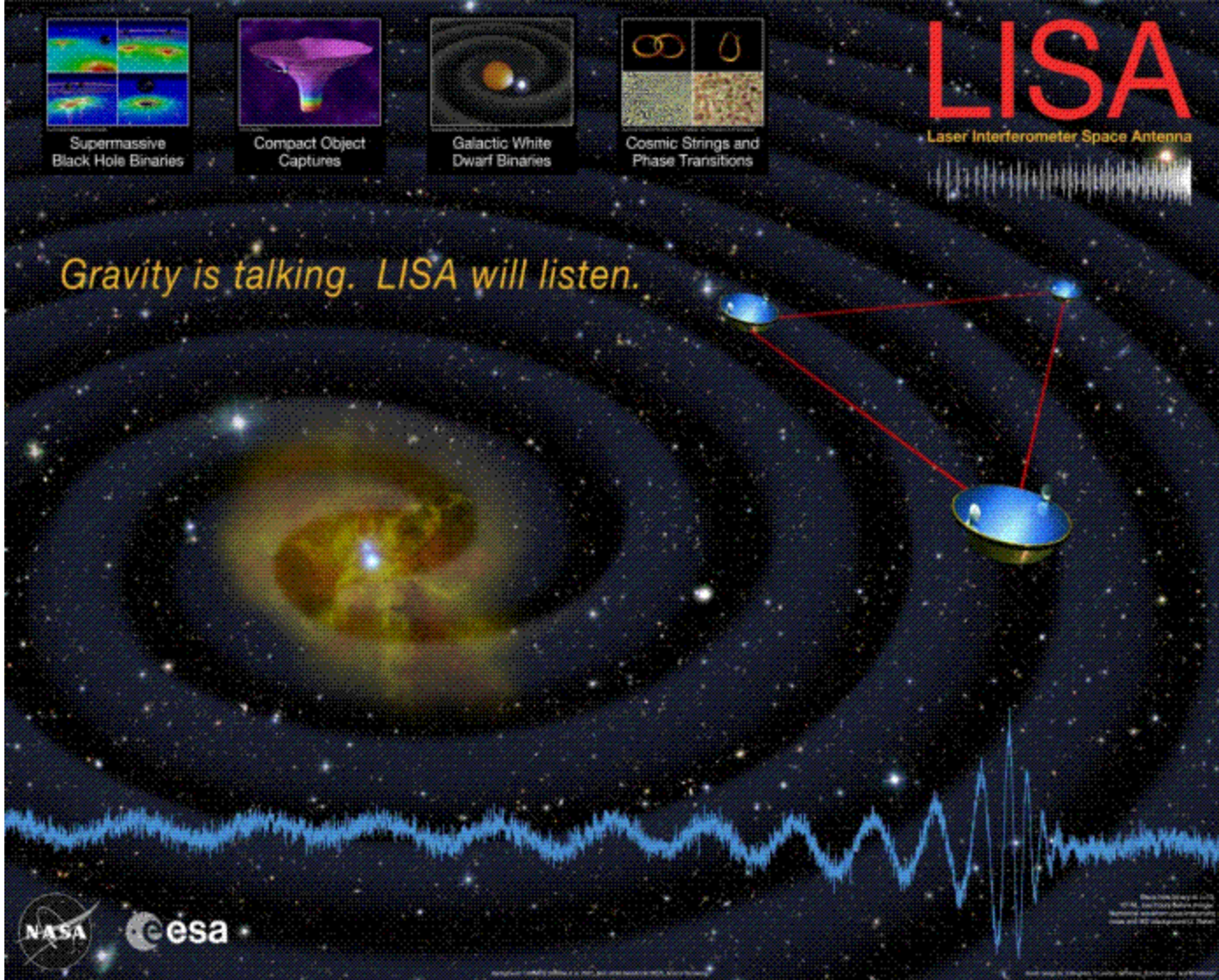
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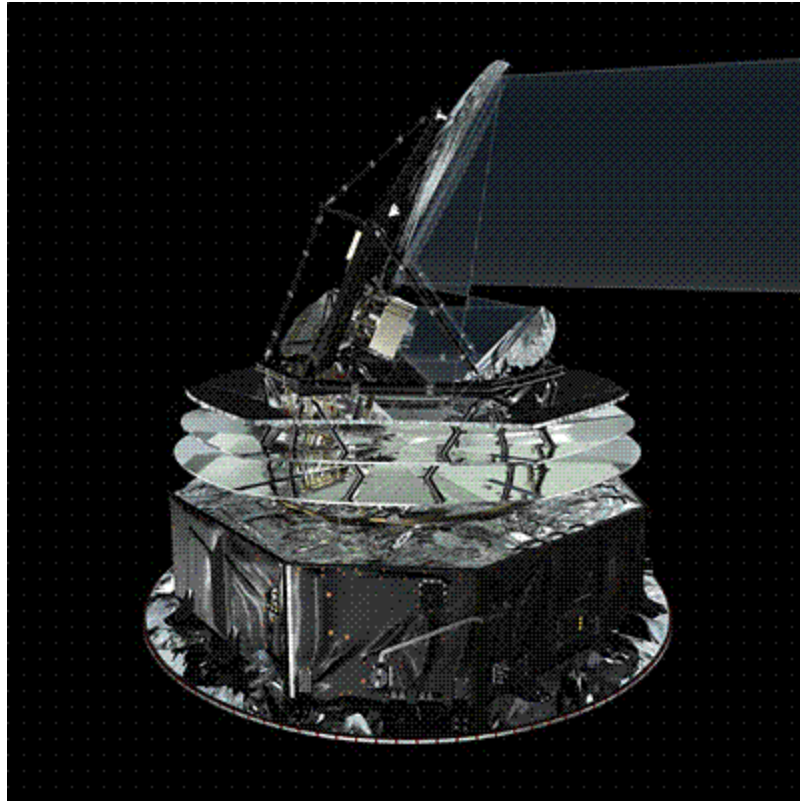
To measure Expansion rate of univ w/ time

Weak gravitational lensing

Probes Nature of
dark energy



Eventual measurements of grav. waves might
provide evidence of cosmic strings



Planck Satellite

map CMB more
carefully

might uncover
evidence of inflation
and help probe
Dark matter +
Dark energy
content of universe

Study probability distribution of
Nature's parameter set.

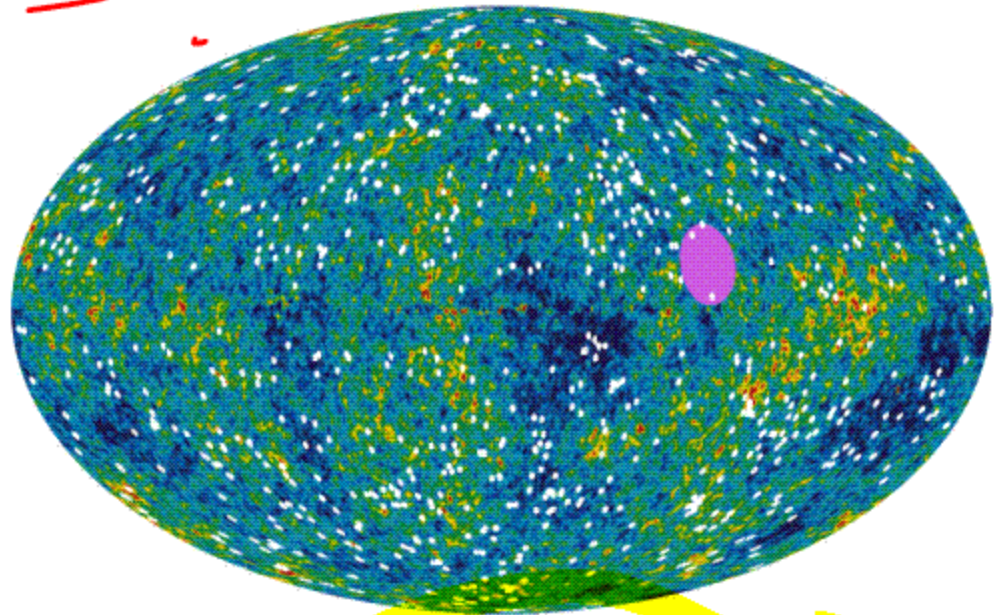
Optimal for Black hole production

IF so \rightarrow supports cosmological
Natural selection thru
Fecund universe

Typical for \rightarrow Mathematical Structures?

\rightarrow Cosmic String landscape?

Surprises!



Dark
Flow
(2008)

Sasha Kashlinsky
NASA Goddard
Detailed study of WMAP data

Able to see motion of galactic clusters thru small effects in the CMB Temp near the cluster. See clusters all moving toward one part of sky — due to effect of things beyond the observational horizon ??