

# Fundamental Physics and the Big Questions

How science has answered or recast many  
of the famous questions of philosophy.

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# Traditional Philosophy

- Where did the world come from?
- What makes the crops grow?
- Are there gods? How does prayer work?
- Angels and demons?
- Where did life come from?
- Where did humans come from?
- Do we have free will?
- Is everything that happens, determined in advance?

# Traditional Questions about the Universe

- Where did the universe come from?
- Is there a Purpose?
- How does the universe work?
- What makes the crops grow?
- Where will the universe end up?

# Questions about Life

- Where did humans come from?
- How does the mind work?
- Do we have Freewill?
- Is what happens in the universe predetermined?
- Where do ethics come from?
- What are human rights?
- Animal rights?

# Questions about the Supernatural

- What is spirit? What is the soul?
- The Afterlife?
- Are there gods?
- How does prayer work?
- Angels and demons?
- What about the occult?

# New questions which arise from science

- The ultimate theory of physics?
- Dark Matter?
- Dark energy?
- The eventual fate of the universe?
- Is the universe infinite?
- Does it have an edge?
- Black Holes?
- Worm holes?

# Questions about Philosophy

- Definition
- Epistemology
- Logic
- Metaphysics
- Reason

# Questions about Philosophy

- Philosophy is defined as the application of pure thought to the solution of questions
- Can reason alone lead to any conclusion about the real world?
- But should it take into account the findings of science?

Philosophers have debated Big Questions for millennia.

Many questions have been answered. Some questions have been reformulated.

Some questions remain.

**After going through the evidence, we will re-examine these mysteries.**

Motivation for this talk:

discussions with other groups...

When you travel...



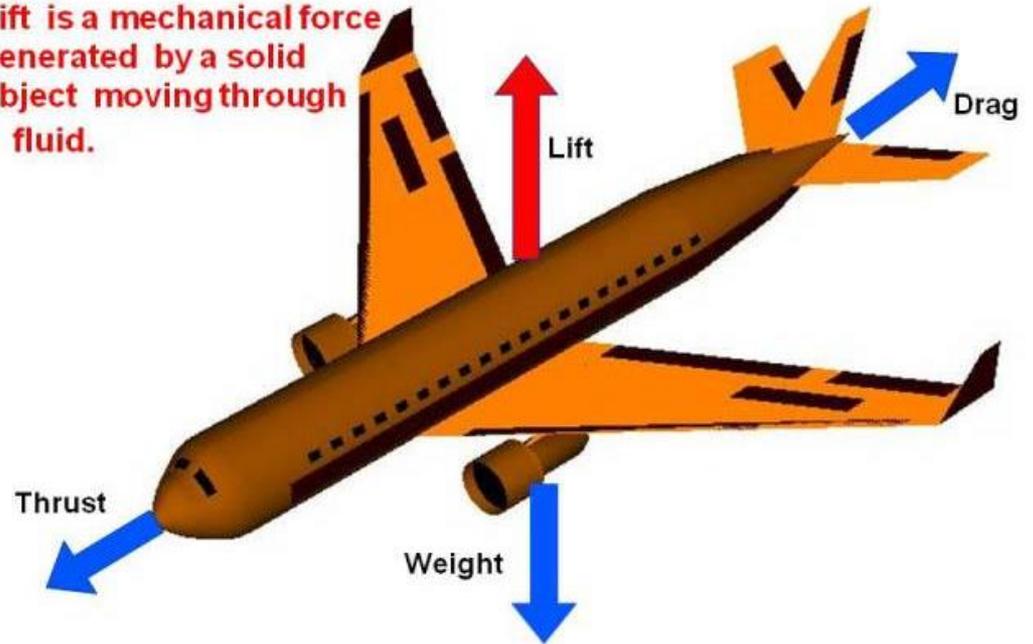
# Which method do you use?

## SPIRITUALITY



## SCIENCE

Lift is a mechanical force generated by a solid object moving through a fluid.



When you  
communicate...



# Which method do you use?

SPIRITUALITY



SCIENCE



But hang on...This is showing a battle between religion and science.

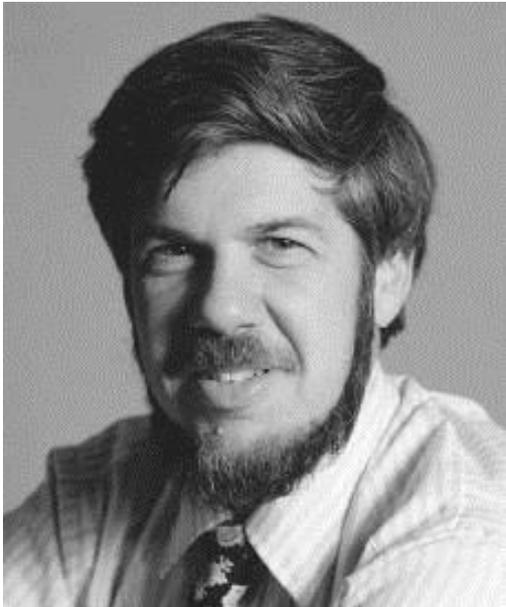


Perhaps they can BOTH exist in harmony?

# Relation between science and spirituality

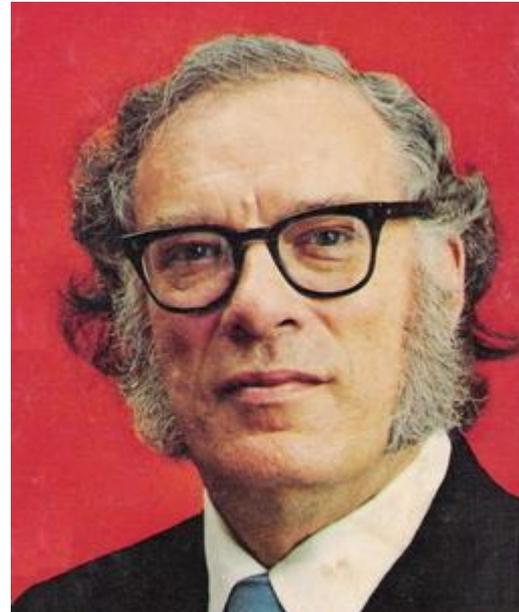
“Science and religion are Non-overlapping Magisteria”

– Steven J Gould



“There is a single light of science, and to brighten it anywhere is to brighten it **everywhere.**”

- Isaac Asimov



# The scientific method

- One method far more effective than any other, in finding the truth.
- Has revealed the origins of the universe,
- of our planet,
- of life,
- and of humans.

# The scientific method

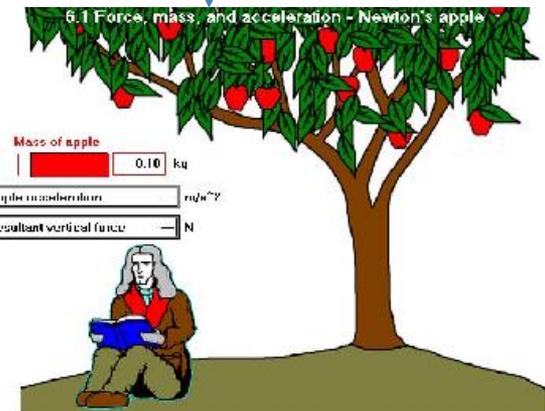
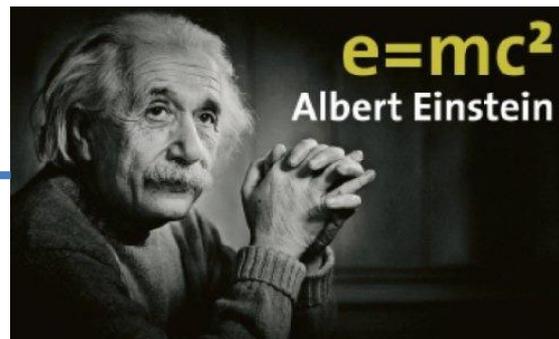
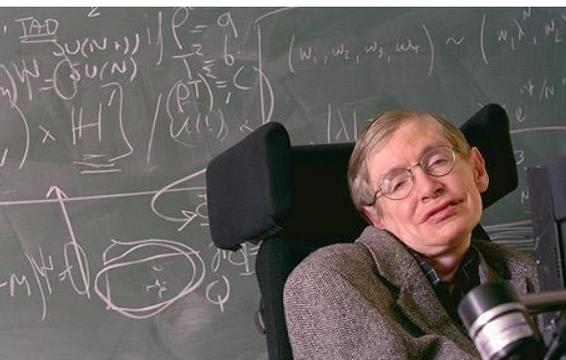
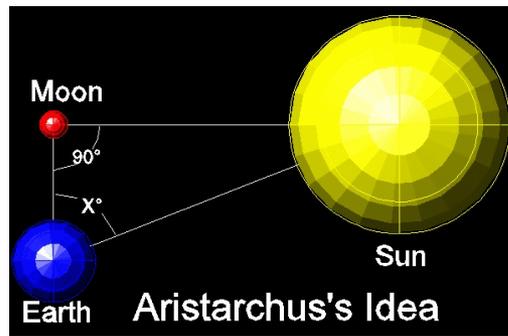
Science combines two elements:

- Observation or testing (gathering evidence)
- Analysis (using known data and applying theory)

Also, philosophy helps us to place that knowledge in our intellectual framework.

# Where science comes from.

Many researchers, many countries,  
hundreds of years, constant checks



# A map of physics

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## Fundamental Physics

- Standard Model of Particle Physics
- Quantum Mechanics
- General relativity

## Elementary Particles

- Quarks
- Gluons, photons
- Electrons etc

## The four forces

- Gravity
- Electromagnetism
- Weak interaction
- Strong interaction

## Compound particles

- Proton
- Neutron
- Mesons etc

## Atoms

- Nucleus + electrons + QM

## Molecules

- Assemblies of atoms

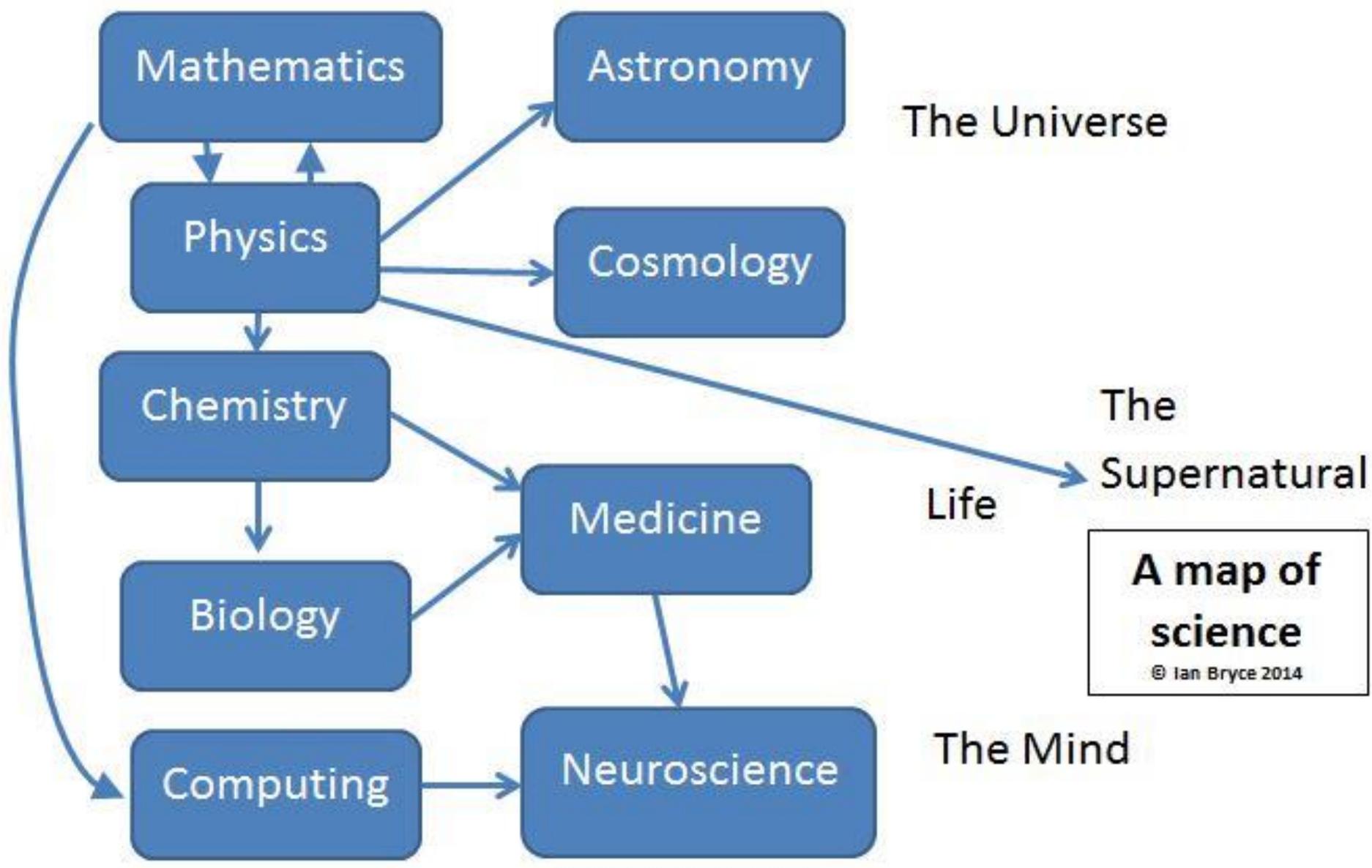
## Matter

- Complex assemblies of atoms and molecules

## Other sciences

Evolution of the universe





The Universe

The  
Supernatural

Life

The Mind

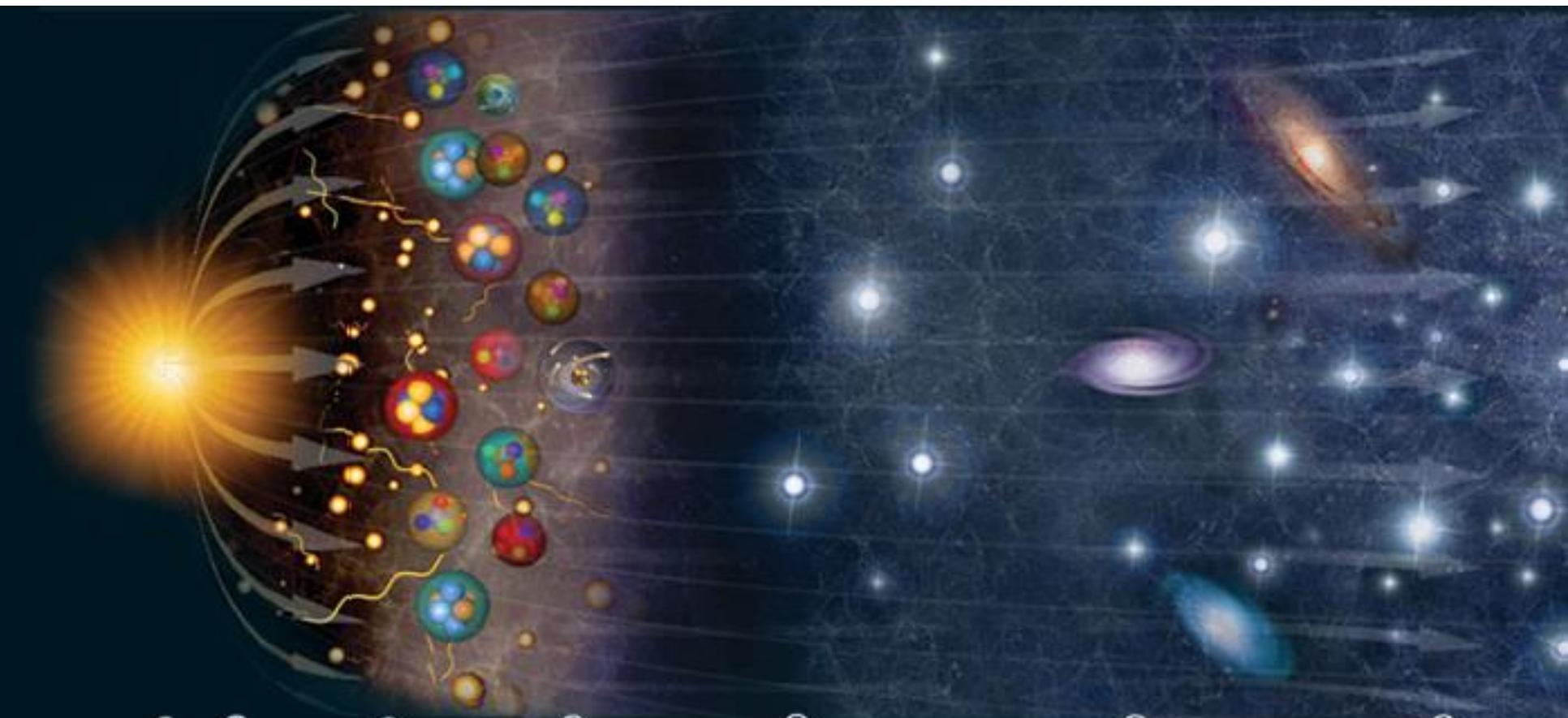
**A map of  
science**  
© Ian Bryce 2014

# Enlightenment through science

**Cosmology** has revealed the beginning of the universe

- The big bang





**10<sup>-32</sup>  
second**

Cosmic  
inflation  
ends

**10<sup>-6</sup>  
second**

Protons  
form

**100  
seconds**

Deuterium,  
helium and  
lithium are  
synthesized

**100 million  
years**

First stars  
form

**500 million  
years**

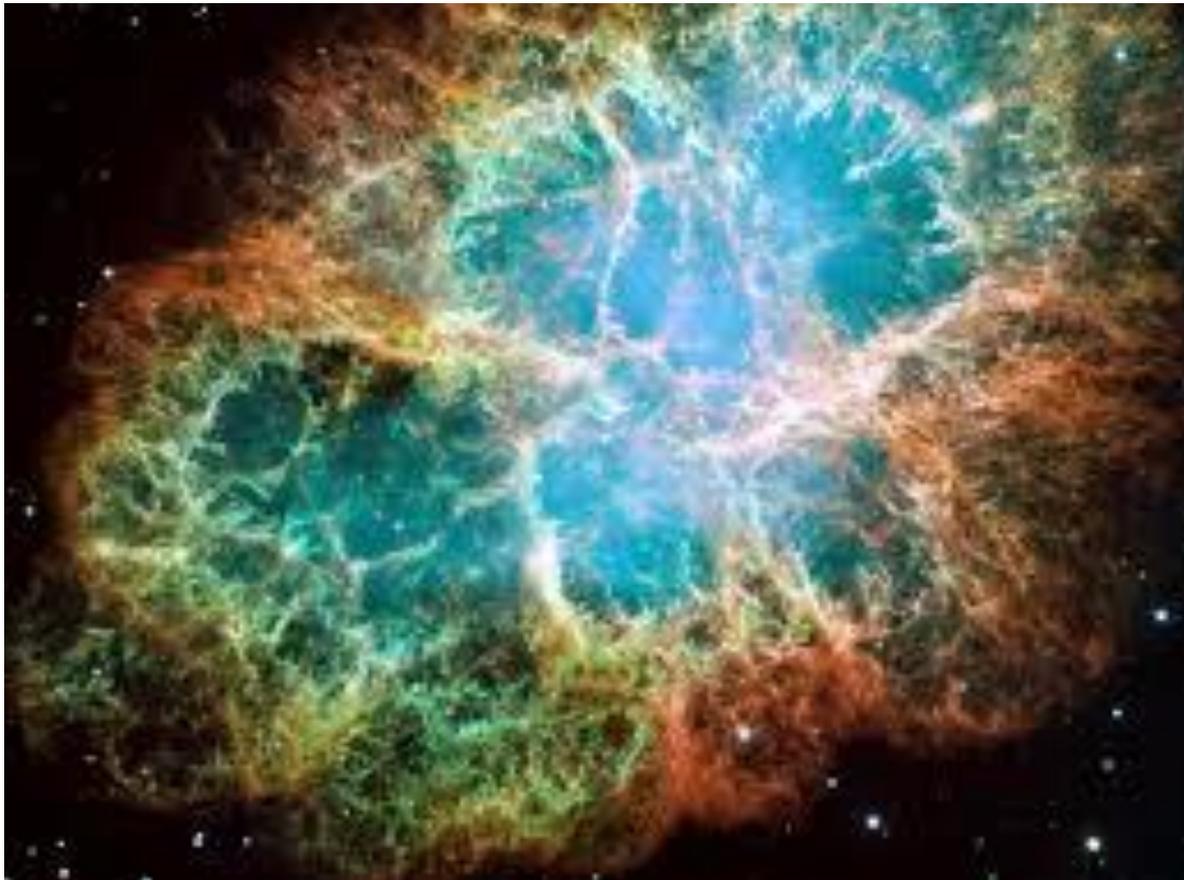
Current  
record holder  
for earliest  
known galaxy

**4 billion  
years**

Star  
formation  
peaks

# Enlightenment through science

- The first generation of stars - synthesized heavy elements (of which we are now made)



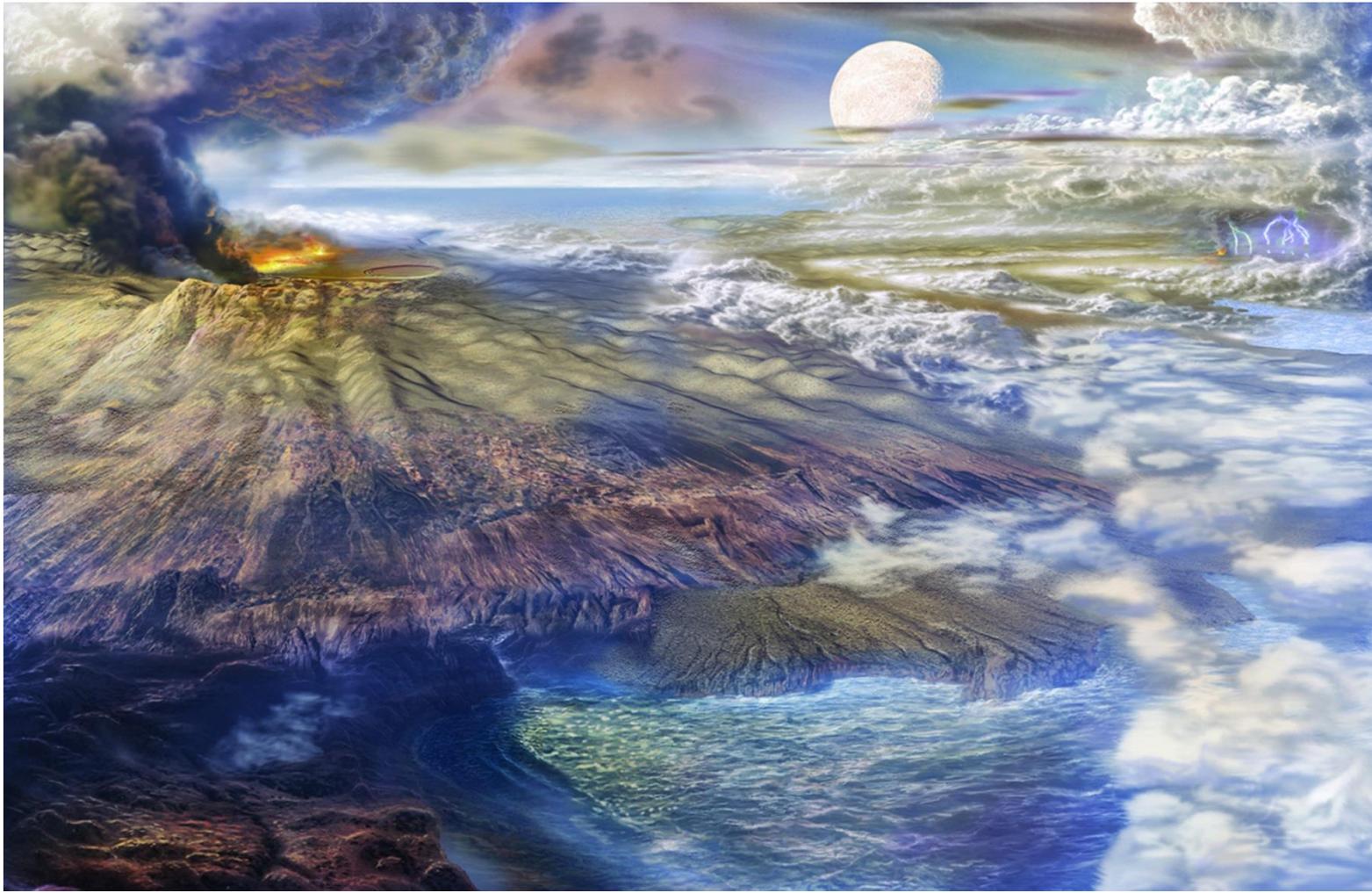
# Enlightenment through science

- The gas clouds condensed into new stars and planets



# Enlightenment through science

- The Earth accumulated a mixture of materials, and the temperature stabilized



# Enlightenment through science

- Life began, when a replicating molecule arose
- (no trace left now - possibly RNA )



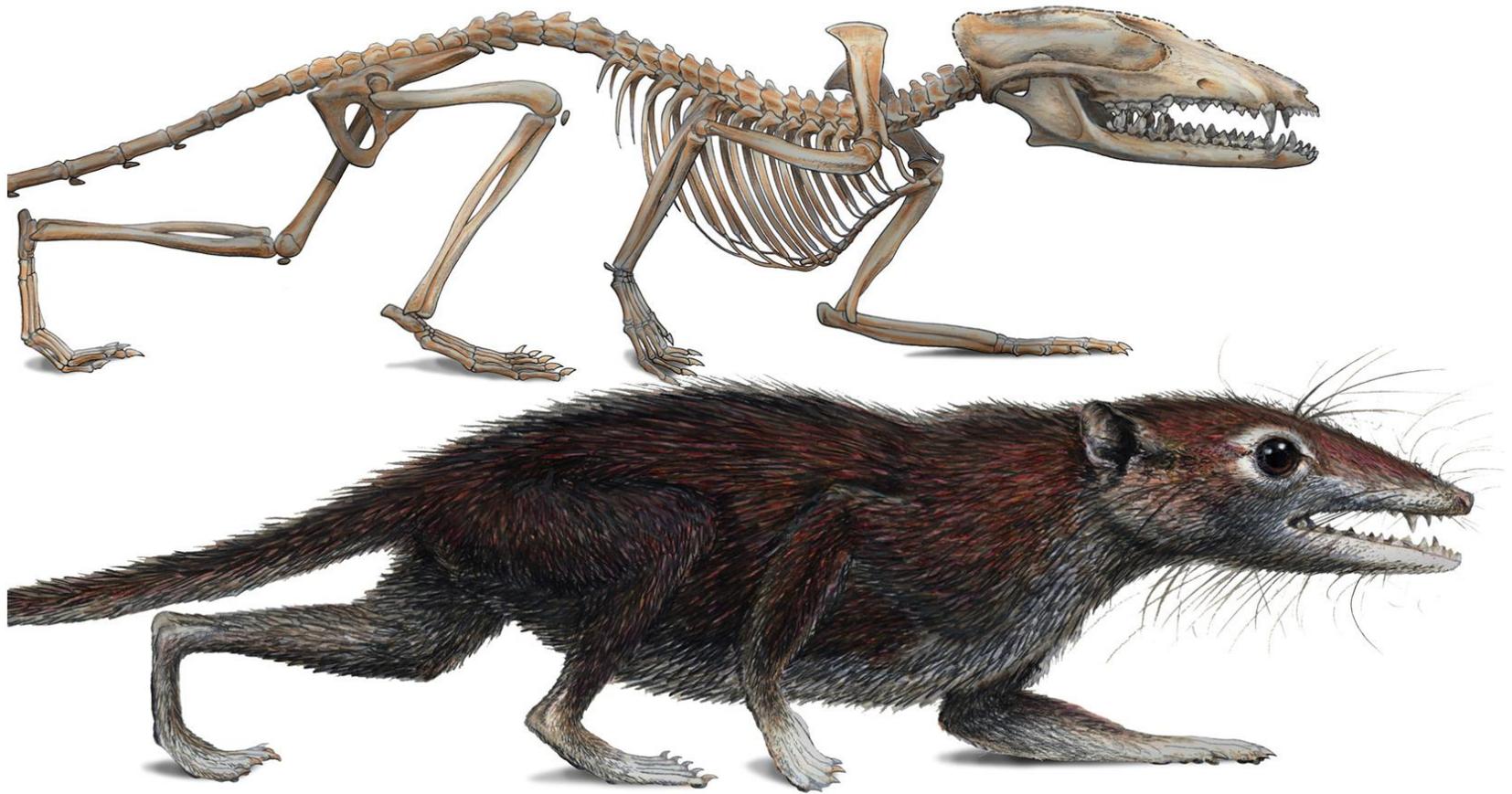
# Enlightenment through science

- Fish and Reptiles evolved



# Enlightenment through science

- Then came Mammals



10 mm

# Enlightenment through science

- Hominids



# Enlightenment through science

- And eventually Homo Sapiens - intelligent



# Intelligent enough to (eventually) invent science



# Where does spirituality fit in? A traditional view

**Spiritual realm**

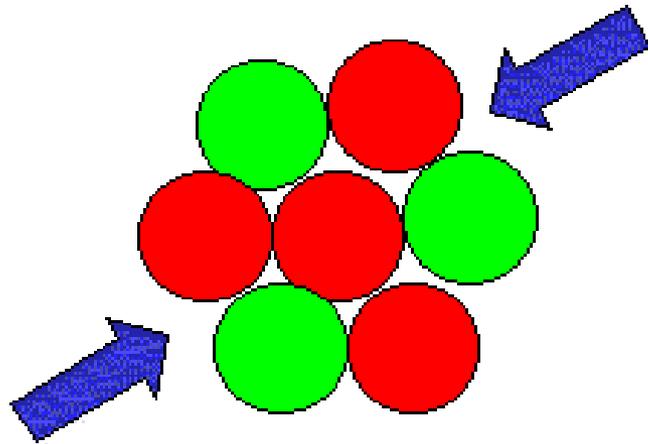
Gods, angels, demons,  
prophets, the occult

**Material realm**

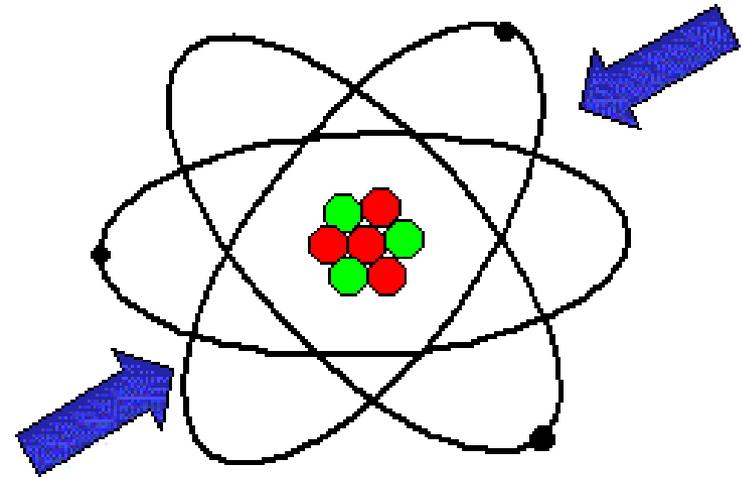
**Planets, trees,  
humans**

How does the universe work, at a  
fundamental level?

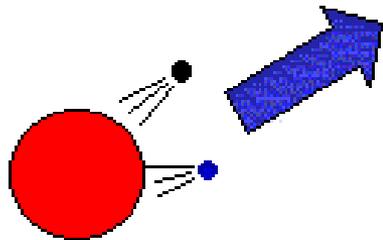
There are Four forces:



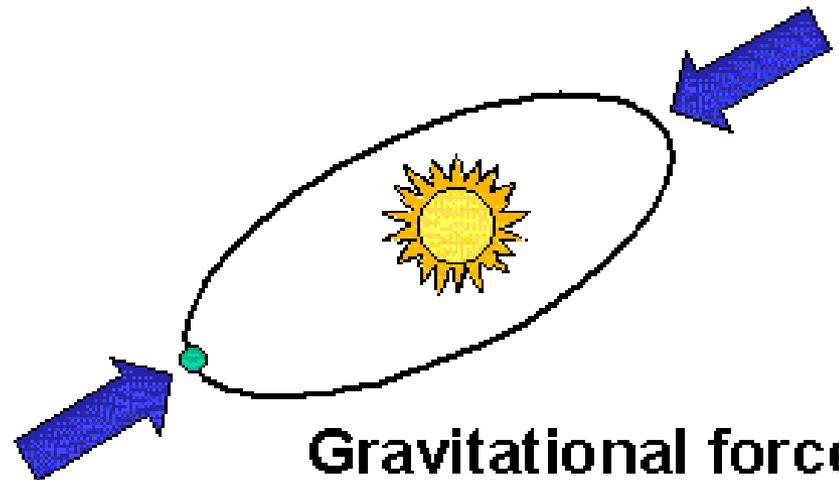
**Strong force  
binds the nucleus**



**Electromagnetic  
force binds atoms**



**Weak force in  
radioactive decay**



**Gravitational force  
binds the solar system**

These four forces account for everything we see happening in the universe (at the most fundamental level)

**THERE ARE APPARENTLY NO GAPS**

Your car won't start...

Your car won't start...

THERE ARE NO GAPS  
IN HOW THE WORLD WORKS\*

\*At least in the here and now

Therefore:

Spiritual realm  
Empty?

Material realm  
Must include  
everything,  
material and  
spiritual

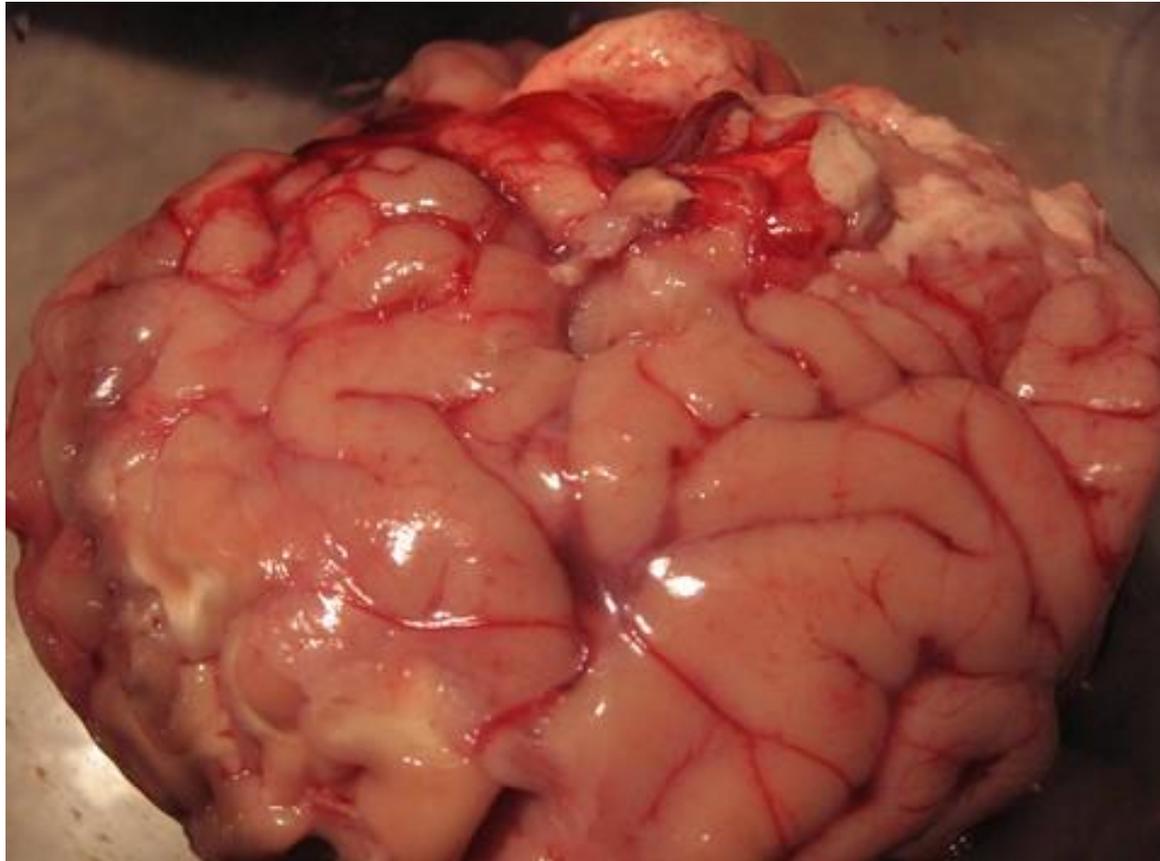
“Spirituality” is a  
layer of  
complexity in the  
Material realm.

The mystery of the human mind.

What can science tell us?

# What has science told us about the brain?

Physics has shown that the brain obeys the Law of Conservation of Mass



# What has science told us about the brain?

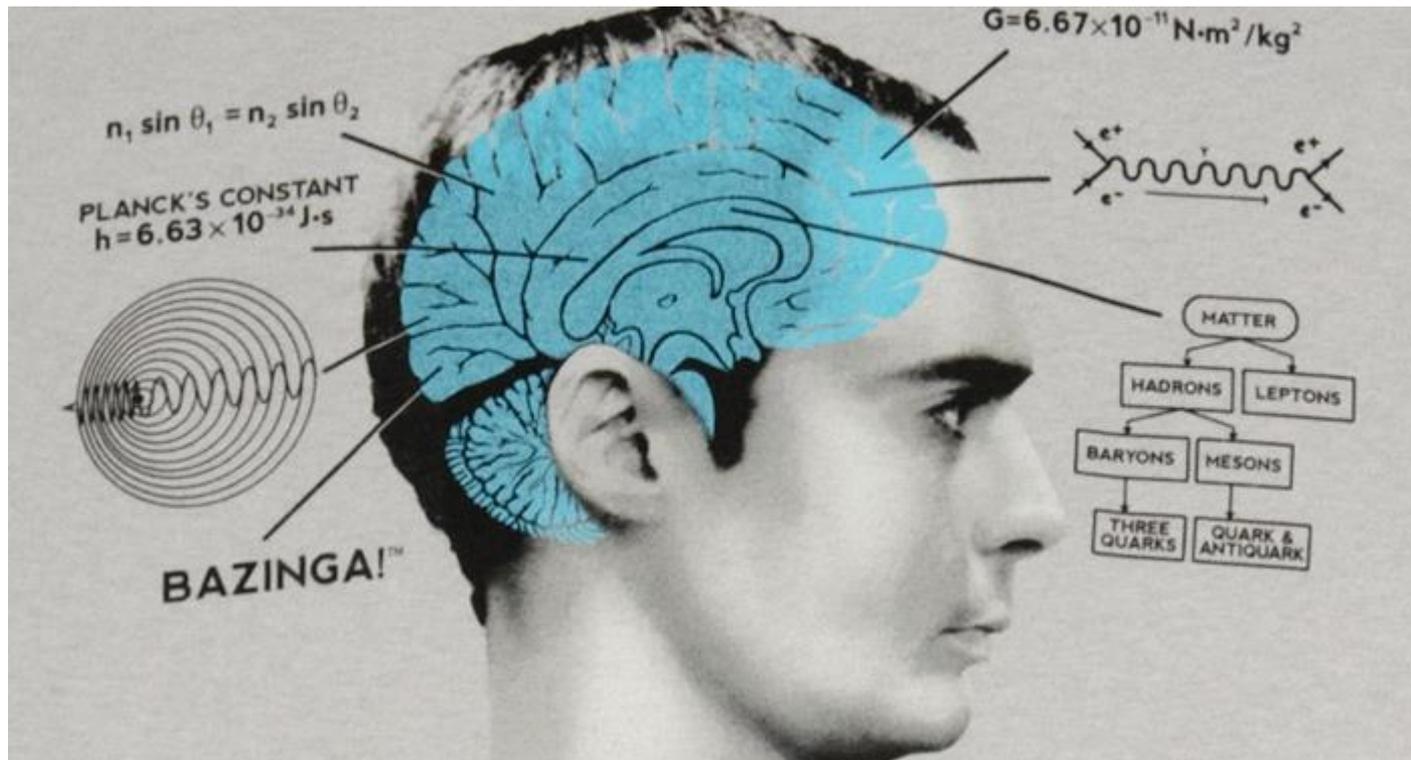
Physics has shown that the brain obeys the Laws of Motion



# What has science told us about the Mind?

Physics has shown that the brain obeys the Law of Conservation of Energy.

Solving difficult mental problems burns calories!



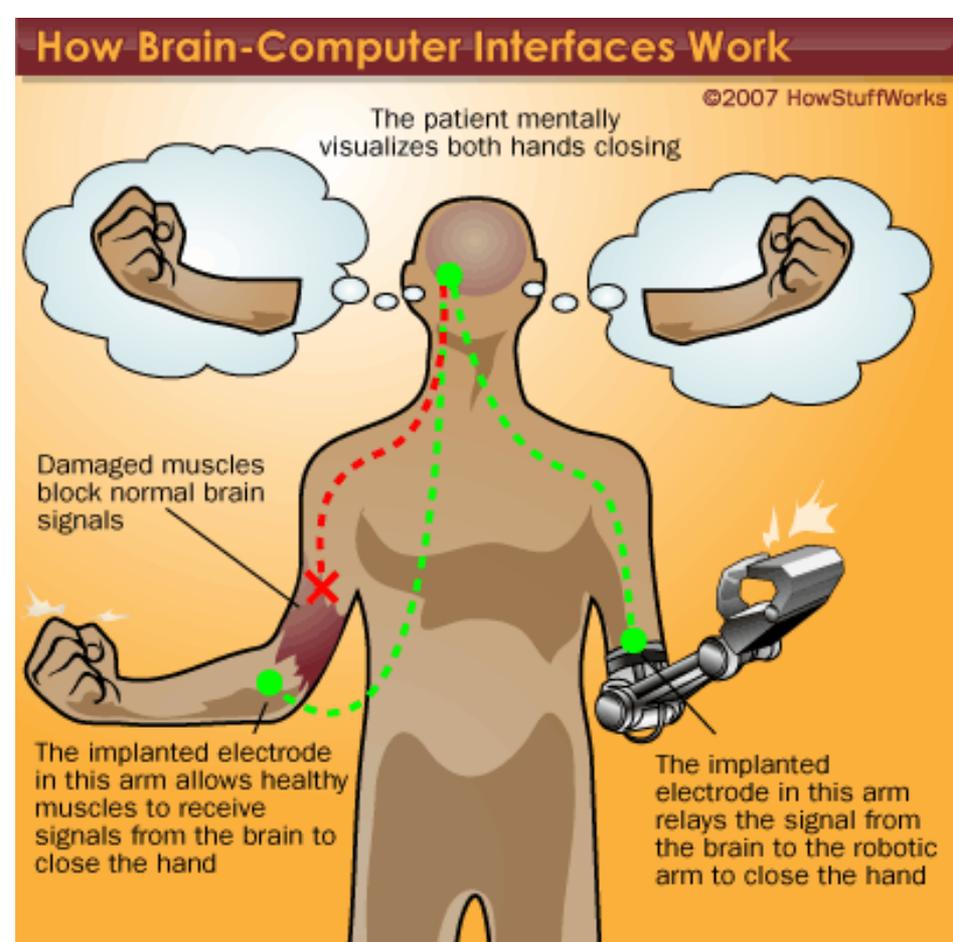
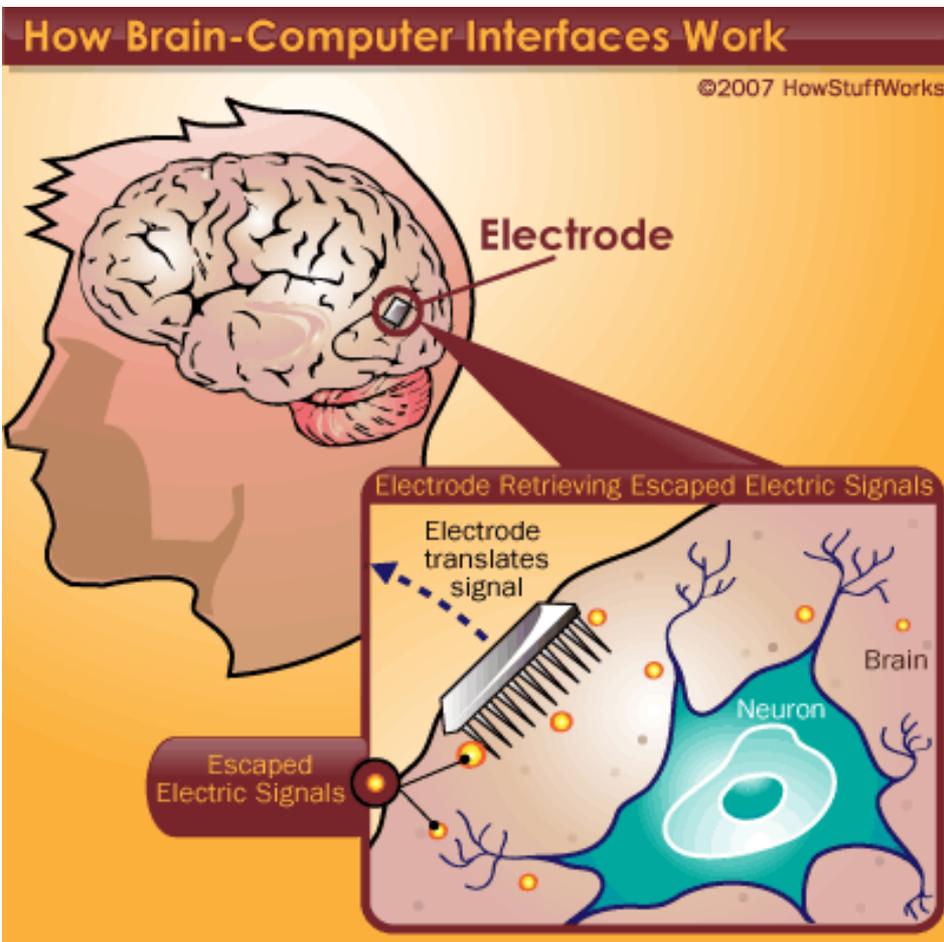
# What has science told us about the Mind?

- THUS the brain obeys ALL the laws of physics
- Its operation is based on the four forces of nature
- To communicate with a deity would require a new force in physics

# How does the mind interface with the world?

Inputs: senses

Outputs: Motor functions



# What has science told us about the Mind?

Conscience

Prayer

Meditation

Thought

Science

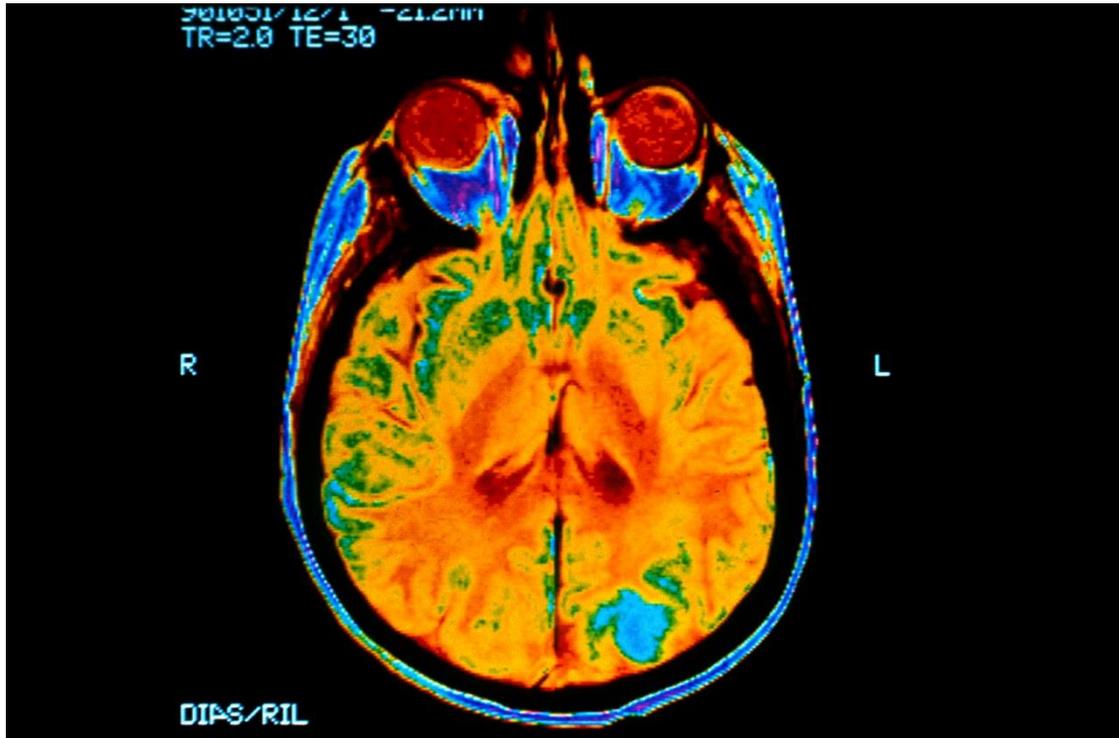
Admiration

Fear

Happiness

**These are mental processes!**

What are mental processes? They are all internal brain functions!



They are layers of complexity – emergent properties  
– of physical matter

# Eg Conscience or Prayer

- Many people believe they can communicate with an external being...
- Science shows this to be untrue.
- Could examining your conscience be an interaction of two different brain functions?
- Eg: the immediate needs
- Vs the ingrained moral rules established over a lifetime?
- Even Prayer...?

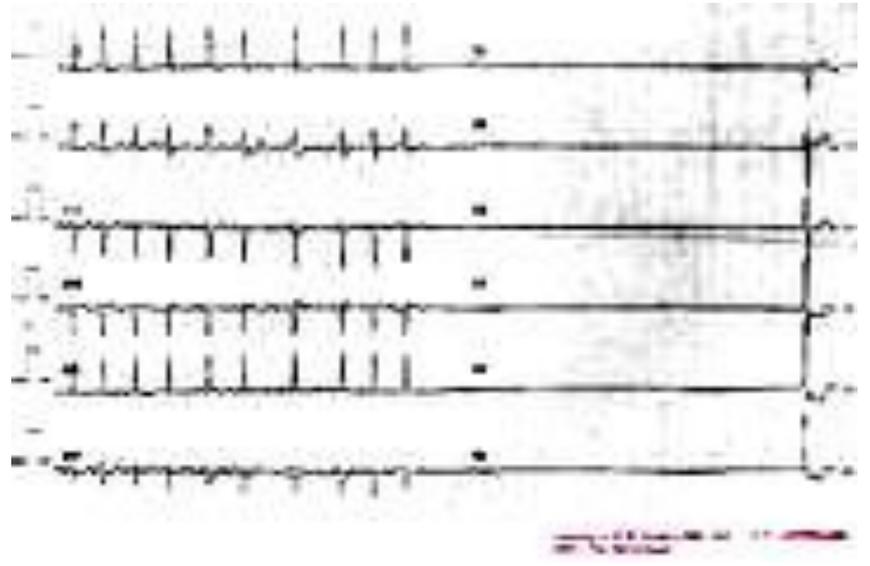
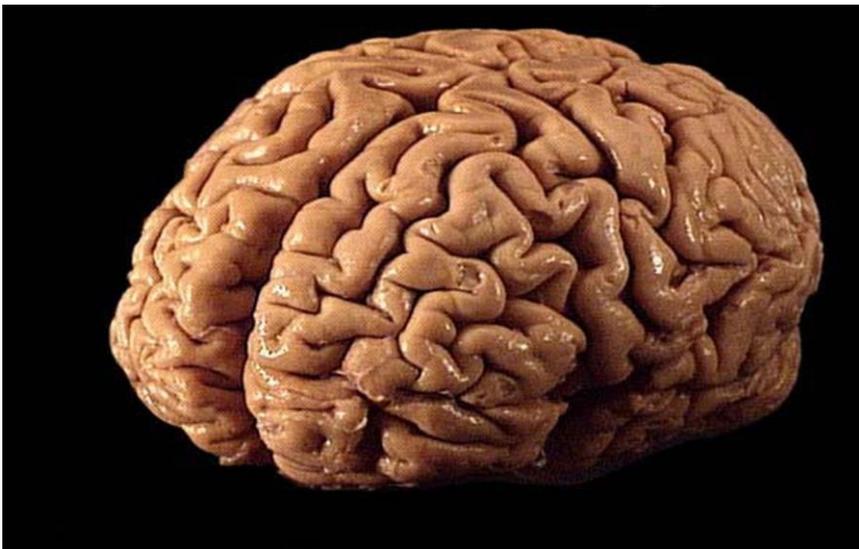
# The Mind and Afterlives

SCIENCE HAS SHOWN:

The MIND is a function of the brain.

It is entirely dependent on physical support systems.

When the body dies, the mind stops.



Now we can revisit  
the Big Questions...

# Traditional Questions about the Universe

## **Where did the universe come from?**

- Traced all the way back to the big bang
- Its origin is still unknown.

**Partly answered.**

# Traditional Questions about the Universe

## **Is there a purpose to life?**

- Purposes can only exist in a mind.
- The only minds we have found, are our own.
- We are free to set our own purposes.
- Aliens would be free to set their own purposes.

**Answered.**

# Traditional Questions about the Universe

## **How does the universe work?**

- Largely answered by science
- New questions arise

**Largely answered.**

# Traditional Questions about the Universe

## **What makes the crops grow?**

- Nutrients from the atmosphere
- Nutrients from the soil
- Water
- Sunlight
- Propagated by seeds, cuttings etc

**ANSWERED BY SCIENCE**

# Questions about Life

# Questions about Life

## **Where did life come from?**

- Natural physical processes
- The mechanism is NOT known

**THIS MYSTERY SURVIVES!**

# Questions about Life

## **Where did humans come from?**

- Evolution from more primitive species
- Random mutations
- Natural selection
- Survival of the fittest

**ANSWERED BY SCIENCE**

# Questions about Life

## **What makes the crops grow?**

- Nutrients from the atmosphere
- Nutrients from the soil
- Water
- Sunlight
- Propagated by seeds, cuttings etc

**ANSWERED BY SCIENCE**

# Updating the Big Questions:

**How does the mind work?**

**(a) At a fundamental level:**

Electrochemical processes

Obeys ALL the laws of physics, chemistry  
etc

**ANSWERED Y SCIENCE**

# Updating the Big Questions:

**How does the mind work?**

**(b) At a higher level of complexity:**

- Much is known...
- And much is not yet understood
- Research is constantly revealing more detail
- The mind emerges as higher levels of complexity.

**IN PROGRESS**

# Questions about Life

## **Do we have freewill?**

- The mind operates at a fundamental level by the four known forces
- This includes decision making
- Our choices are influenced by our genes – genetic packages from our parents
- And memes – behaviour packages from society
- And chance
- Freewill is the feeling we have, while our brain performs the operation of choosing

**ANSWERED**

# Questions about Life

**Is what happens in the universe predetermined (ie fatalism)?**

- Everything that happens is influenced by prior events
- There is also chance involved through quantum mechanics\*
- Therefore NOT determined
- ANSWERED!
- \* most likely. One theory (De Broglie–Bohm) says QM has underlying truths which make the universe fixed since the big bang.

# Questions about Life

## **Where do ethics come from?**

- Brain functions
- Genes (selfish and altruistic)
- Memes
- Developed by groups of animals and humans
- Have survival value
- Evolving
- No gods or holy books

**ANSWERED**

# Questions about Life

## **What are human rights?**

- Arise through human NEEDS
- Physical needs include food, water, clothing, shelter, safety
- Psychological needs include freedom from oppression, forming relationships, setting goals
- If we respect other peoples feelings, we will recognise these rights
- **ANSWERED!**

# Questions about Life

## **What about animal rights?**

- Animals also have needs
- Physical needs include food, water, clothing, shelter, safety
- Psychological needs include freedom from oppression, forming relationships, (less than humans)
- Animals generally have less sentience (capacity for pleasure and pain)
- So animals should have rights to suit their needs
- ANSWERED!

# Questions about the Supernatural

# Questions about the Supernatural

## **The afterlife?**

- A mind is what the brain does
- It is totally reliant on life support system
- There cannot be any sort of mind after the brain stops functioning\*

**ANSWERED BY SCIENCE**

\*download to a computer (Max Headroom)?

# Questions about the Supernatural

## **Are there gods?**

- Definition: as per the founders of religions
- Gods intervene in mankind's affairs
- The 4 forces of physics account for all we observe
- There is NO influence from a supernatural realm

**ANSWERED BY SCIENCE**

# Questions about the Supernatural

## **How does prayer work?**

- Humans communicate through the senses
- There is NO mechanism which would allow prayer
- And all tests have failed
- Prayer is only an internal brain process, like talking to oneself

**ANSWERED BY SCIENCE**

# Questions about the Supernatural

## **Angels and demons?**

- Same as gods
- Do not exist

**ANSWERED BY SCIENCE**

# Questions about the Supernatural

## **What about the occult?**

- Invented by humans before scientific knowledge
- Does not exist

**ANSWERED BY SCIENCE**

# New questions which arise from science

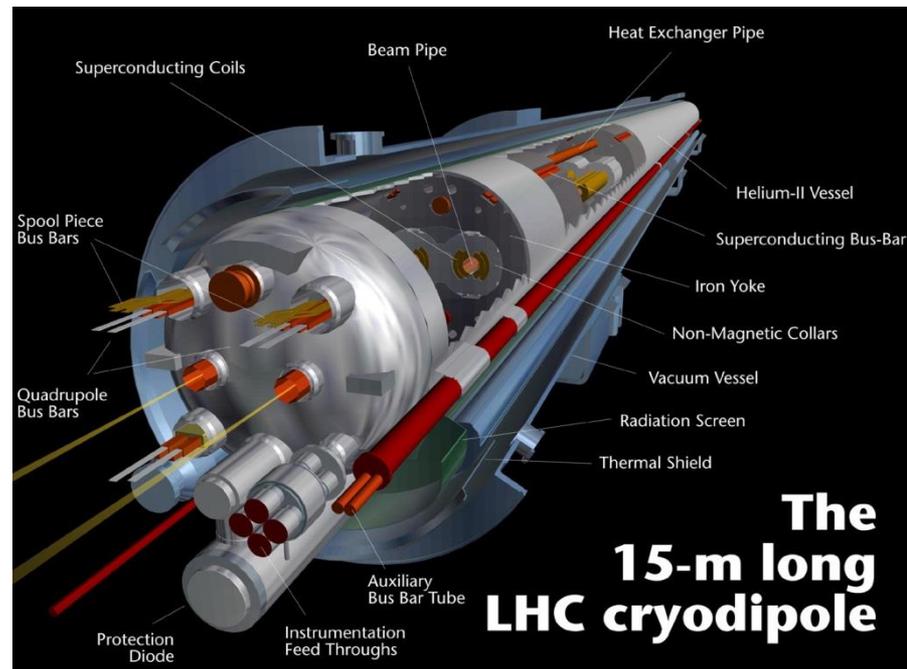
- The ultimate structure of reality?
- Where did the bog bang come from?
- Dark Matter?
- Dark Energy?
- The eventual fate of the universe?
- Is the universe infinite?
- Does it have an edge?
- Black Holes?
- Worm holes?
- Higher level brain functions?

A topic for  
another day!

**How science is addressing  
these questions**

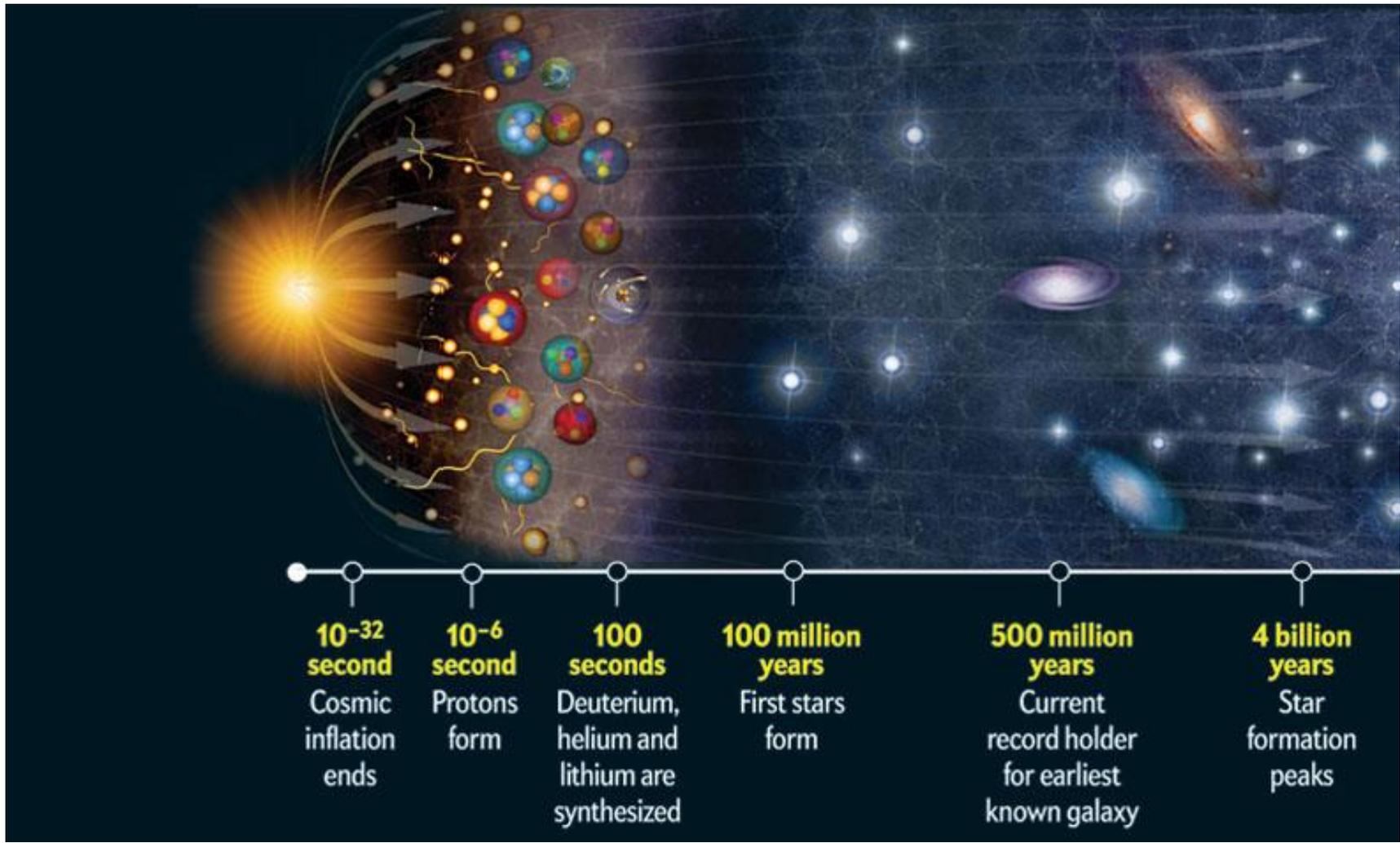
# Structure of the universe?

- Might there be a new force in physics?
- The search for the Higgs Boson – found a new force field
- Does not interact with matter, under current conditions

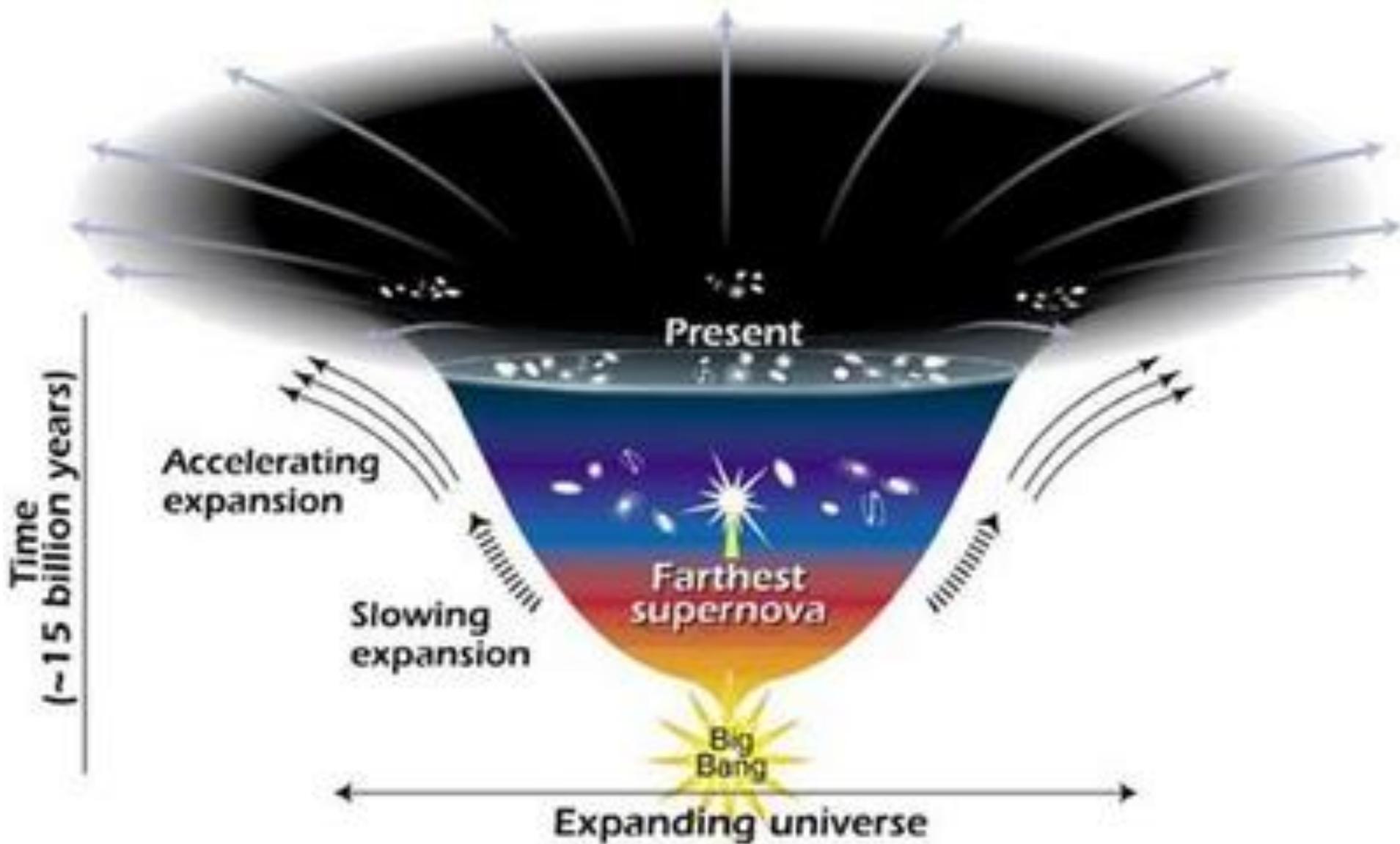


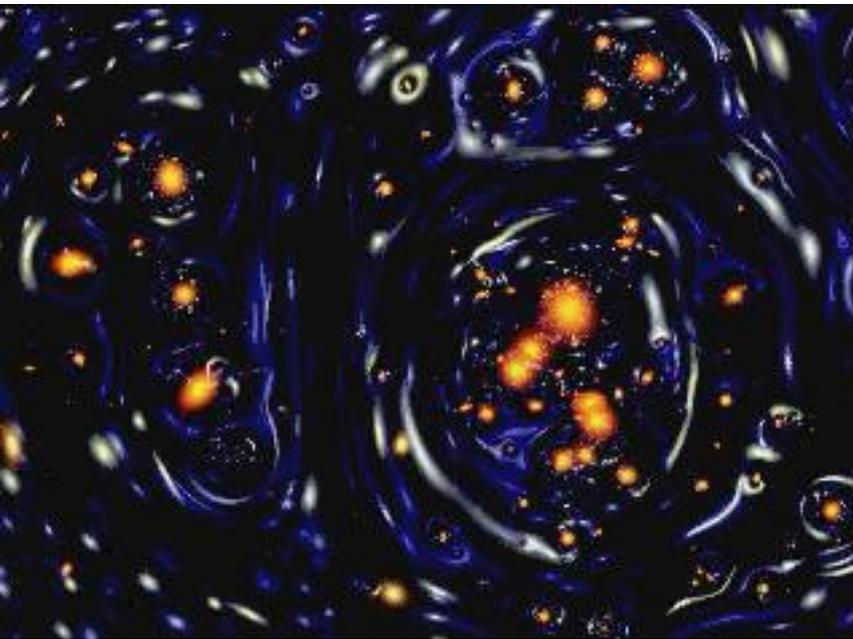
# Universe and big bang?

- Telescopes (optical radio, IR)
- Simulations
- Particle accelerators
- Theory



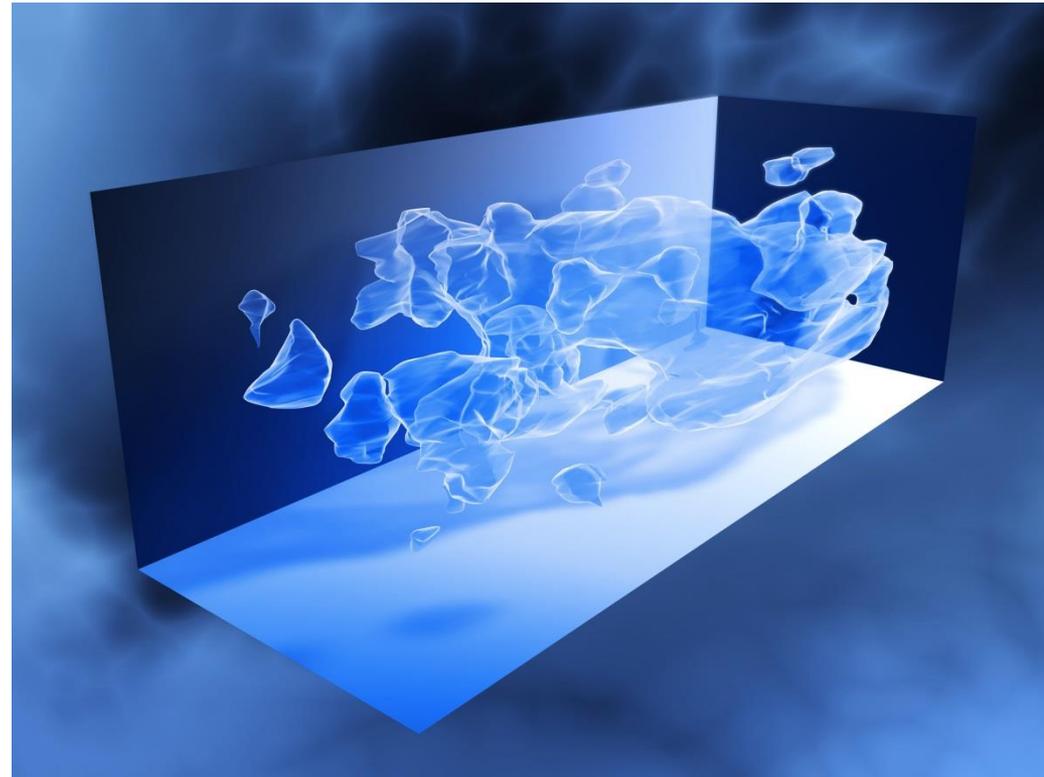
# Ultimate Fate of the universe?





# Dark matter?

- There is too much gravity in galaxies, therefore dark matter
- Gravitational lensing can map it



# Dark energy?

$$H^2 = \frac{\overbrace{8\pi G}^{\text{matter density}}}{3} \rho - \frac{\overbrace{kc^2}^{\text{curvature}}}{R^2} + \frac{\overbrace{\Lambda}^{\text{dark energy}}}{3}$$

$H$  = Hubble's constant

$\rho$  = matter density of the Universe

$c$  = speed of light

$k$  = curvature of the Universe

$G$  = gravitational constant

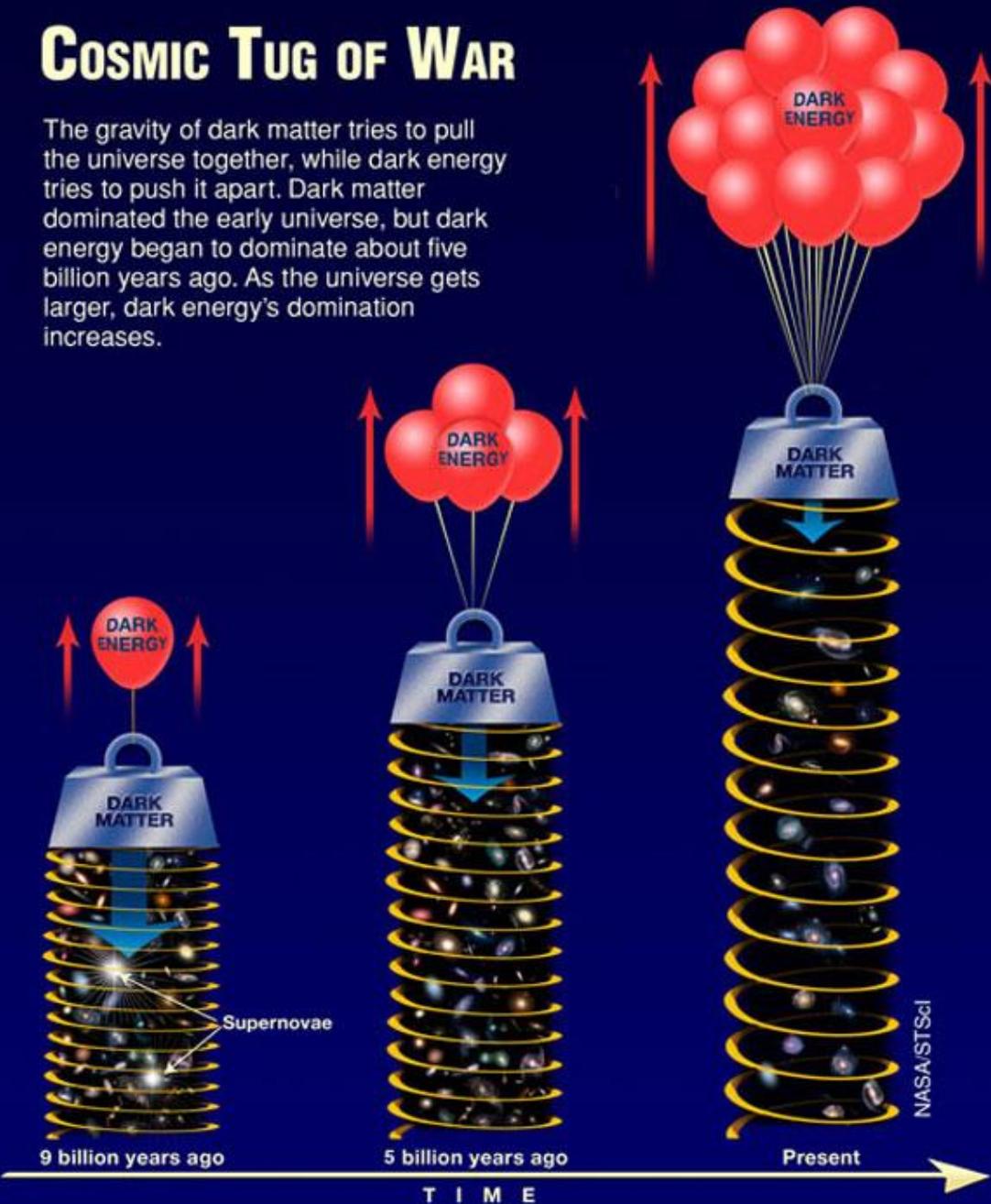
$\Lambda$  = cosmological constant

$R$  = radius of the Universe

# Dark energy?

## COSMIC TUG OF WAR

The gravity of dark matter tries to pull the universe together, while dark energy tries to push it apart. Dark matter dominated the early universe, but dark energy began to dominate about five billion years ago. As the universe gets larger, dark energy's domination increases.

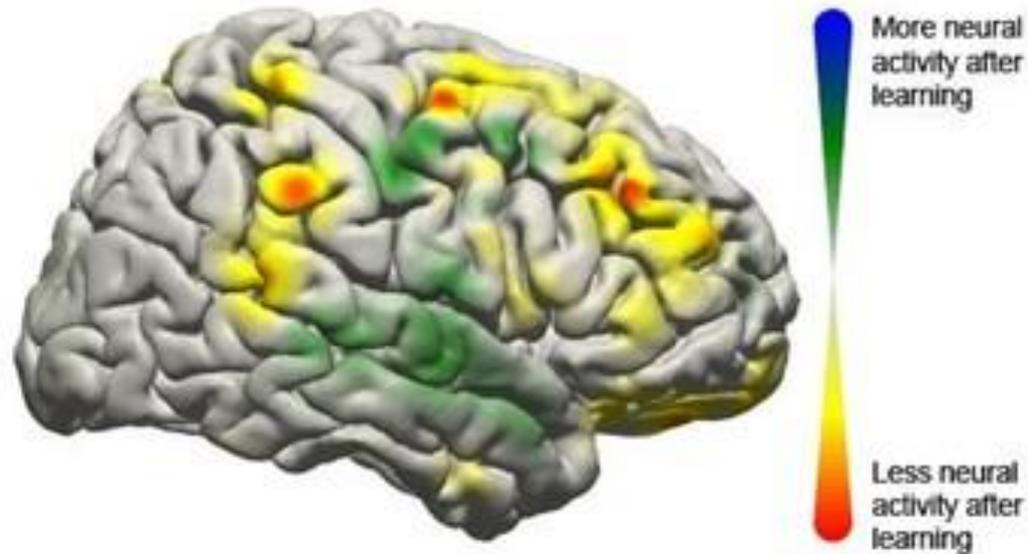
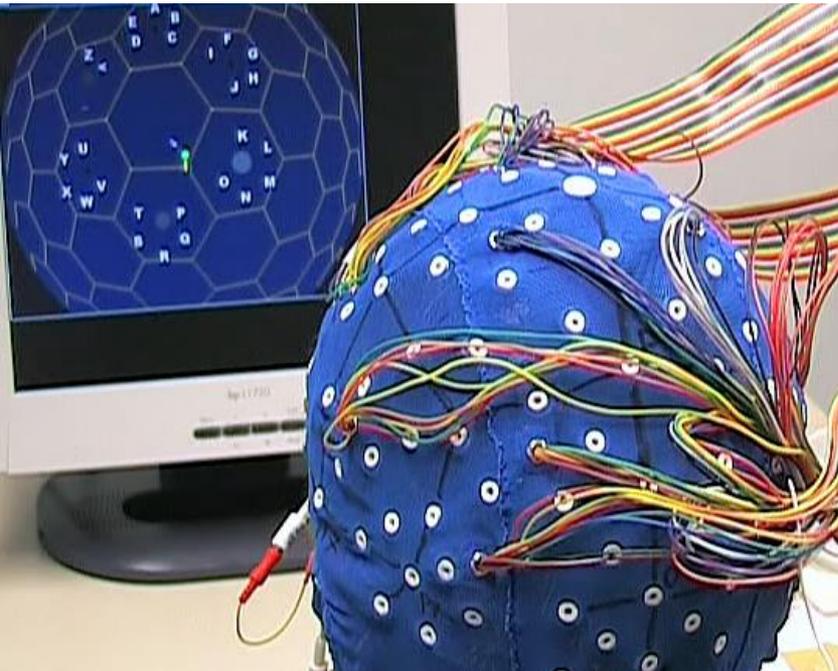


# Black holes?

- Left as an exercise!

# Brain and mind

- Advanced measurement techniques
- Artificial intelligence



# Conclusions

- Religion, philosophy and science have always sought answers to the mysteries of the universe
- Science has been very productive
- Many questions have been answered
- Many questions have been reformulated
- Many new questions have arisen
- I think pursuing these questions is the biggest adventure we can have!

# To continue the quest

- Australian Skeptics [www,skeptics.com.au](http://www.skeptics.com.au)
- Humanist Society of NSW [www.hsnsw.asn.au](http://www.hsnsw.asn.au)
- WEA lectures
- Sydney Uni Centre for Continuing Education
- Read New Scientist, Scientific American
- Lectures by scientists eg Sydney Science Forum
- [ianrbryce@gmail.com](mailto:ianrbryce@gmail.com)