

**Session 2: First Light**

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**First Light**

13 March 2024

From the Big Bang to Biology:  
do we detect the hand of God?

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**Scripture's account**



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### Preliminaries

- **Light year**

- The distance that light travels in 1 year
- Speed of light 186,000 miles per second  
300,000 km per second



Therefore 1 light year

$$= 186,000 \times 3,600 \times 24 \times 365 = 5.9 \times 10^{12} \text{ miles}$$

$$\sim 6,000,000,000,000 \text{ miles}$$

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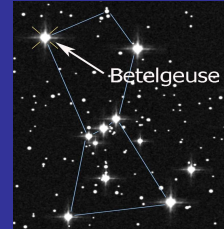
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### Preliminaries

- **Time travel!**

- When you look up, you 'travel' into the past
  - Moon: 1.3 seconds into the past
  - Sun: 8 minutes
  - Pluto: 5½ hours
  - Nearest star (Proxima Centauri): 4 years
  - Andromeda galaxy: 2½ million years
  - ...



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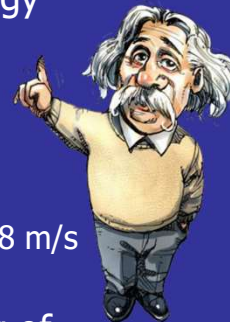
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### Preliminaries

- The equivalence of mass and energy

$$E = m c^2$$

- $E$  is energy (Joules)
- $m$  is mass (kg)
- $c$  is the speed of light = 299,792,458 m/s



- Fundamental to our understanding of the physics of the Big Bang!

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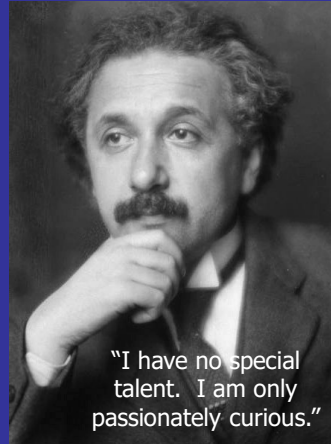
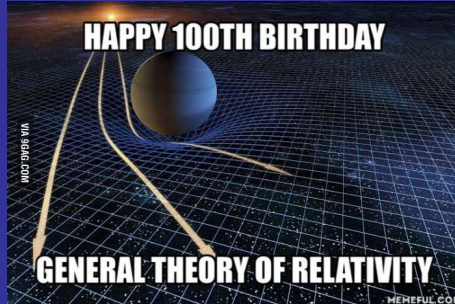
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### How did we arrive at the 'Big Bang' theory?

- General relativity (1915)
  - Einstein's theory of gravity



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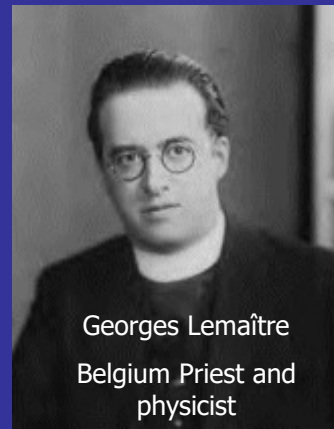
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### How did we arrive at the 'Big Bang' theory?

- Other pioneers at the time applied Einstein's theory to the Universe as a whole ...
  - ... and confirmed that it predicted that the Universe was expanding.



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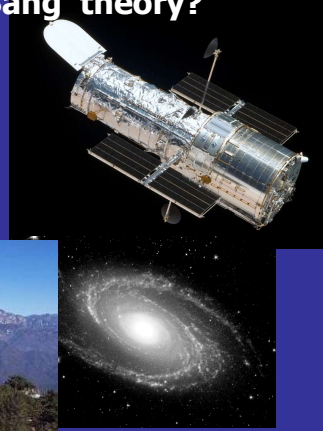
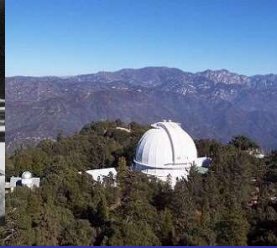
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How did we arrive at the 'Big Bang' theory?

- Enter Edwin Hubble (1929)



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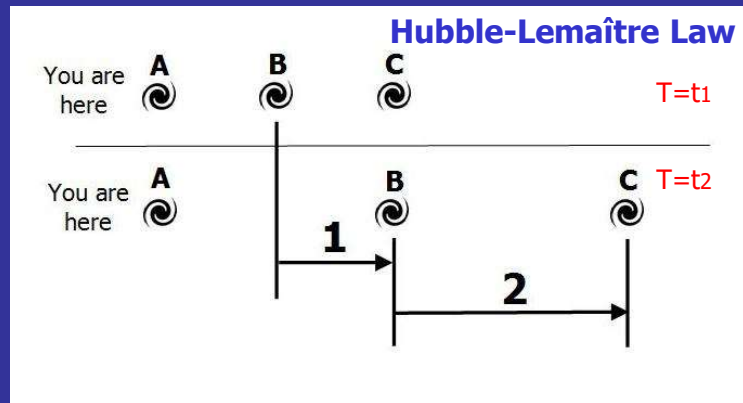
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How did we arrive at the 'Big Bang' theory?

- Universal expansion ...



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How did we arrive at the 'Big Bang' theory?

□ So, the late 1920's brought a revolutionary change in our view of the Universe:

- The Universe was not static and eternal
- The universal expansion implied that something extraordinary happened billions of years ago

→ A creation event  
(in conformity with Scripture!)

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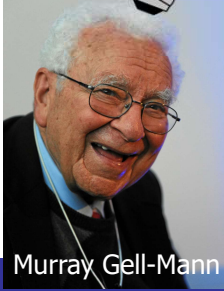
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Detour

#### The Standard Model of Particle Physics

	FERMIONS (matter particles)			BOSONS (force carriers)	
QUARKS	$u$ up	$c$ charm	$t$ top	$g$ gluon	$H$ Higgs boson
	$d$ down	$s$ strange	$b$ bottom	$\gamma$ photon	
	$e$ electron	$\mu$ muon	$\tau$ tau	$Z^0$ Z boson	
LEPTONS	$\nu_e$ electron neutrino	$\nu_\mu$ muon neutrino	$\nu_\tau$ tau neutrino	$W^\pm$ W boson	



Murray Gell-Mann

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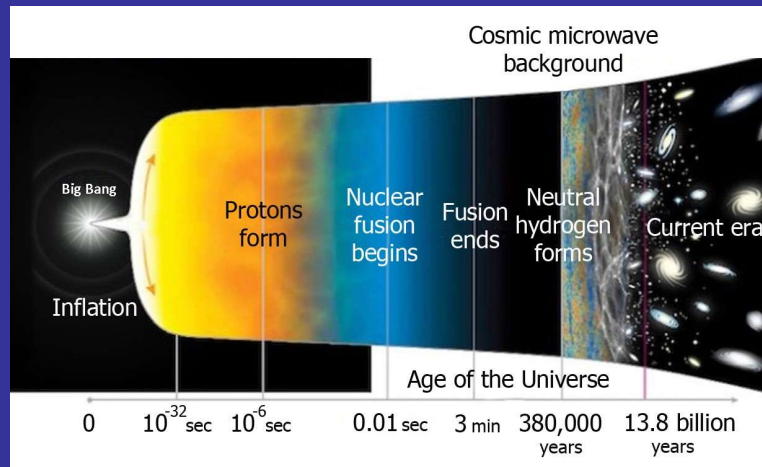
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### The history of the early Universe



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## Session 2: First Light

### The history of the early Universe – Cosmic Inflation

#### □ The process that gave the Big Bang its 'Bang'!

- Tiny speck of space infused by the 'inflaton field'
- Einstein's gravity generates repulsive gravity
- Space expands by a huge factor  $\sim 10^{30}$  in a 'blink of an eye'
- **A Universe is born!**

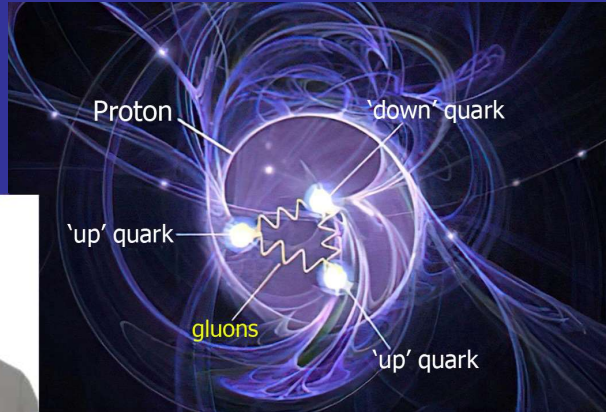
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### The history of the early Universe – Protons and Neutrons form



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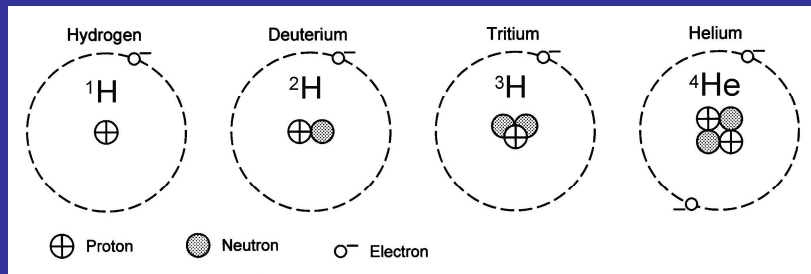
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### The history of the early Universe – Primordial Nucleosynthesis

- The production of the first elements by a process of nuclear fusion



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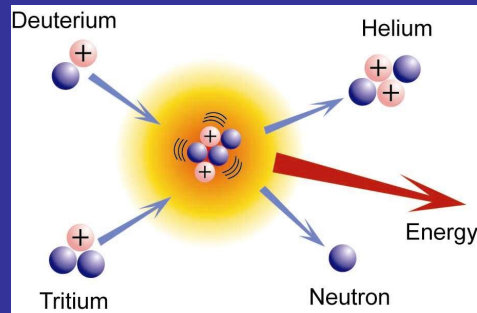


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### The history of the early Universe – 'Primordial Nucleosynthesis'

#### □ The production of the first elements by a process of nuclear fusion

- 76% hydrogen
- 25% helium
- Traces of lithium



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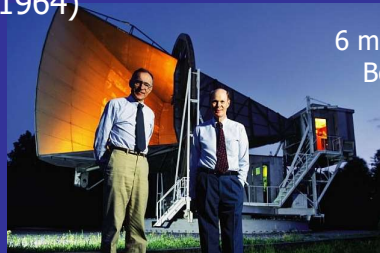
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### The history of the early Universe – the Cosmic Microwave Background (CMB)

- Scientists predicted that the 'after-glow' of the BB could be detected (Alper and Herman, 1948)
- Discovered by Arno Penzias and Robert Wilson (1964)



6 metre (20 foot) Horn antenna  
Bell Labs, New Jersey, USA

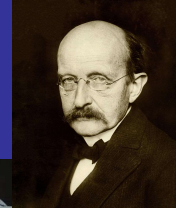
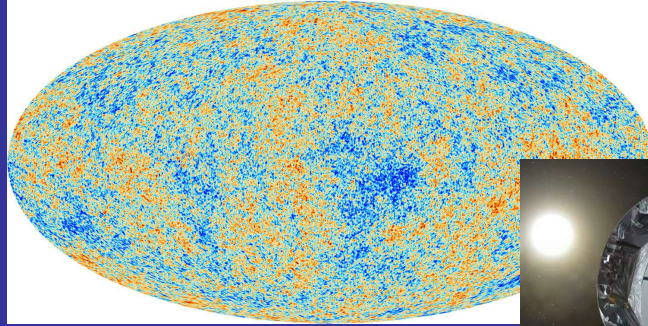
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### The history of the early Universe – the Cosmic Microwave Background (CMB)



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### Did the Big-Bang happen?

#### Principal evidence for the Big Bang

- **Universal expansion - recession of the galaxies**
- **Cosmic Background Radiation (after-glow of BB)**
- **Chemical composition of Universe**
- **Cosmic evolution (looking back in time)**

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### The Big Bang rules – OK!

#### ☐ Conformity with Scripture

- “The best data we have concerning the Big Bang are exactly what I would have predicted, had I nothing but the five books of Moses, the Psalms, the Bible as a whole” *Arno Penzias* (astrophysicist and Nobel laureate)

#### ☐ The creation of everything

- Matter, energy, space and time

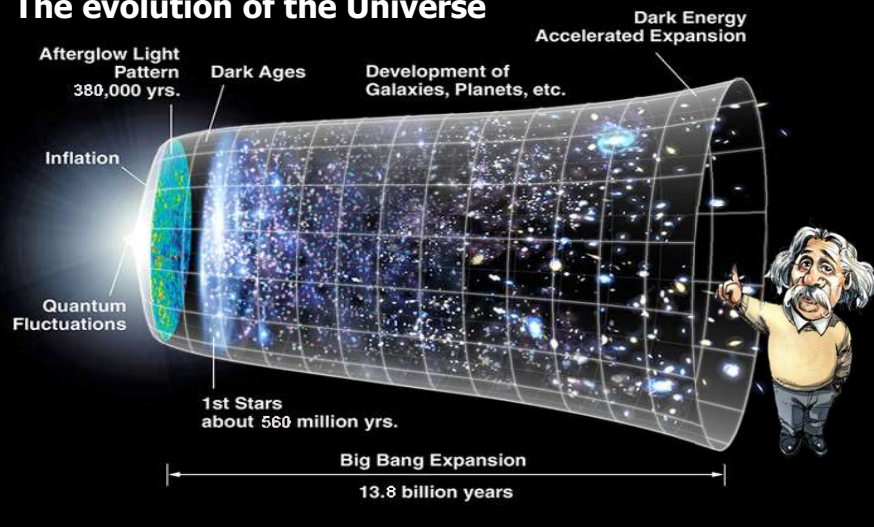
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### The evolution of the Universe

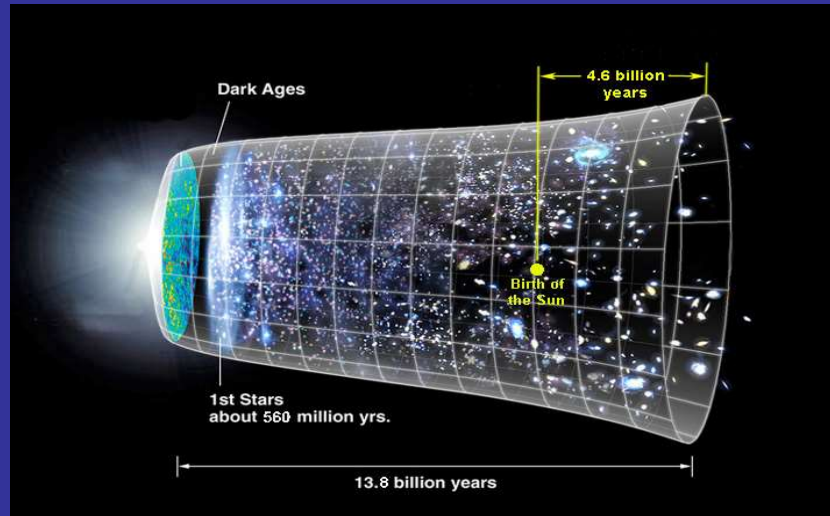


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### ☐ God's Universe!

- **Creation of the Universe** – a Genesis event
  - Observations
- **God of Order**
  - Laws of Nature
- **The Image of God**
  - Our understanding/comprehension
- **One God**
  - Consistency/Universality of laws
- **No fear of science** – God made it all possible!

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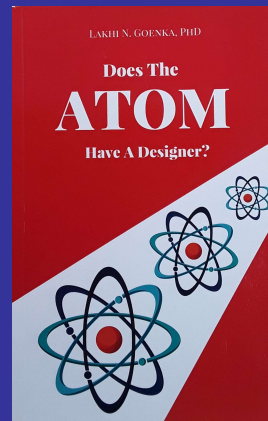
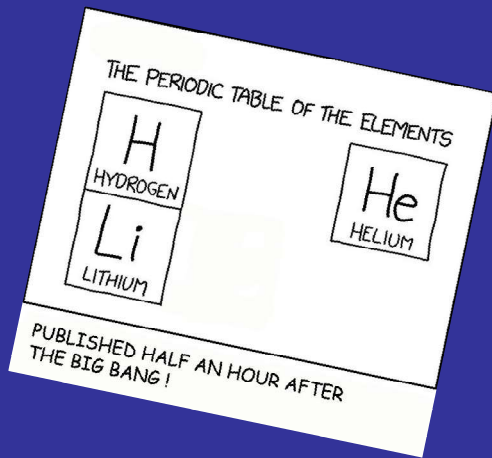
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### ☐ Quotes, etc



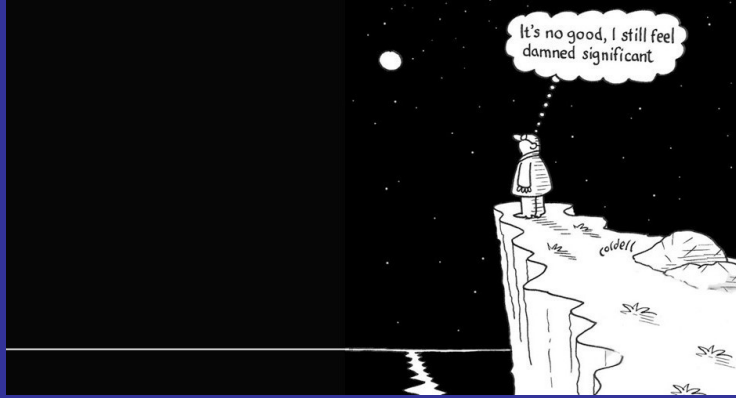
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### ☐ Quotes, etc



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