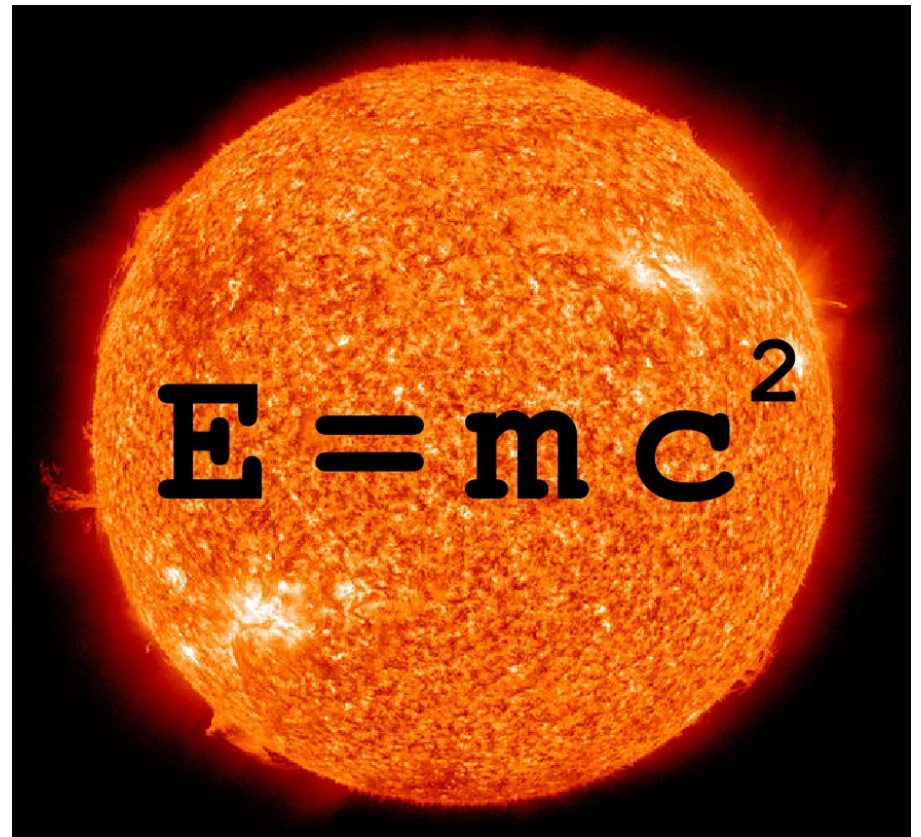


Albert Einstein (1879-1955)
og
afstæðiskenningin

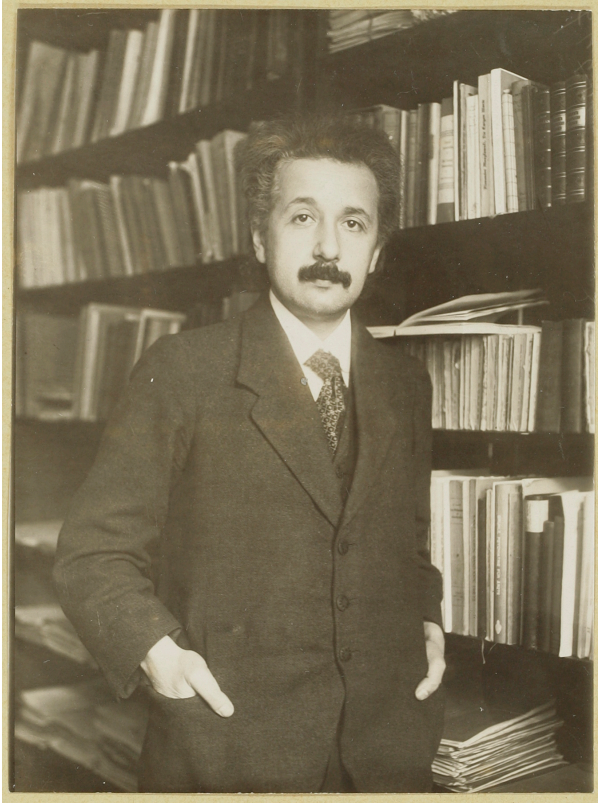
Takmarkaða kenningin 1905



Einstein 1905



Almenna kenningin 1915

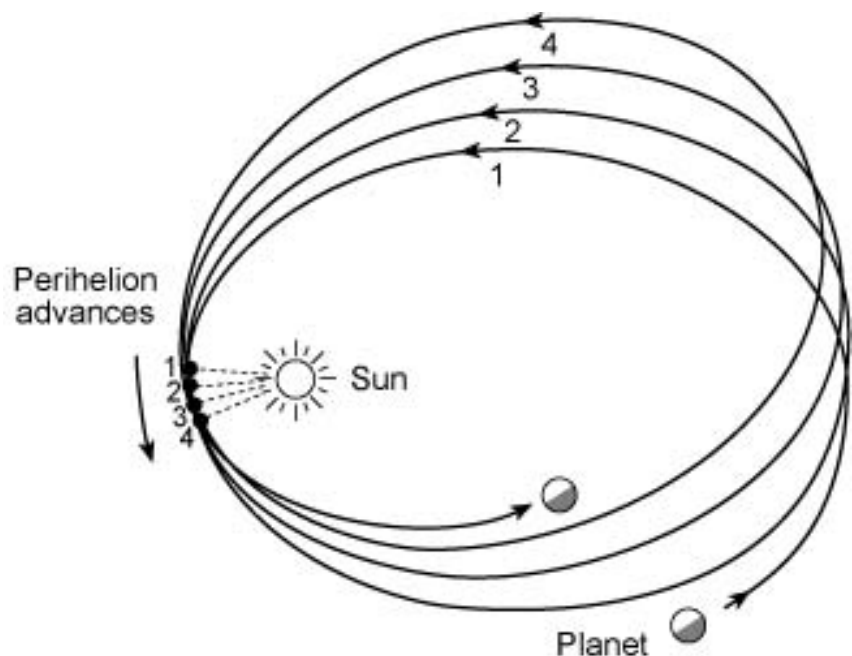


Einstein 1916

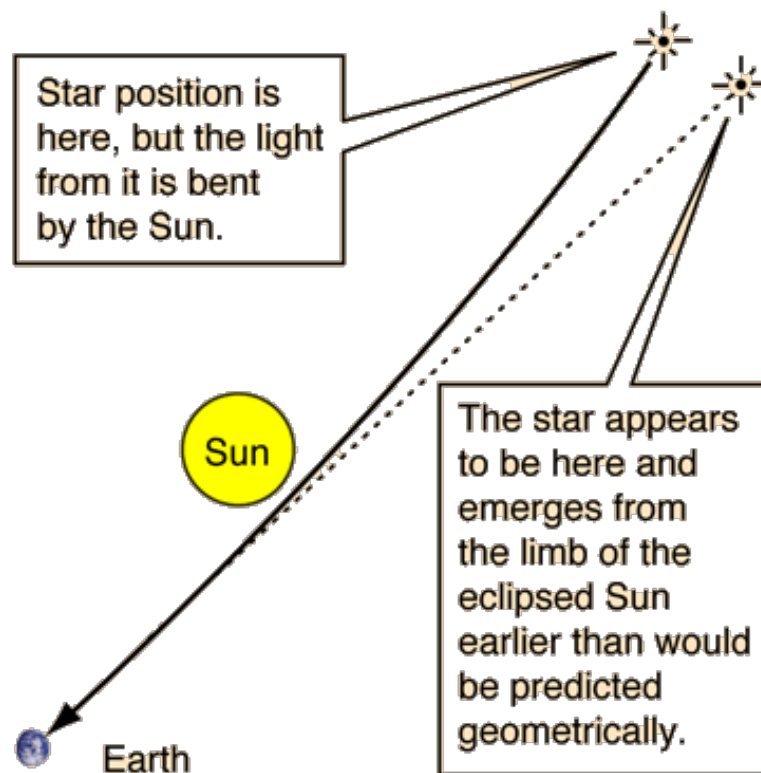


Sviðsjöfnur Einsteins

Niðurstöður Einsteins sannreyndar



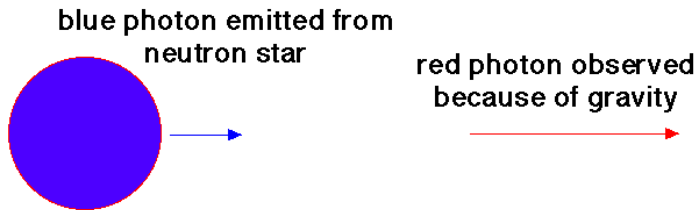
Framsókn sólnándarpunkts
Merkúríusar - Einstein 1915



Sveigja ljóss í þyngdarsviði
Eddington og fleiri 1919

Þyngdarvik

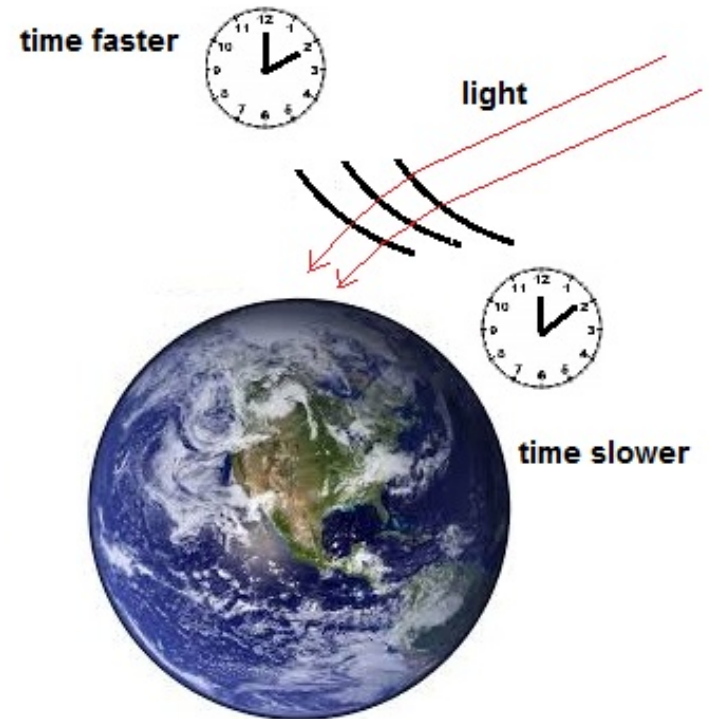
Gravitational Redshift



- photon energy is reduced due to gravity
- object appears redder

53

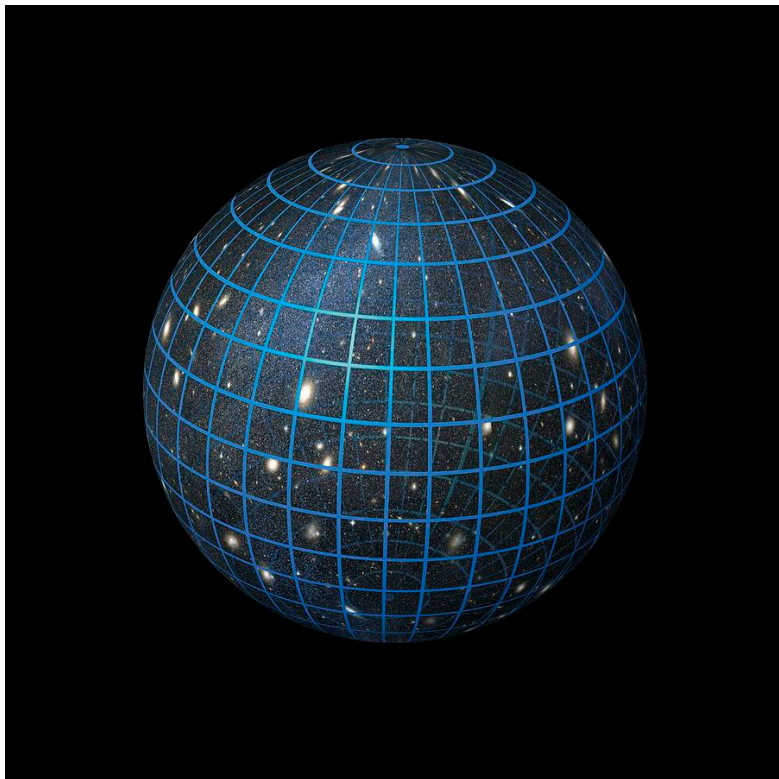
Rauðvik: Ljós á leið frá hnetti.
Blávik: Ljós á leið til hnattar
– Pound og Rebka 1959



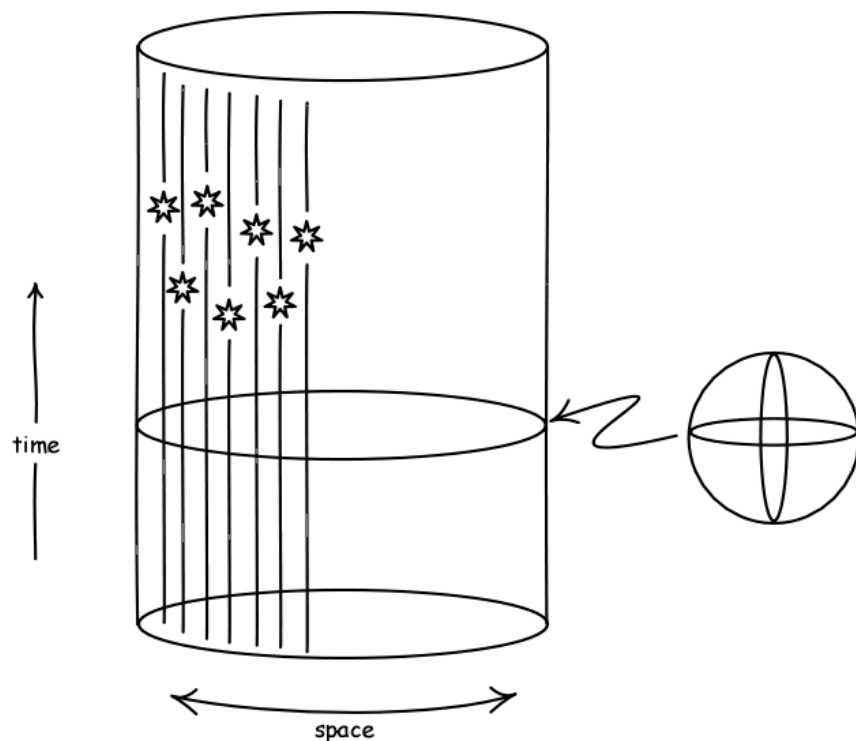
Klukkur ganga hægar í sterku
Þyngdarsviði en veiku - GPS

Afstæðileg heimsfræði

Heimslíkan Einsteins frá 1917

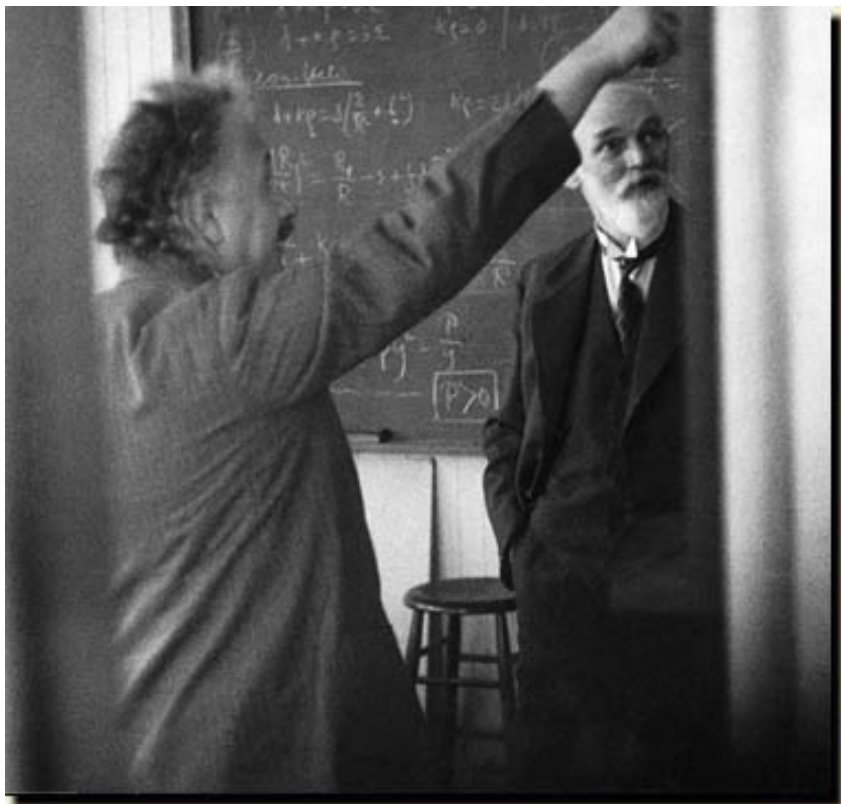


Rúmið = þrívítt kúluyfirborð (myndin sýnir aðeins tvær víddir af þremur).
Kyrrstæður, lokaður og endanlegur heimur

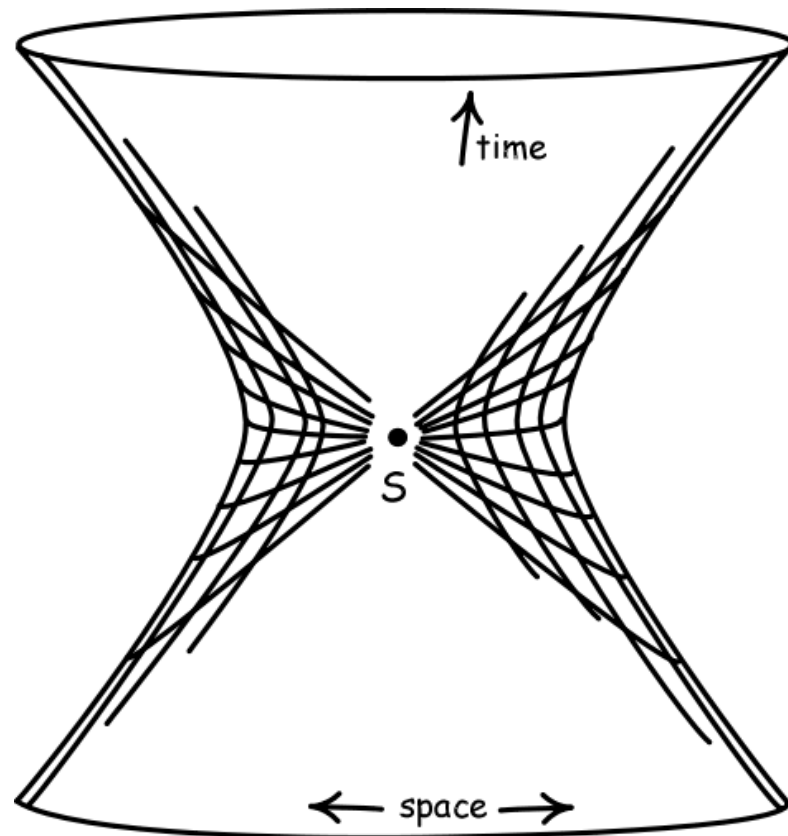


Tímarúm: Myndin sýnir eina rúmvídd (af þremur) og eina tímavídd

Heimslíkan De Sitters frá 1917



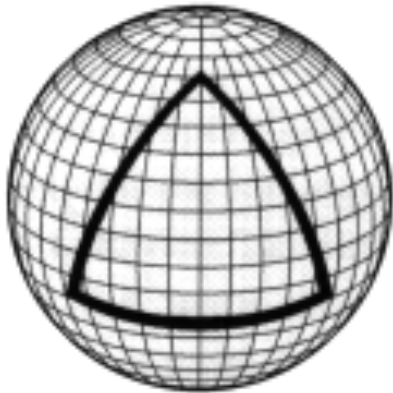
Einstein og Willem de Sitter (1872-1934) ræða málin



Tímarúm: Myndin sýnir eina rúmvídd (af þremur) og eina tímavídd. Þessi heimur er tómur en með heimsfasta og þenst út.

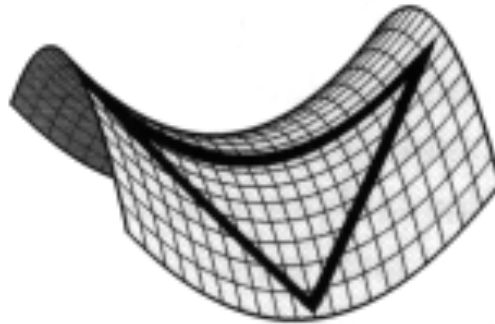
Rúmfræðileg gerð alheimsins
Ýmsir möguleikar

Einföldustu heimslíkönin



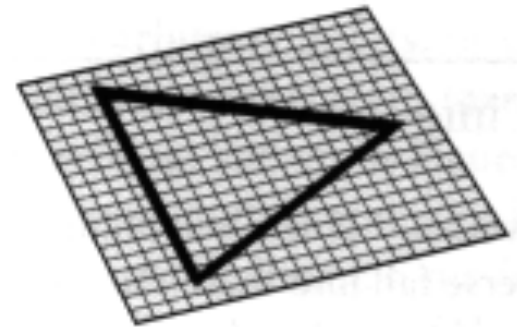
Positive Curvature

Endanlegur heimur



Negative Curvature

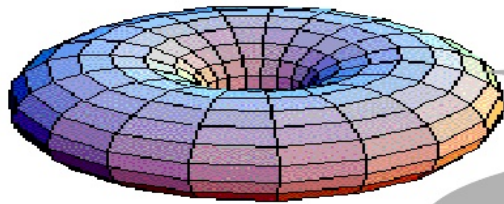
Óendanlegir heimar



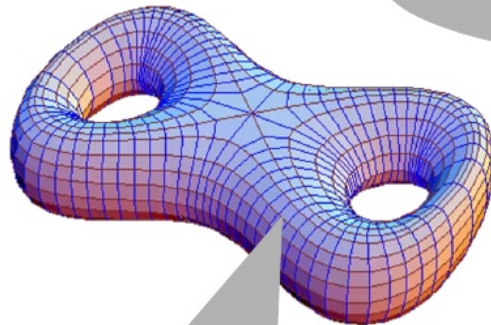
Flat Curvature

Ýmsar gerðir lokaðra heima

Is the Universe Compact ?



Simple Torus
(Euclidean)



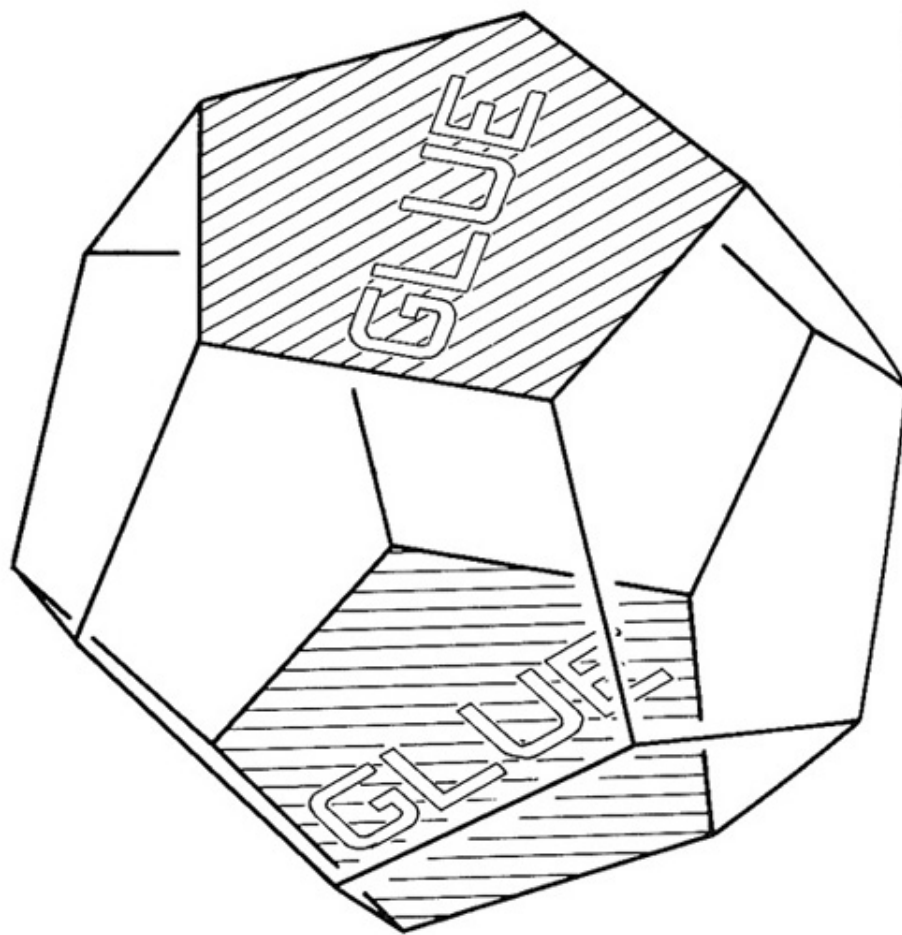
Compact hyperbolic space

Multiply connected **Spherical** space
(Poincare dodecahedron)

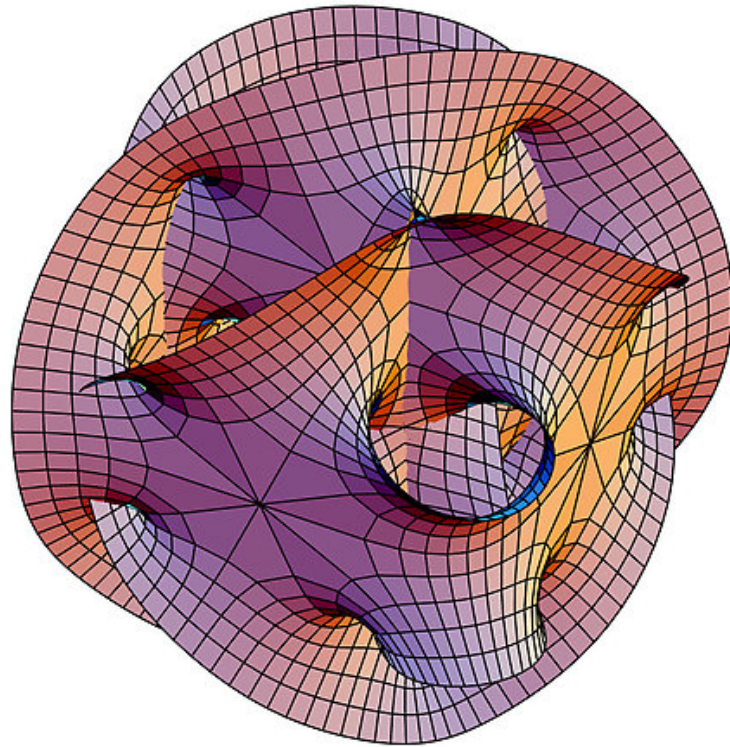


Post WMAP Nature article
(Luminet et al 2003)

Tólflötungur Poincarés

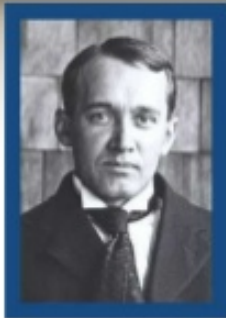


Calibai-Yau víđátta



Útþenslan

Discovery of Galactic Redshifts

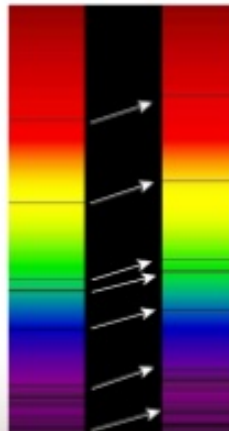


In 1912, **Vesto Slipher** was the first to observe the *shift of spectral lines* of galaxies, making him the discoverer of **galactic redshifts**.

Redshifts are analogous to the *Doppler effect* – think racing cars or trains passing you at speed.

An observed *redshift* due to the Doppler effect occurs whenever a light source *moves away from* an observer.

Conversely, light sources *moving towards* an observer are *blueshifted*.



Heimar Alexanders Friedmann (1888-1925)

Friedman models of the cosmos



Alexander Friedmann 1888 -1925

- ▣ **Allow time-varying solutions to the field equations**

Expanding, contracting universes

- ▣ **Geometry, evolution depends on matter content**

Positive curvature (1922)

Hyperbolic curvature (1924)

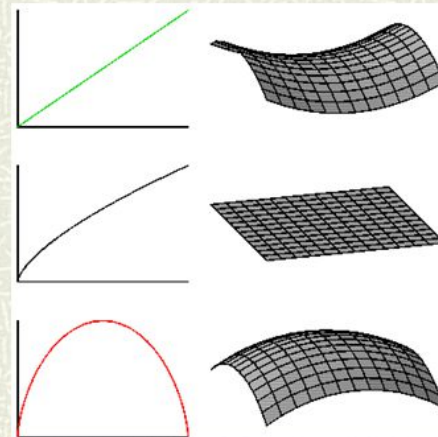
- ▣ **Mathematical models (Zf. Ph.)**

To be decided by astronomy

- ▣ **Ignored by community**

Disliked by Einstein

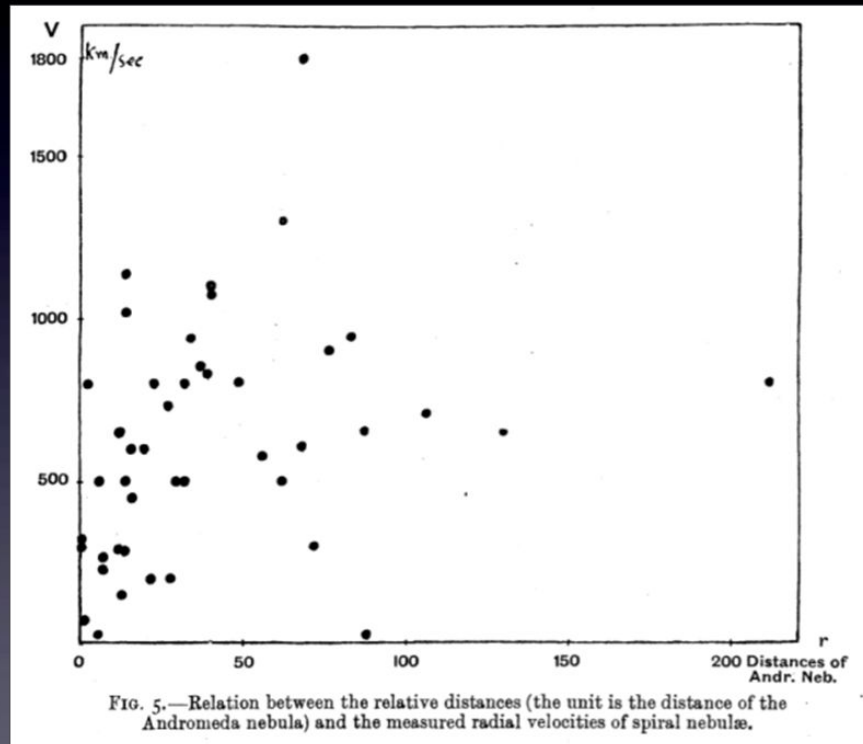
Correction and retraction



1924: First “distance-velocity diagram” by Knut Lundmark



Lundmark
(1889-1958)



Heimar Georges Lemaître (1894-1966)

Lemaître's universe (1927)



De Sitter model not static (1925)

New evolving solution: Einstein \rightarrow de Sitter

Redshifts of galaxies = expansion of space?

Rate of expansion from mean distances and redshifts

$$H = 585 \text{ km/s/Mpc} \quad (1927)$$

Fr Georges Lemaître

*Not an empirical law
Edited in 1931 translation*

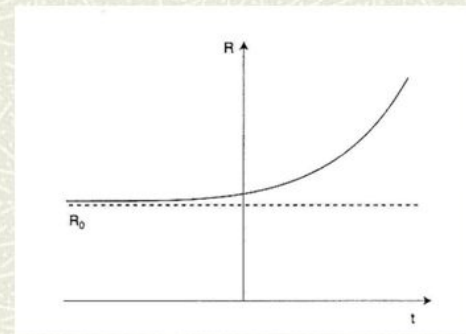
Rejected by Einstein

"Votre physique est abominable"

Ditto for Friedman

No beginning: indefinite age

Starts from Einstein universe at $t = -\infty$



Fyrsta Hubbleslínuritið frá 1929

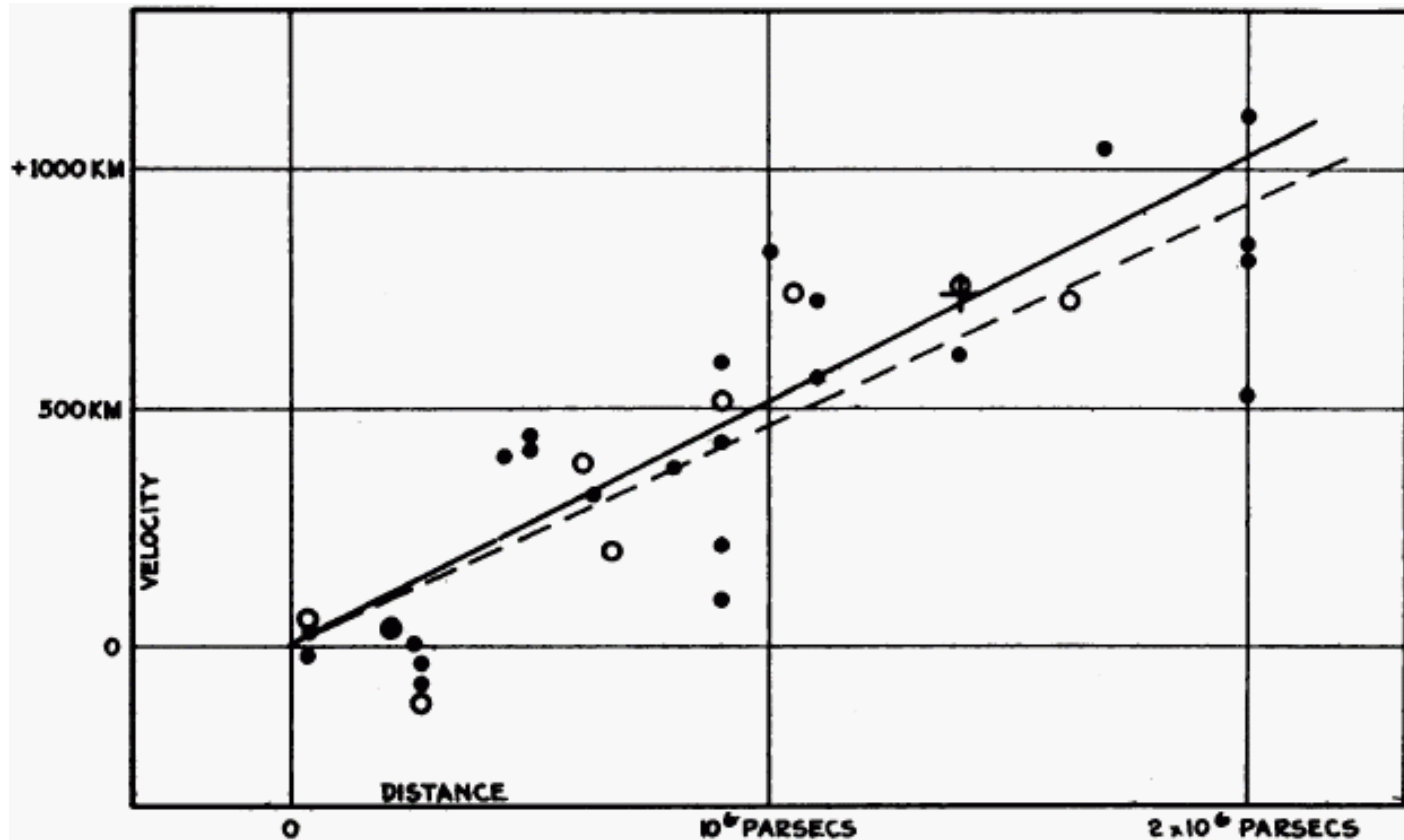


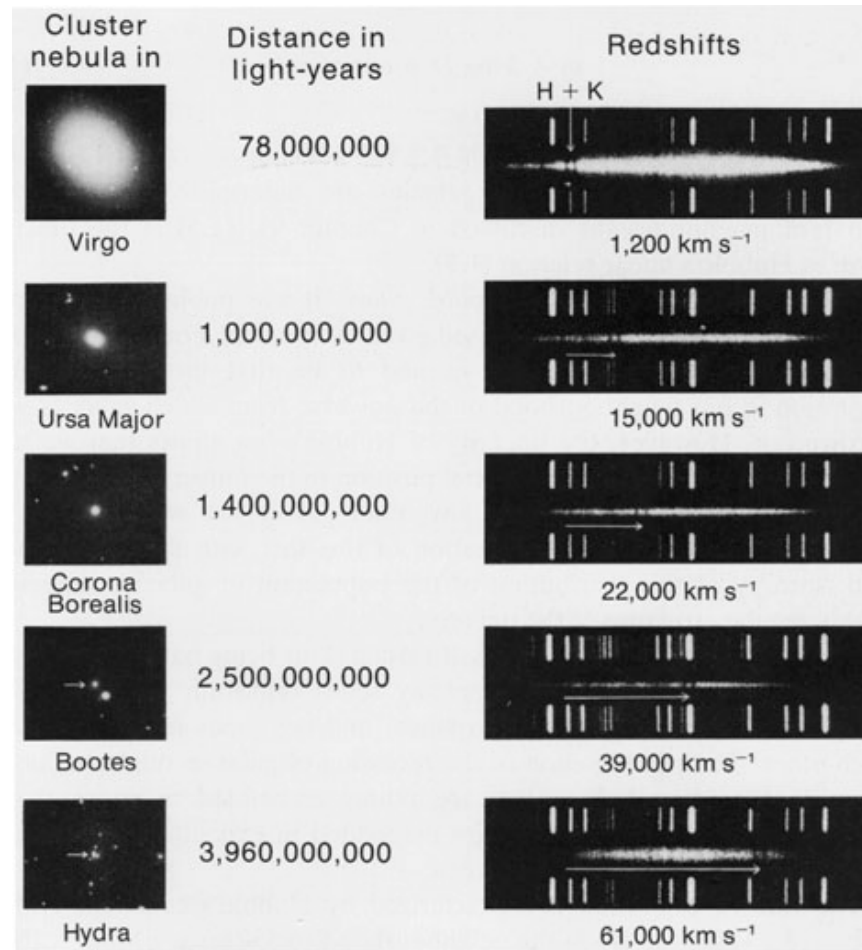
FIGURE 1

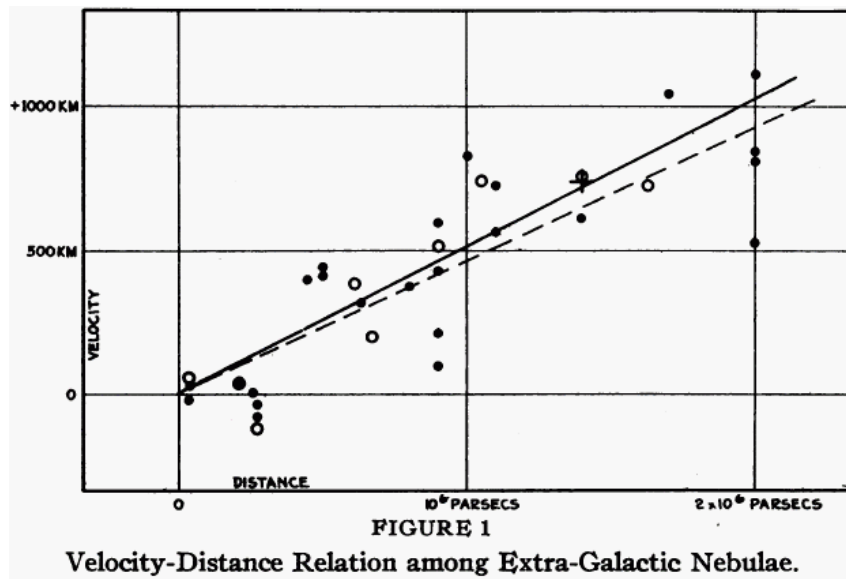
Velocity-Distance Relation among Extra-Galactic Nebulae.

Stađalkerti

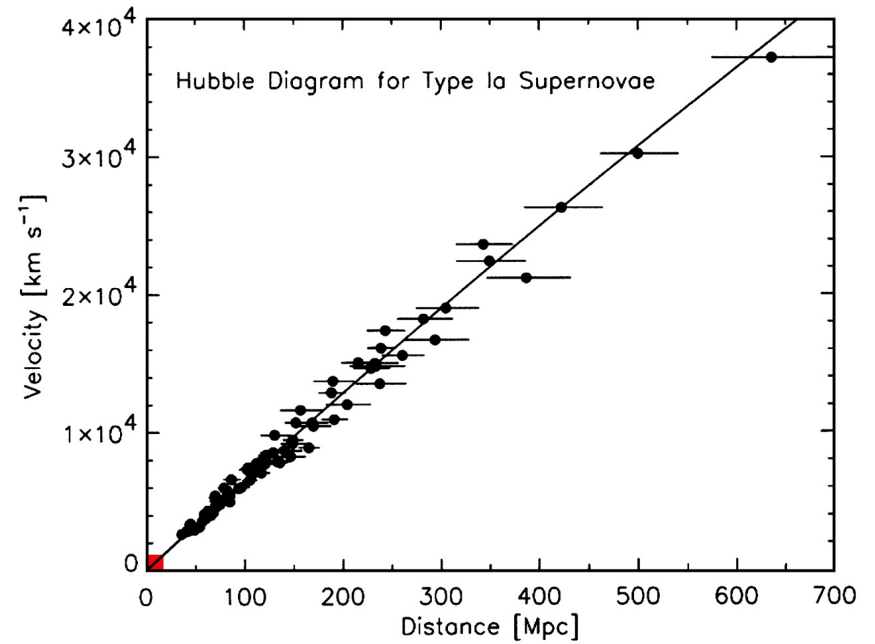


Mæligögn fyrir Hubbleslínurit



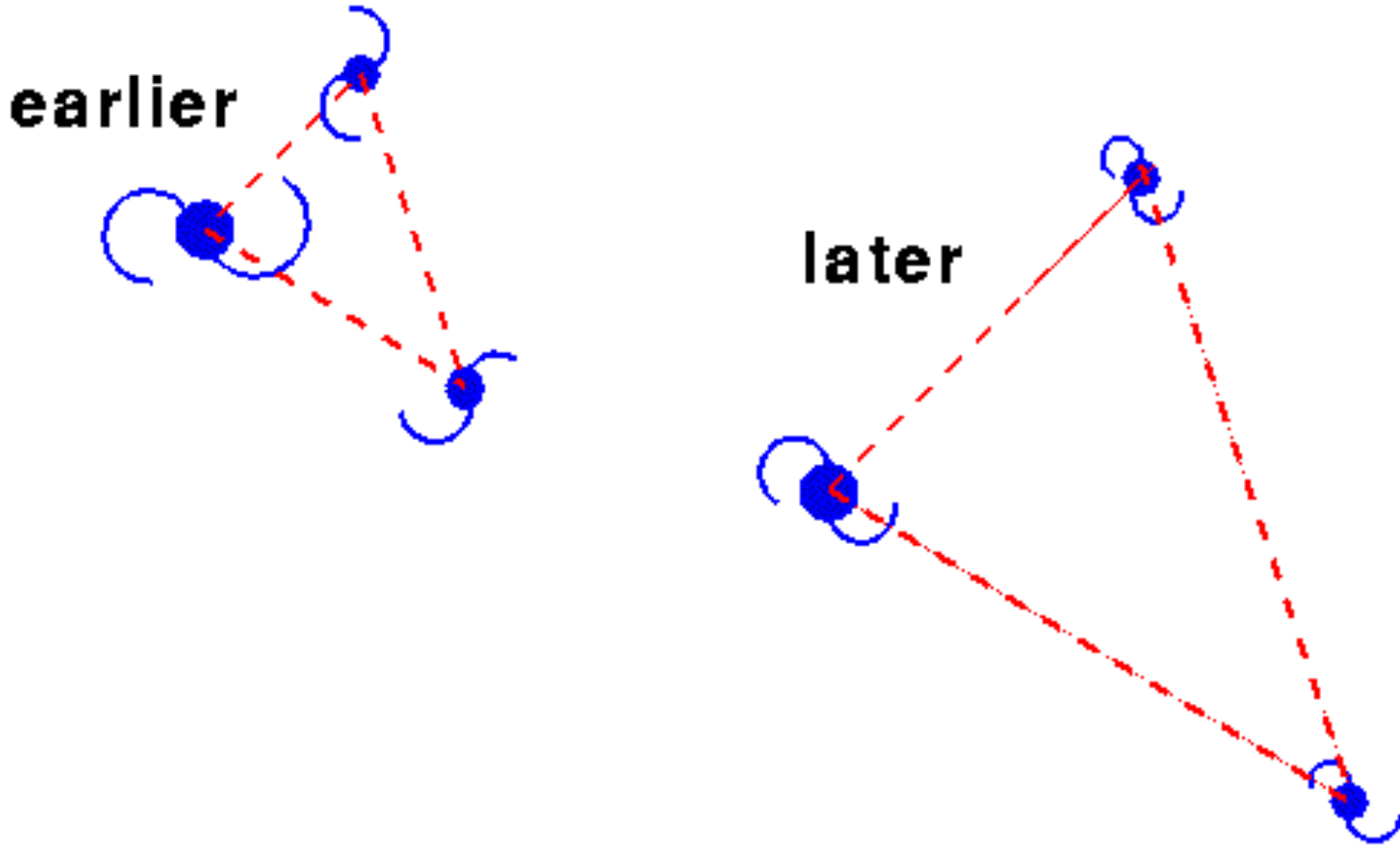


Niðurstaða Hubbles frá 1929



Nýlegt Hubbleslínurit

Myndræn lýsing á þenslu alheims I



Myndræn lýsing á þenslu alheims II

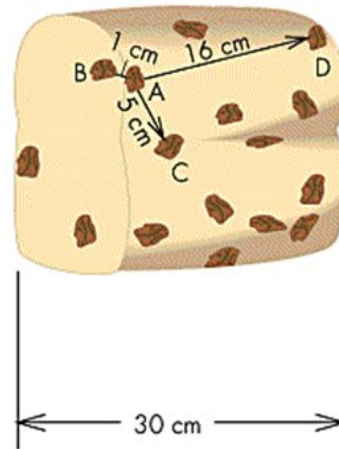
Hubble Expansion

Hubble's Law can be thought of two ways:

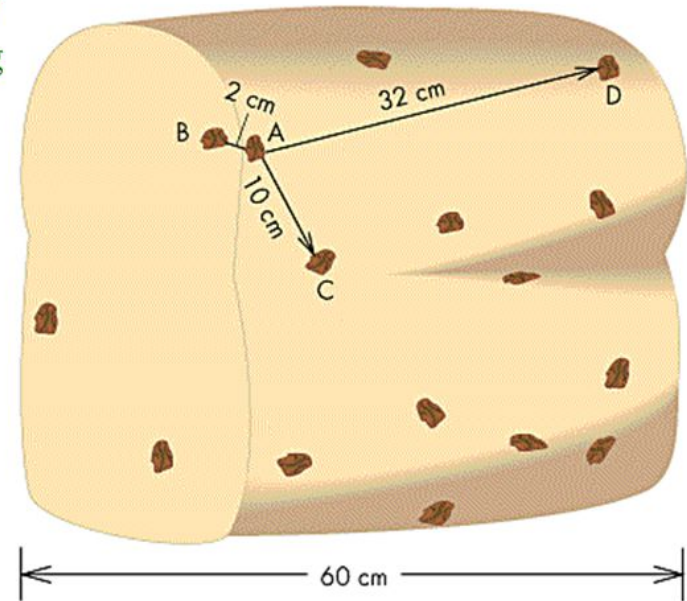
- All galaxies are flying apart from each other
- The space between the galaxies is expanding

There is no special place in the universe

- It is meaningless to ask "where is it expanding from"
- All observers see the same thing

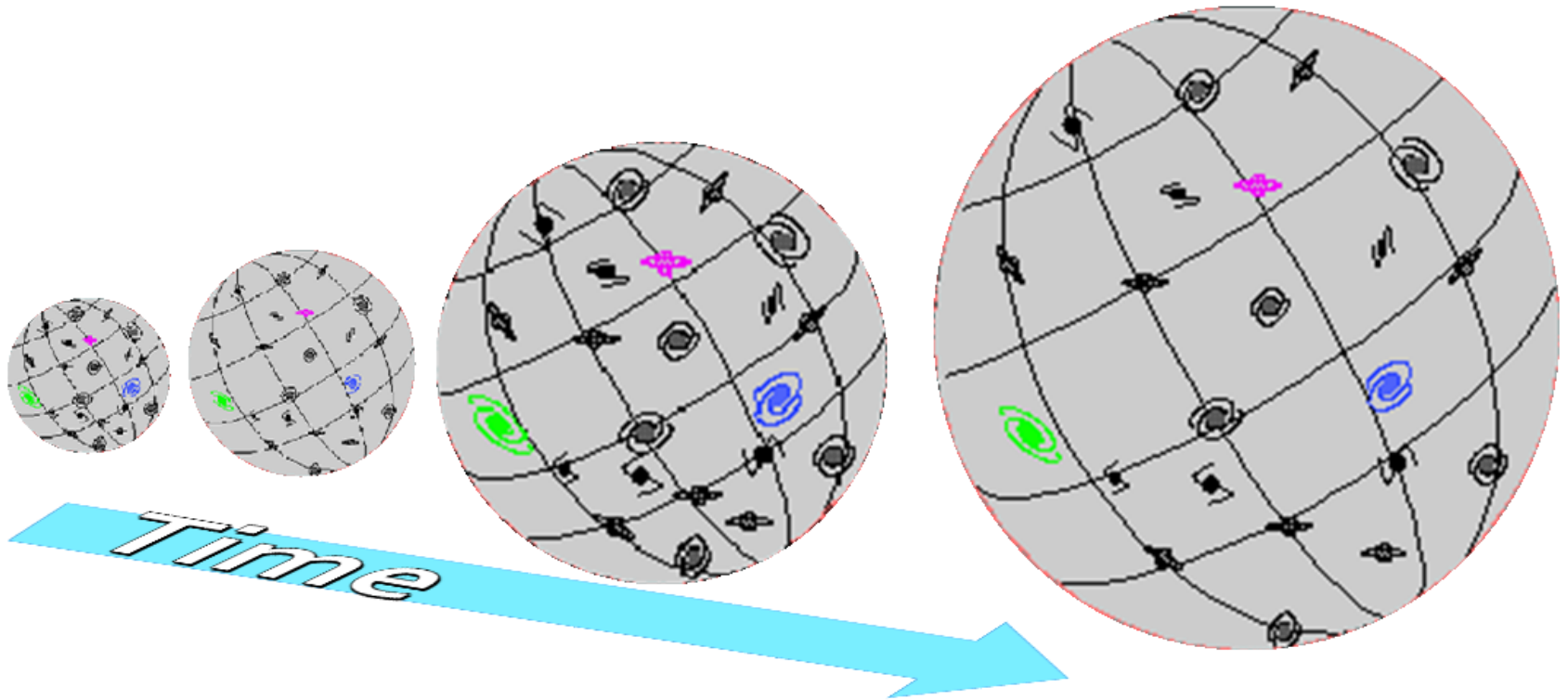


A Raisin bread dough before rising



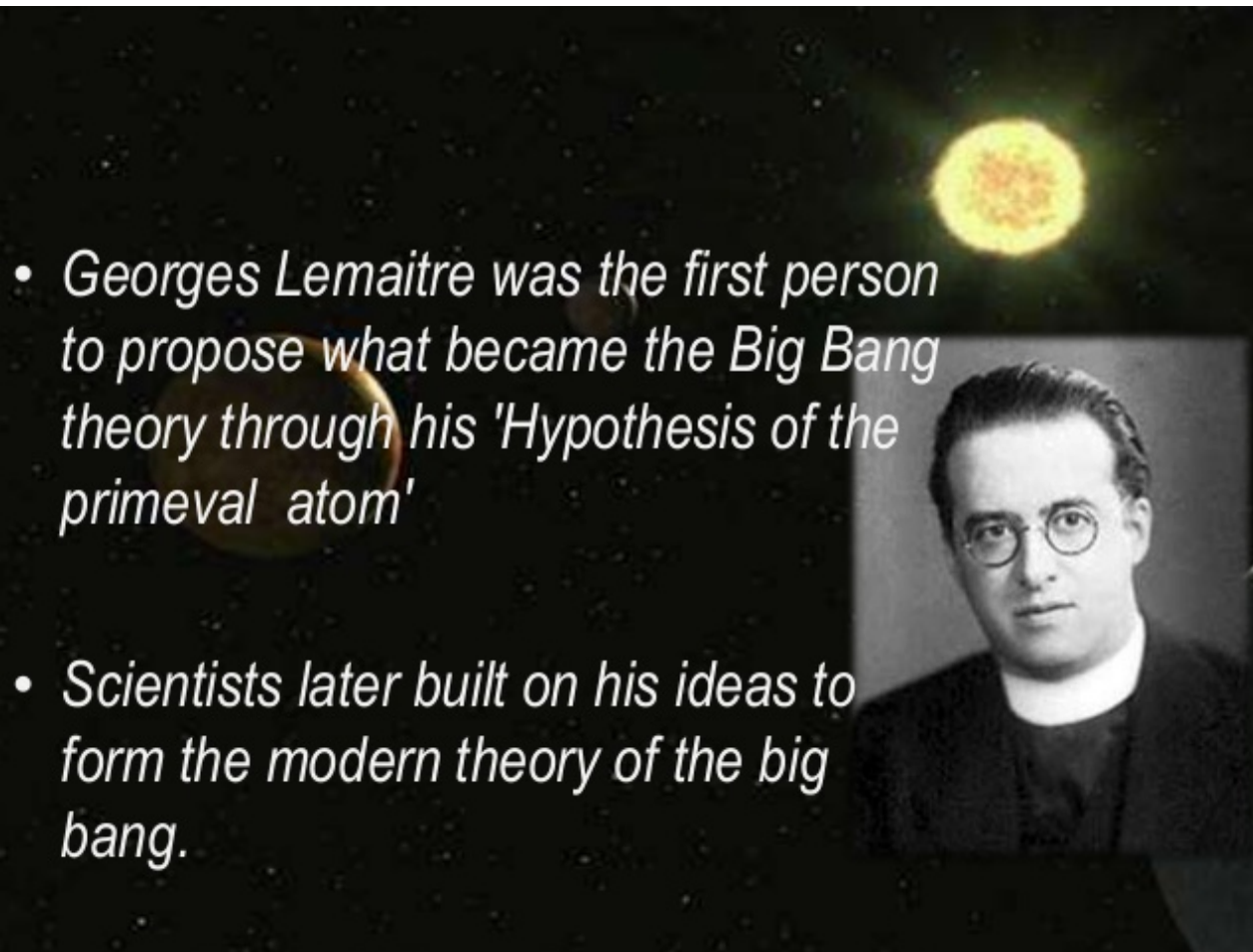
B Raisin bread dough after rising

Myndræn lýsing á þenslu alheims III



Miklahvellskeningin

Faðir Miklahvellskenningarinnar



- *Georges Lemaitre was the first person to propose what became the Big Bang theory through his 'Hypothesis of the primeval atom'*
- *Scientists later built on his ideas to form the modern theory of the big bang.*

Þróun mismunandi Miklahvells-heimslíkana

