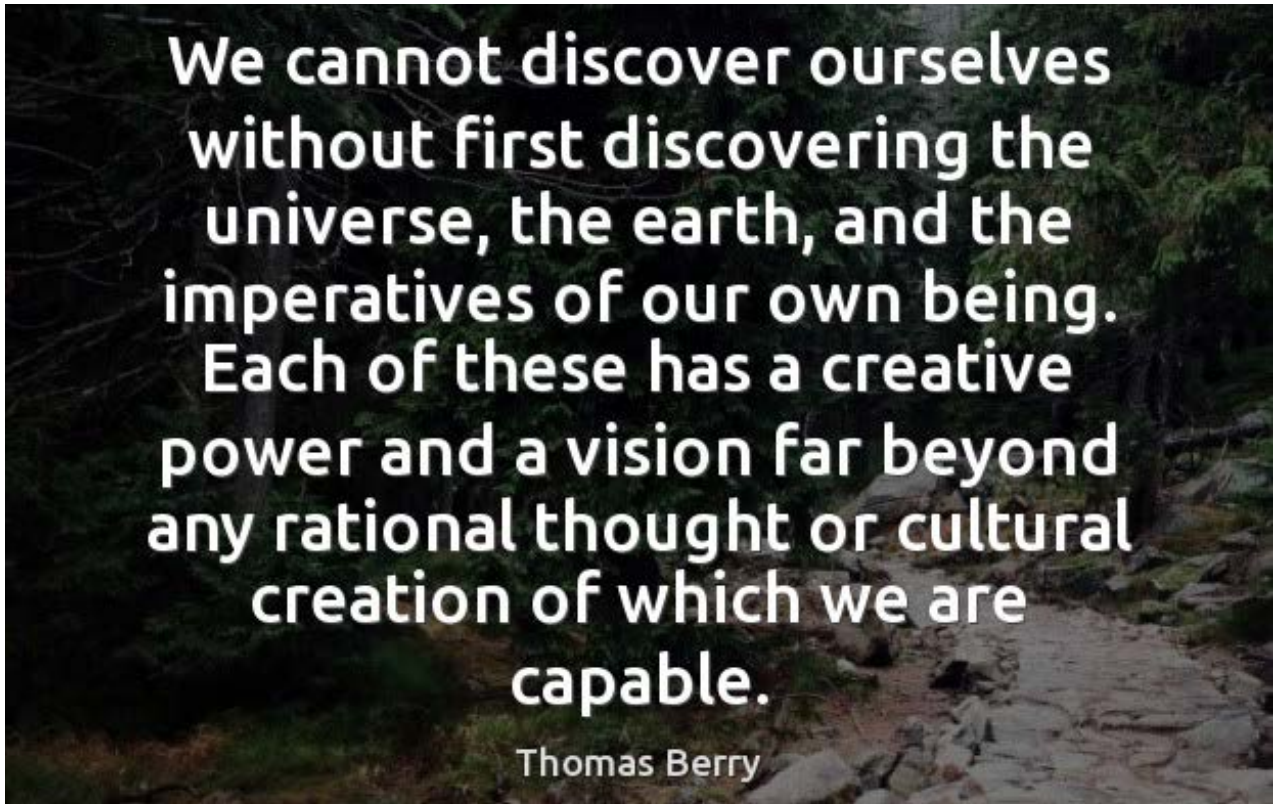
From Milky Way to the Universe

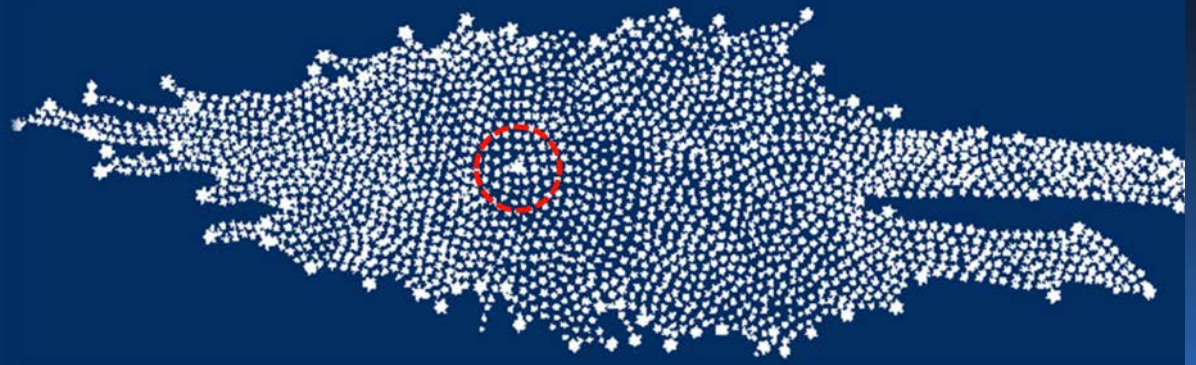
宇宙认识史（简略版）


We cannot discover ourselves without first discovering the universe, the earth, and the imperatives of our own being. Each of these has a creative power and a vision far beyond any rational thought or cultural creation of which we are capable.
Thomas Berry

宇宙地图 V1 (1785): 银河系/Galaxy

The Entire Universe

In 1785 the Herschels completed in making a complete map of the Milky Way. In size, this Milky Way is a huge universe. 100 - 180 kilo light-years in diameter. 2 kilo light-years in thickness. The sun is the bright dot near the middle.



Harlow Shapley's Universe

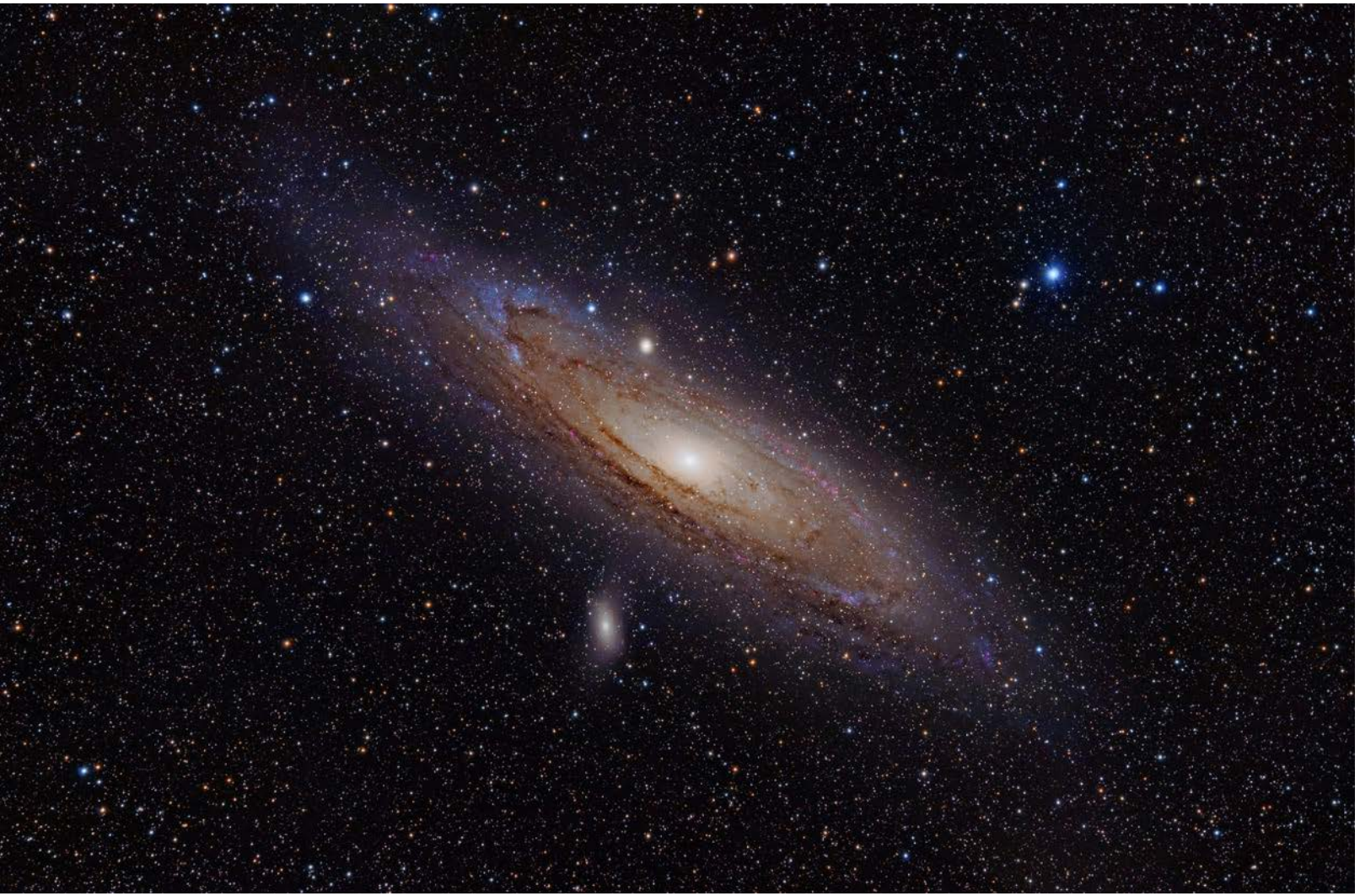
About 27,000 light-years from the Galactic centre

Shapley succeeded in measuring and constructing an overall picture of the Milky Way galaxy, showing also the position of the solar system. This was supposed to be the first complete picture of what is believed to be our entire universe.

1915

https://www.slideshare.net/StephenKwong1/ca-308-the-milky-way-universe?from_action=save

宇宙地图 V2 (1920)：本星系群/Local Group

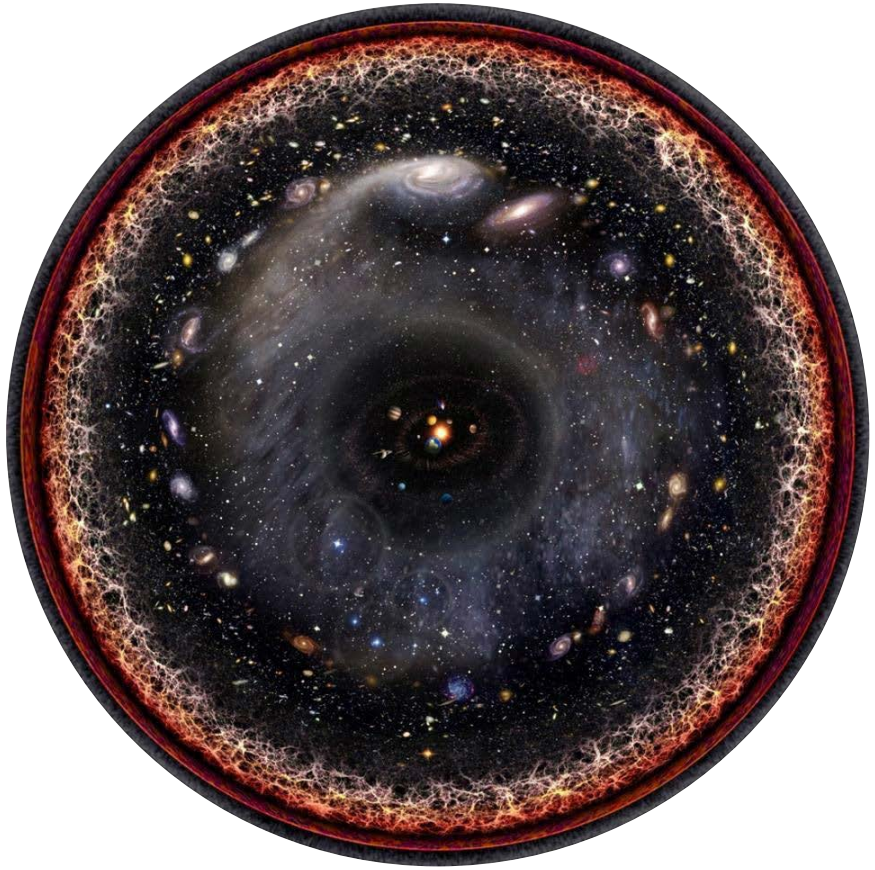


- Great Debate between Harlow Shapley & Heber Curtis：仙女座星云是星系
- 仙女座星系：距離地球 ~2.5x10^6 光年, 本星系群中最大的星系，直径 ~2x10^5光年 ~10^{13}恒星，~4 Ga 后与银河系相撞
- 更多（数百~数千星系）组成的体系叫做星系团 (cluster of galaxies)

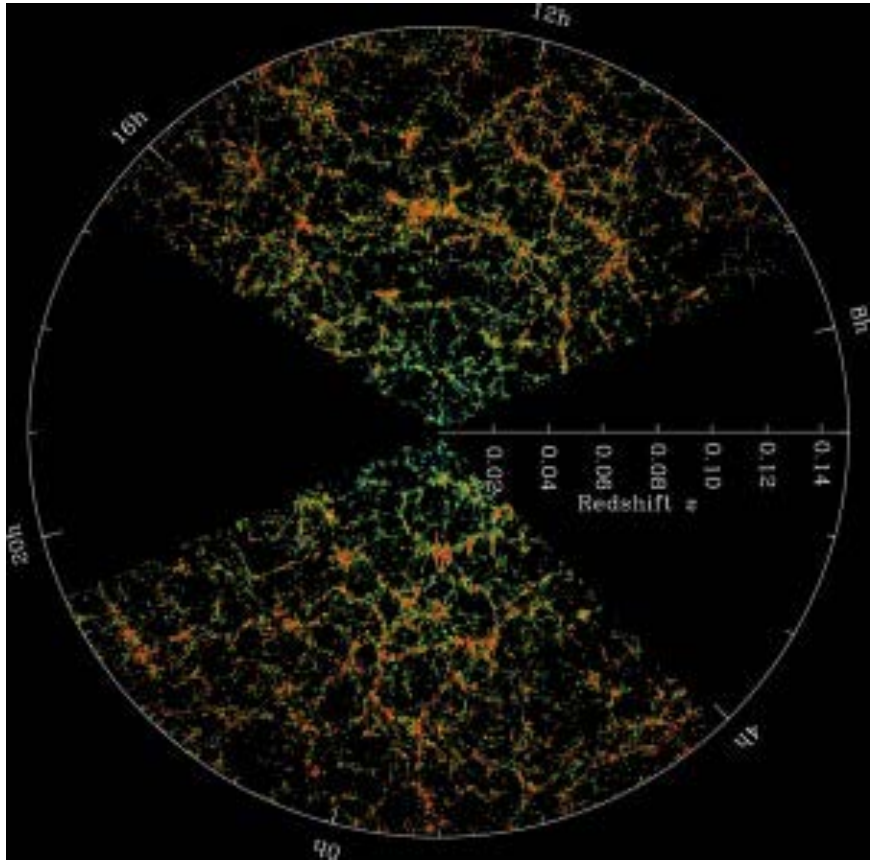
Illustration Sequence of the Milky Way
and Andromeda Galaxy Colliding

NASA, ESA, Z. Levay and R. van der Marel (STScI), T. Hallas, and A. Mellinger ▪ STScI-PRC12-20b

宇宙地图v3: 宇宙大尺度结构



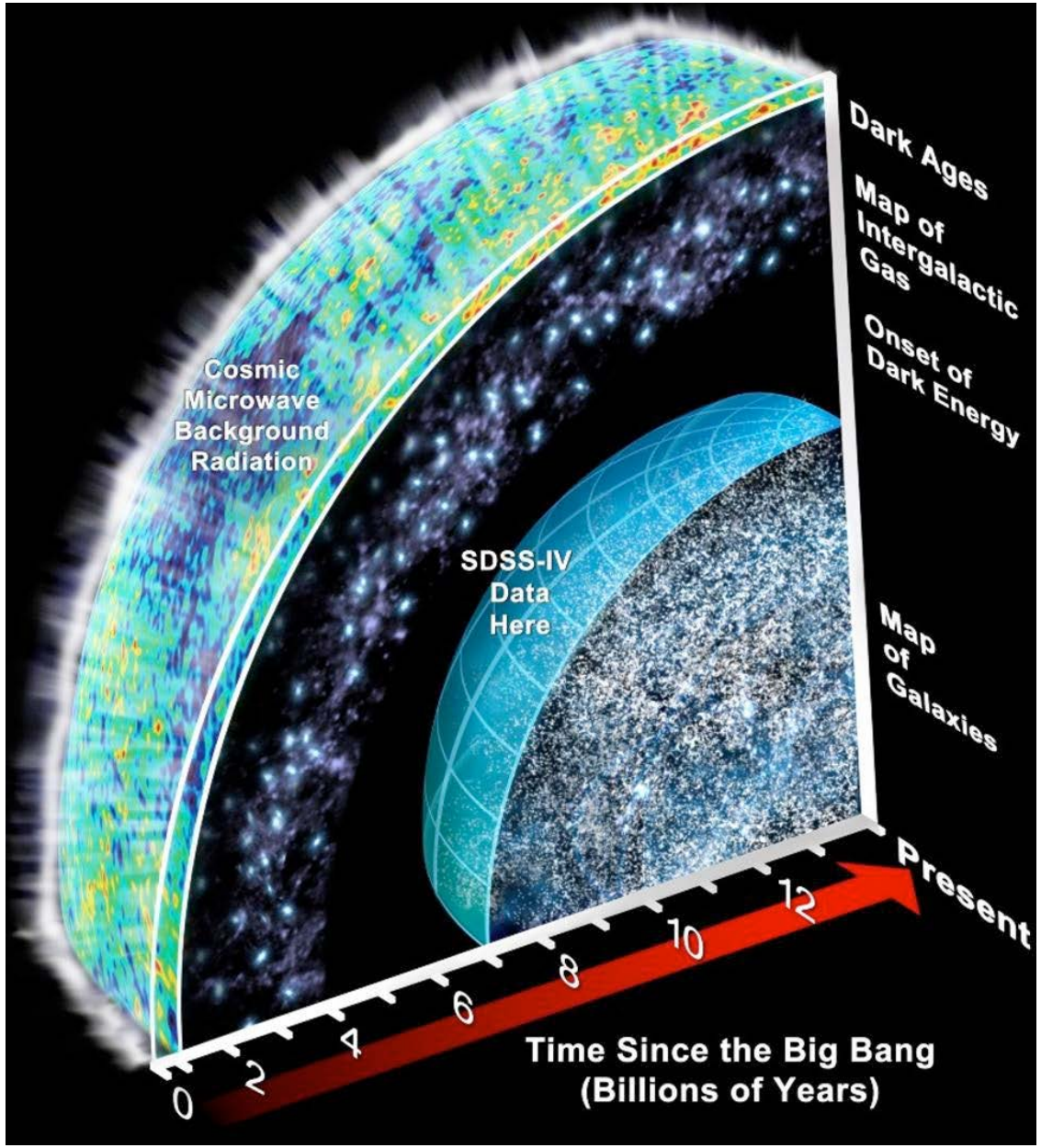
Artist's logarithmic scale conception of the observable universe

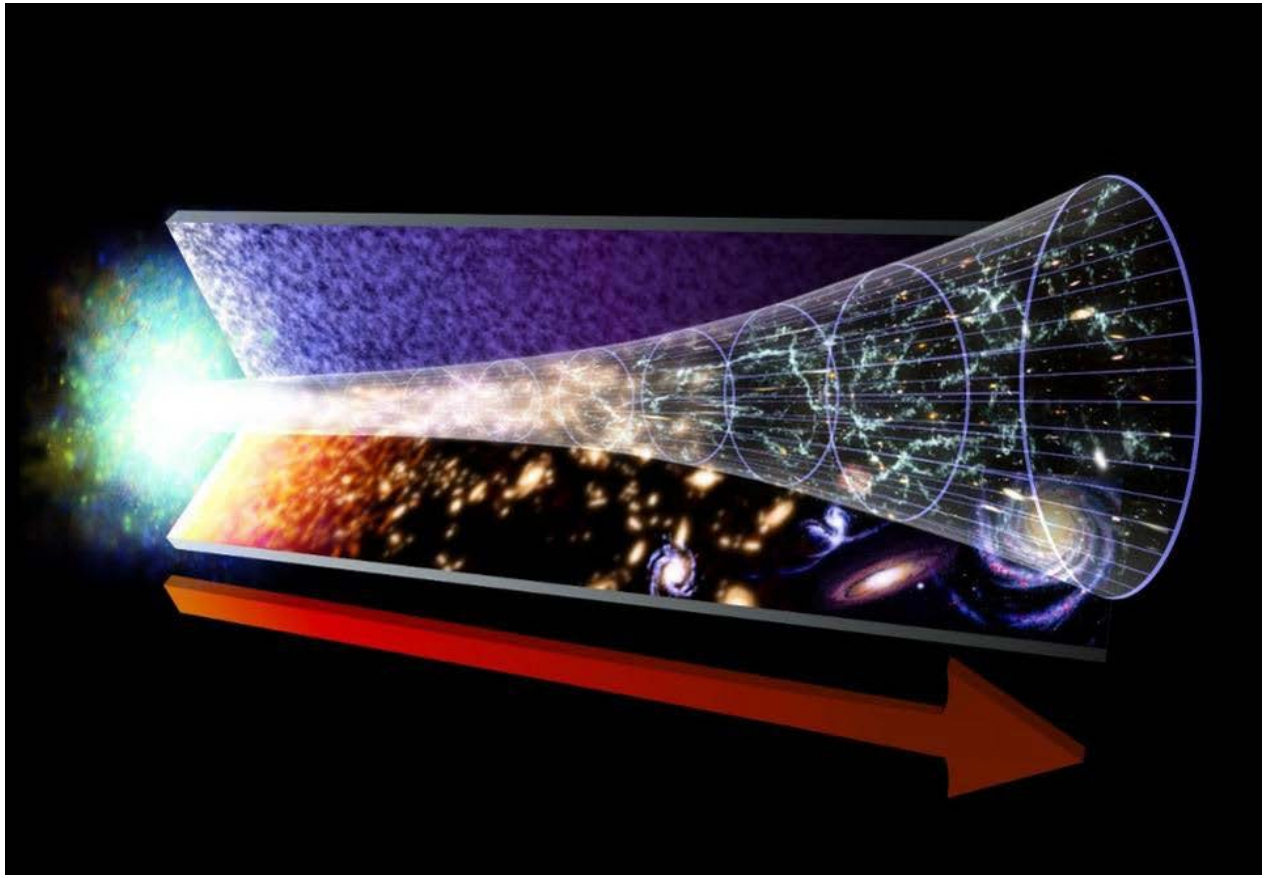


史隆长城

- 巨牆、纖維狀結構和空洞
- End of Greatness浩瀚界限: 结构的组织看起来是跟随着等级制度的模型，以超星系团和纤维状结构的尺度为最上层，再大的似乎就没有连续的结构了(end of “cosmological principal”)~$3x10^8$光年

Observable Universe (~$9x10^{10}$ 光年)





我们在宇宙中的运动

- 步行速度：4 km/h~ 10^{-3} km/s
- 人类跑步最快成绩：100 m/9.58 s =10^{-2} km/s
- 音速 ~ 0.3 km/s
- 未来高铁速度可达　1200 km/h ~ 0.3 km/s
- 飞行器速度 < 3 km/s
- 导弹速度 4–30马赫(音速)< 9 km/s
- 太阳神号　~ 70 km/s

- 地球自转 ~1 km/s
- 太阳系运动速度 ~200 km/s
- 银河系运动速度 ~ 600 km/s
- 本星系群运动速度　600~1000km/

- 光速 ~300,000 km/s

Postulates: 假定

The Postulates of Special Relativity

On June 30, 1905 Einstein formulated the two postulates of special relativity:

1. *The Principle of Relativity*
The laws of physics are the same in all inertial frames of reference.

2. *The Constancy of Speed of Light in Vacuum*
The speed of light in vacuum has the same value *c* in all inertial frames of reference.

Milky Way Galaxy

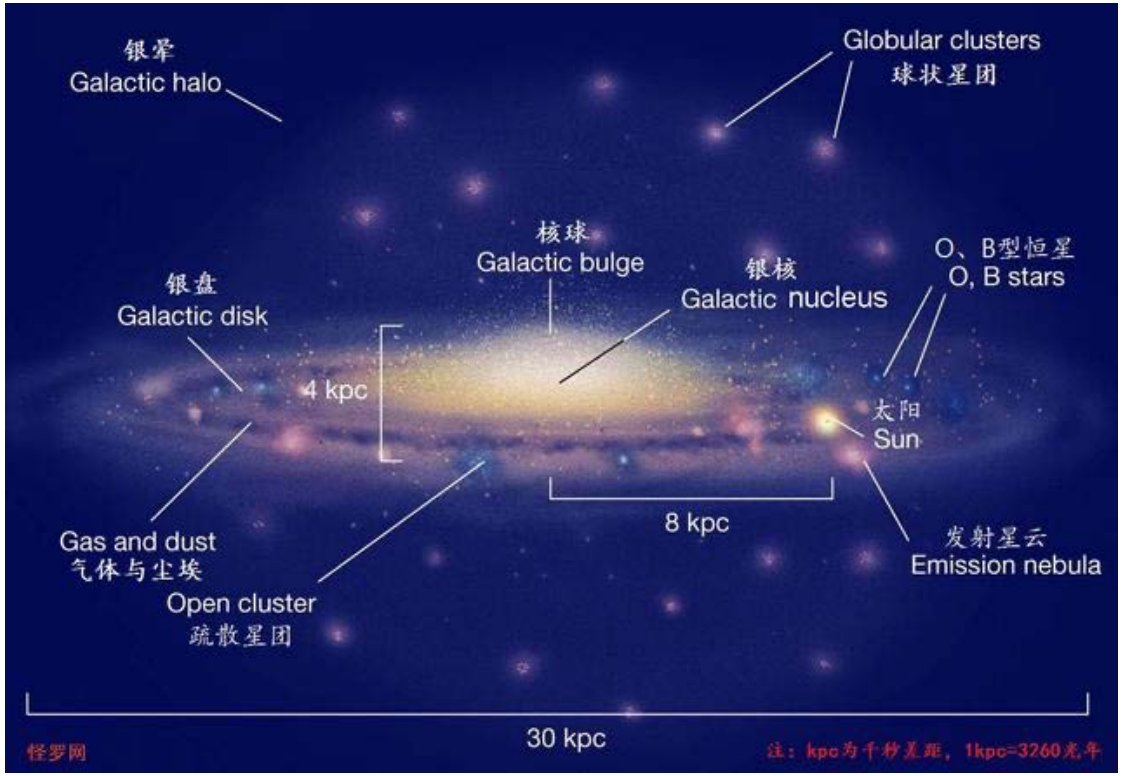
- 尘埃和气体，星云
- 暗物质，黑洞，气泡
- Spectra

银河系

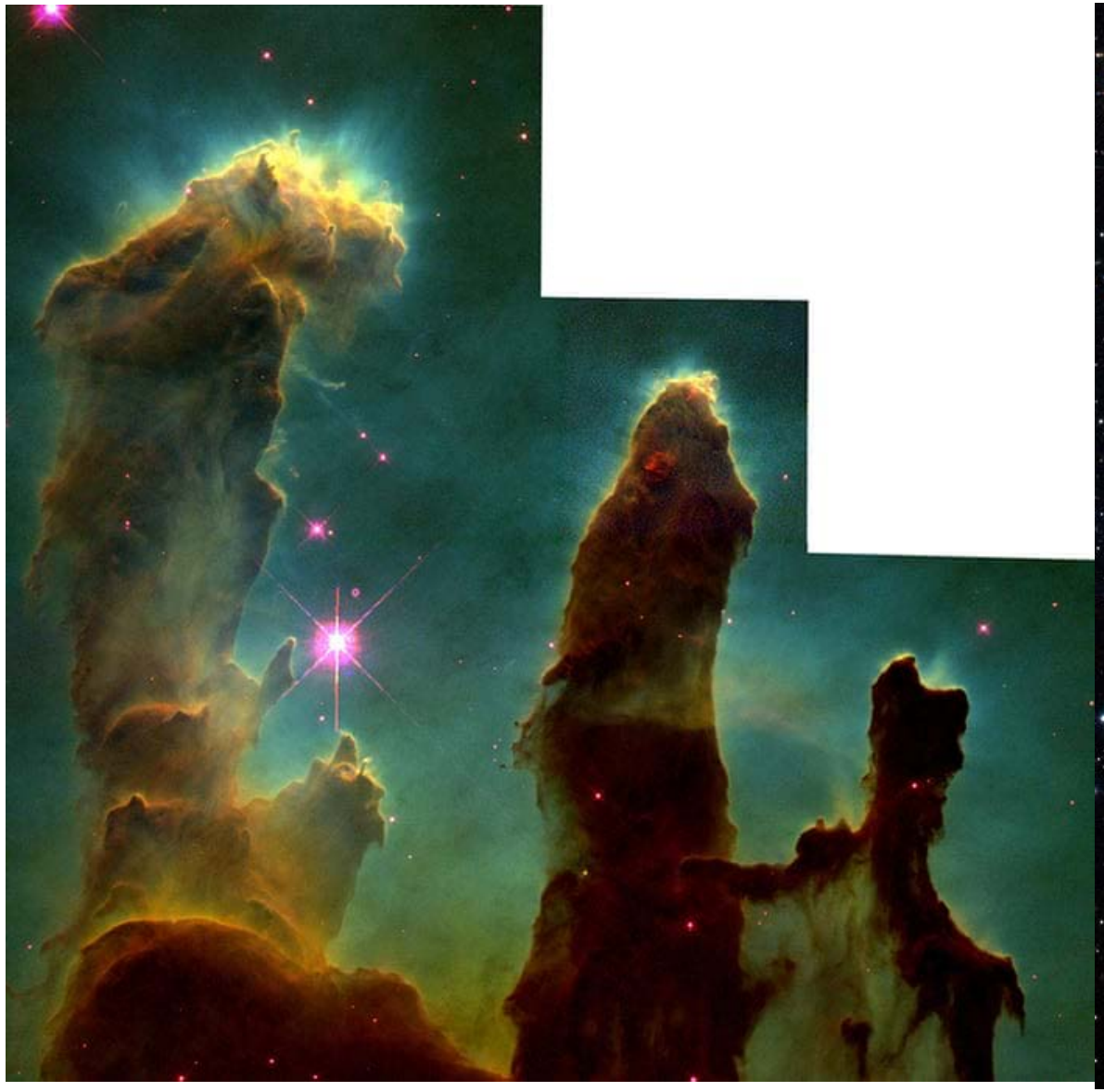
星际介质

- 尘埃和气体（暗黑区域）：吸收光，尤其是短波
- 星云 (Nebula)：发射星云，反射星云

银核：黑洞



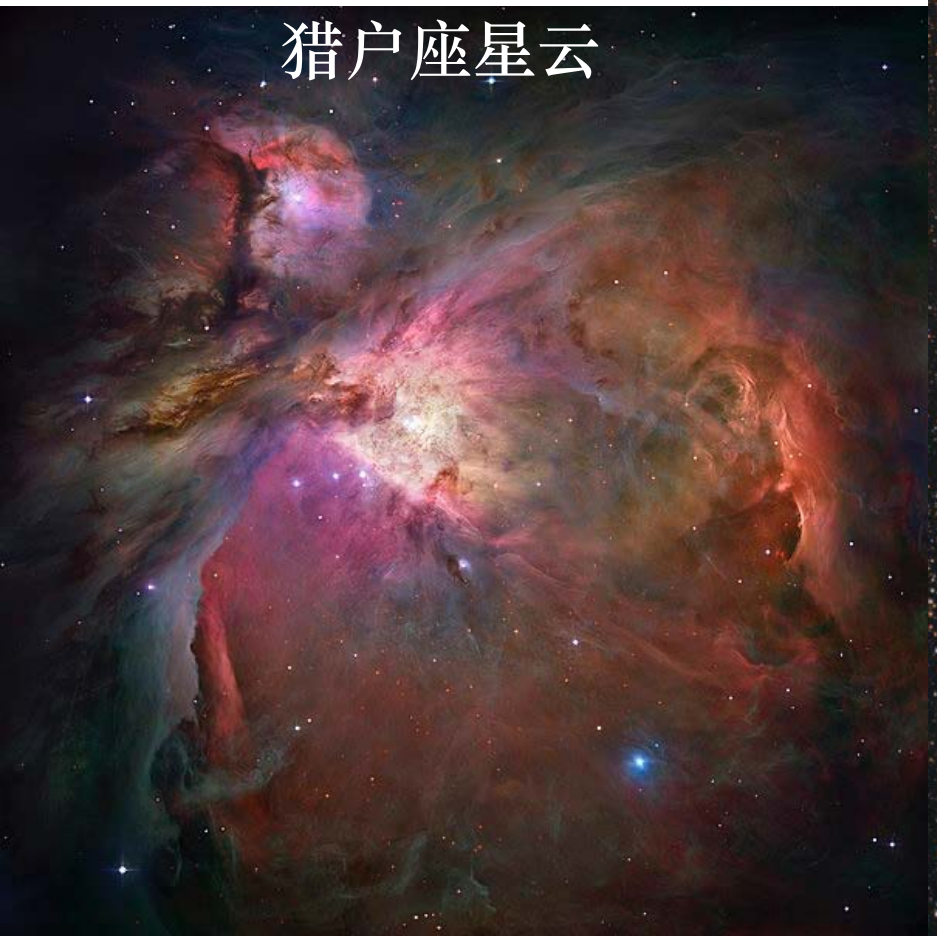
星云：恒星育婴室

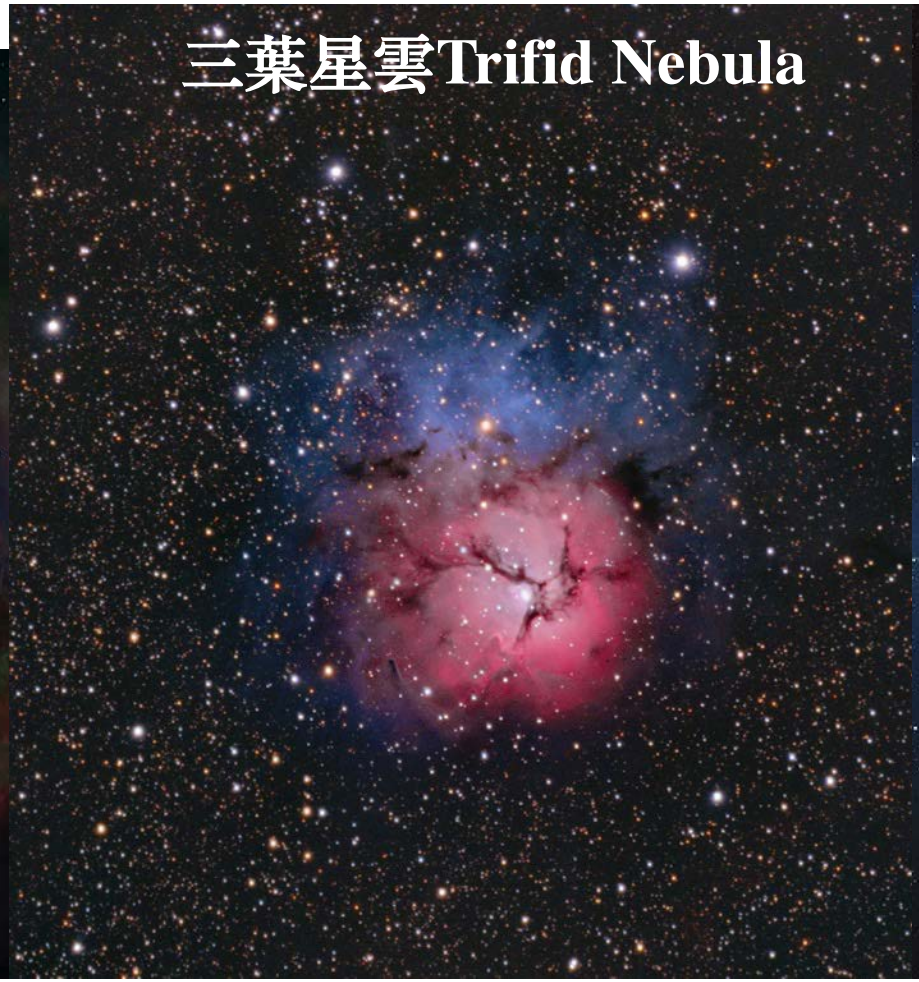


Pillars of Creation, NASA/PA

Credit:NASA, ESA and the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration

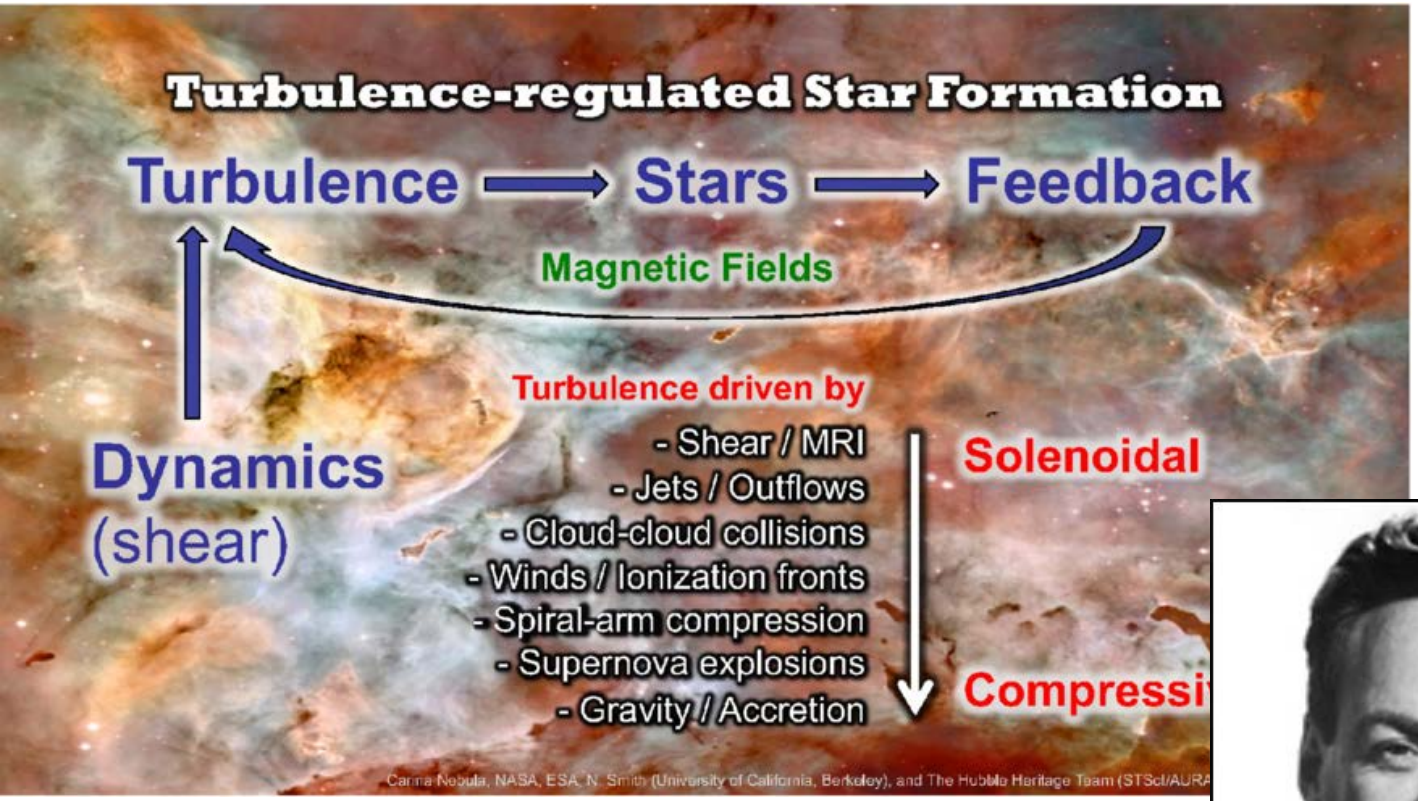
发射星云和反射星云

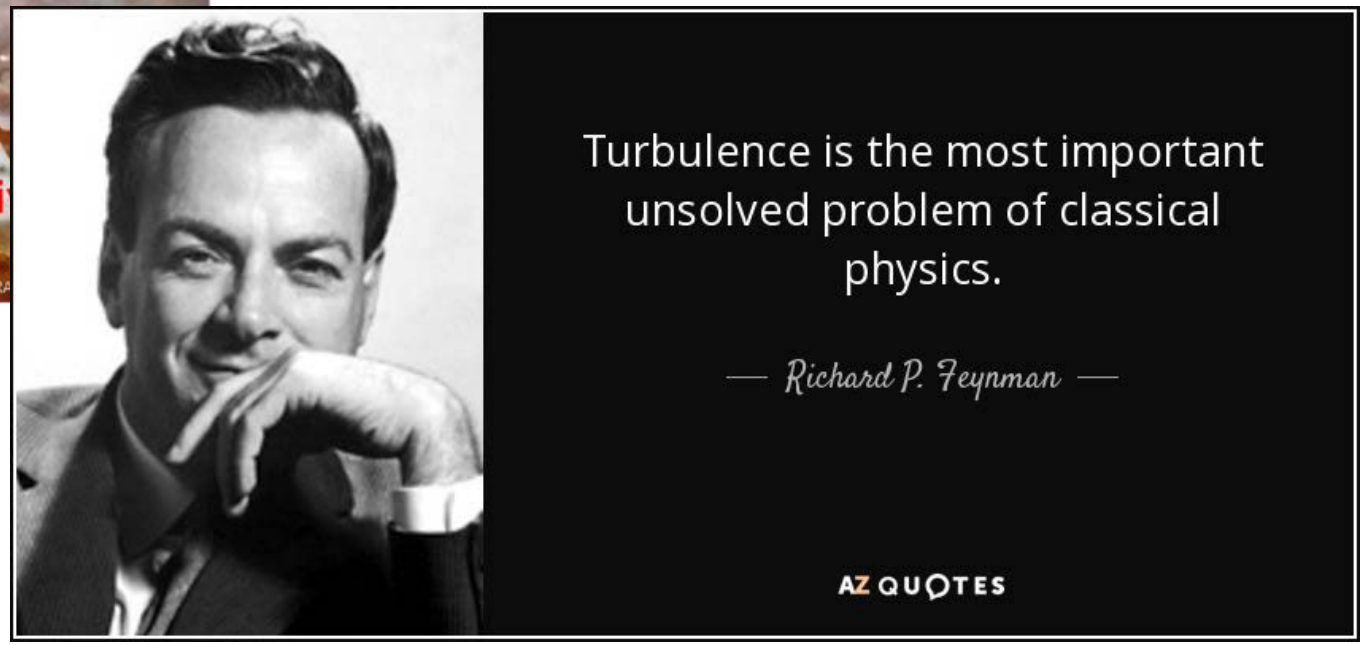




- 红色: 氢原子由n=3 到n = 2 发射光子的颜色
- 绿色: 氧原子
- 蓝色： 蓝色恒星受尘埃反射

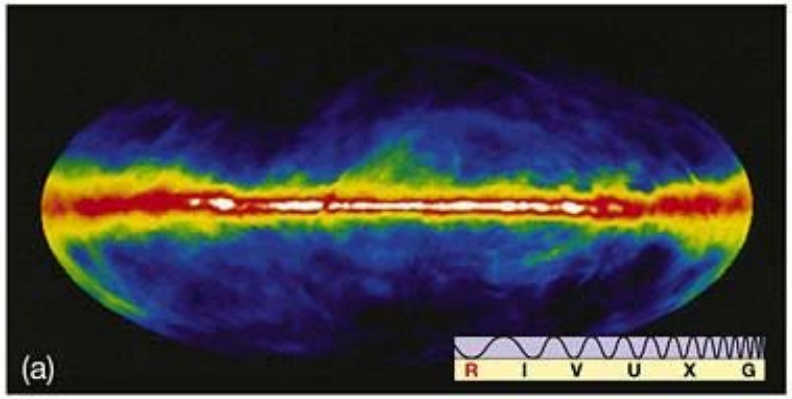
恒星风

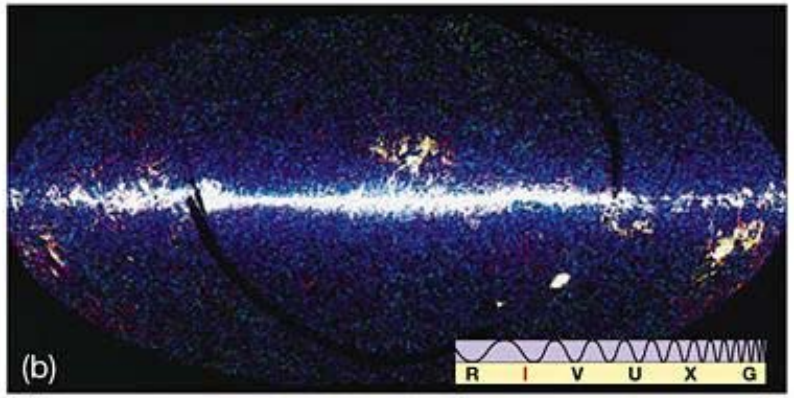


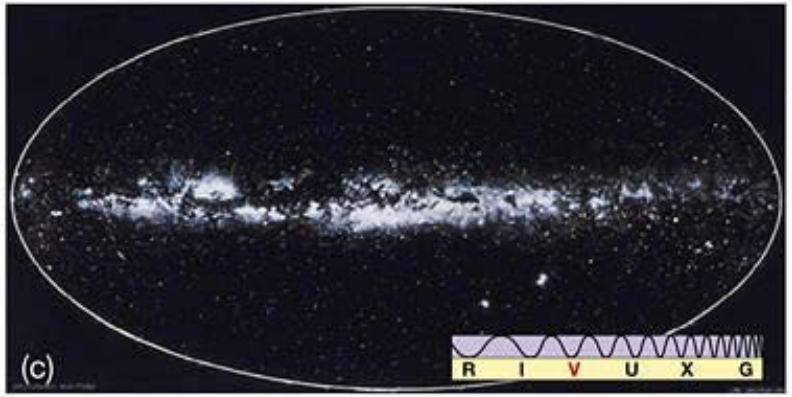


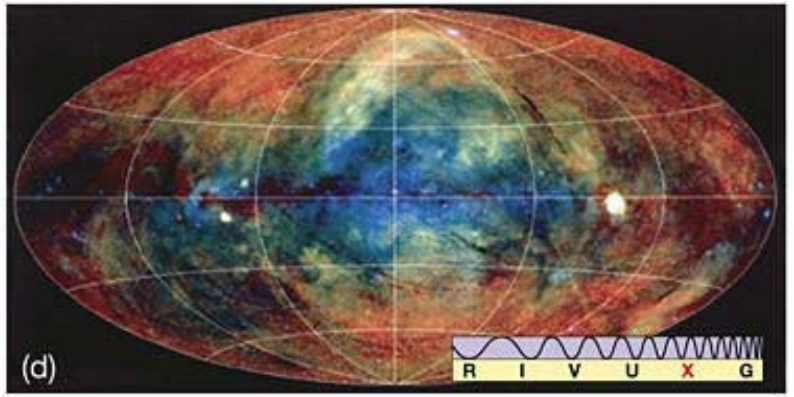
- https://www.mso.anu.edu.au/~chfeder/pubs/brick/brick.html

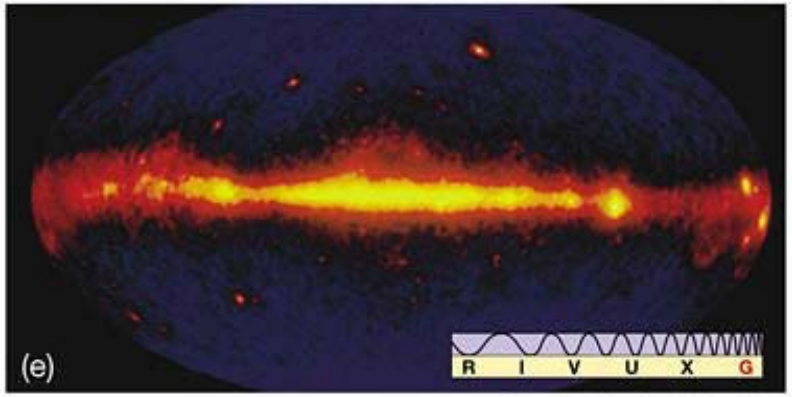
银河系光谱







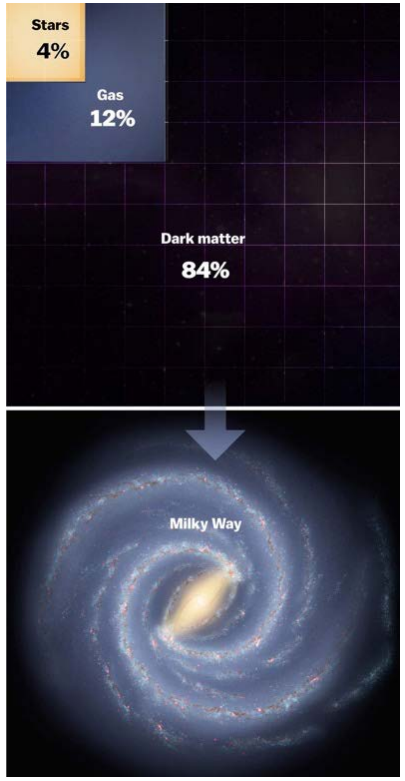


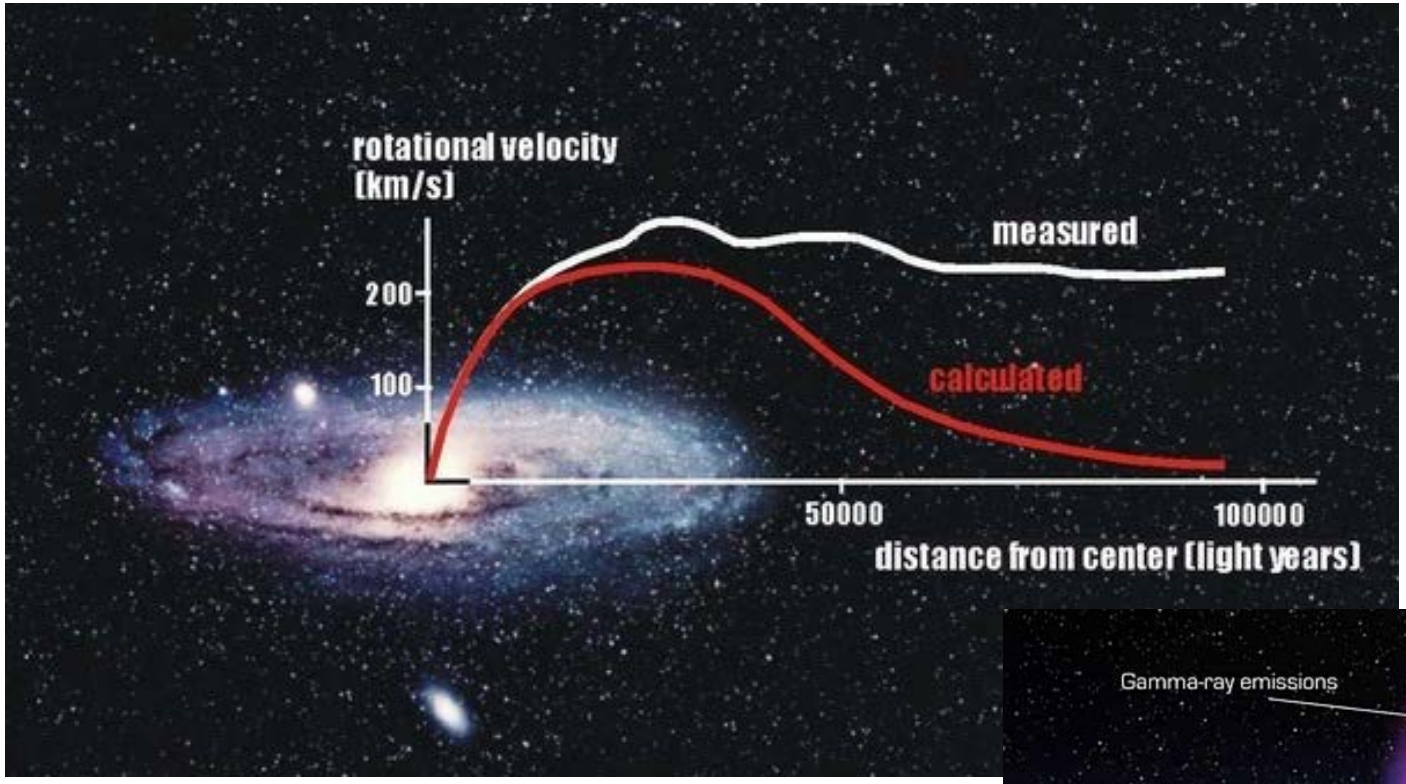


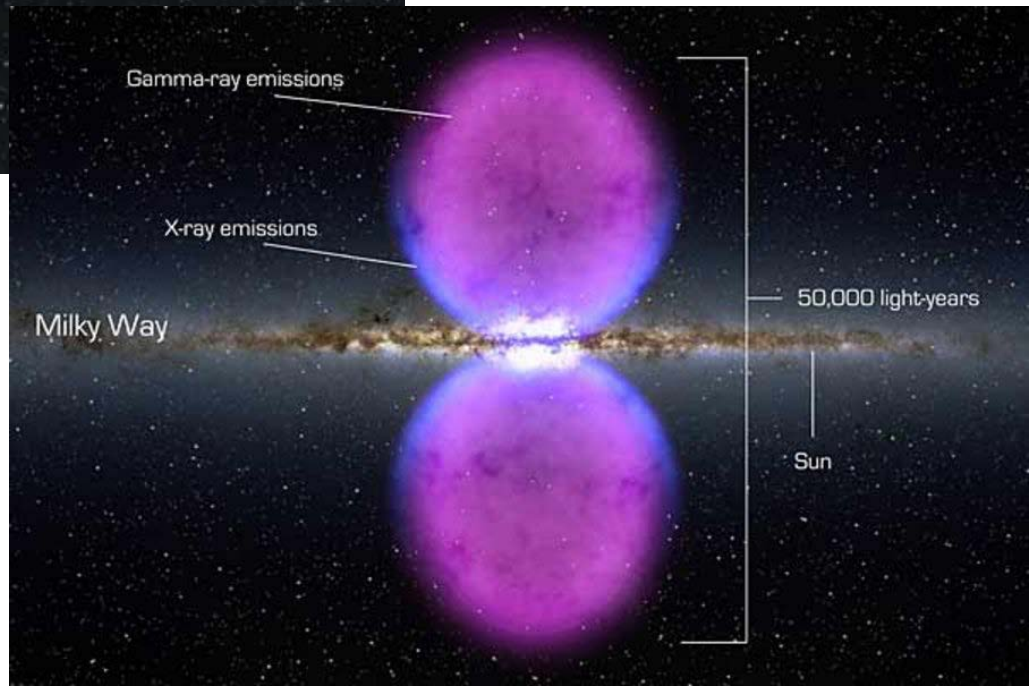
https://www.forbes.com/sites/startswithabang/2019/03/25/what-would-the-milky-way-look-like-if-you-could-see-all-of-its-light/#5add446e1b23

- Radio (无线电): electrons and hydrogen gas
- Infrared: obscured stars
- Visible: billions of stars with light-blocking dust
- Ultra-violet: hot, newly-formed stars
- X-ray: matter gets heated due to collisions, stellar outflows, cataclysmic events, or acceleration from neutron stars or black holes
- Gamma-ray：the highest-energy light from black holes, neutron stars, nova outbursts, high-energy antimatter-driven bubbles, and supernova remnants.

银河系暗物质和气泡

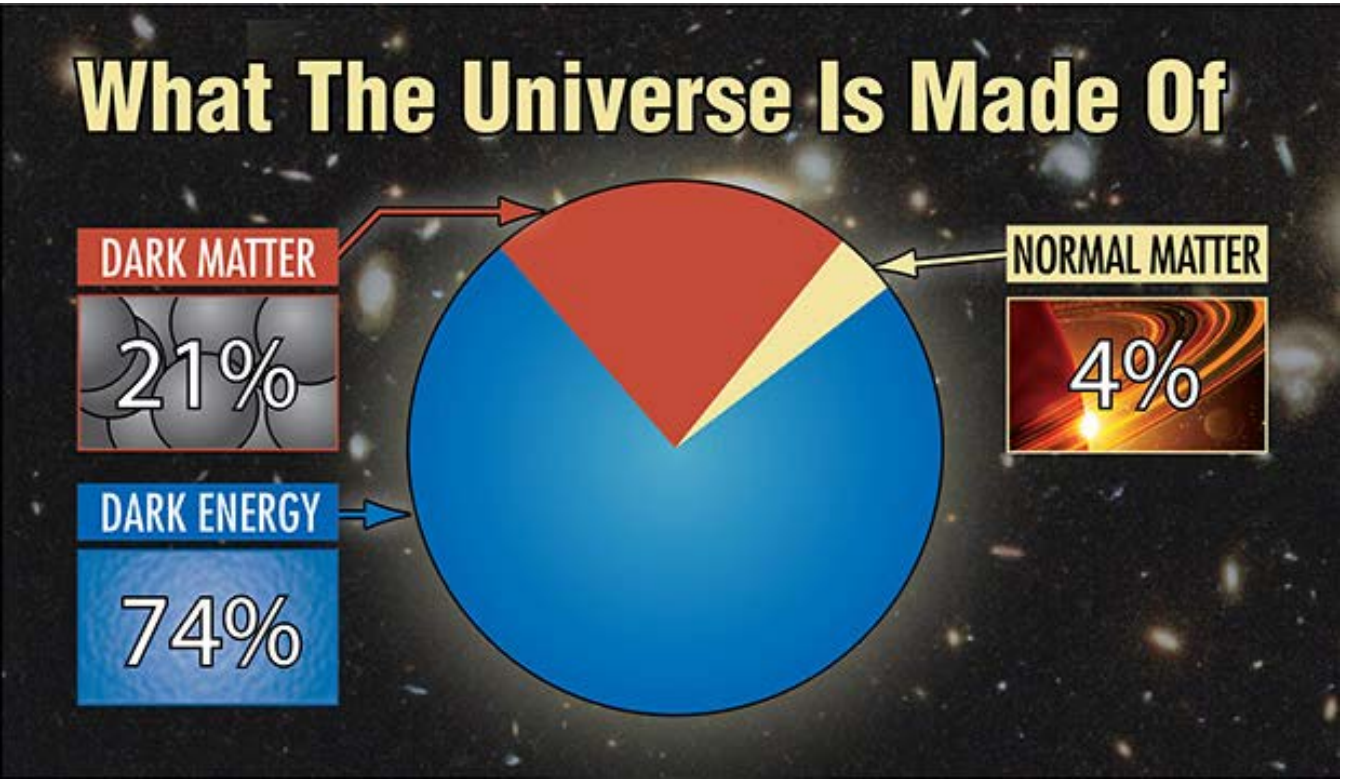


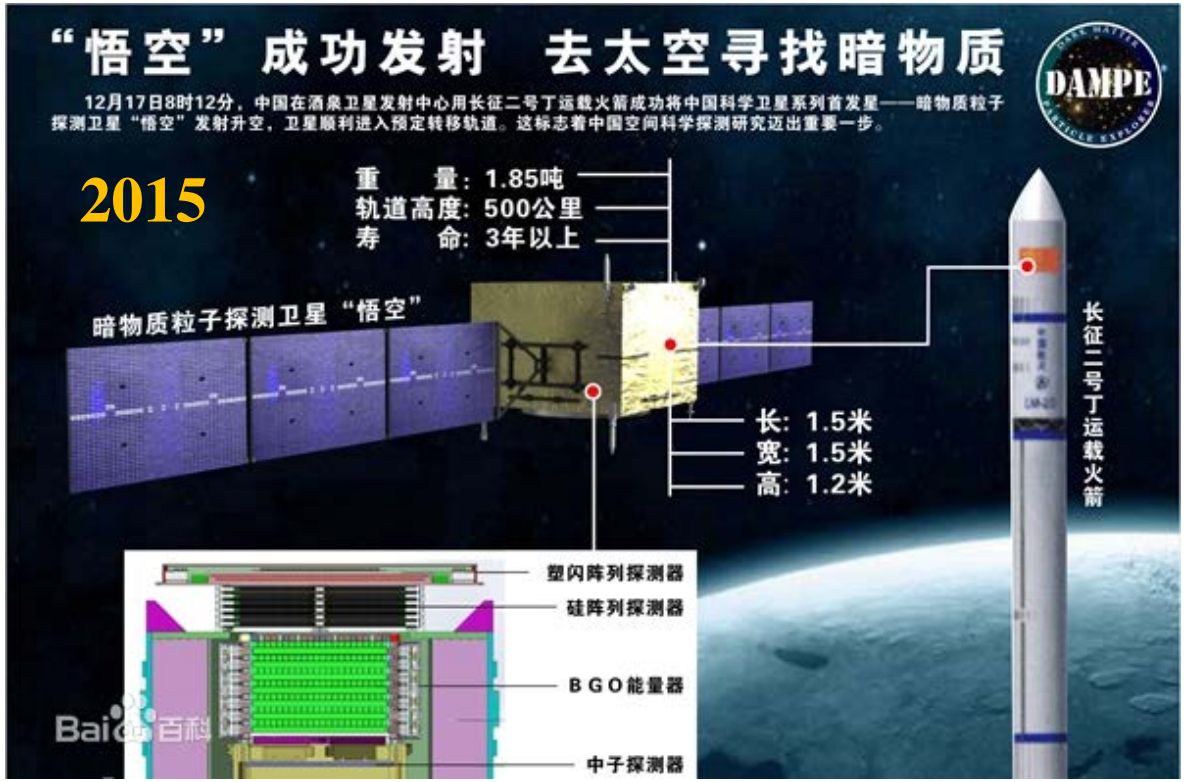




- 暗物质：不與电磁力產生作用的物质，也就是不會吸收、反射或發出光。人们目前只能透过重力产生的效应得知
- The Fermi Bubbles：two enormous orbs of gas and cosmic rays that tower over the Milky Way, covering a region roughly as large as the galaxy itself. These giant space bubbles may be fueled by a strong outflow of matter from the center of the Milky Way.

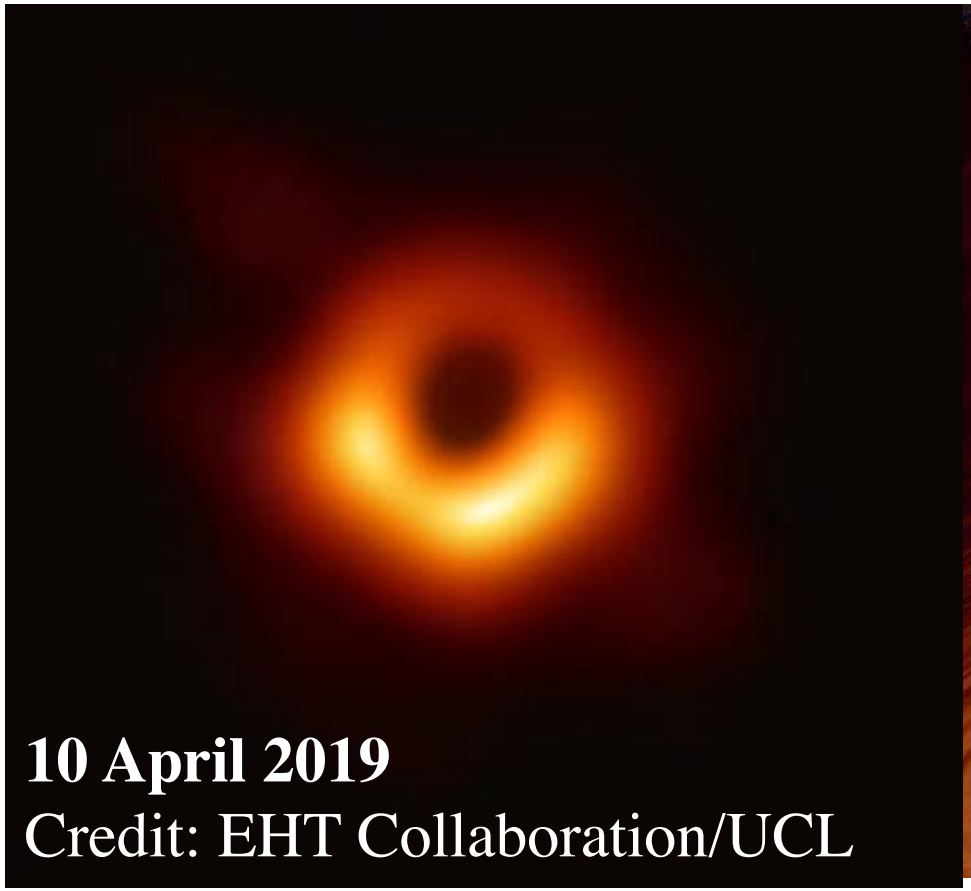
Hunt for Dark Matter & Energy



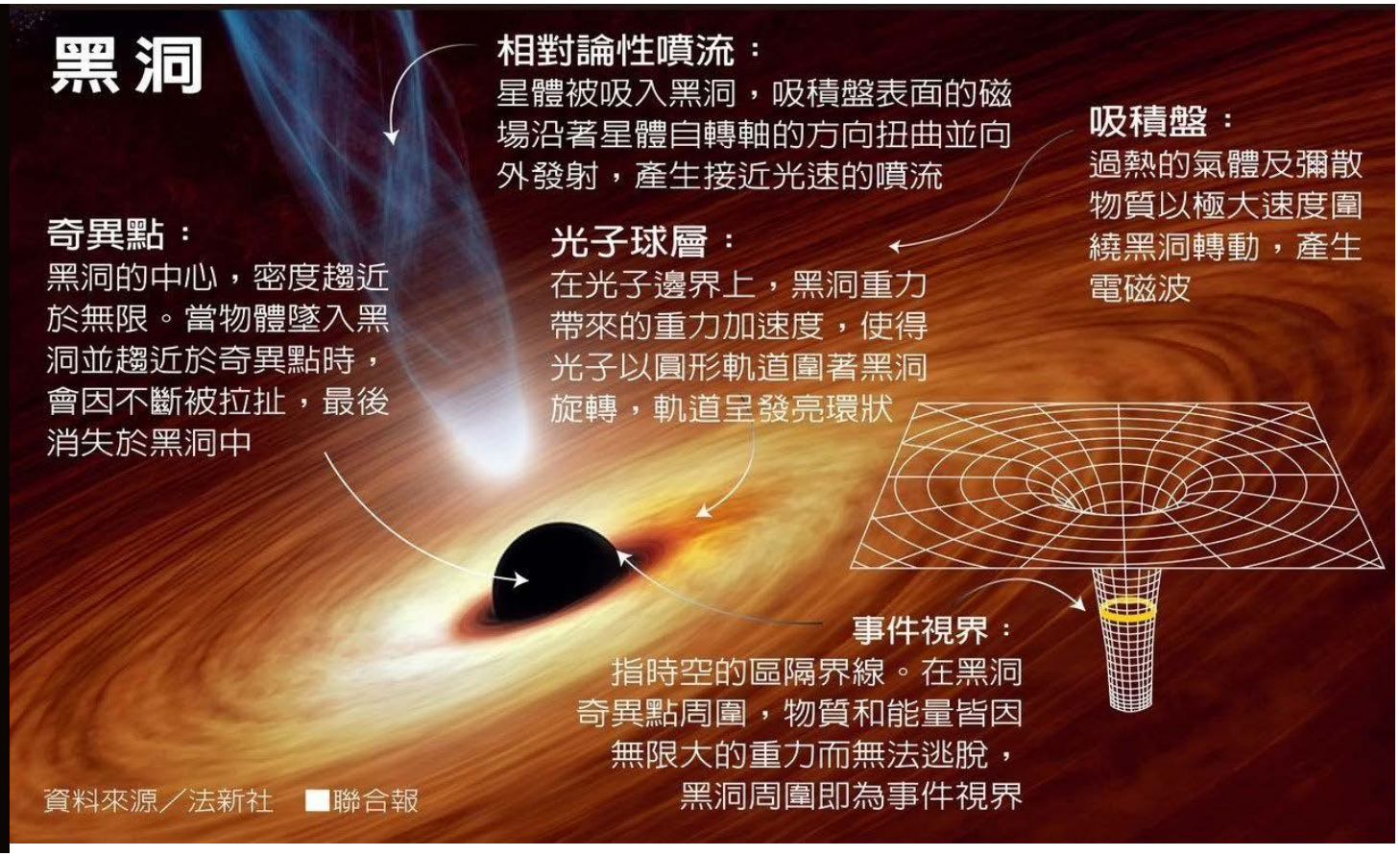


- 暗物质和暗能量 物理学天空这两朵乌云何时才能消散
- 杨振宁：大型对撞机盛宴已过，从30年前开始就已走在末路上
- 如果大型对撞机不该建，那么建什么对中国科技更好？ | 科技袁人
- The International Hunt for Dark Energy Is On, Here’s What’s Coming

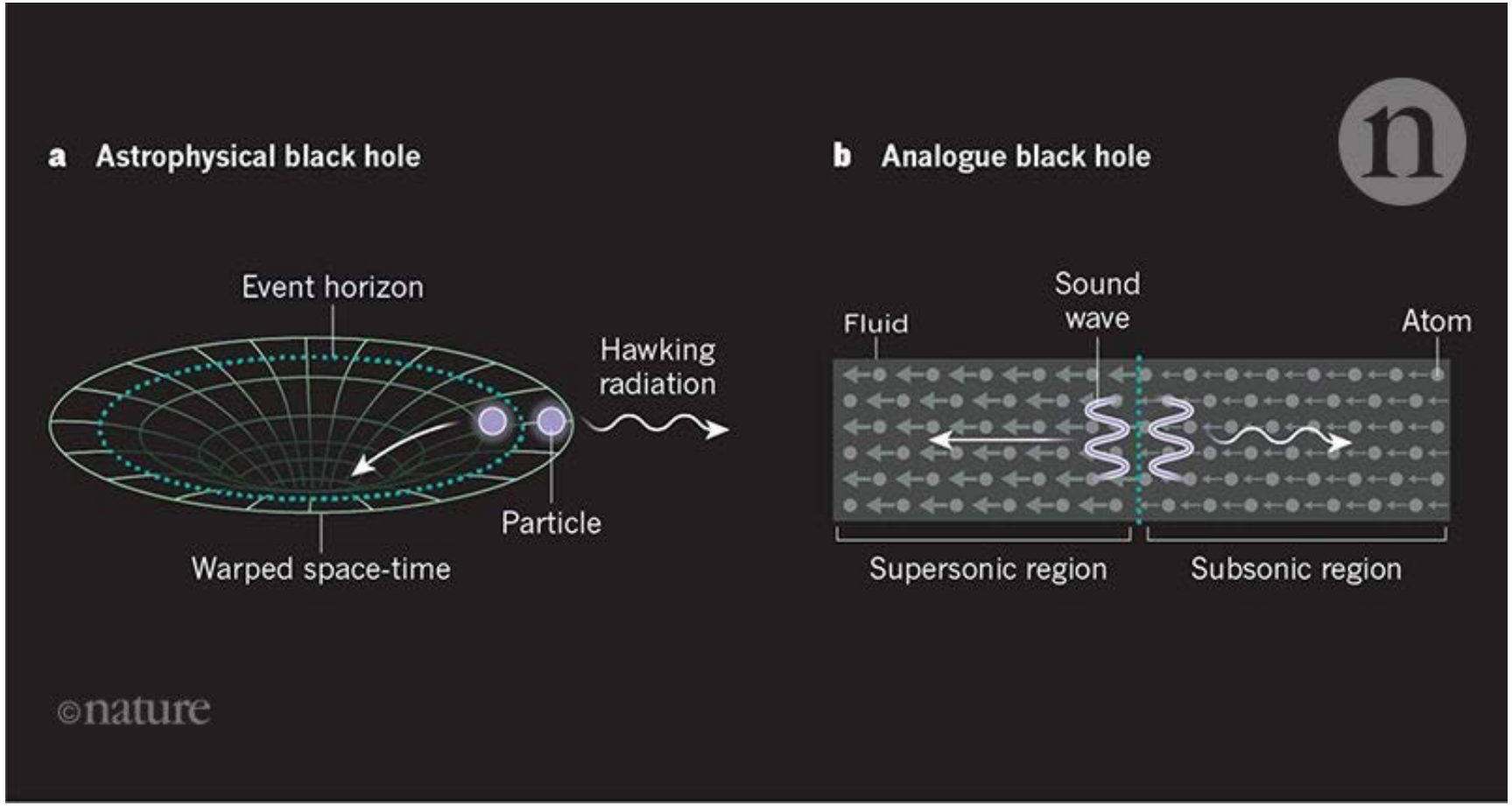
黑洞



10 April 2019
Credit: EHT Collaboration/UCL



霍金辐射（ 1974 ）



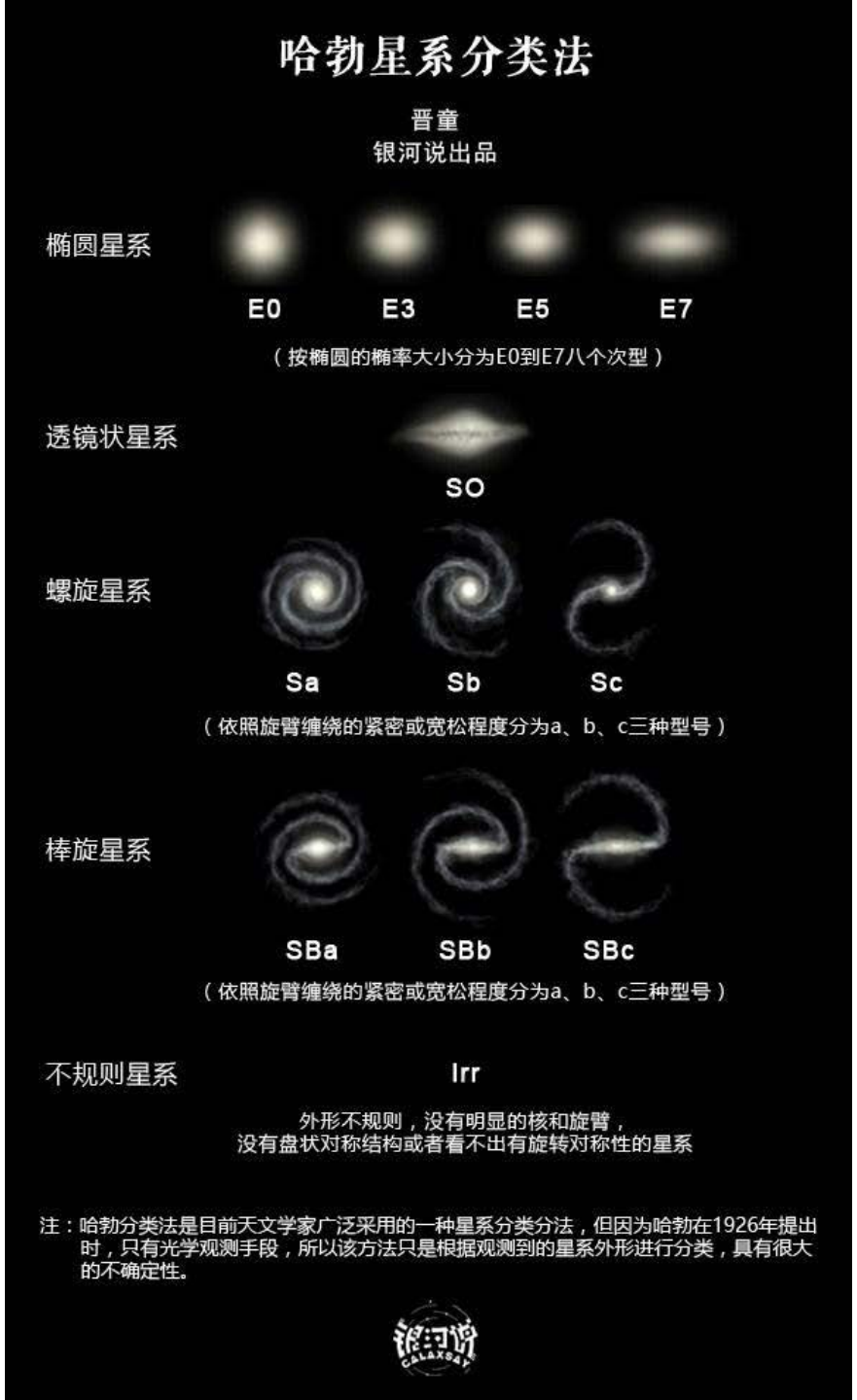
- 霍金輻射解释了黑洞蒸散的現象，但是仍未被實際觀測到
- 理论概述：绝对真空违反了量子力学中的测不准原理，所以并不存在。当空间趋向绝对真空的过程中会產生虚粒子對，两个粒子對撞后又会消失，这样即不会违反量子力学，也不会违反物质守恒。當這種量子現象發生在黑洞的视界邊緣，视界之外的虚粒子因为在视界之外，所以可以被观测到，从而变为实粒子，而视界之内的虚粒子因为在视界之内，所以会被黑洞吞噬，不会被观察到。因为视界之外的粒子是带有质量的真实粒子，由质量和能量守恒定律，视界之内被黑洞吞噬的粒子有负质量，所以黑洞的质量會因為這樣的作用而減少。从外界看来，黑洞好像在慢慢蒸发。

Galaxy and Universe

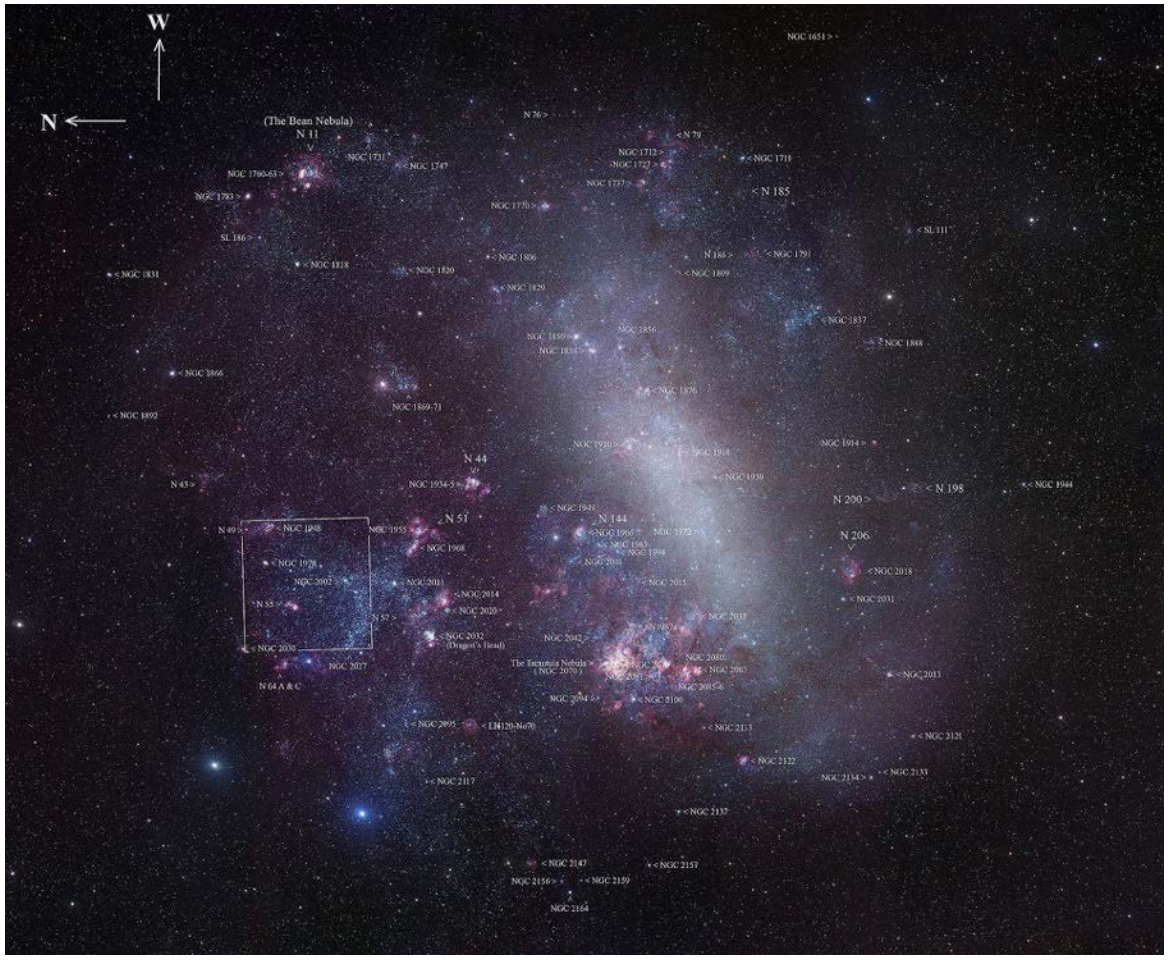
- Types of Galaxies
- Measure Distance
- Big Bang Theory & CMB

星系

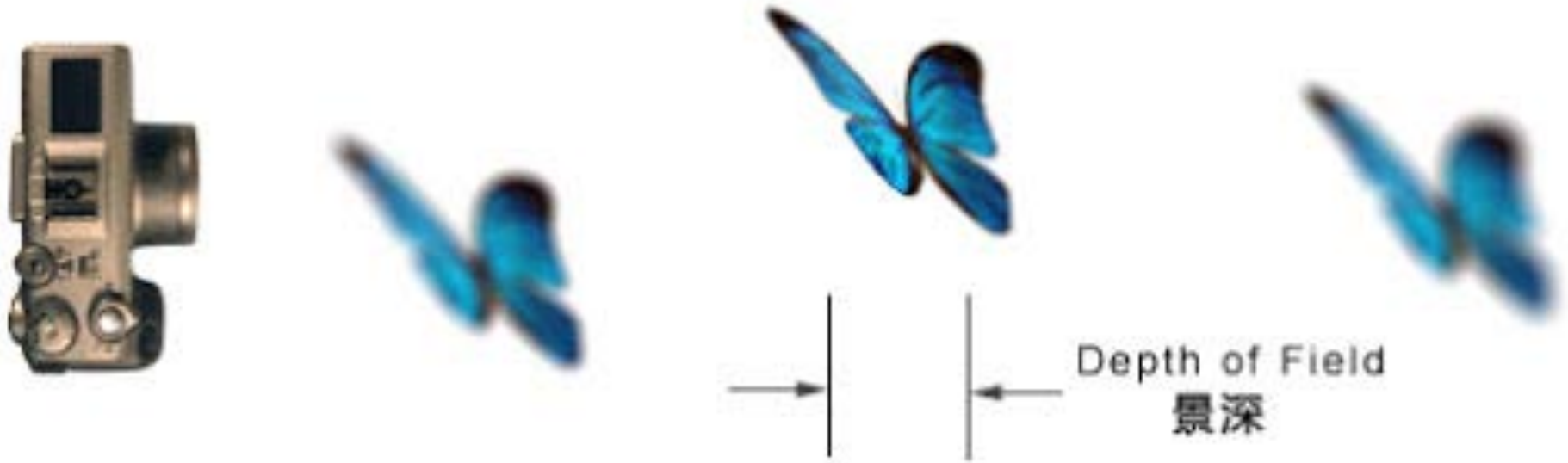
- **25 September 2012**
- Called the eXtreme Deep Field, or XDF, this photo was assembled by combining 10 years of Hubble space telescope photographs taken of a patch of sky at the centre of the original Hubble Ultra Deep Field. By collecting faint light over many hours of observation, the telescope revealed thousands of galaxies, both nearby and very distant, making it the deepest image of the universe ever taken at that time
- Photograph: Hubble space telescope/Nasa/ESA



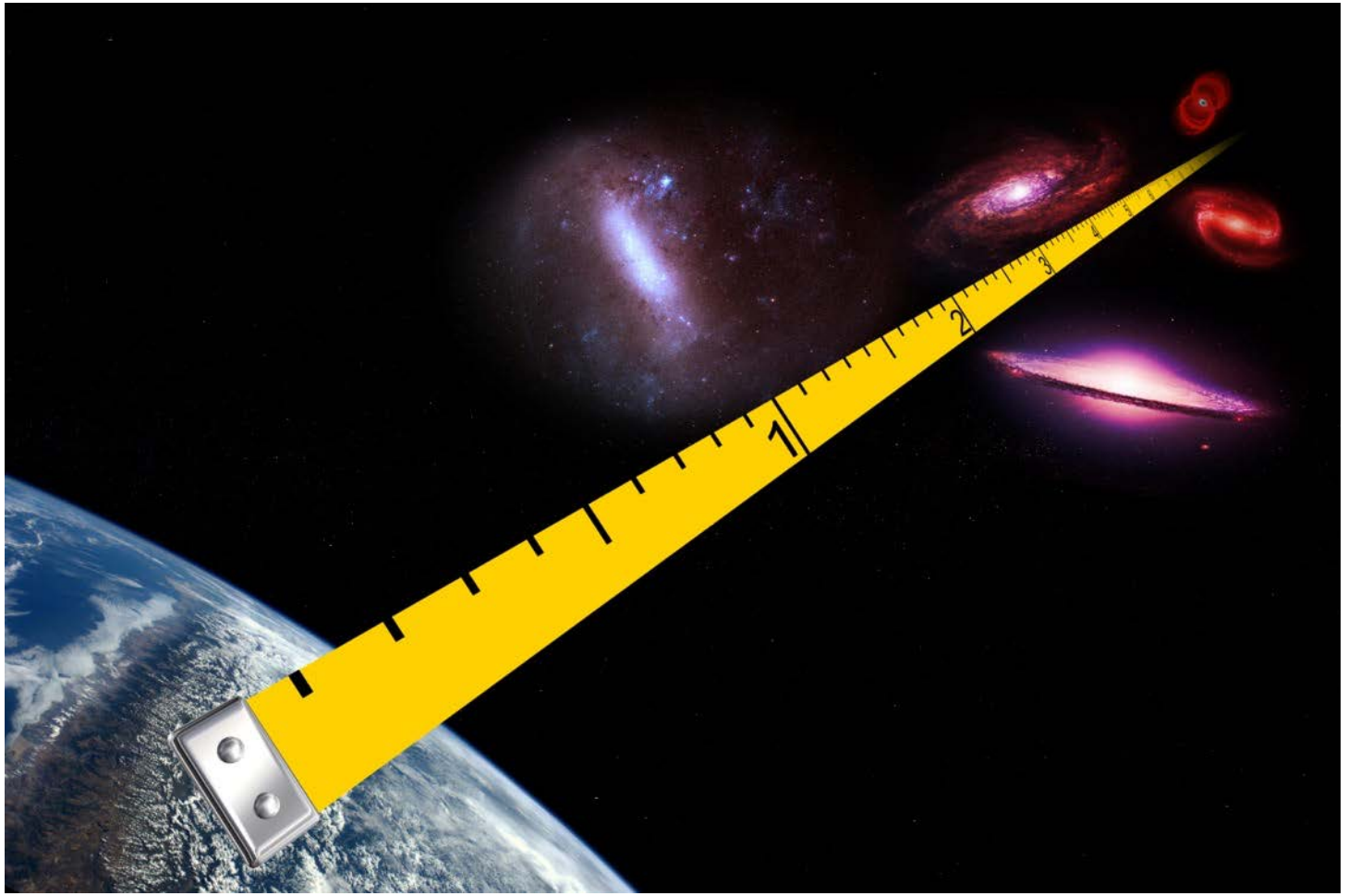
- 螺旋星系（仙女座 - 蓝移，风车星系）
- 椭圆星系（英仙座星系团）
- 不规则星系（大麦哲伦星系）



星空摄影：
如何区别较近的星云和较远的星系？



测量遥远星系的距离： cosmic distance ladder



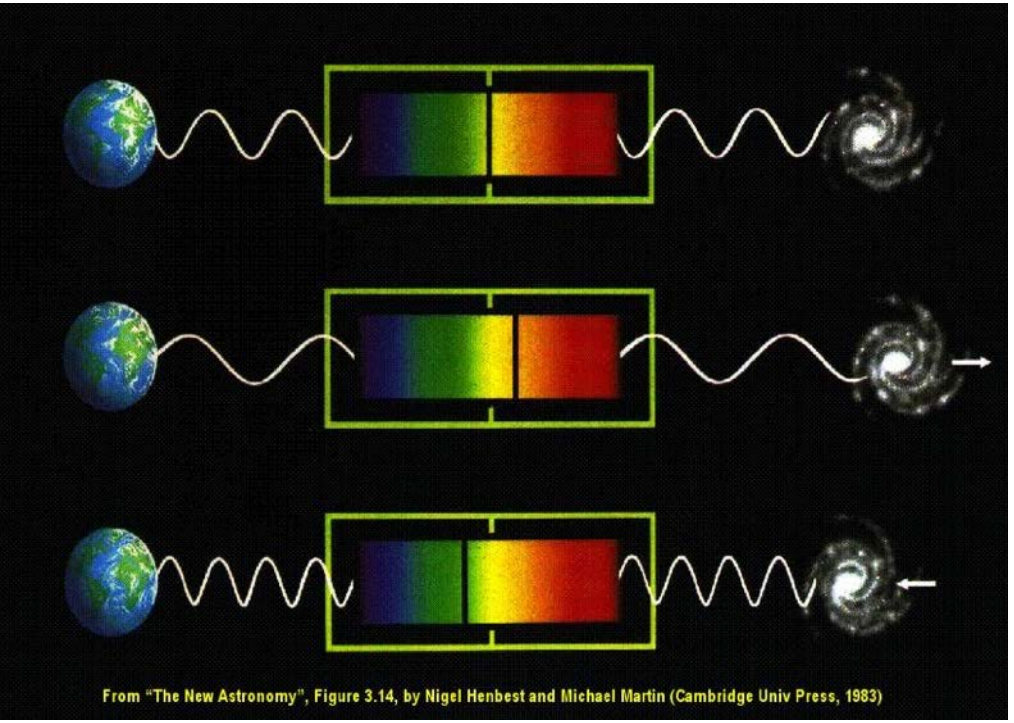
Recall: 1. 视差法测距

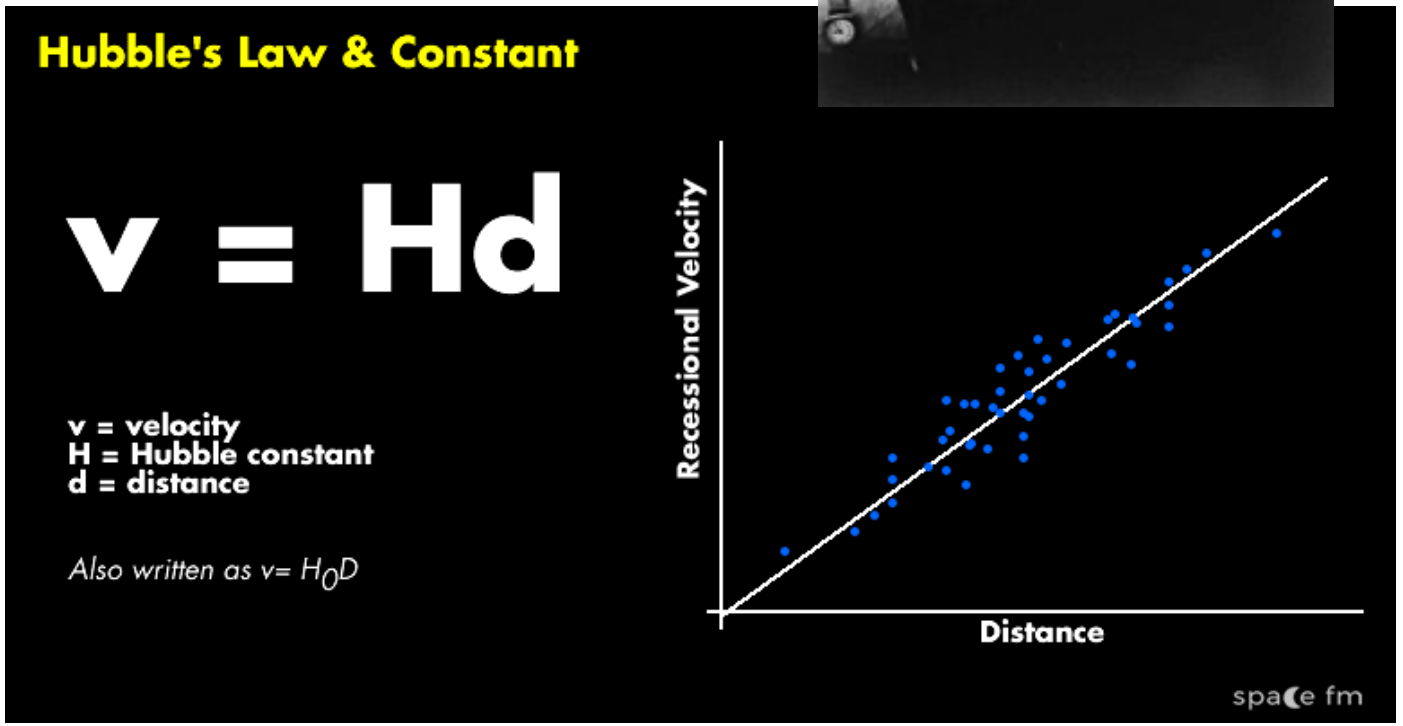
2.HR 图：对于主序星，通过恒星颜色/光谱-> 表面温度， 结合视星等 -> 距离

More info: https://www.slideshare.net/embeds/cosmic-distance-ladder

哈勃定律(1929)测距

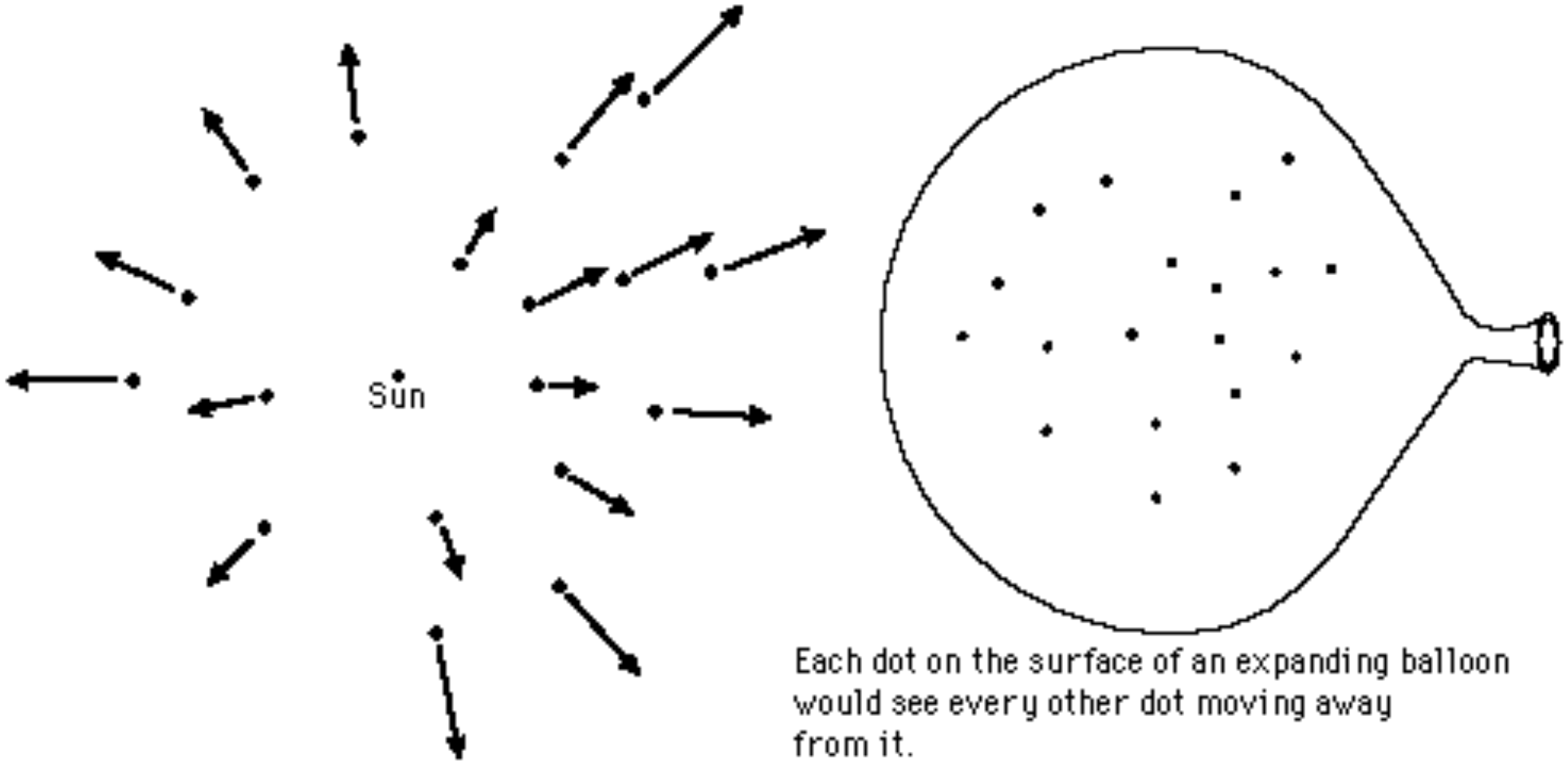
光谱红移：多普勒效应





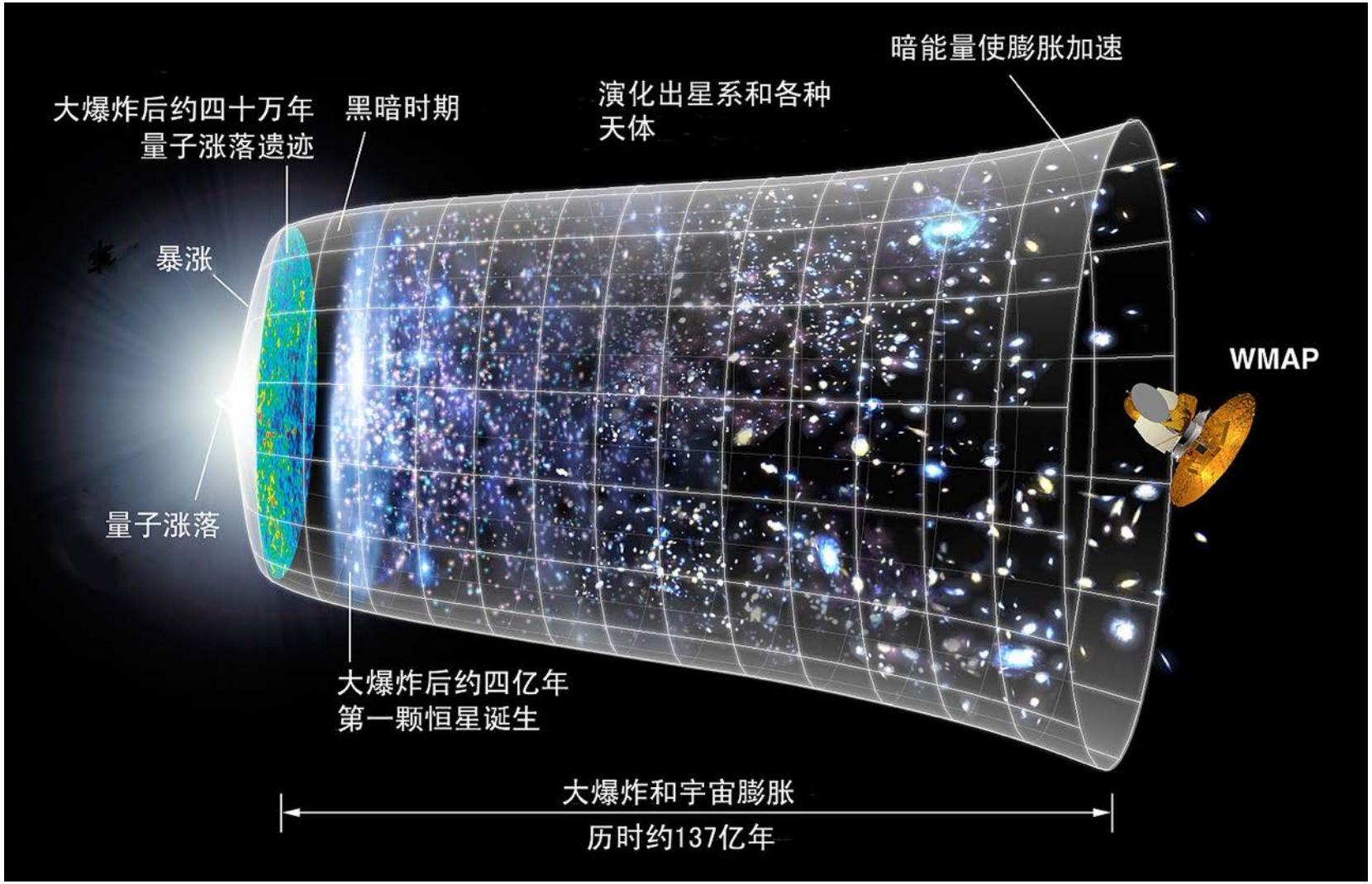
- V 由光谱移动量给出

膨胀的宇宙



http://ummalqura-phy.com/HYPER1/hubble.html

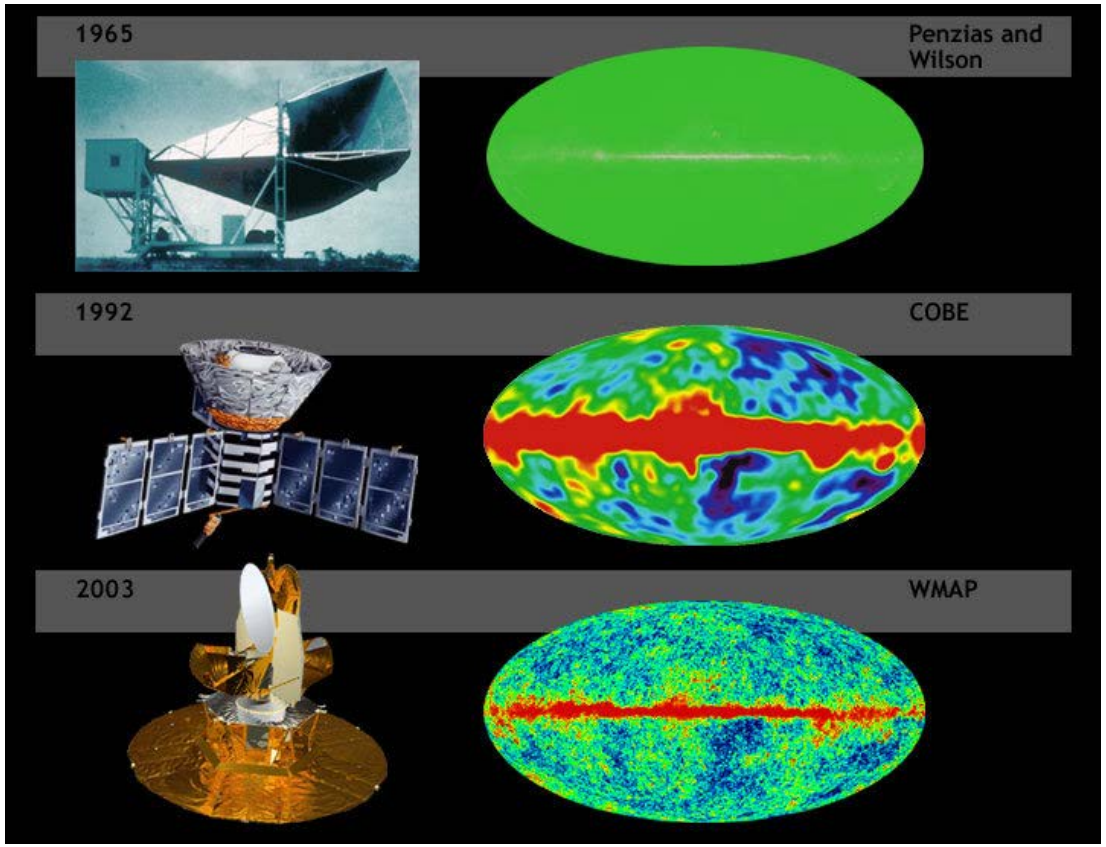
Big Bang Theory

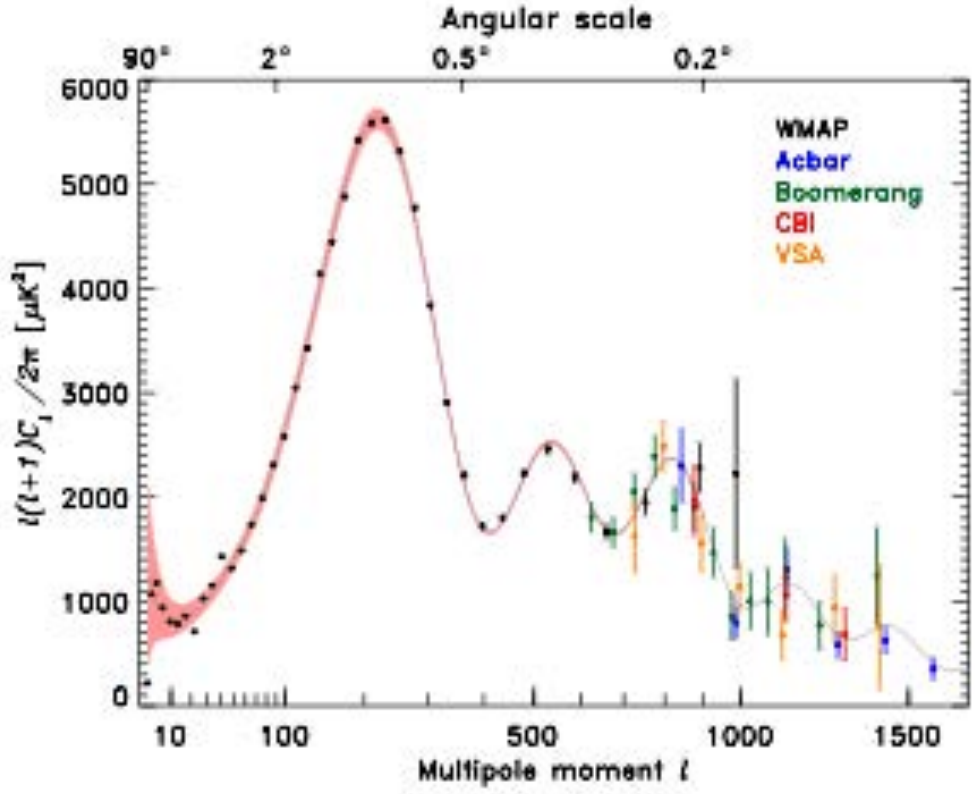


- 宇宙的年龄是13.8 Ga
- 宇宙早期轻元素产生
- 宇宙冷却到3,000 K 时，自由电子和质子结合成为H原子，光子（波长1微米）可以在宇宙中通行
- 之后这些光子随着宇宙膨胀而波长变长到 1 mm (微波波段)，即宇宙微波背景辐射

大爆炸理论的重大胜利：宇宙微波背景辐射(CMB)

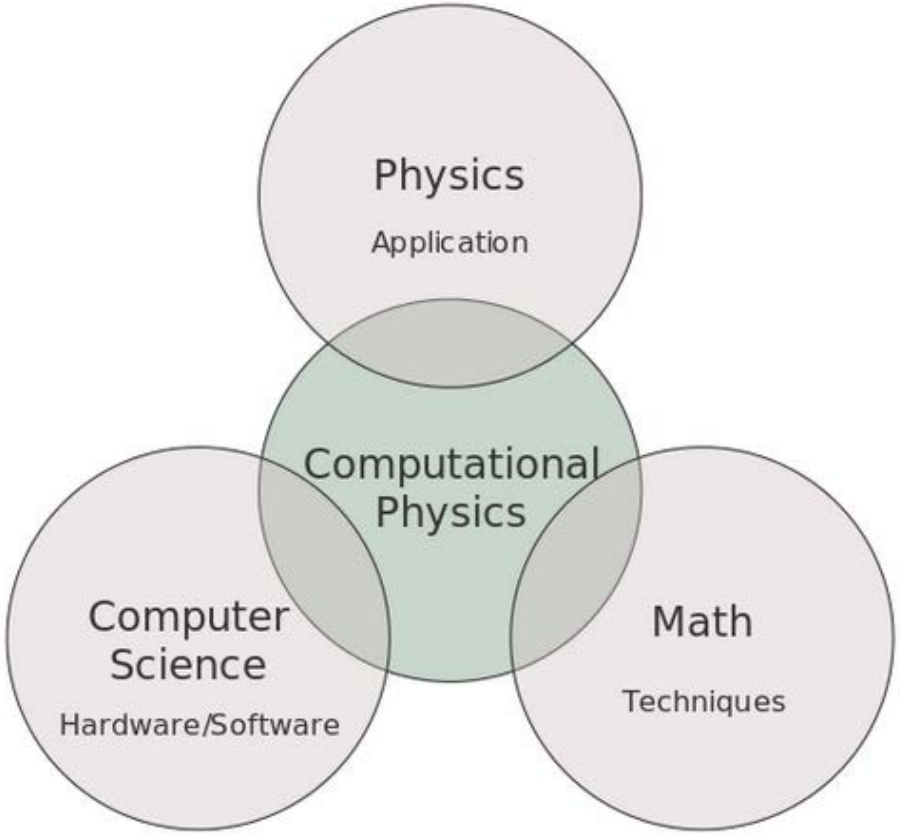
- 1948: 拉爾夫·阿爾菲，羅伯特·赫爾曼首次預測
- 1965年: 阿諾·彭齊亞斯和羅伯特·威爾遜測量溫度約為3 K。羅伯特·迪克，P.J.E.皮布爾斯，P.G.Roll及威爾金森解釋這種輻射是 Big Bang 的印記。
- 特徵和絕對溫標2.725K的黑體輻射相同。頻率屬於微波範圍. 天空中不同角度的光譜輻射包含相同的各向異性，或不規則性，隨區域大小變化。

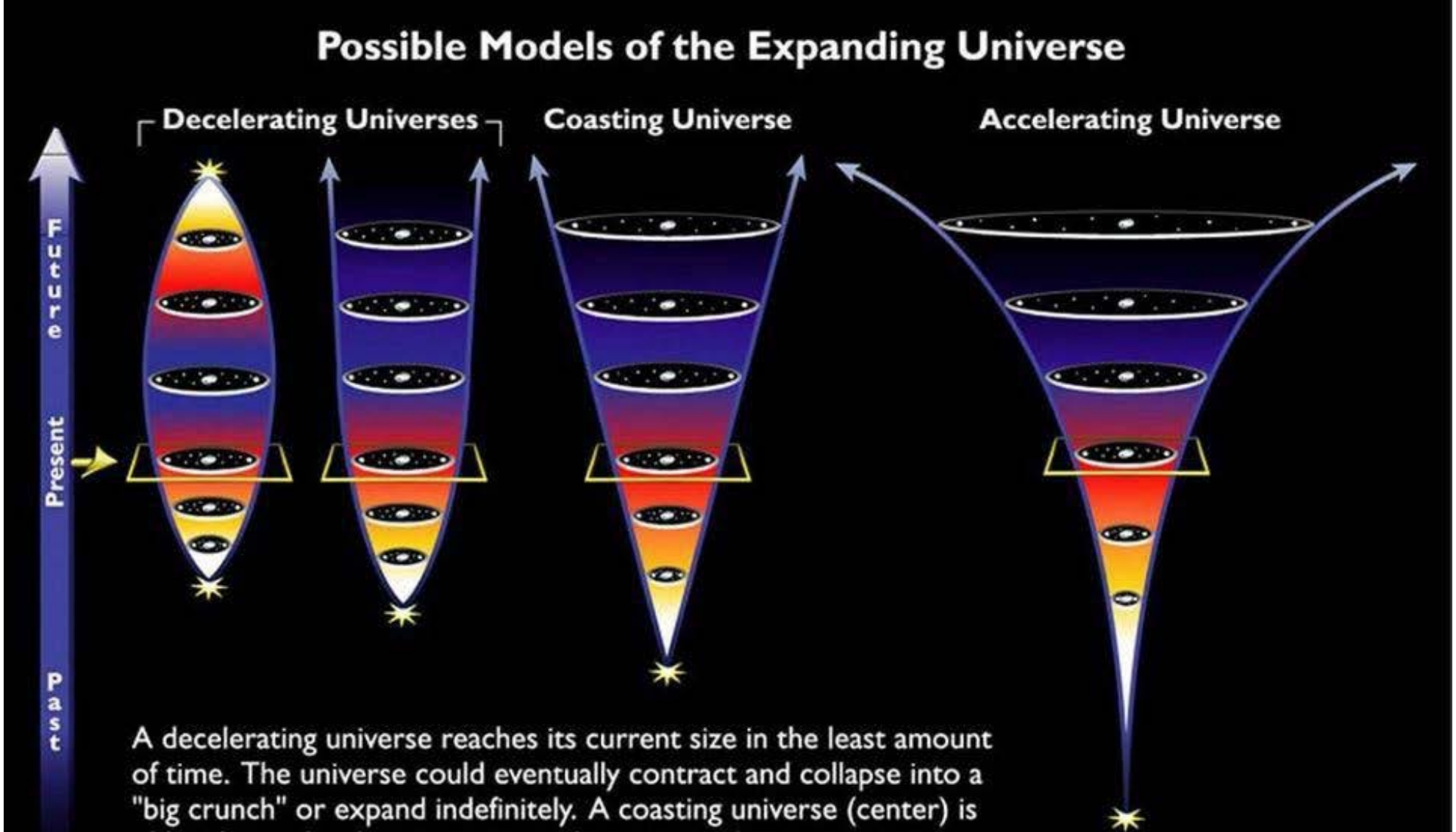




从CMB 开始：宇宙演化的数值模拟

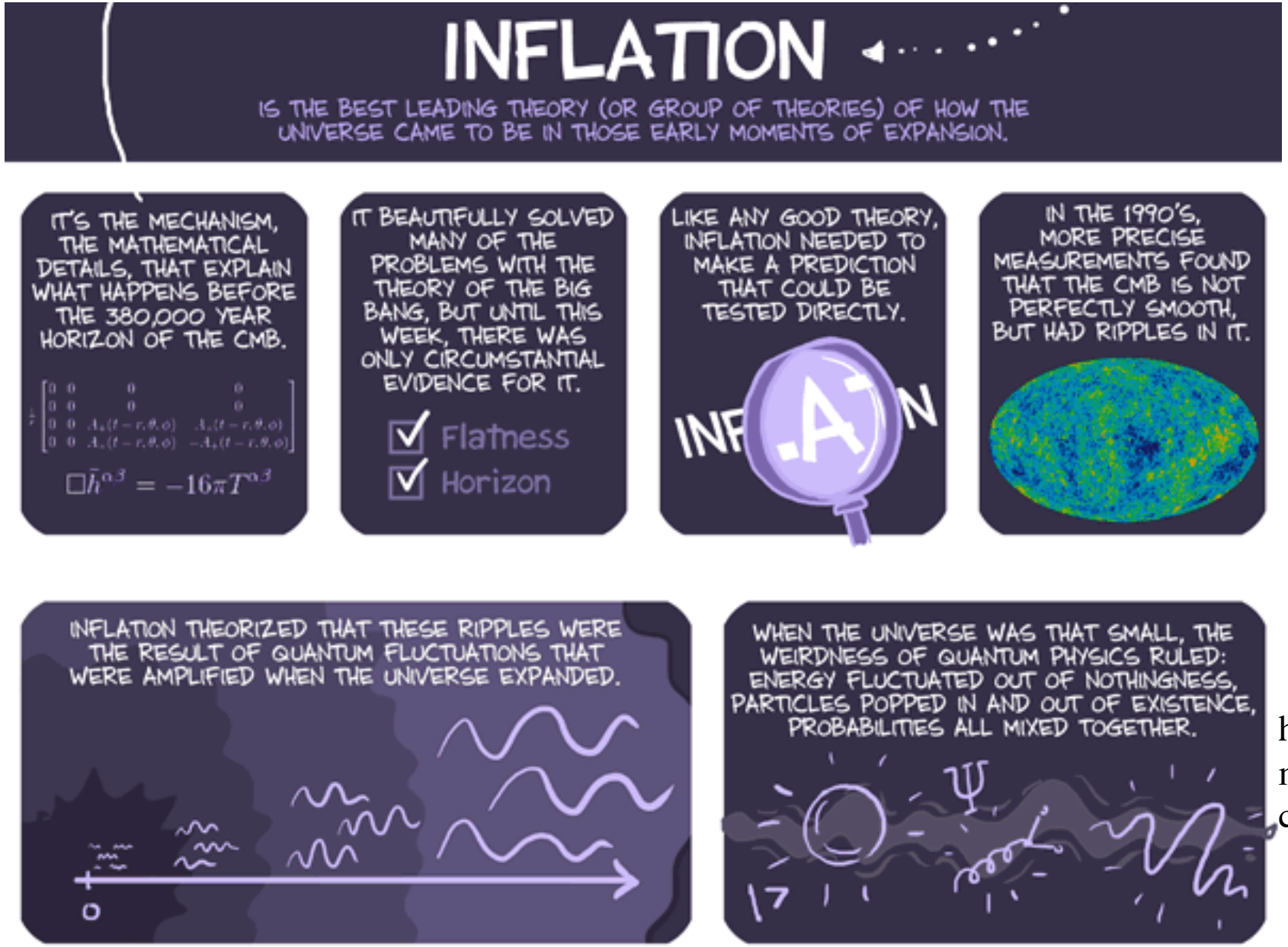
- New EAGLE Simulation Shows Galaxies as They Really Are (Video)





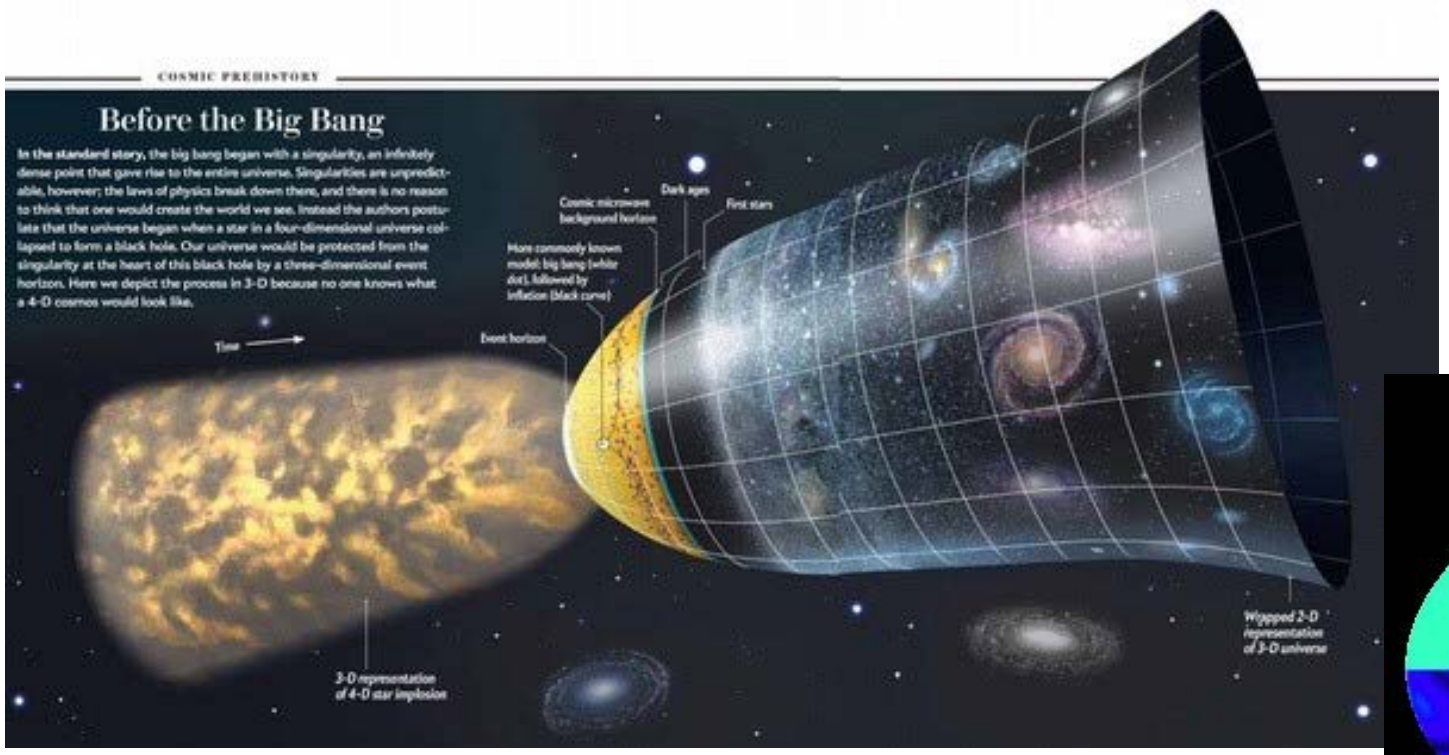
The different possible fates of the Universe, with our actual, accelerating fate shown at the right. After enough time goes by, the acceleration will leave every bound galactic or supergalactic structure completely isolated in the Universe, as all the other structures accelerate irrevocably away. (NASA & ESA)

CMB之前: 宇宙暴涨-通过量子效应造成CMB的变化

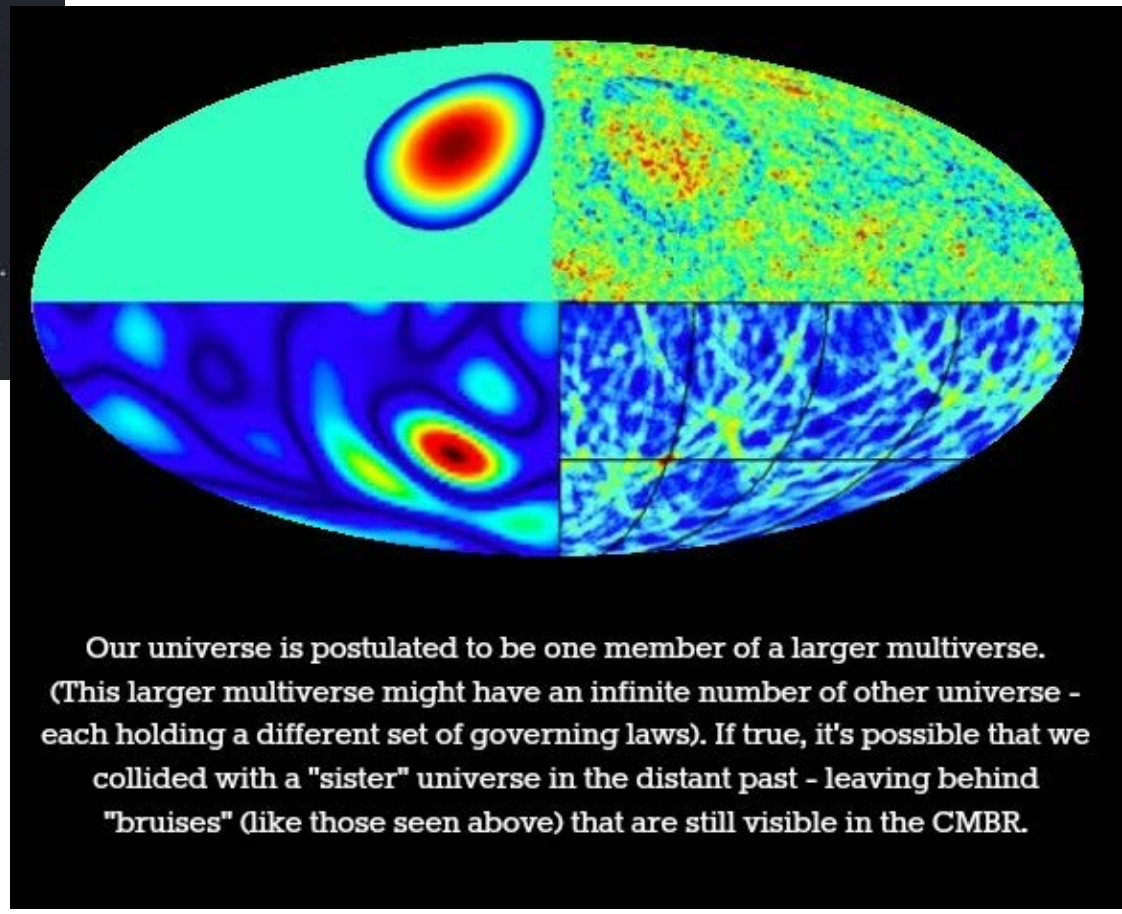


https://itsokaytobesmart.tumblr.com/post/80278959762/freshphotons-cosmic-inflation-explained

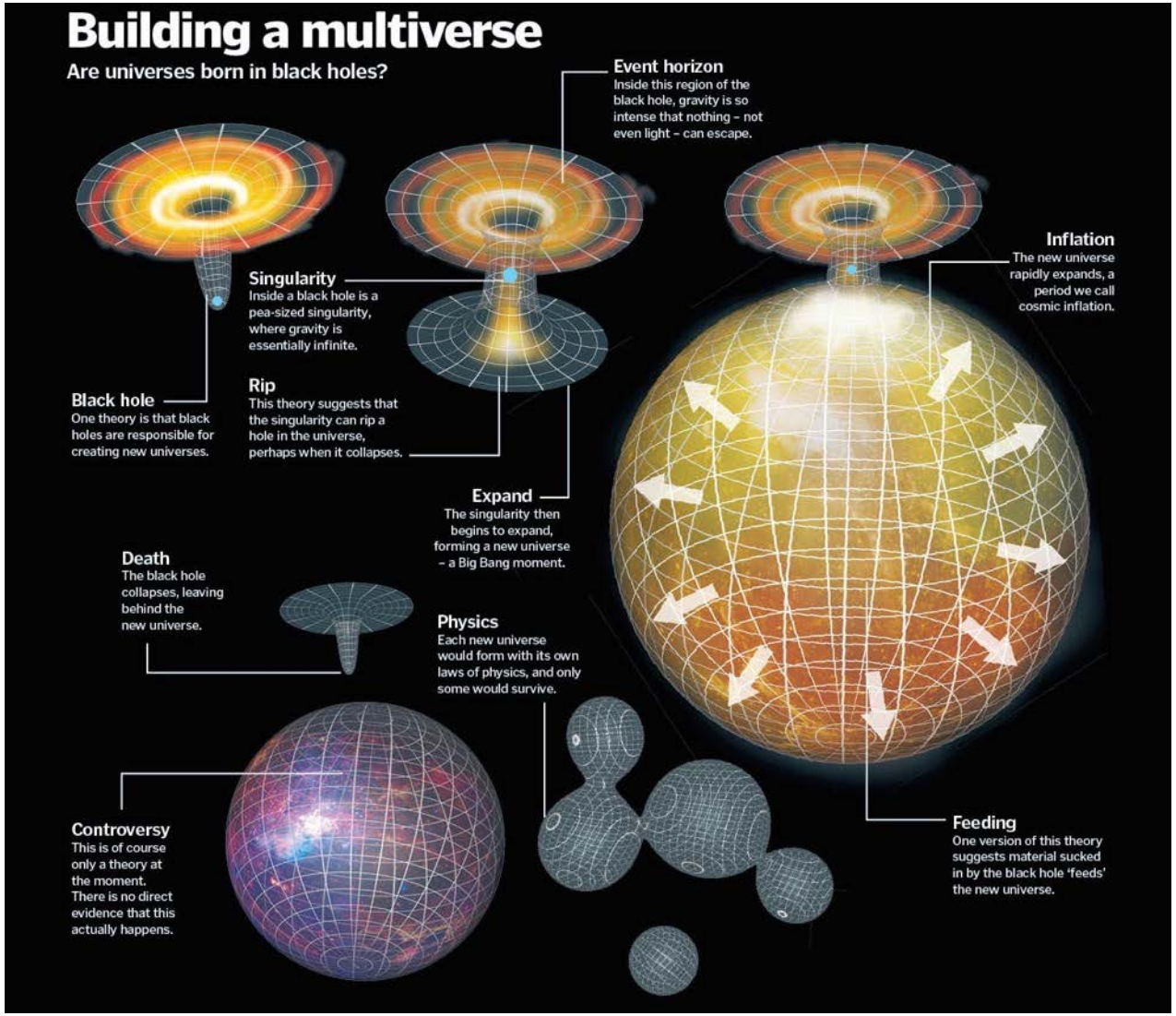
Big Bang/暴涨 之前是什么？

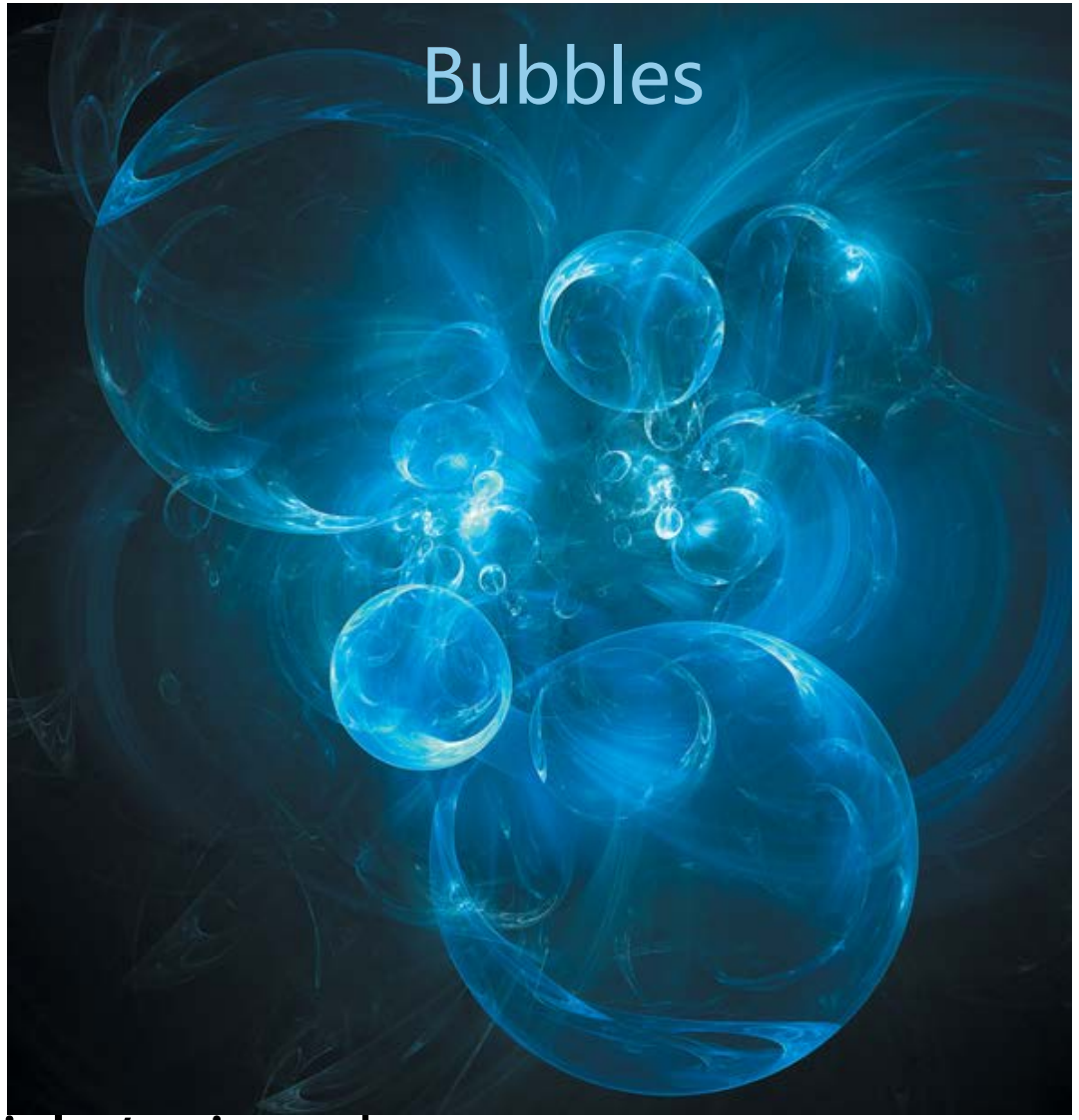


https://futurism.com/wp-content/uploads/2015/11/multiverse-theory1.jpg



多重宇宙 (Multiverse)

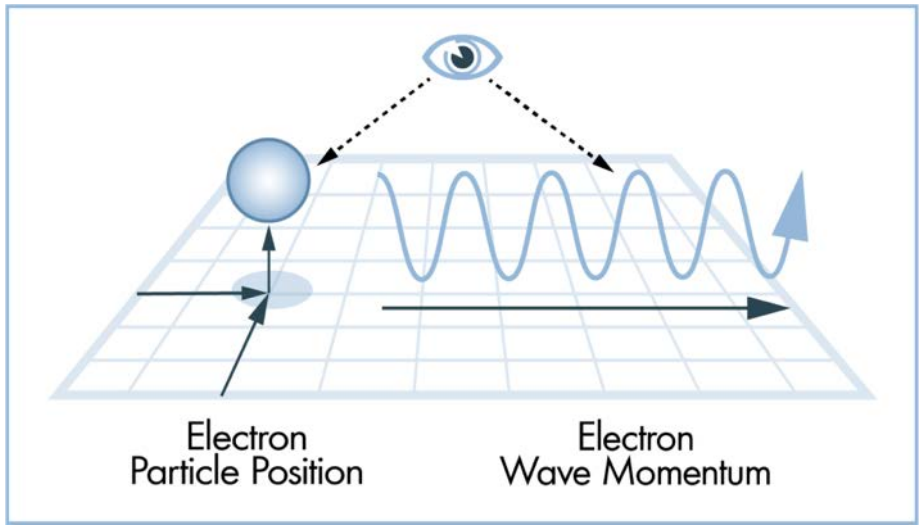




- https://www.scientificamerican.com/article/string-theory-may-create-far-fewer-universes-than-thought/

量子力学和大统一理论

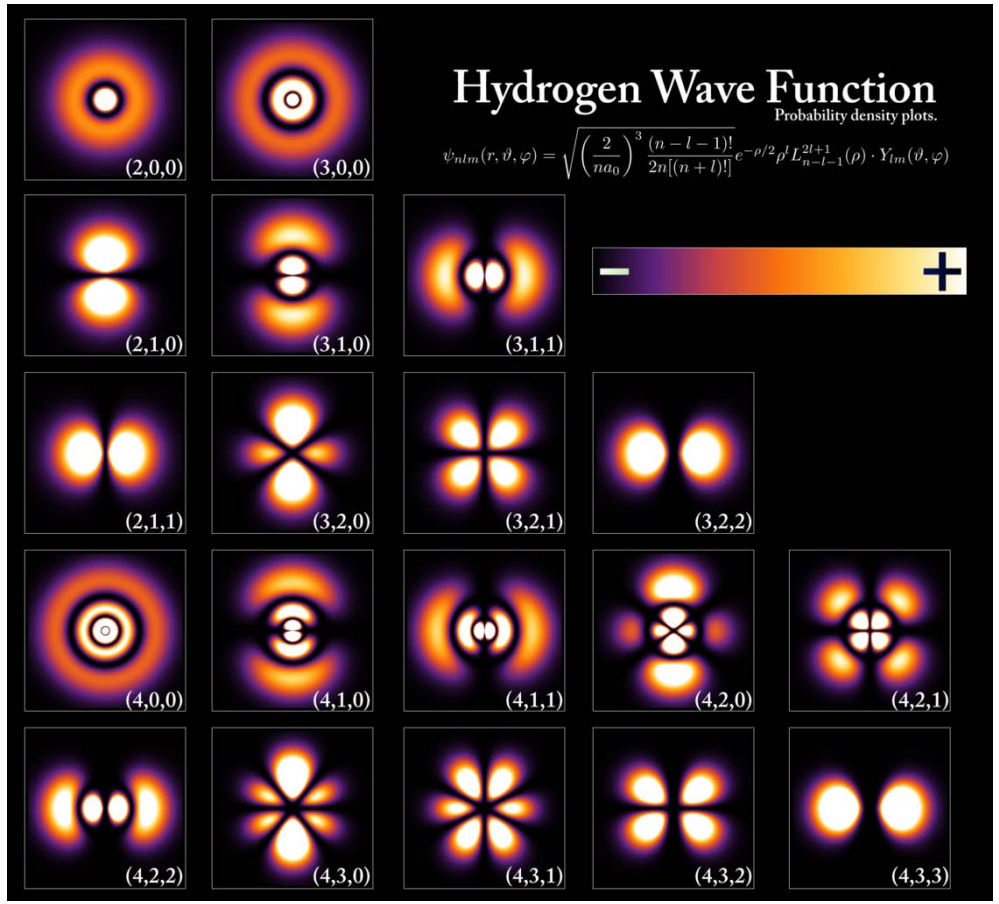
量子效应介绍：测不准原理和量子力学



Heisenberg Uncertainty Relationships

$$\Delta x \cdot \Delta p \sim \hbar$$

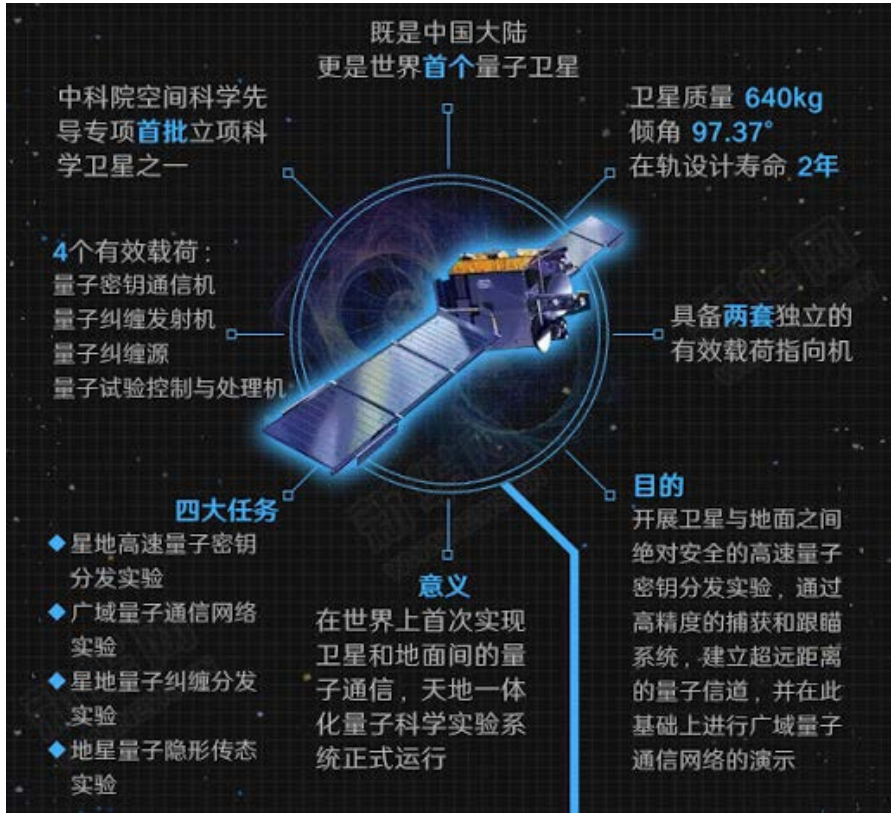
$$\Delta E \cdot \Delta t \sim \hbar$$



$$\frac{-\hbar^2}{2m}\nabla^2\Psi(\mathrm{r}) + V(r)\Psi(\mathrm{r}) = E\Psi(\mathrm{r}) \qquad H(t)\,|\psi(t)\rangle = i\hbar\frac{d}{dt}\,|\psi(t)\rangle$$

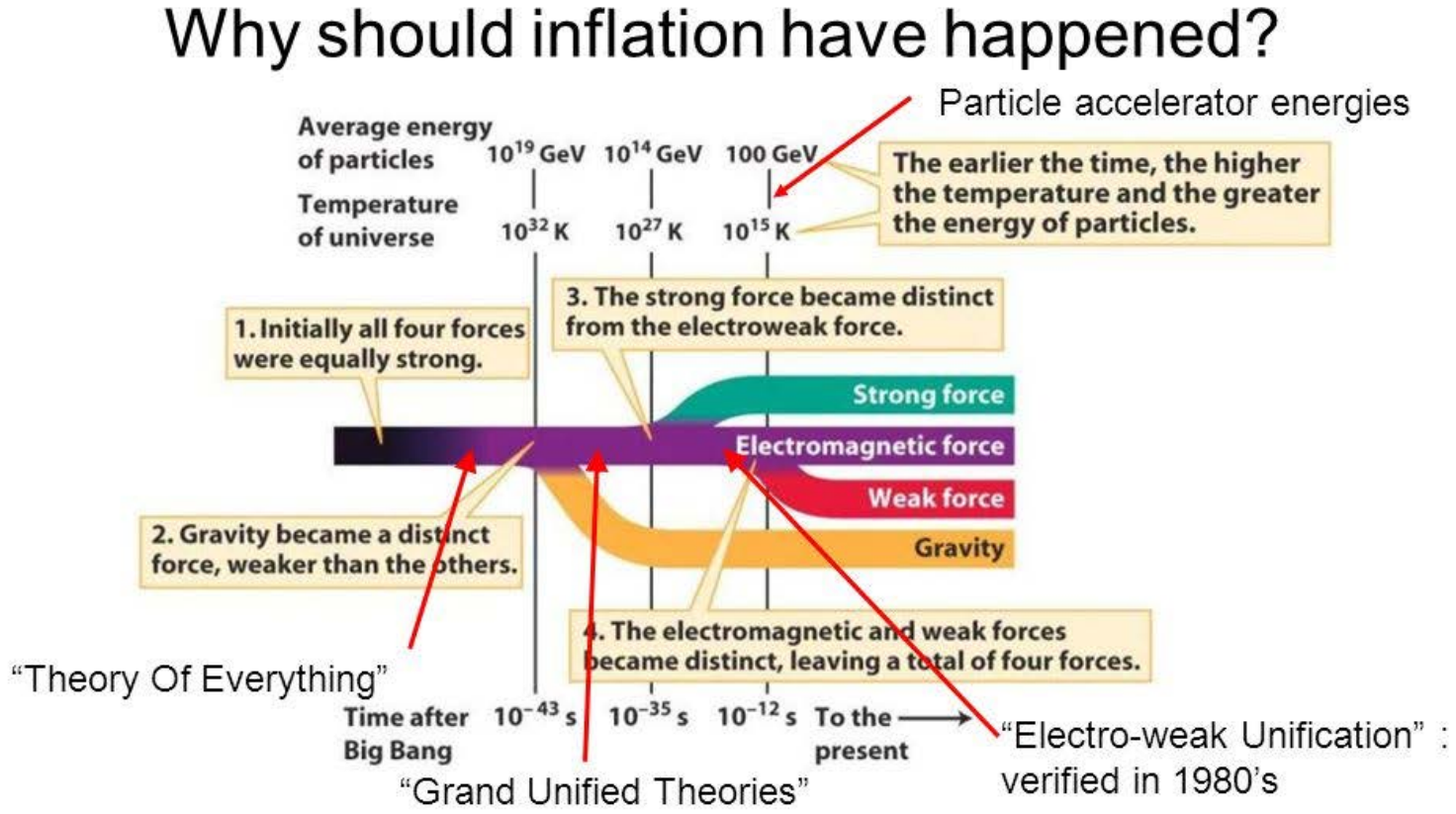
Kinetic Energy + *Potential Energy* = *Total Energy*

量子效应介绍：量子计算和墨子号量子卫星(2016)



https://tech.sina.com.cn/d/i/2019-03-06/doc-ihsxncvh0282275.shtml

暴涨可能是由于四大基本力解耦造成的

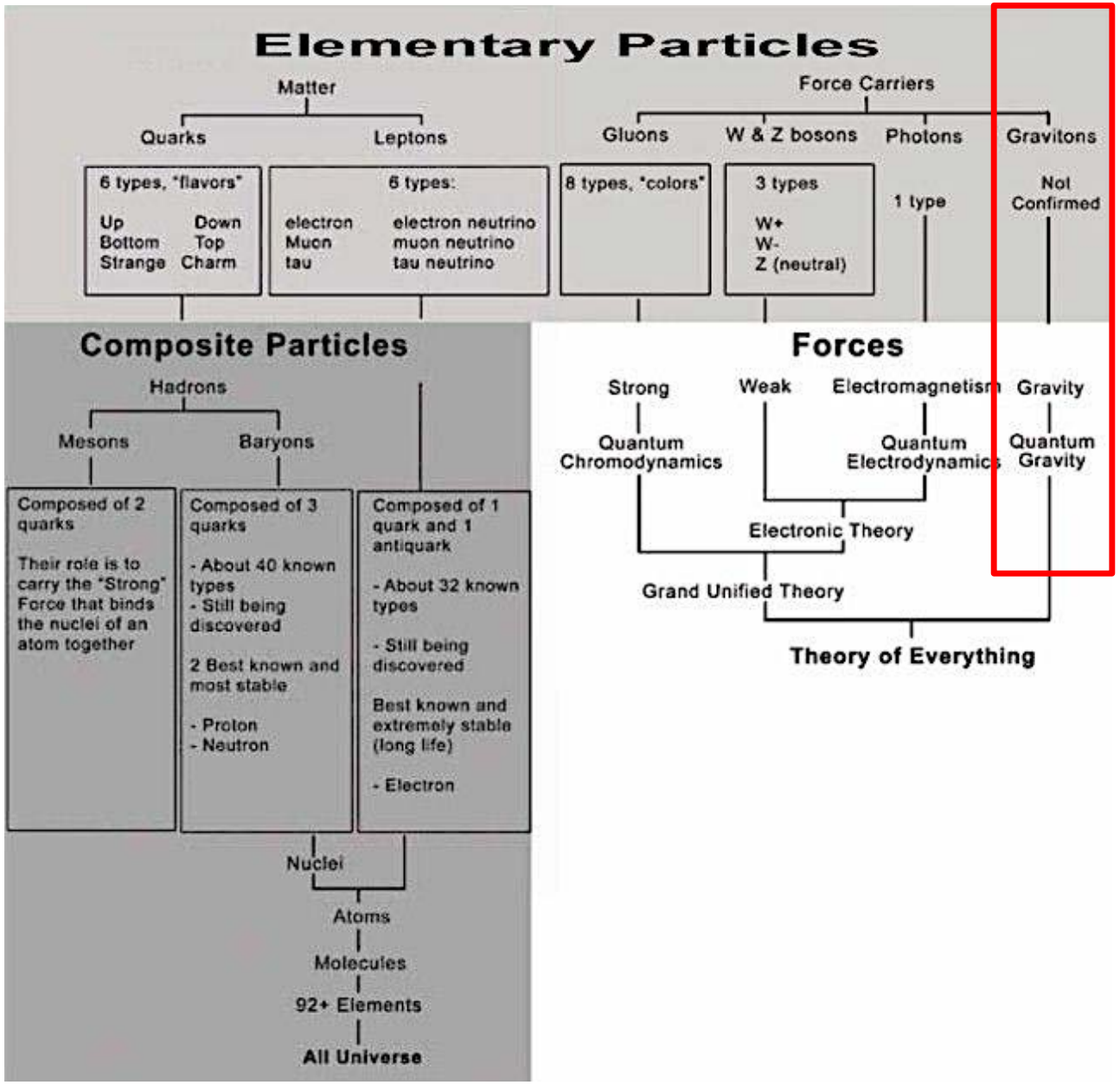


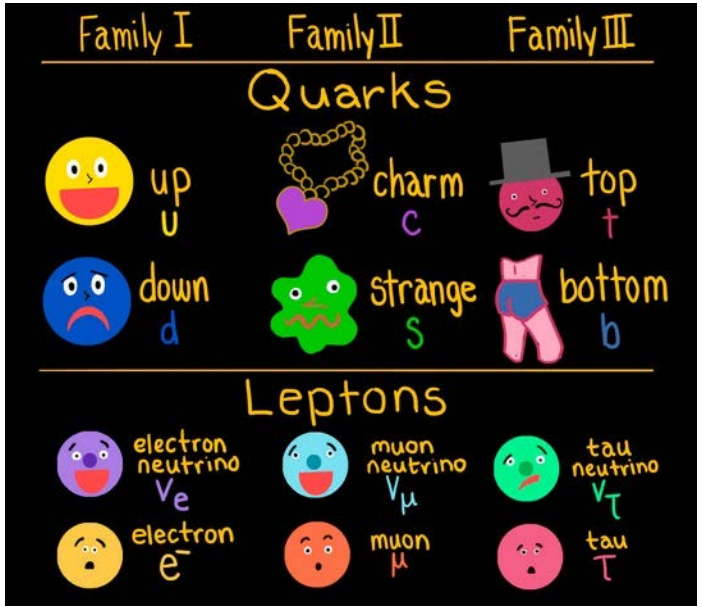
Inflation is a predicted consequence of the strong force decoupling from the electro-weak force, but physics is very difficult and not at all well understood.

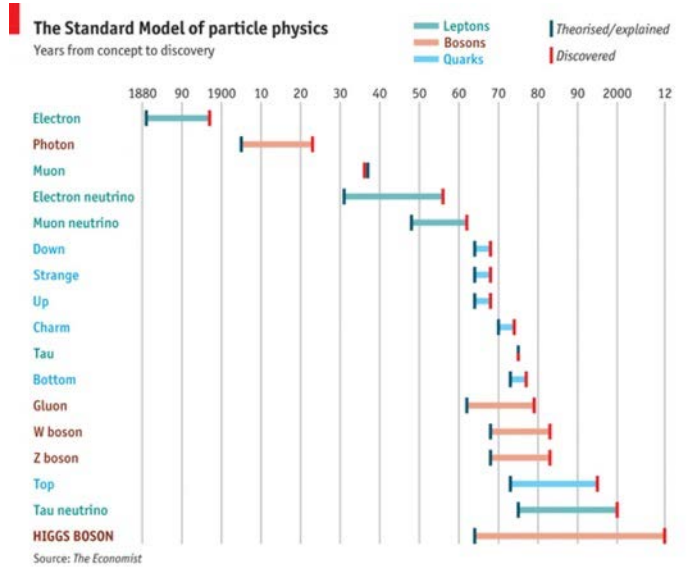
48

- https://slideplayer.com/slide/4703691/15/images/48/Why+should+inflation+have+happened.jpg

粒子物理标准模型和四大基本力

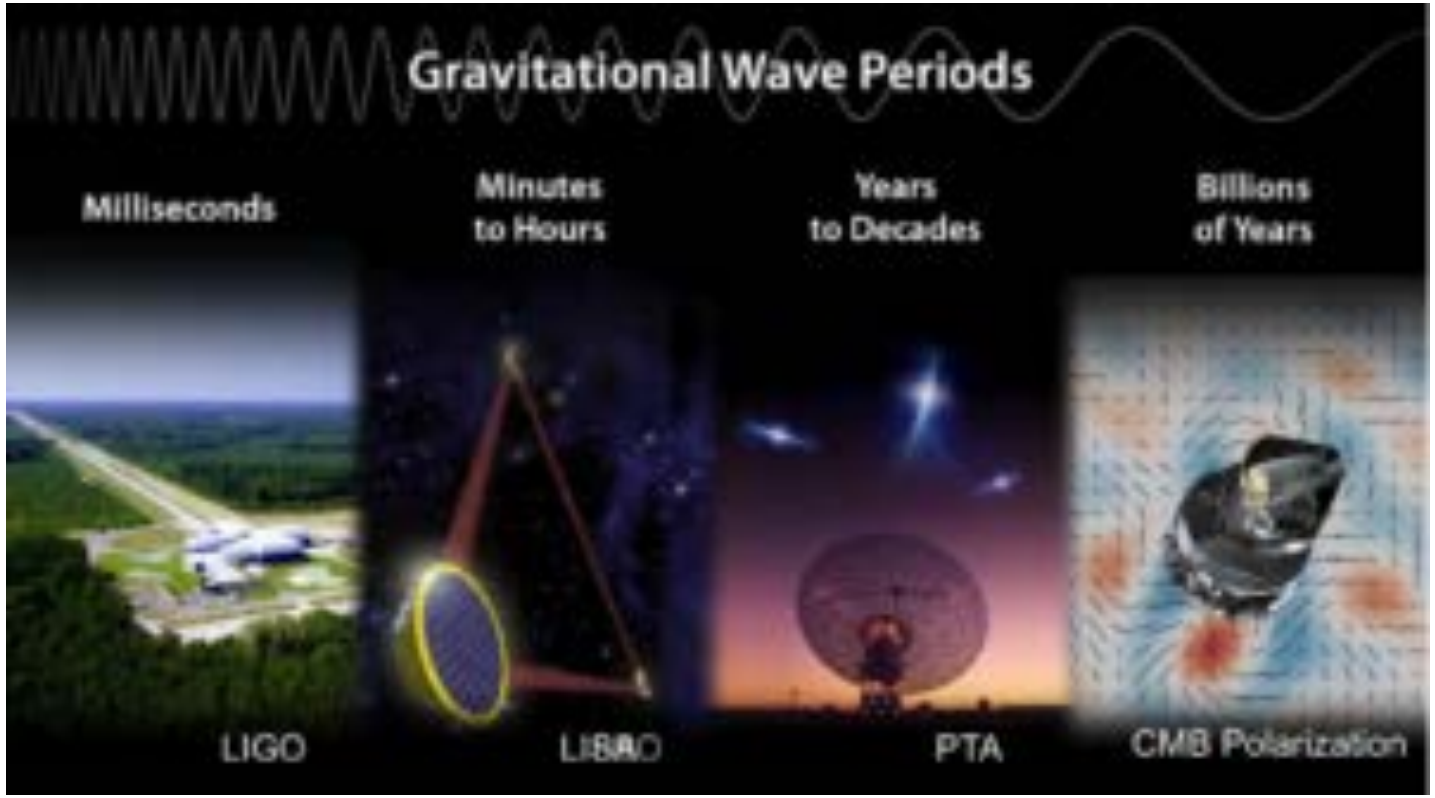


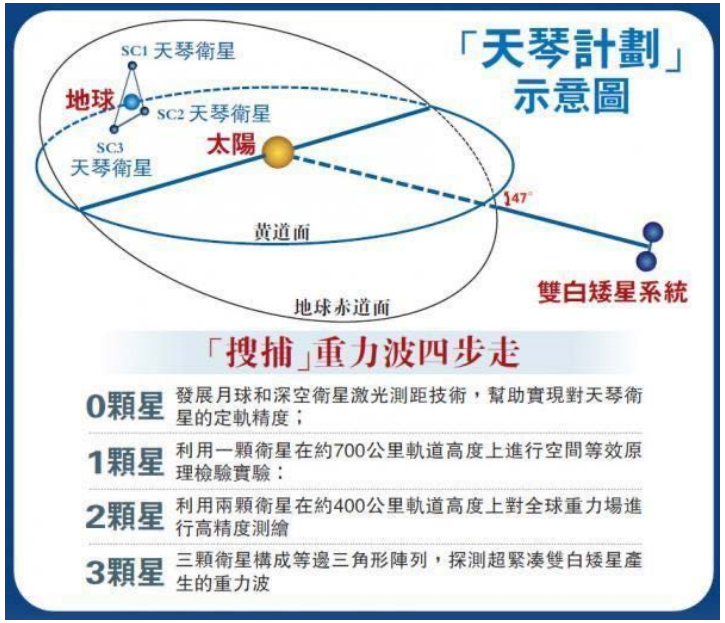




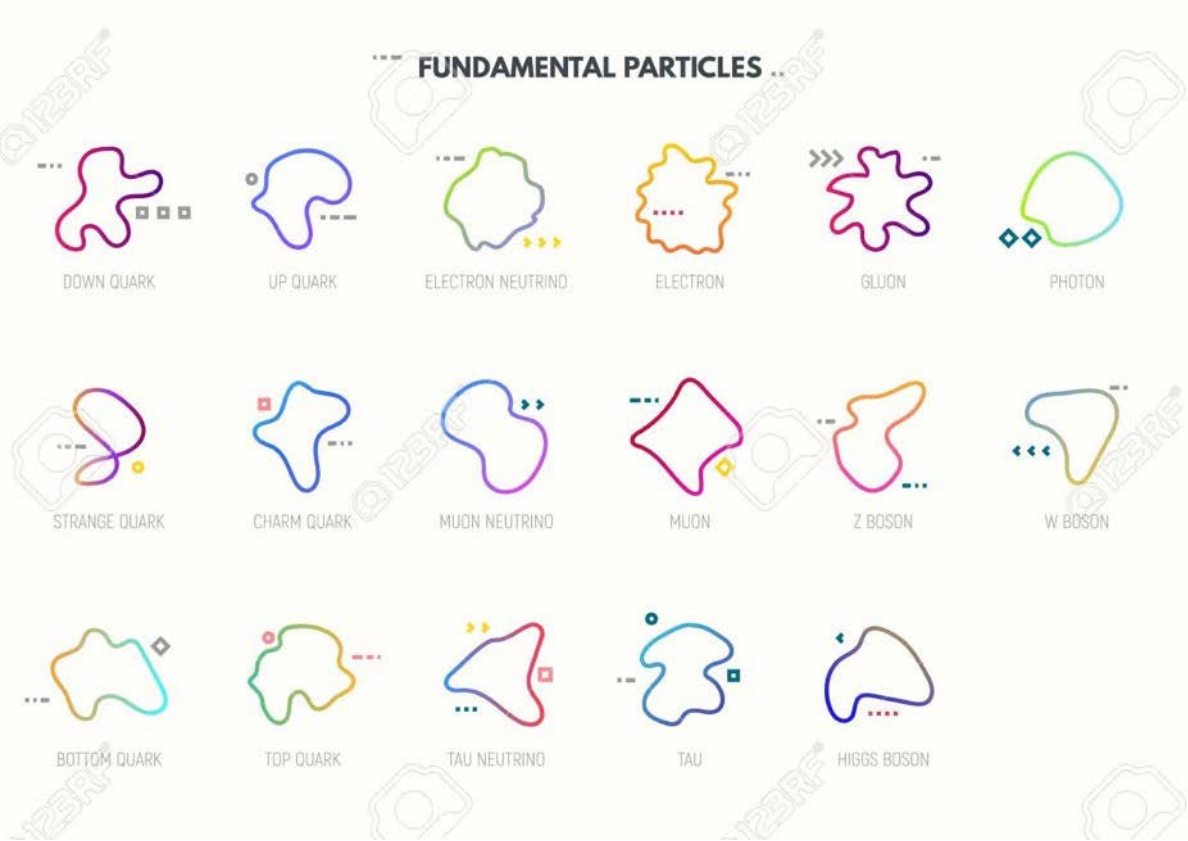
重力波探測(2016)

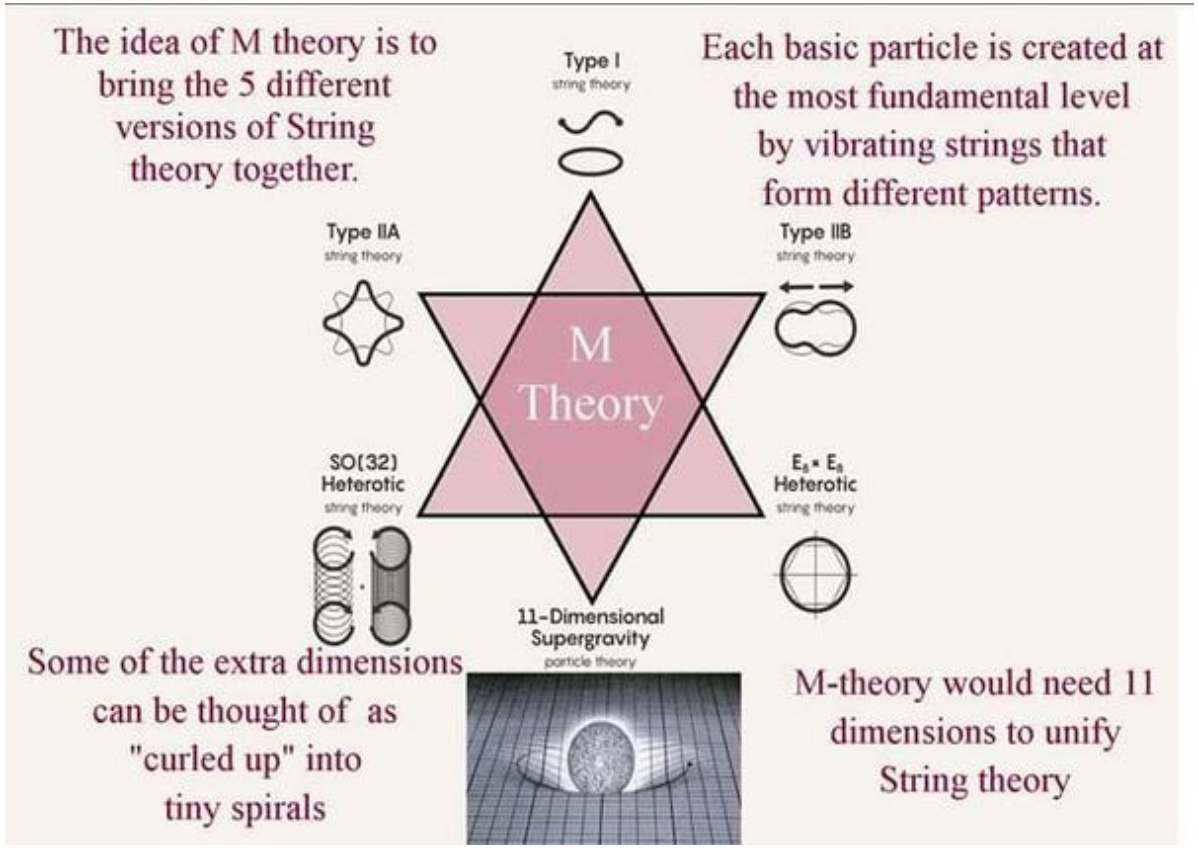
- [LIGO: The First Observation of Gravitational Waves]



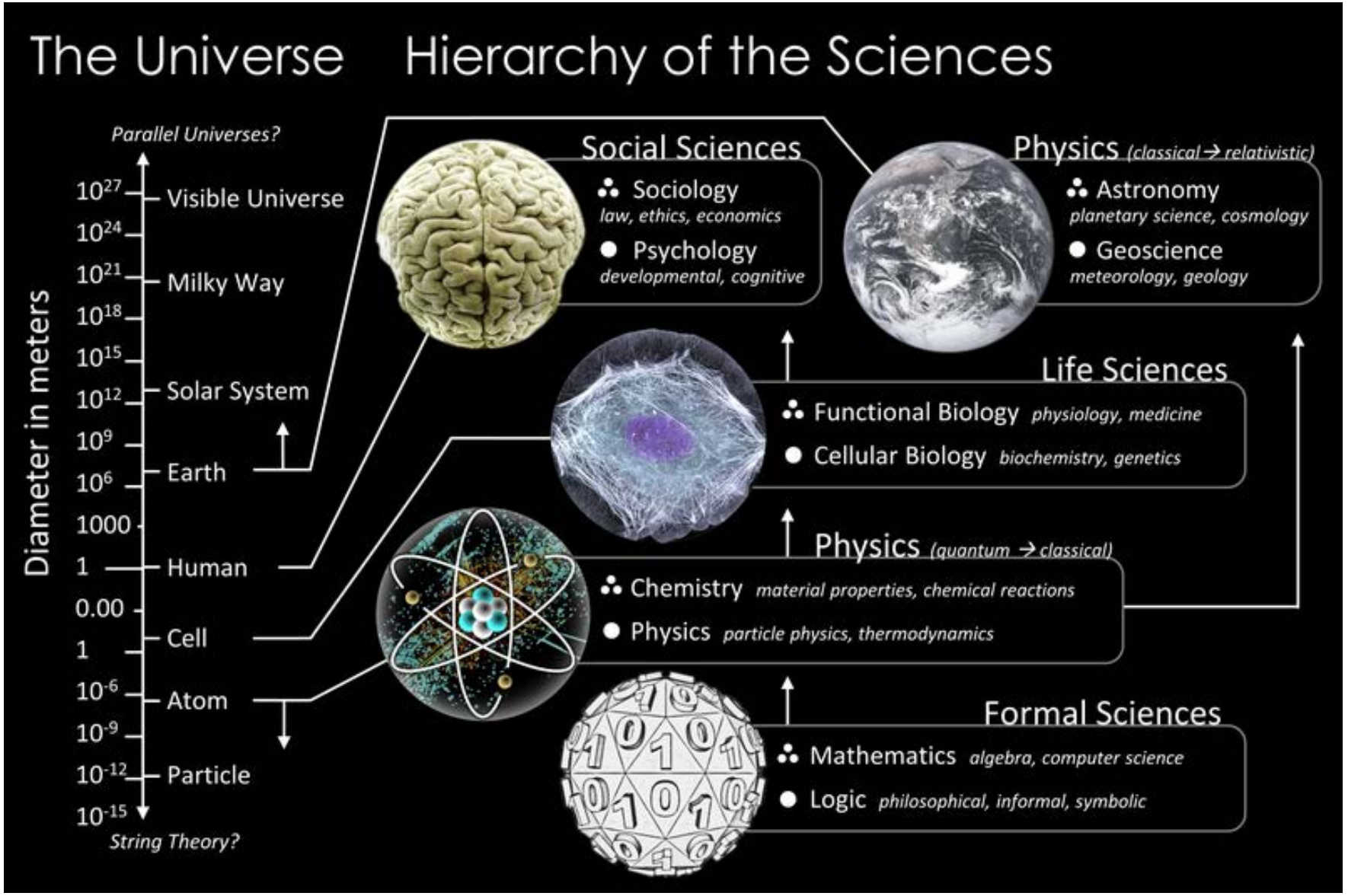


可能的大统一理论：弦论


FUNDAMENTAL PARTICLES
DOWN QUARK
UP QUARK
ELECTRON NEUTRINO
ELECTRON
GLUON
PHOTON
STRANGE QUARK
CHARM QUARK
MUON NEUTRINO
MUON
Z BOSON
W BOSON
BOTTOM QUARK
TOP QUARK
TAU NEUTRINO
TAU
HIGGS BOSON


The idea of M theory is to bring the 5 different versions of String theory together.
Each basic particle is created at the most fundamental level by vibrating strings that form different patterns.
Type I
string theory
Type IIA
string theory
Type IIB
string theory
M Theory
SO(32) Heterotic
string theory
E8 × E8 Heterotic
string theory
11-Dimensional Supergravity
particle theory
Some of the extra dimensions can be thought of as "curled up" into tiny spirals
M-theory would need 11 dimensions to unify String theory

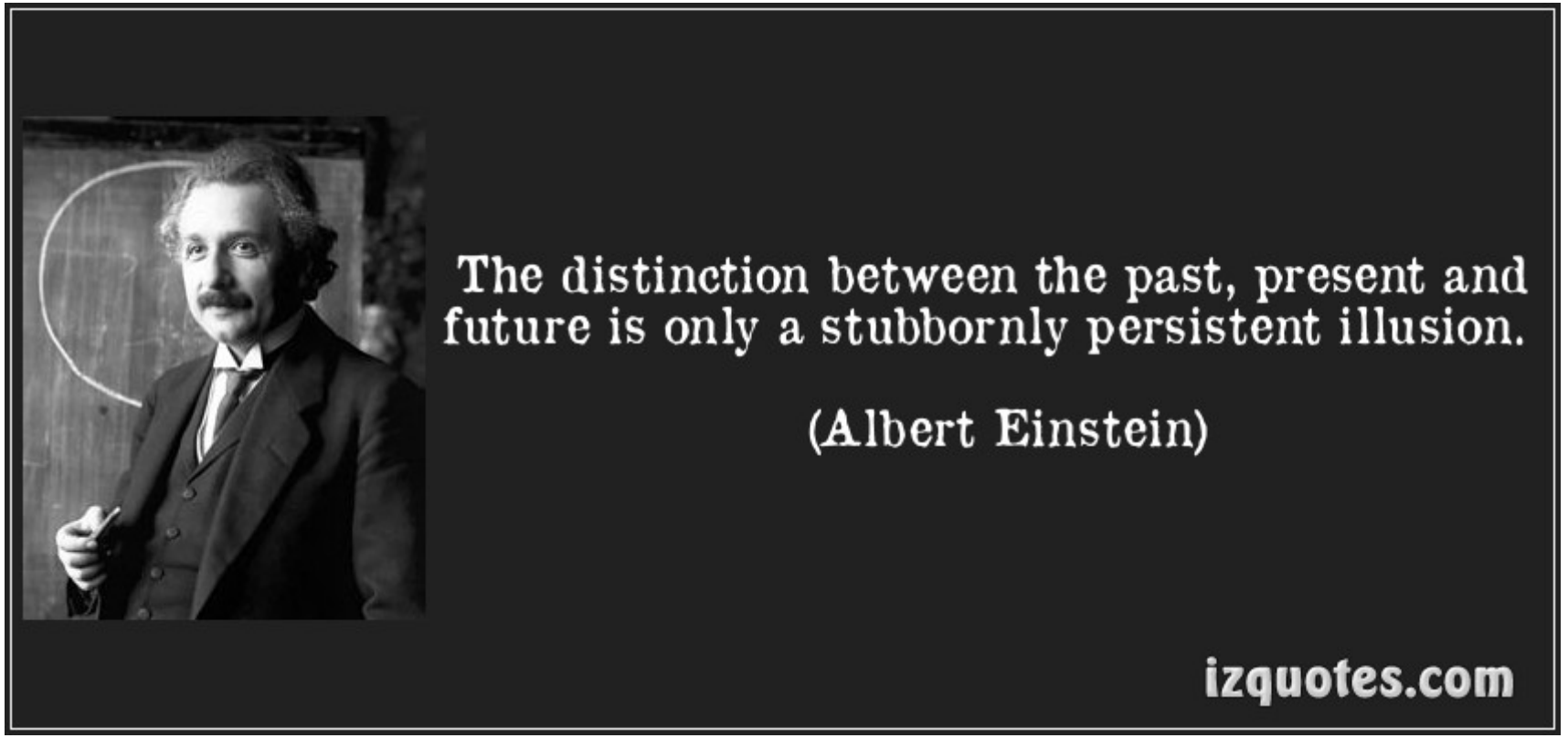
统一广义相对论（宏观）和量子力学（微观）

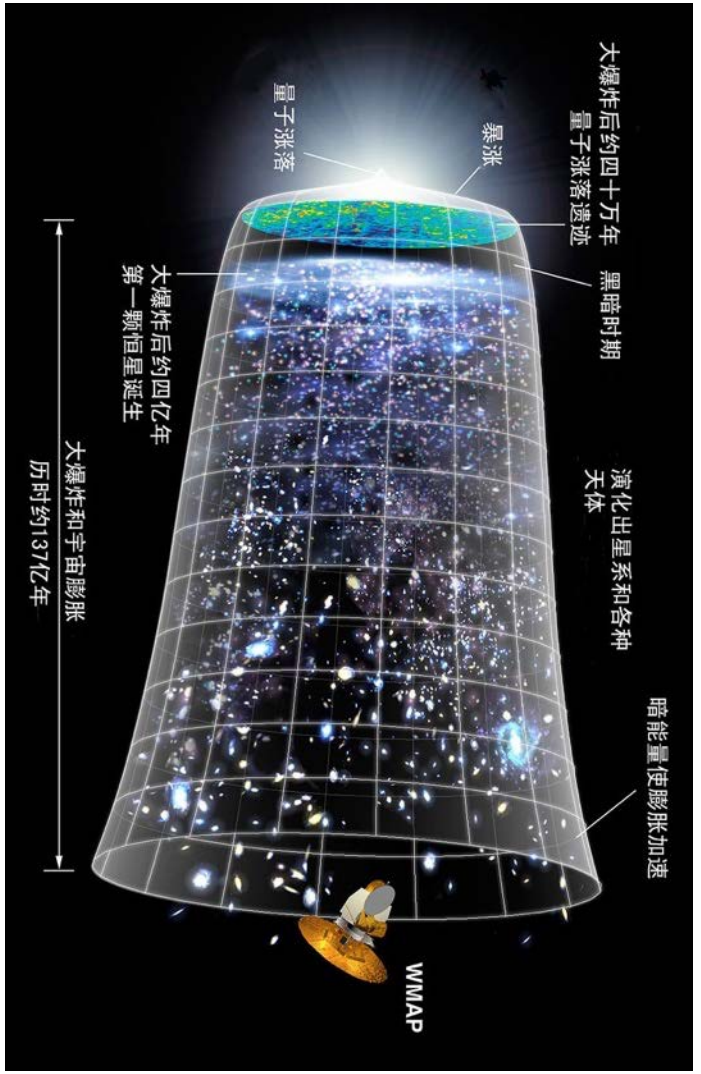


11-Dimension TimeSpace

- How to imagine? https://www.youtube.com/watch?v=0ca4miMMaCE

什么是时间的本质？





- Nature of Time：https://www.youtube.com/watch?v=lwW-5fIKaxg
- Nature of Space and Time, Stephen W. Hawking and Roger Penrose, 1996

Relativity and Time Traveling

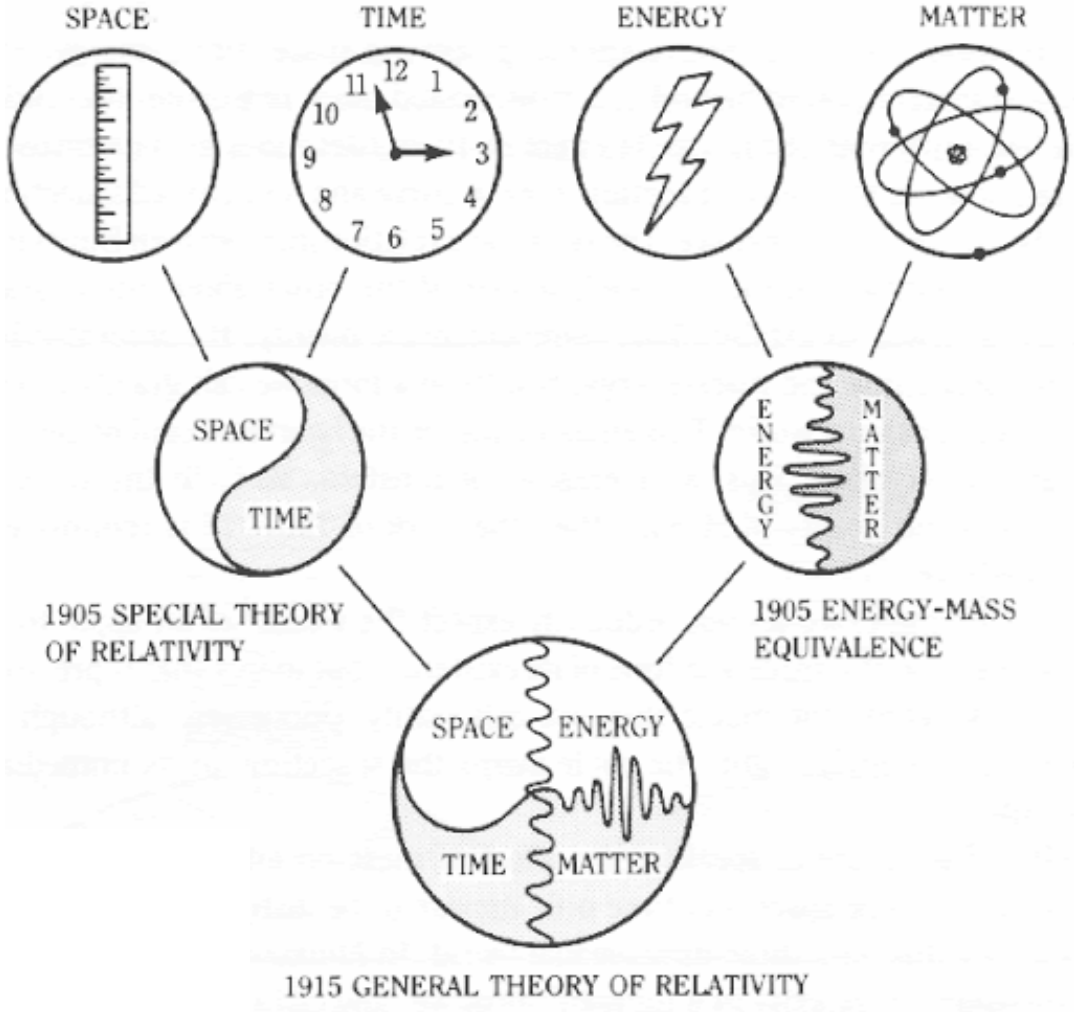
相对论

The Postulates of Special Relativity

On June 30, 1905 Einstein formulated the two postulates of special relativity:

1. *The Principle of Relativity*
The laws of physics are the same in all inertial frames of reference.

2. *The Constancy of Speed of Light in Vacuum*
The speed of light in vacuum has the same value *c* in all inertial frames of reference.



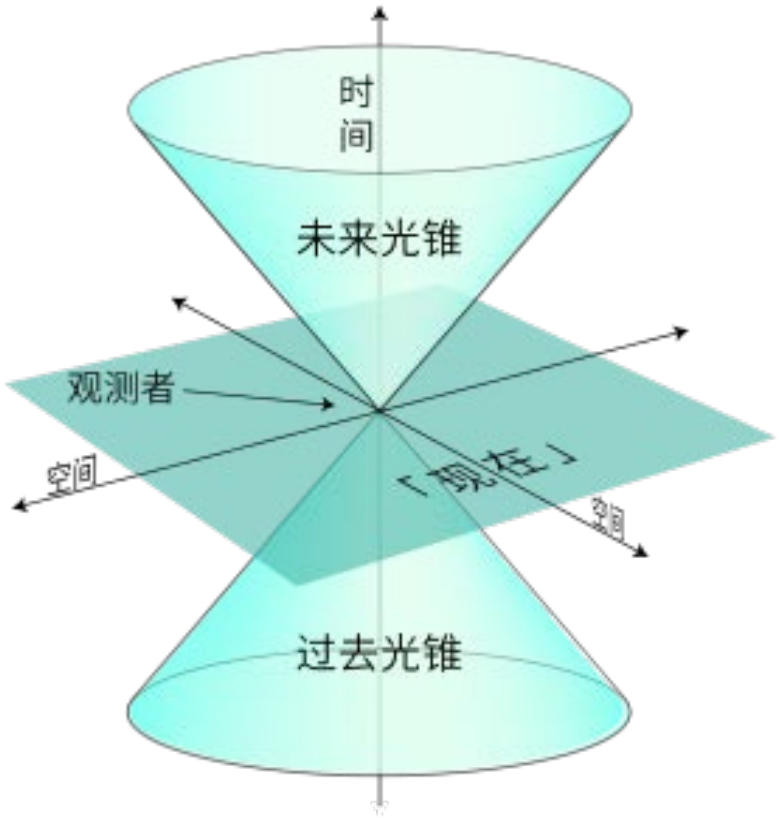
Einstein equations:

$$G_{\mu\nu} = 8\pi\, G\, T_{\mu\nu}$$

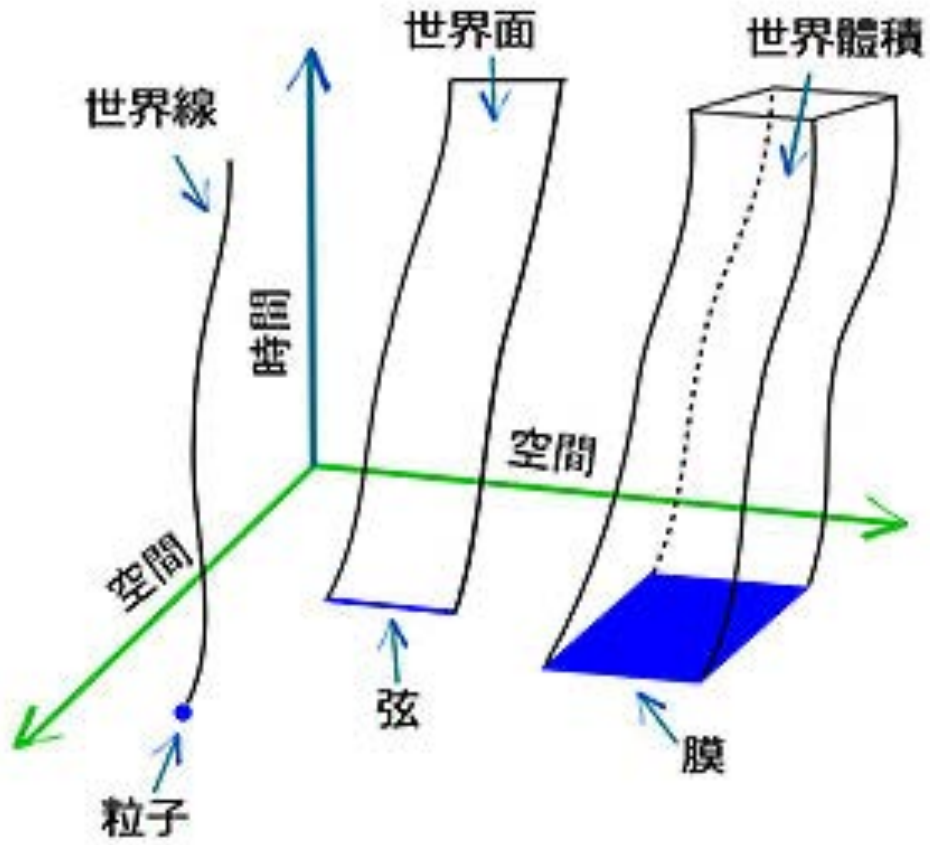
Einstein tensor (describes curvature of spacetime)

energy-momentum tensor (describes distribution of matter in the spacetime)

Minkowski Spacetime

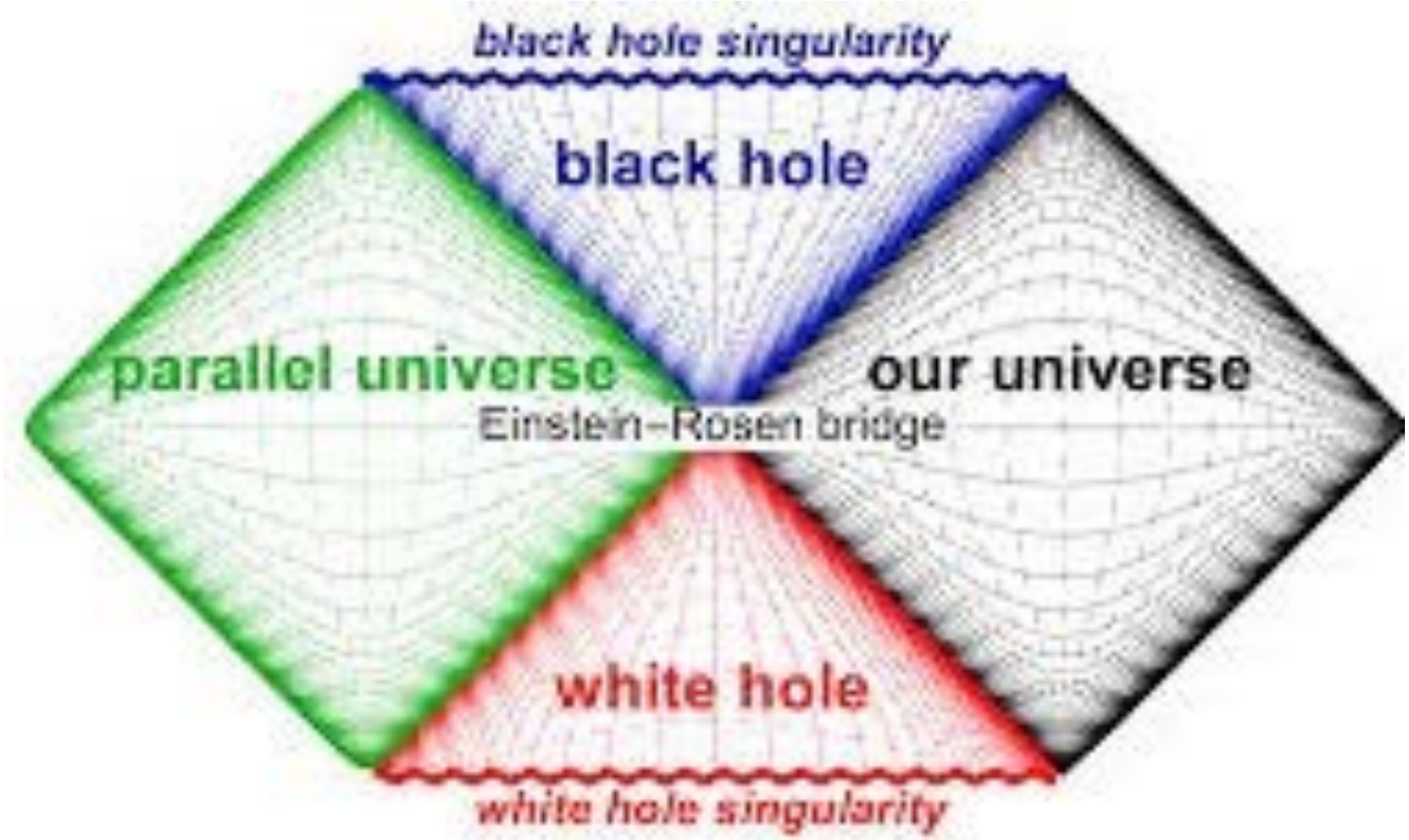


World Line

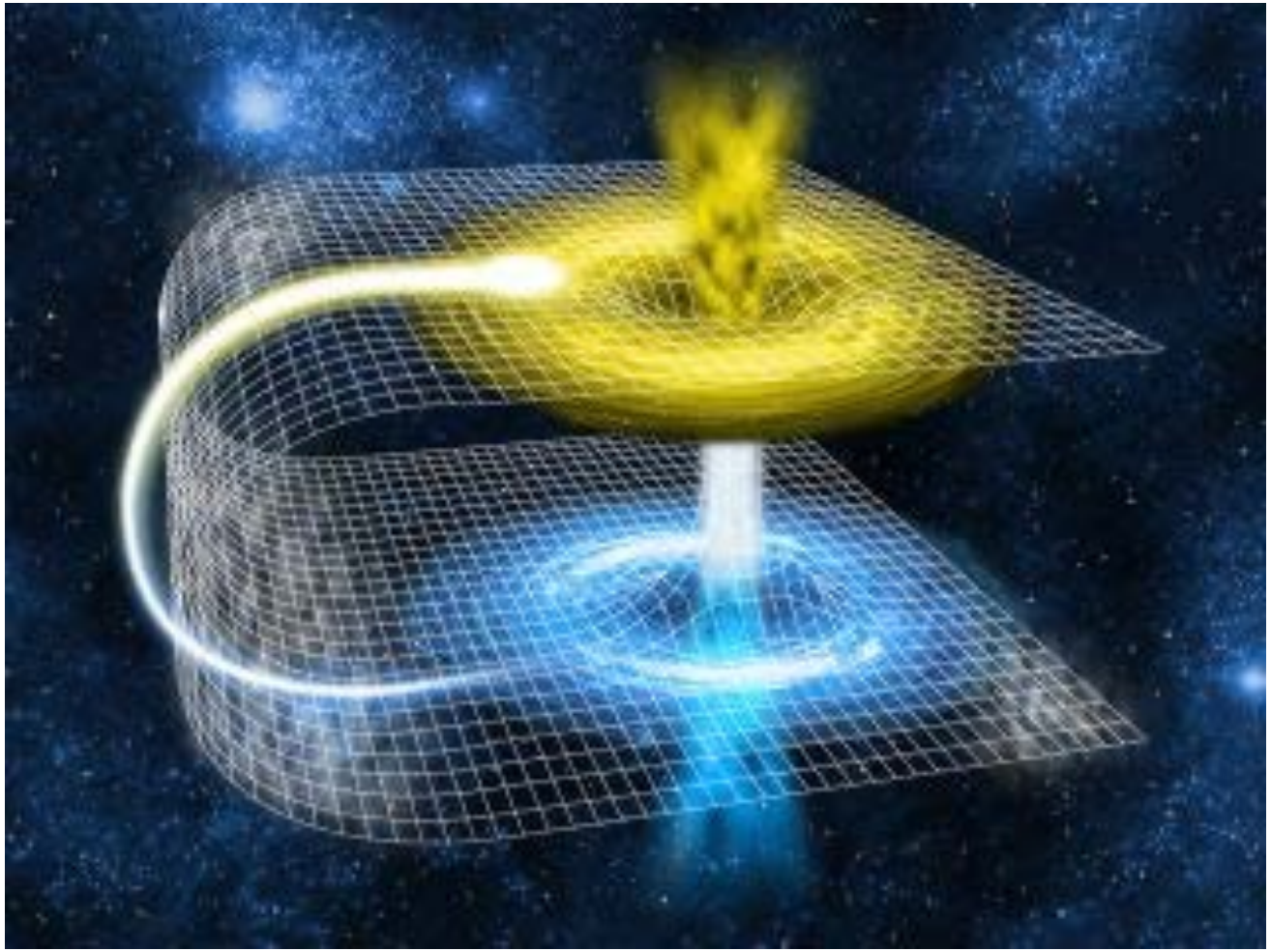


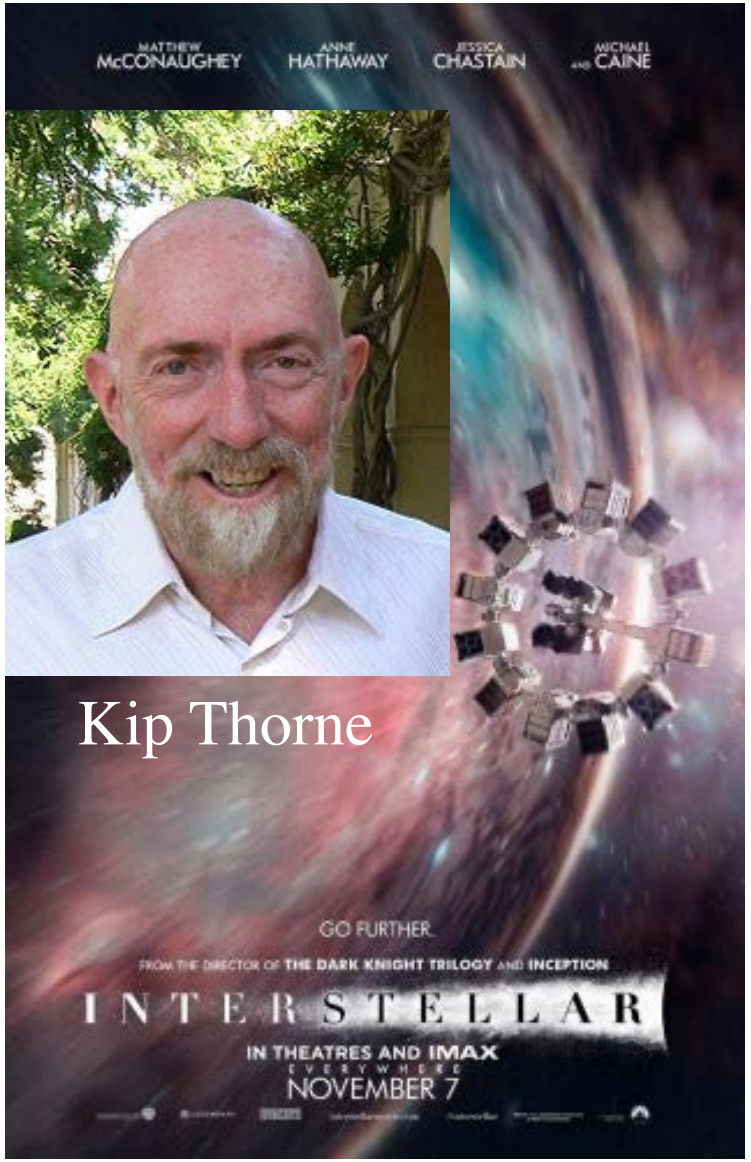
- 双生子佯谬, MinutePhysics
- 支配宇宙的法则：什么是因果？过去、现在、未来如何区分？李永乐老师讲时光锥
- 祖父悖论如何解决？多重宇宙和霍金的时序保护假说是怎么回事？

视界，黑洞、白洞和虫洞


black hole singularity
black hole
parallel universe
our universe
Einstein-Rosen bridge
white hole
white hole singularity

基于广义相对论的时间旅行方案:虫洞

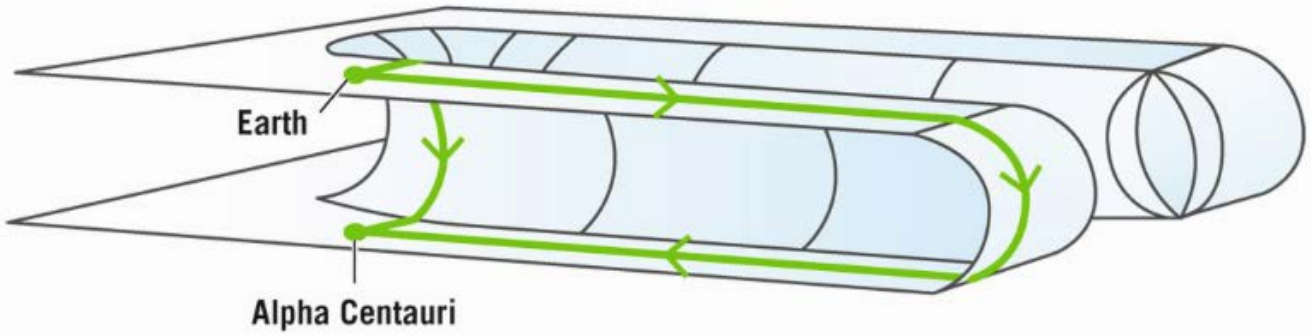




如何建造虫洞时光机：

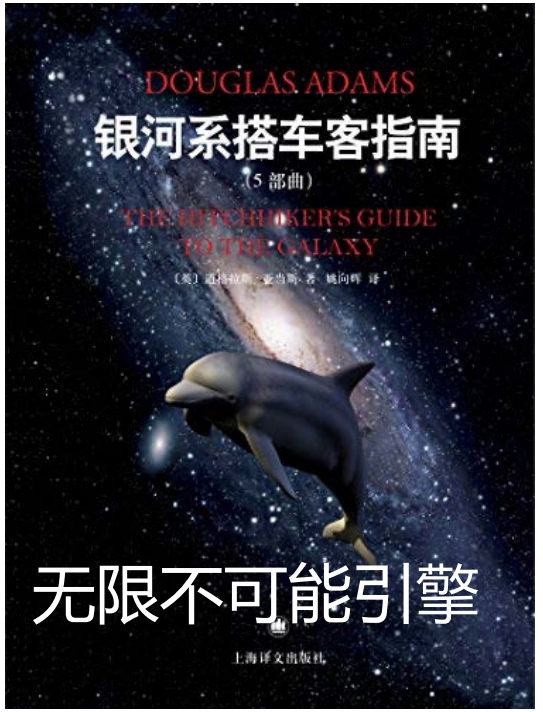
1. 寻找一个量子虫洞开口，1.6×10^{-33} cm
2. 放大这个虫洞，加入一亿倍太阳质量， 1 AU 半径

时间旅行方案: 曲率引擎

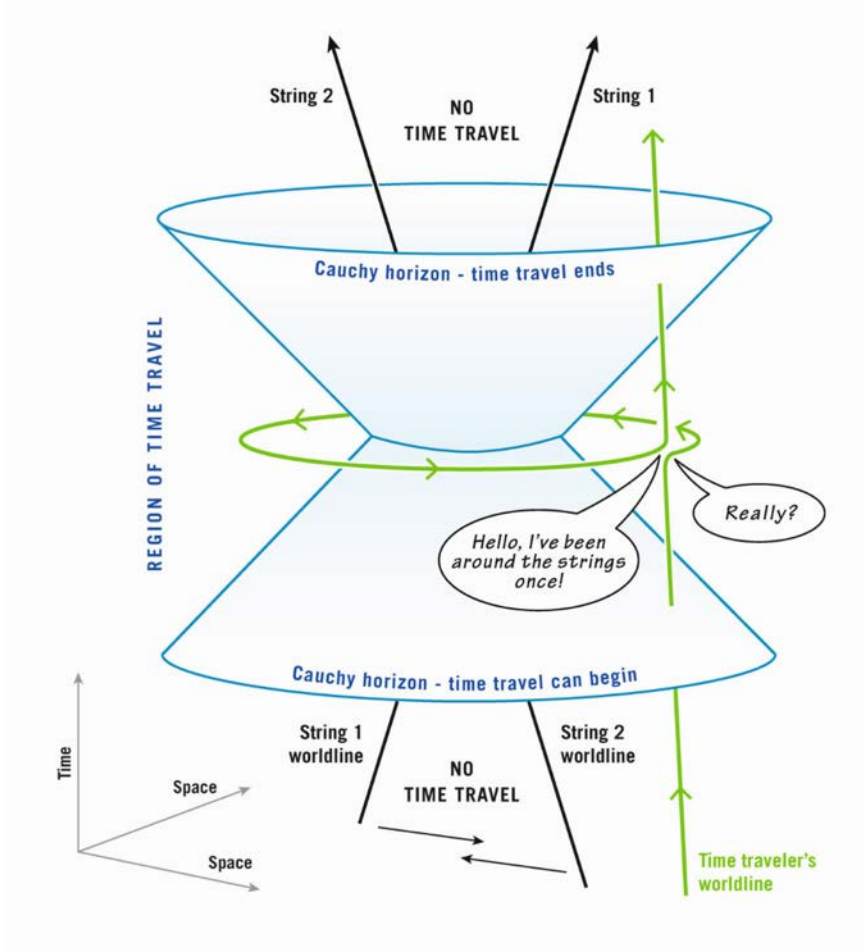


Warpdrive creates a u-shaped distortion in spacetime, also creating a shortcut from Earth to Alpha Centauri

如何建造曲率引擎：
https://www.youtube.com/watch?v=rfZ80JvDvfY



时间旅行方案：双弦时光机

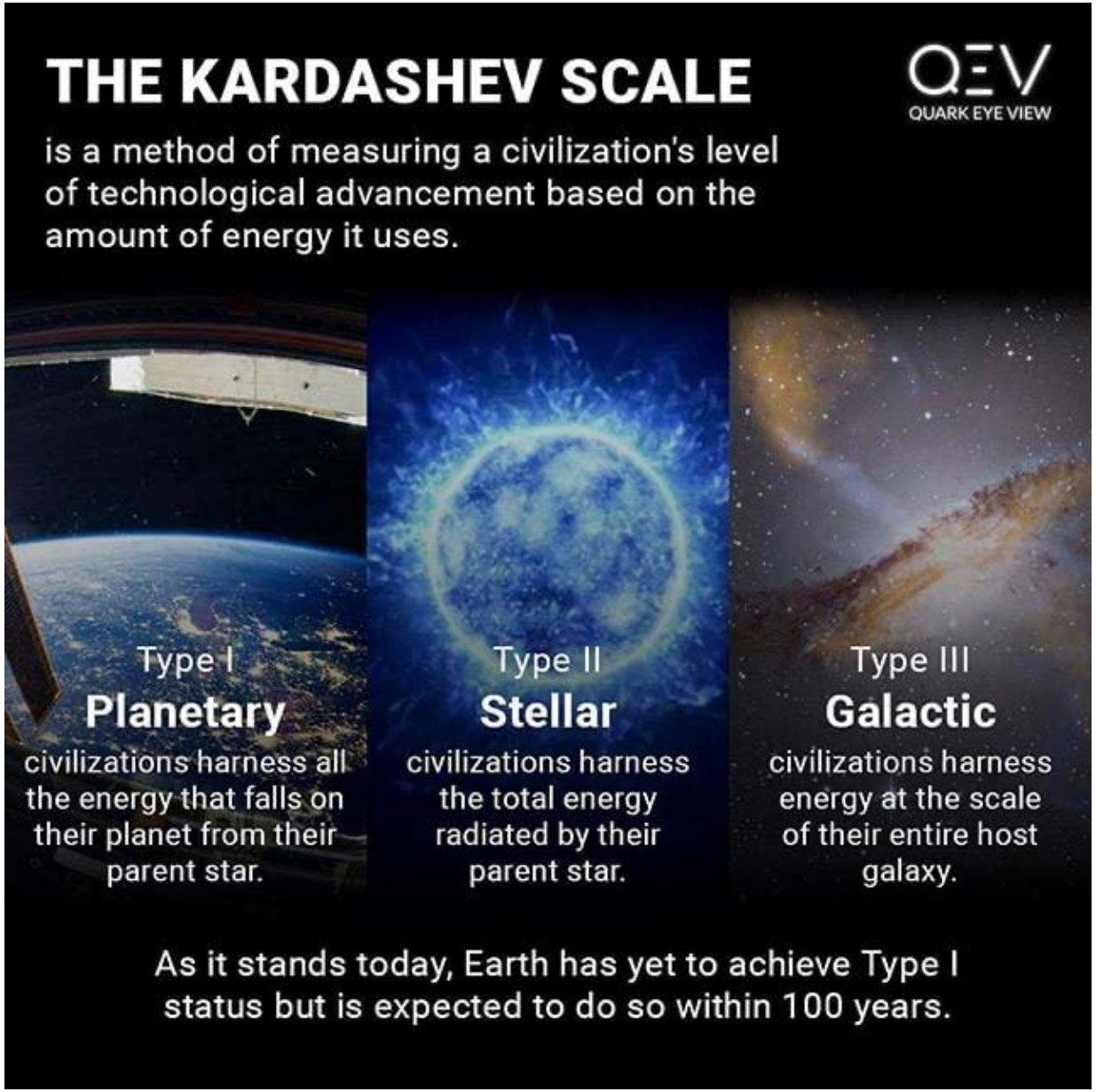


如何建造双弦时光机：

1. 寻找宇宙弦（来自大爆炸的高能量真空能量弦）
2. 使两根宇宙弦交错而过
3. 在宇宙弦交错时进行时间旅行

Credit: J. Richard Gott (Time Travel in Einstein's Universe, Houghton Mifflin, 2001)

宇宙超级文明


THE KARDASHEV SCALE
QEV
QUARK EYE VIEW
is a method of measuring a civilization's level of technological advancement based on the amount of energy it uses.
Type I
Planetary
civilizations harness all the energy that falls on their planet from their parent star.
Type II
Stellar
civilizations harness the total energy radiated by their parent star.
Type III
Galactic
civilizations harness energy at the scale of their entire host galaxy.
As it stands today, Earth has yet to achieve Type I status but is expected to do so within 100 years.

自我创生多重宇宙？

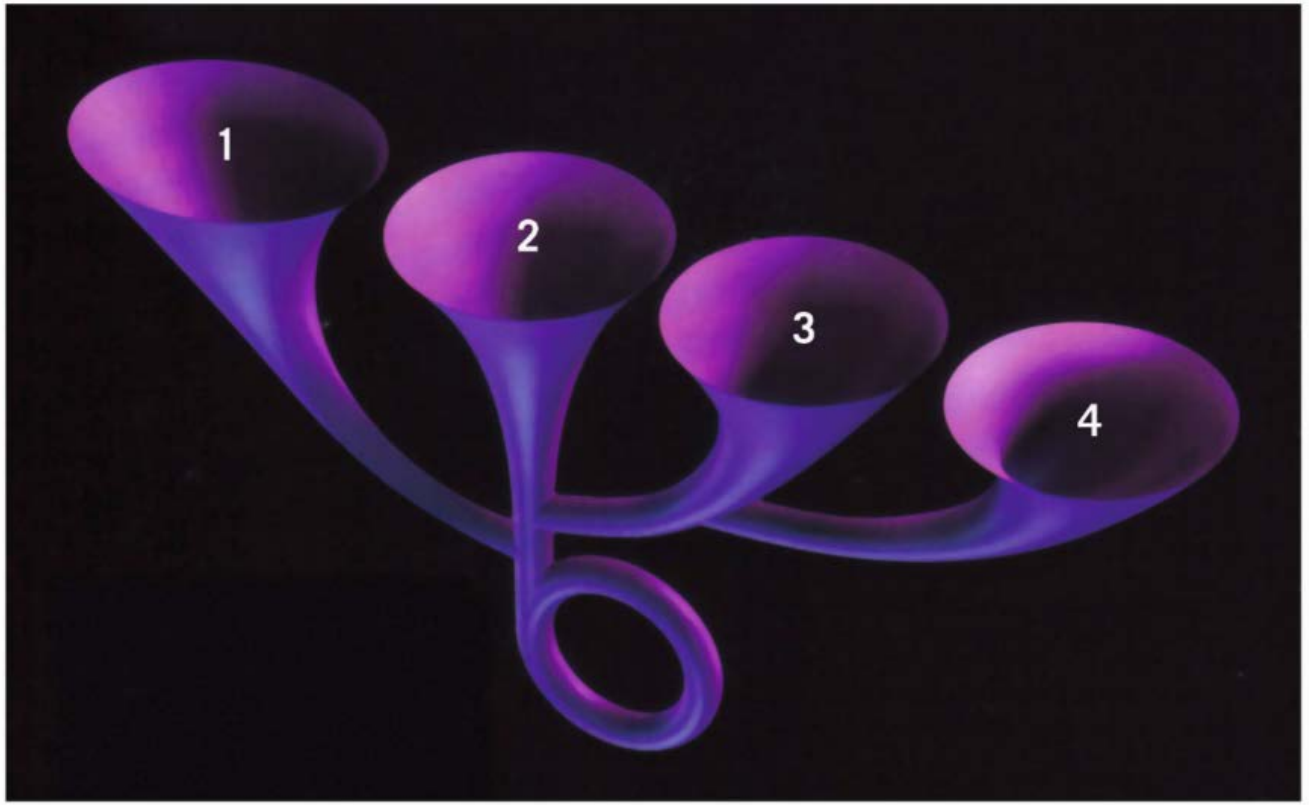
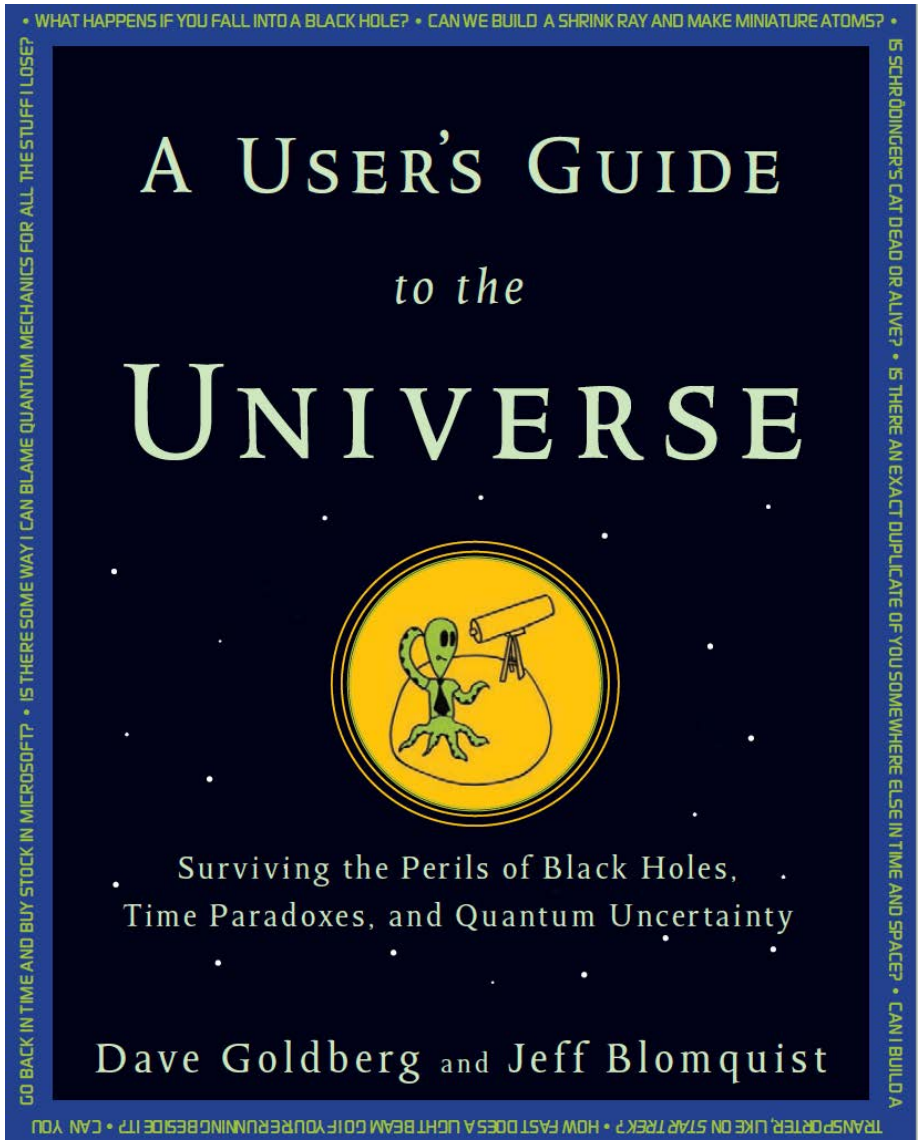


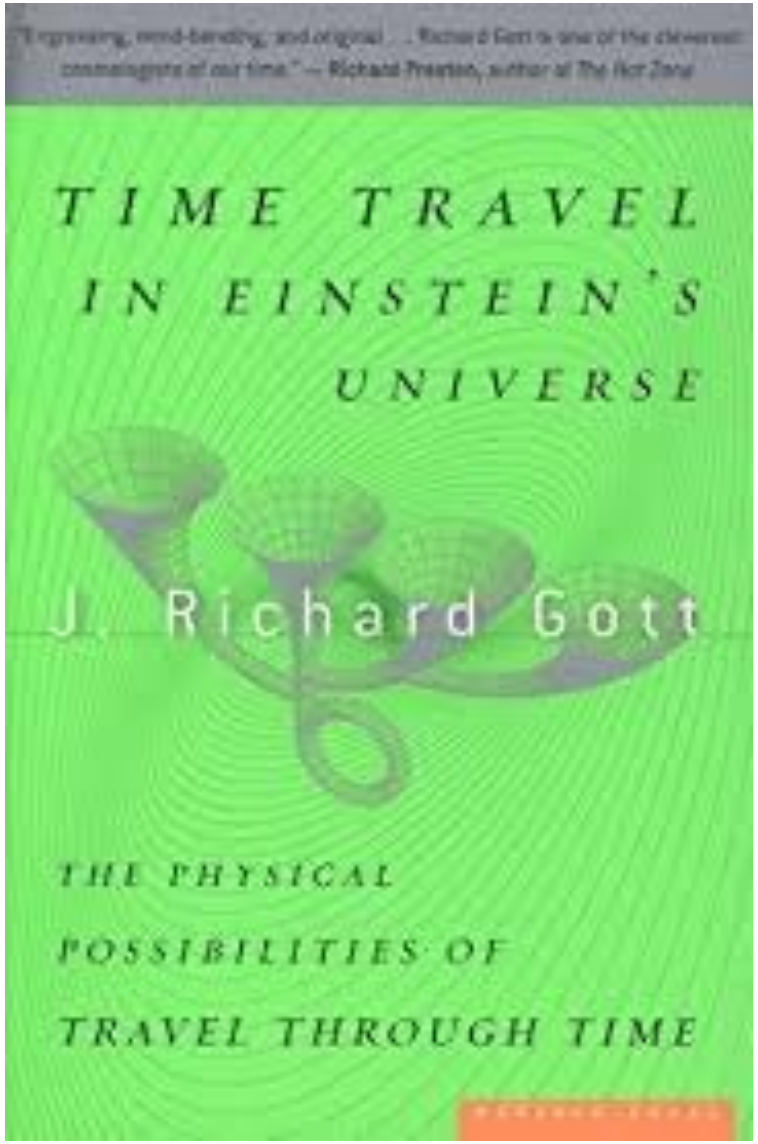
FIGURE 23.7. Gott–Li self-creating multiverse. The loop at the bottom represents a time machine; the universe gives birth to itself. *Photo credit:* J. Richard Gott, Robert J. Vanderbei (*Sizing Up the Universe*, National Geographic, 2011).

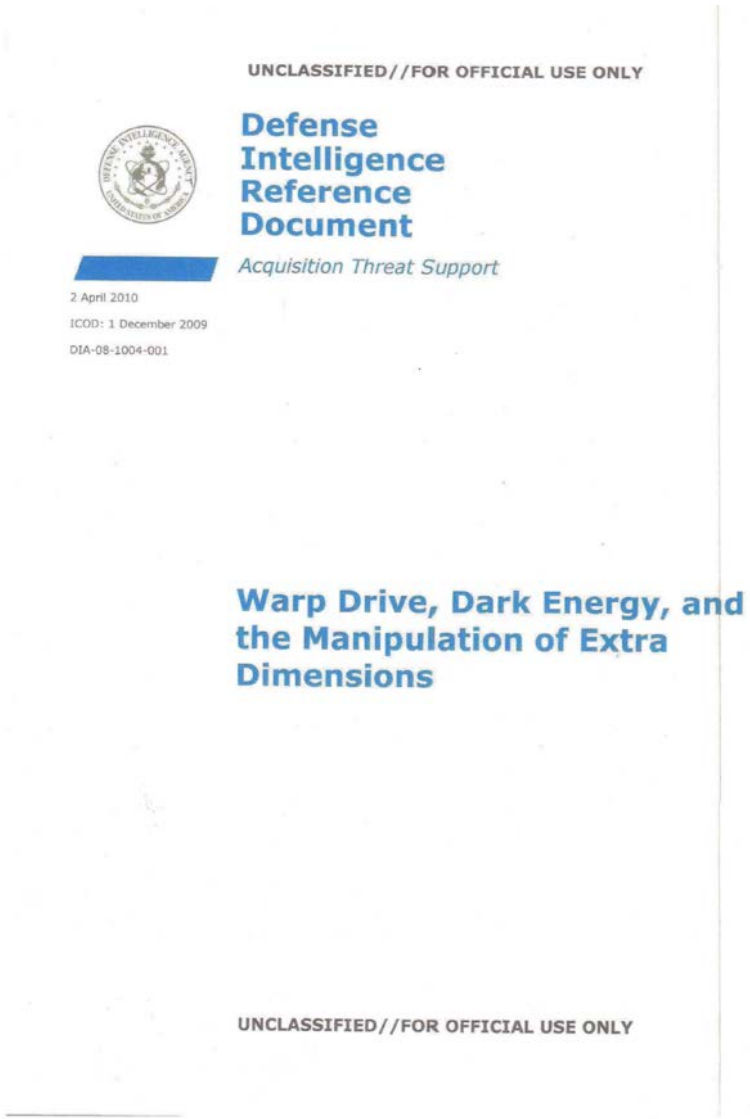
加來道雄：如果愛因斯坦是錯的？

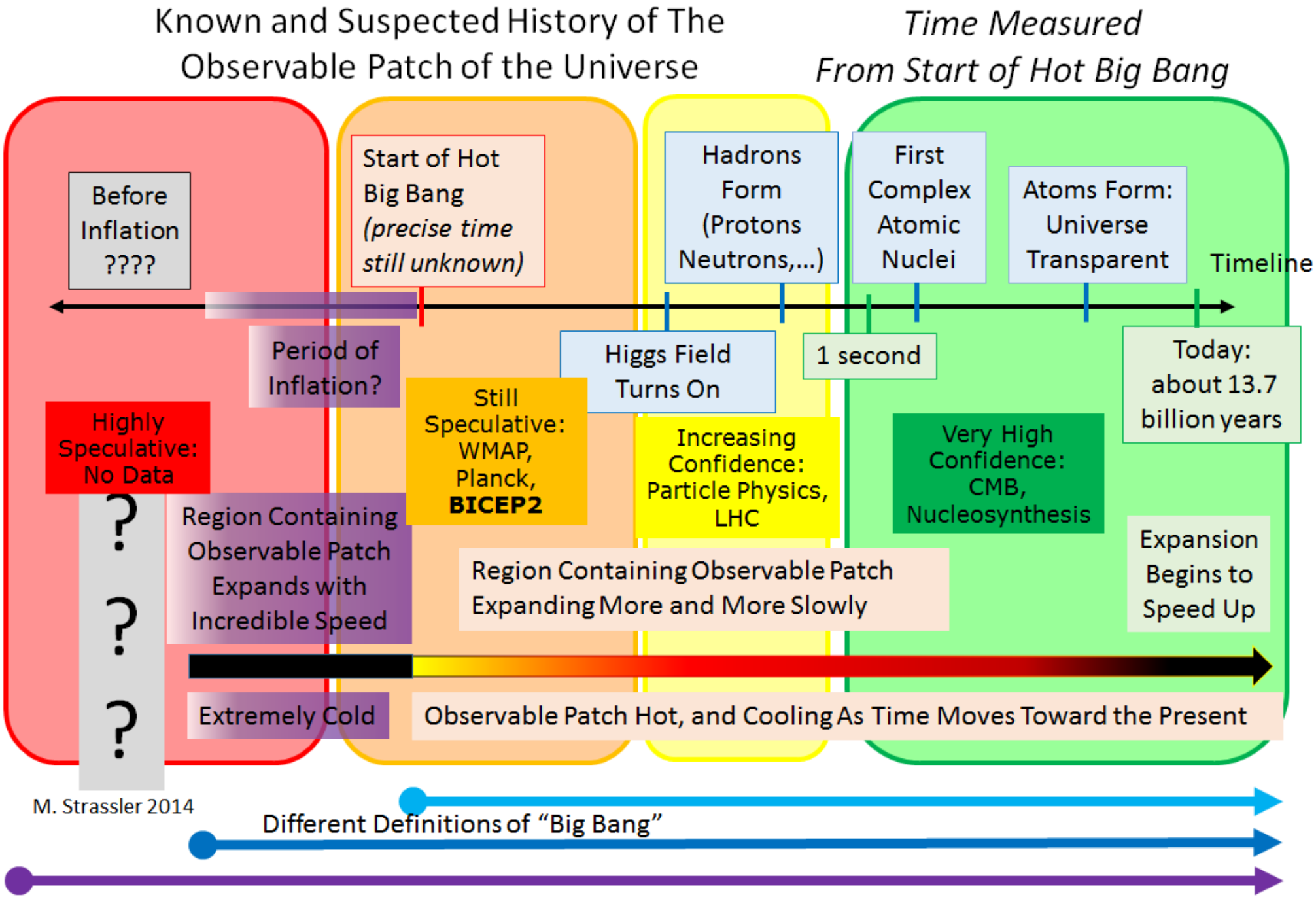
- https://www.youtube.com/watch?v=EaKsQzrNRRY

More References on Time Traveling








Known and Suspected History of The Observable Patch of the Universe
Time Measured From Start of Hot Big Bang
Before Inflation ????
Start of Hot Big Bang (precise time still unknown)
Hadrons Form (Protons Neutrons,...)
First Complex Atomic Nuclei
Atoms Form: Universe Transparent
Timeline
Period of Inflation?
Higgs Field Turns On
1 second
Today: about 13.7 billion years
Highly Speculative: No Data
Still Speculative: WMAP, Planck, BICEP2
Increasing Confidence: Particle Physics, LHC
Very High Confidence: CMB, Nucleosynthesis
? ? ?
Region Containing Observable Patch Expands with Incredible Speed
Region Containing Observable Patch Expanding More and More Slowly
Expansion Begins to Speed Up
Extremely Cold
Observable Patch Hot, and Cooling As Time Moves Toward the Present
M. Strassler 2014
Different Definitions of "Big Bang"

ON THE VERGE OF THE QUANTUM REVOLUTION

Quantum technology is based on controlling and manipulating individual quantum systems, such as single atoms and photons. Extremely fast quantum computers, intercept-proof communication, and hypersensitive measuring instruments are in sight.

Central quantum phenomena

used in quantum technology:

SUPERPOSITION

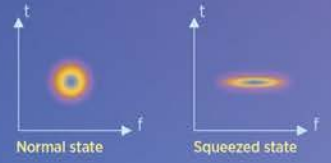
If an electron were on skis, it would be absolutely normal for it to go around both sides of a tree. In the world of quantum physics, particles can be simultaneously both here and there, have different energies, polarisations, and more. Such composite states are called *superpositions*.

ENTANGLEMENT

A superposition can extend between several particles. The link remains even if they are geographically separated – a manipulation of one particle affects the other one immediately. Einstein was sceptical, calling it "spooky action at a distance", but experiments have proved it.

SQUEEZED STATES

In the world of quantum physics, there is a limit to how accurately you can simultaneously know linked variables, such as frequency and time, for an object. By manipulating the object into a so-called squeezed state, one can have the uncertainty to primarily affect just one of the variables.



Quantum computers

There is still no quantum computer that can surpass a regular computer, but many are working on it. The most promising techniques are ion traps and superconducting circuits.

0 AND 1 AT THE SAME TIME

The basic information unit in a regular computer is the bit, which can take the value 0 or 1.

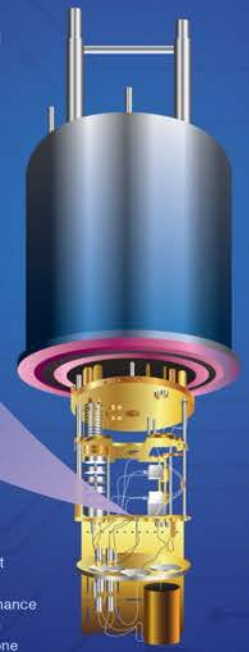
Thanks to superposition, the so-called qubits of the quantum computer can take the values 0 and 1 at the same time. Therefore, a quantum computer can calculate many possibilities at the same time, while a regular computer calculates just one thing at a time.

WHAT IS A QUANTUM COMPUTER GOOD AT?

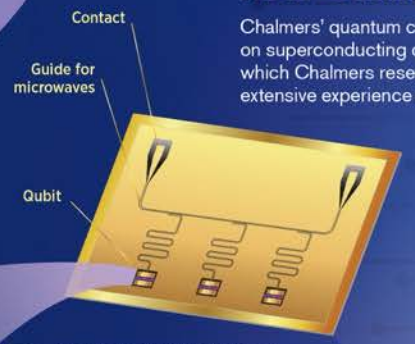
50–60 qubits are needed to surpass today's supercomputers. The quantum computer is particularly suitable for solving problems that involve a large number of possibilities, such as optimisation problems in machine learning, and calculation of properties of large molecules.

How Chalmers' quantum computer works

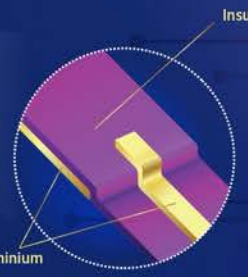
Chalmers' quantum computer is based on superconducting circuits, something which Chalmers researchers have extensive experience of working with.



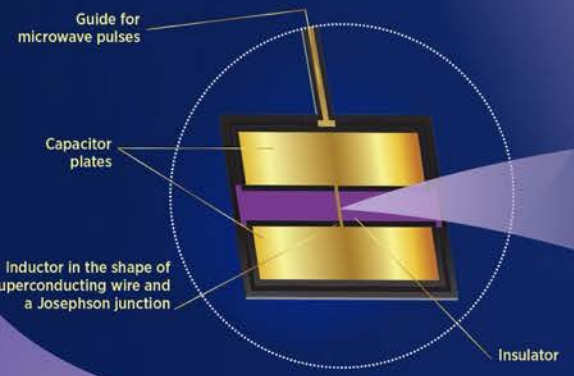
1 The superconducting circuits are placed in a cryostat, an advanced cooling unit in which the temperature is only 0.015 degrees above absolute zero. In here, the circuits conduct electricity without losses and thermal disturbances are almost non-existent.



2 The superconducting qubits, and microwave guides, are printed directly onto a circuit board using photo- and electron beam lithography.



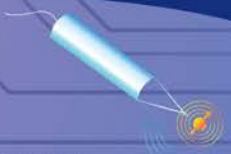
4 In the Josephson junction, the current passes, without resistance, a thin insulating layer. This affects the resonance frequency of the circuit, and prevents the qubit from absorbing more than one microwave photon.



3 The qubit is a lossless resonant circuit, which is activated by injecting a microwave pulse. Value 0 = no oscillating energy in the circuit, 1 = oscillating energy corresponding to a microwave photon. By designing the microwave pulse, the qubit can be set to any desired superposition of 0 and 1.

Quantum communication

By transferring encryption keys with single photons, it is possible to create completely intercept-proof communication. This can already be done today through unbroken optical fibres. But, in order to ensure the security of the future communication system, a global quantum network which can transmit encryption keys between many different points needs to be developed. In such a network, the phenomenon of entanglement would play a key role.



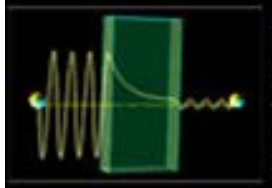
Quantum sensing

By using individual particles as sensors, the measurement ability is pushed to completely new levels. Squeezed states make it possible to further increase the accuracy, or make measurements immune to certain noise. The vision is that quantum sensors will make major contributions in, among other things, studying different processes within the body and making geological measurements.

Graphic: **Yen Strandqvist** Text: **Ingela Roos**

https://scrapbookingsinn.blogspot.com/2019/02/how-can-you-travel-faster-than-light.html

10 TECHNOLOGIES AND METHODS FOR TIME CONTROL AND TIME TRAVEL



Quantum Tunneling: is an evanescent wave coupling effect that occurs in quantum mechanics. The correct wavelength combined with the proper tunneling barrier makes it possible to pass signals faster than light, backwards in time. MORE

Circulating Light Beams: can be created using gamma and magnetic fields to warp time. The approach can twist space that causes time to be twisted, meaning you could theoretically walk through time as you walk through space. MORE

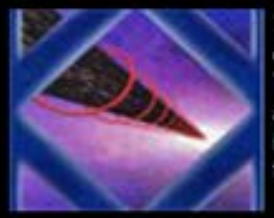
Near-Lightspeed Travel: has the ability to significantly dilate time, sending an accelerating traveler rapidly forward in time relative to those left behind before her travel. The closer to the speed of light, the further into the future the travel. MORE

Wormholes: are hypothetical areas of warped spacetime with great energy that can create tunnels through spacetime. If traversable they would allow a traveler to quickly move through great distances in space and also travel through time. MORE

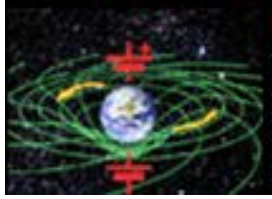
Alcubierre Warp Drive: stretches spacetime in a wave causing the fabric of space ahead of a spacecraft to contract and the space behind it to expand. The ship can ride the wave to accelerate to high speeds and time travel. MORE

Cosmic Strings: are a hypothetical 1-dimensional (spatially) topological defect in the fabric of spacetime left over from the formation of the universe. Interaction could create fields of closed timelike curves permitting backwards time travel. MORE

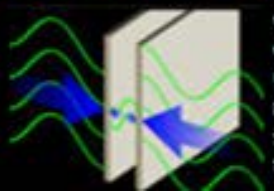
Faster-than-Light Travel: is a controversial subject. According to special relativity anything that could travel faster-than-light would move backward in time. As the same time, special relativity states that this would require infinite energy. MORE



Tipler Cylinder: uses a massive and long cylinder spinning around its longitudinal axis. The rotation creates a frame-dragging effect and fields of closed timelike curves traversable in a way to achieve subluminal time travel to the past. MORE



Time-warped Fields: use energy within curvatures of spacetime around a rotating mass or energy field to generate containable and controllable fields of closed-timelike curves that can move matter and information forward or backward in time. MORE



Casimir Effect: a physical force arising from a quantized field, for example between two uncharged plates. This can produce a locally mass-negative region of space-time that could stabilize a wormhole to allow faster than light travel. MORE


Futurism
The Kardashev Scale
Are We Advanced Yet?
Written by Luke Kingma
THIS IS NIKOLAI KARDASHEV, THE RENOWNED RUSSIAN ASTROPHYSICIST WHO MADE THIS COMIC STRIP POSSIBLE.
IN 1964, KARDASHEV PROPOSED A METHOD OF MEASURING THE TECHNOLOGICAL CAPABILITIES OF ALIEN CIVILIZATIONS.
THE KARDASHEV SCALE BY NIKOLAI KARDASHEV
WE WOULD CALL IT THE KARDASHEV SCALE (EVEN ASTROPHYSICISTS CAN BE VAIN).
THE ORIGINAL KARDASHEV SCALE HAS THREE TIERS: TYPE I, TYPE II, AND TYPE III CIVILIZATIONS.
THEY ARE STRUCTURED BASED ON THE AMOUNT OF ENERGY A CIVILIZATION IS ABLE TO HARVNESS.
TYPE I CIVILIZATIONS ARE ABLE TO HARNESS ALL OF THE ENERGY THAT REACHES THEIR HOME PLANET FROM THEIR HOME STAR.
TO BE A TYPE I CIVILIZATION WITH TODAY'S TECHNOLOGY, WE'D HAVE TO BLANKET THE ENTIRE EARTH WITH SOLAR PANELS.
THAT WOULDN'T BE A VERY FUN PLACE TO LIVE.
IN THE FUTURE, WE MAY BE ABLE TO INSTALL MASSIVE SOLAR POWER SATELLITES IN SPACE TO HELP US REACH TYPE I.
TYPE II CIVILIZATIONS ARE ABLE TO HARNESS ALL OF THE ENERGY THEIR HOME STAR GENERATES.
TO ACHIEVE THAT, WE'D HAVE TO BUILD A DYSON SPHERE.
NO, NOT THAT KIND OF DYSON SPHERE. WE'RE TALKING ABOUT A SOLID SHELL THAT COMPLETELY ENCLOSES THE SUN.
TYPE III CIVILIZATIONS ARE ABLE TO HARNESS ALL OF THE ENERGY OF THEIR HOME GALAXY.
TO ACHIEVE THAT, WE'D HAVE TO TAP INTO THE ENERGY OF THE SUPERMASSIVE BLACK HOLE THAT EXISTS AT OUR GALAXY'S CENTER.
BLACK HOLE ENERGY
KARDASHEV STOPPED HIS SCALE AT THREE, BUT OTHERS HAVE PROPOSED FURTHER LEVELS OF ADVANCEMENT.
TYPE IV CIVILIZATIONS WOULD BE ABLE TO HARNESS ALL OF THE ENERGY OF THEIR HOME UNIVERSE.
UNIVERSE 1
UNIVERSE 2
UNIVERSE 3
UNIVERSE 4
TYPE V CIVILIZATIONS WOULD BE ABLE TO HARNESS ALL OF THE ENERGY OF COLLECTIONS OF UNIVERSES.
SO, WHERE DOES HUMANITY RANK ON THE KARDASHEV SCALE?
WELL, IN 1973, CARL SAGAN ESTIMATED THAT WE'RE A .07.
.07
SEE MR. ASTER CLASS!!
TODAY, WE'RE PROBABLY CLOSER TO A .073.
Zzzzz
EXPERTS ESTIMATE THAT WE'LL REACH TYPE I IN 100-200 YEARS.
TYPE II COULD TAKE 1,000 TO 5,000 YEARS.
TYPE III MAY TAKE AS MANY AS 100,000 TO 1,000,000 YEARS.
SO... NO, WE'RE NOT ADVANCED YET.