早期宇宙與基礎物理

Toy Story

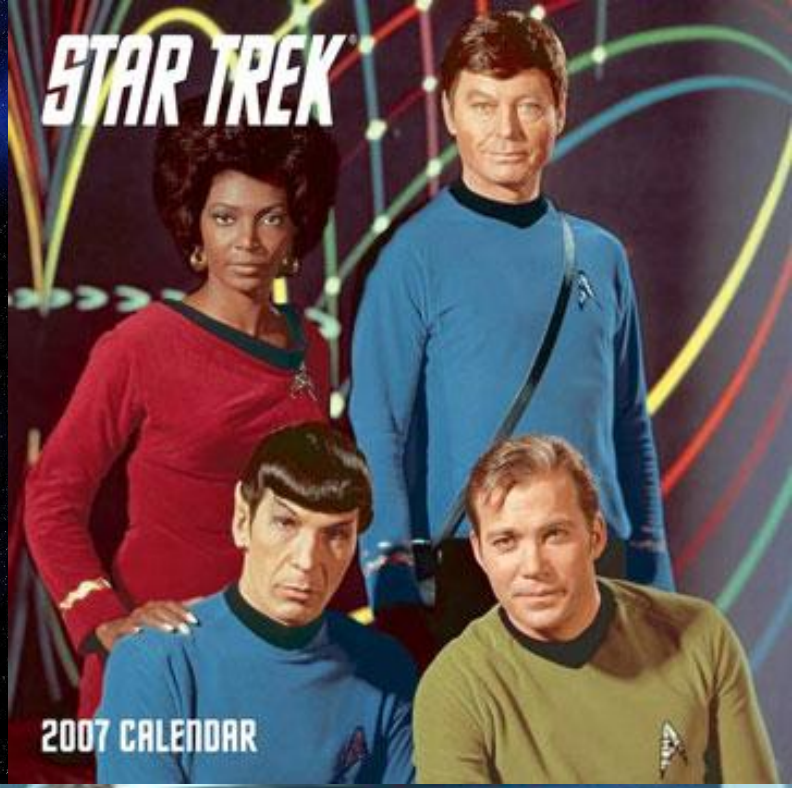
高文芳

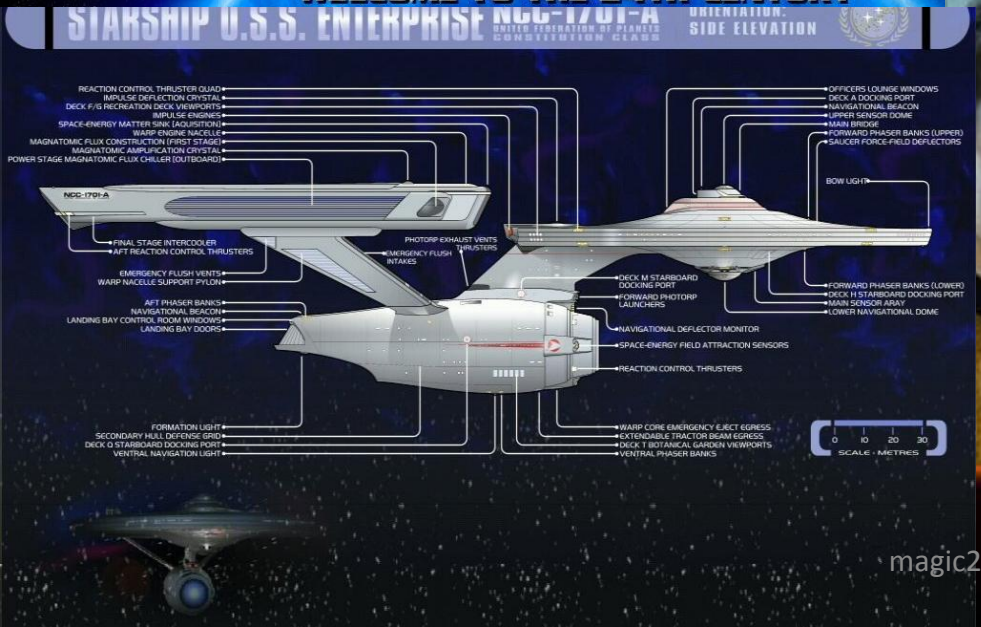
交大物理所

Stardate:1120120403

http://web.it.nctu.edu.tw/~wfgore/physics21.ppt

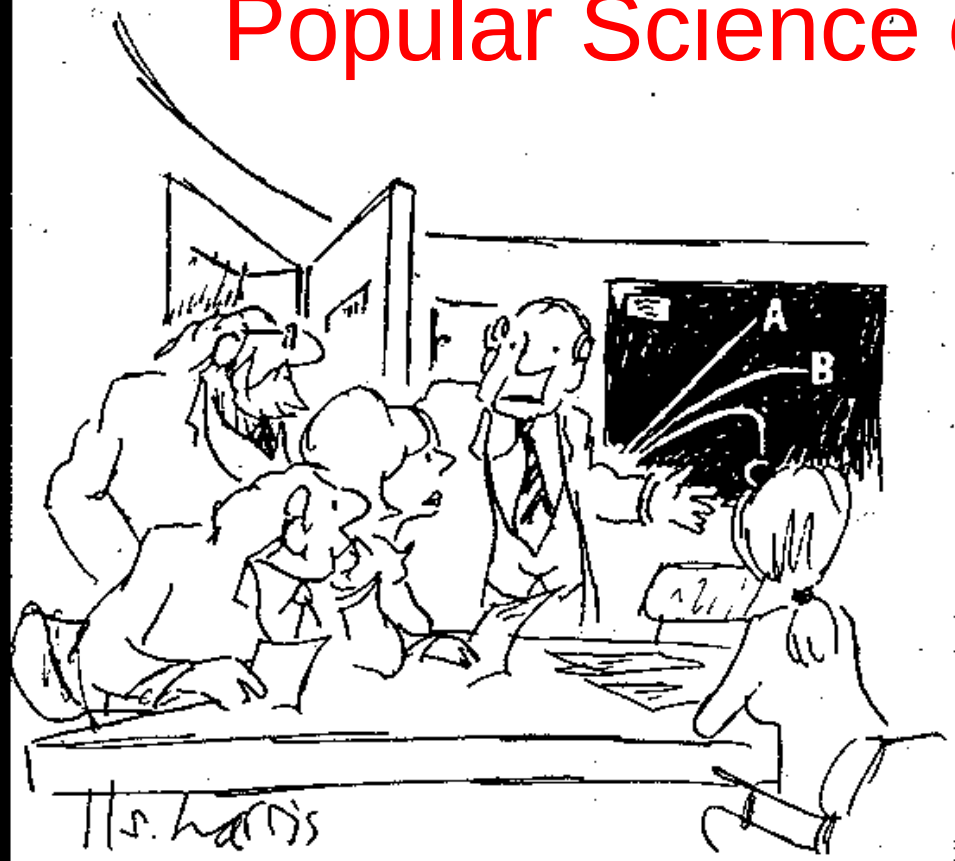

STAR TREK
WELCOME TO THE 24TH CENTURY


STAR TREK
2007 CALENDAR

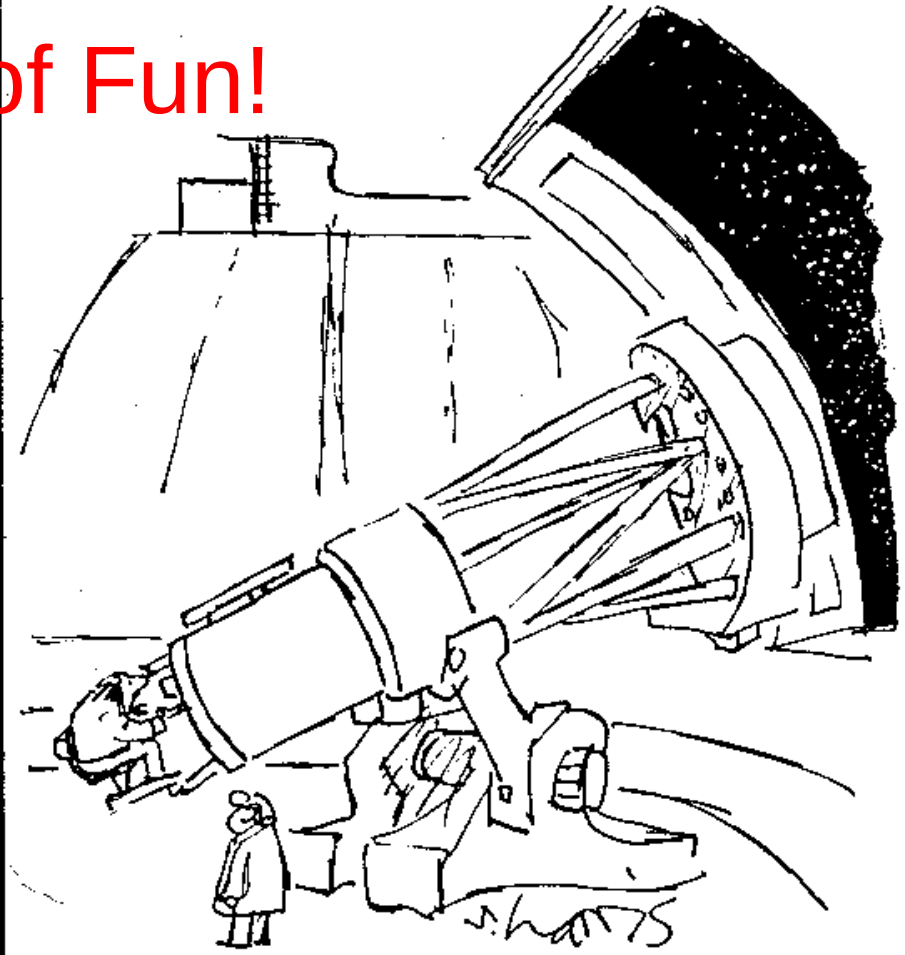

STARSHIP U.S.S. ENTERPRISE NCC-1701-A
SIDE ELEVATION
REACTION CONTROL THRUSTER QUAD
IMPULSE DEFLECTION CRYSTAL
DECK F/G RECREATION DECK VIEWPORTS
IMPULSE ENGINES
SPACE-ENERGY MATTER SINK [AQUISITION]
WARP ENGINE NACELLE
MAGNATOMIC FLUX CONSTRUCTION [FIRST STAGE]
MAGNATOMIC AMPLIFICATION CRYSTAL
POWER STAGE MAGNATOMIC FLUX CHILLER [OUTBOARD]
FINAL STAGE INTERCOOLER
AFT REACTION CONTROL THRUSTERS
EMERGENCY FLUSH VENTS
WARP NACELLE SUPPORT PYLON
AFT PHASER BANKS
NAVIGATIONAL BEACON
LANDING BAY CONTROL ROOM WINDOWS
LANDING BAY DOORS
FORMATION LIGHT
SECONDARY HULL DEFENSE GRID
DECK O STARBOARD DOCKING PORT
VENTRAL NAVIGATION LIGHT
PHOTORP EXHAUST VENTS
THRUSTERS
EMERGENCY FLUSH INTAKES
DECK M STARBOARD DOCKING PORT
FORWARD PHOTORP LAUNCHERS
NAVIGATIONAL DEFLECTOR MONITOR
SPACE-ENERGY FIELD ATTRACTION SENSORS
REACTION CONTROL THRUSTERS
WARP CORE EMERGENCY EJECT EGRESS
EXTENDABLE TRACTOR BEAM EGRESS
DECK T BOTANICAL GARDEN VIEWPORTS
VENTRAL PHASER BANKS
OFFICERS LOUNGE WINDOWS
DECK A DOCKING PORT
NAVIGATIONAL BEACON
UPPER SENSOR DOME
MAIN BRIDGE
FORWARD PHASER BANKS (UPPER)
SAUCER FORCE-FIELD DEFLECTORS
BOW LIGHT
FORWARD PHASER BANKS (LOWER)
DECK H STARBOARD DOCKING PORT
MAIN SENSOR ARRAY
LOWER NAVIGATIONAL DOME
0 10 20 30
SCALE - METRES


STAR TREK 2009
NEW ENTERPRISE CREW

Popular Science of Fun!



The universe will either continue expanding at its present rate, expand at a slower rate, or it will begin to contract. None of this, however, can account for the fact that it sometimes takes four days to get a letter from Chicago."



"Let's see, now ... picking up where we left off ... one billion, sixty-two million, thirty thousand, four hundred and thirteen ... one billion, sixty-two million, thirty thousand, four hundred and fourteen ... "

圖片來源

知識是人類共有財富

所有圖片取自

1. NASA網站 mostly HST pictures
2. 許瑞榮教授講義
3. 物理學家照片取自 APS等網站
4. 部分取自圖片附加說明網站

some of the transparencies were extracted from http://www.cfa.harvard.edu/seuforum/einstein/resources_speaker.htm 、
http://www.aip.de/~mstein/classes/Cosmology_201/

5. 如需轉載 請逕洽相關網站

一棵開花的樹 /席慕容

如何讓你遇見我
在這最美麗的時刻　為這
我已在佛前　求了五百年
求祂讓我們結一段塵緣

佛於是把我化作一棵樹
長在你必經的路旁
陽光下慎重地開滿了花
朵朵都是我前世的盼望

當你走近　請你細聽
那顫抖的葉是我等待的熱情
而當你終於無視地走過
在你身後落了一地的
朋友啊　那不是花瓣
是我凋零的心

Feynman 說教書
會讓自己覺得自己是有用的人
所以先謝謝大家搭乘企業號
讓我有機會變成有用的人

ladyous.blogspot.com

Crab Nebula – 超新星 super nova

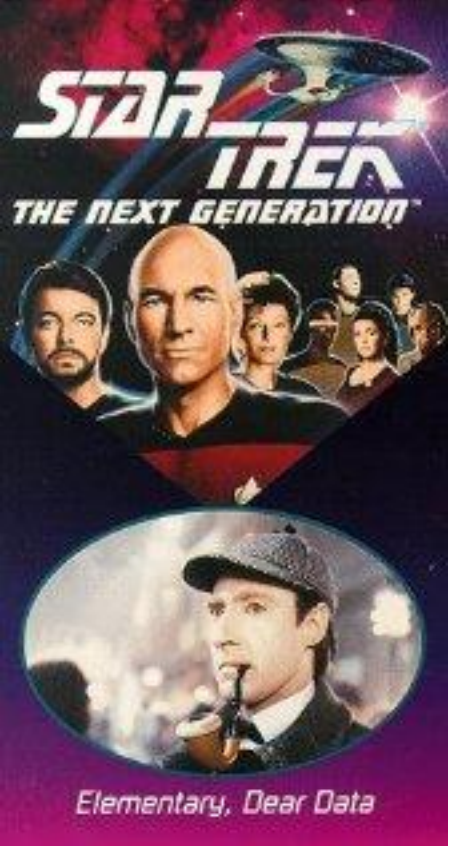
http://rst.gsfc.nasa.gov/Sect20/crab.jpg

十大驚奇

- 什麼物理現象最令人讚嘆？

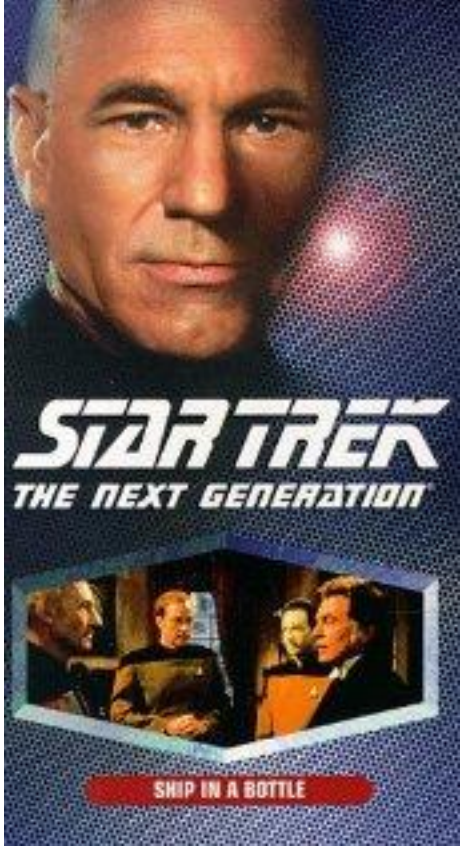
大自然讀過物理？

電子為何這麼聽話？



Professor James Moriarty

Countess Regina Bartholomew



www.imdb.com

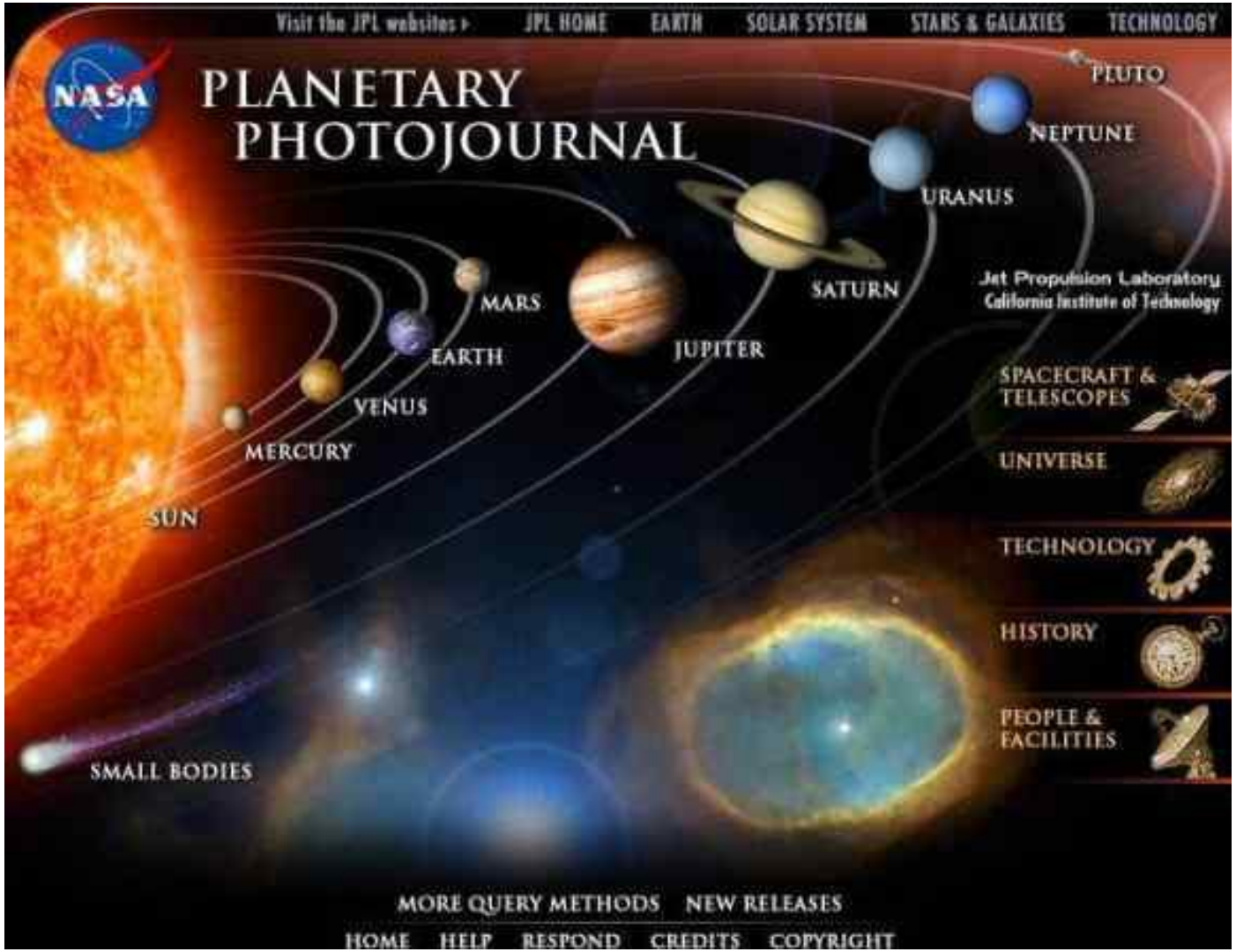
memory-alpha.org

Captain Picard: In a sense, who knows? Our reality may be very much like theirs. All this might just be an elaborate simulation running inside a little device sitting on someone's table.

給我五分鐘
我給你一個溫暖的家

給我十分
我給你一個浩瀚的宇宙

台灣100分，台灣的未來都滿分

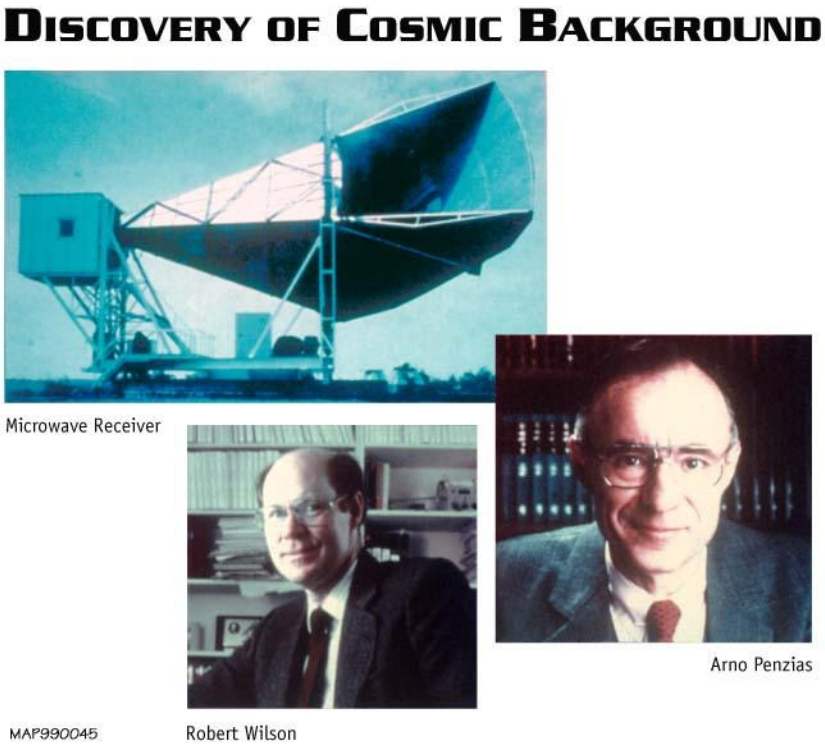


- 交大物理所高文芳為台灣訂製的未來 2004.8

仙女座 *M31.NGC 224* Andromeda

d ~ 2500 (kly) ~ 10^6 ly

圖VII: AT&T研究人員彭佳士與威爾遜與他們的電波天線。1964年，他們發現電波天線偵測到一個背景噪音。幾經努力，他們確信這個噪音不是來自儀器的雜訊，而是來自銀河系外。經過一些仔細、深入的測量與分析，他們推測這些噪音是波長約為$\lambda \fallingdotseq 7.35$ cm 的電磁輻射，更進一步測量不同波長雜訊的輻射強度，發現其輻射強度和波長的關係，暗示輻射源是大約 *2.73 K*的黑體輻射。



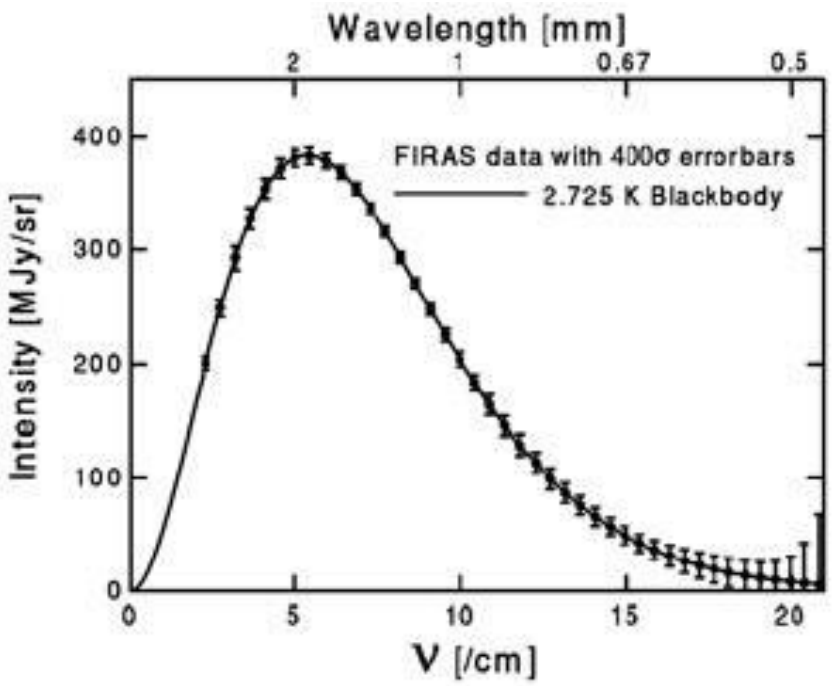
Alpher-Bethe-Gamow theory

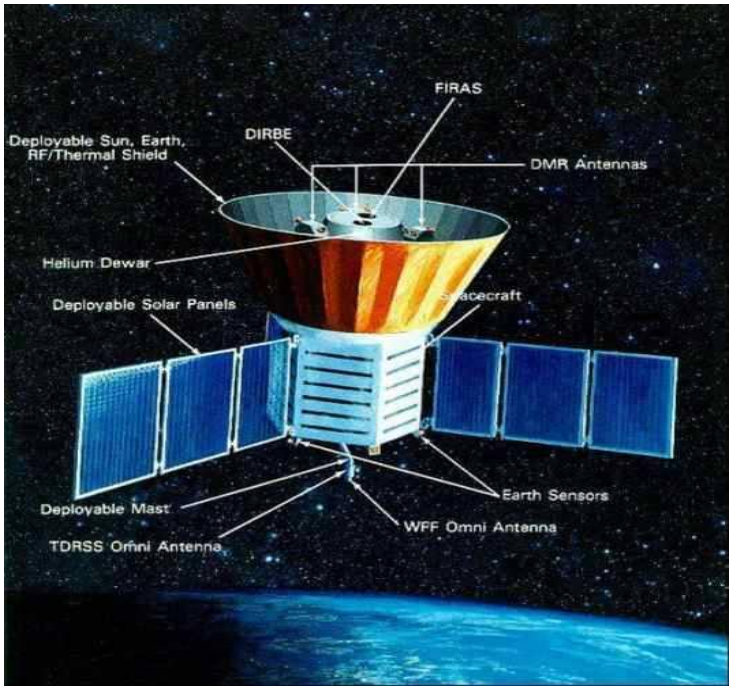
George Gamow
1904-1968

Gamow produced an important cosmogony paper with his student Ralph Alpher, which was published as "The Origin of Chemical Elements" (Physical Review, April 1, 1948). This paper became known as the Alpher-Bethe-Gamow theory. Gamow had the name of Hans Bethe listed on the article as "H. Bethe, Cornell University, Ithaca, New York" to make a pun on the first three letters of the Greek alphabet, alpha, beta and gamma. Bethe was also known for his sense of humor, but had no other role in the α-β-γ paper, and his name had been added without his knowledge. Gamow's lifetime interest in playing pranks, punning, and doggerel verse come across in some of his popular writings, notably his Mr. Tompkins... series of books (1939–1967).

The results of these calculations were first announced in a letter to The Physical Review, April 1, 1948. This was signed Alpher, Bethe, and Gamow, and is often referred to as the 'alphabetical article.' It seemed unfair to the Greek alphabet to have the article signed by Alpher and Gamow only, and so the name of Dr. Hans A. Bethe (in absentia) was inserted in preparing the manuscript for print. Dr. Bethe, who received a copy of the manuscript, did not object, and, as a matter of fact, was quite helpful in subsequent discussions. There was, however, a rumor that later, when the alpha, beta, gamma theory went temporarily on the rocks, Dr. Bethe seriously considered changing his name to Zacharias.

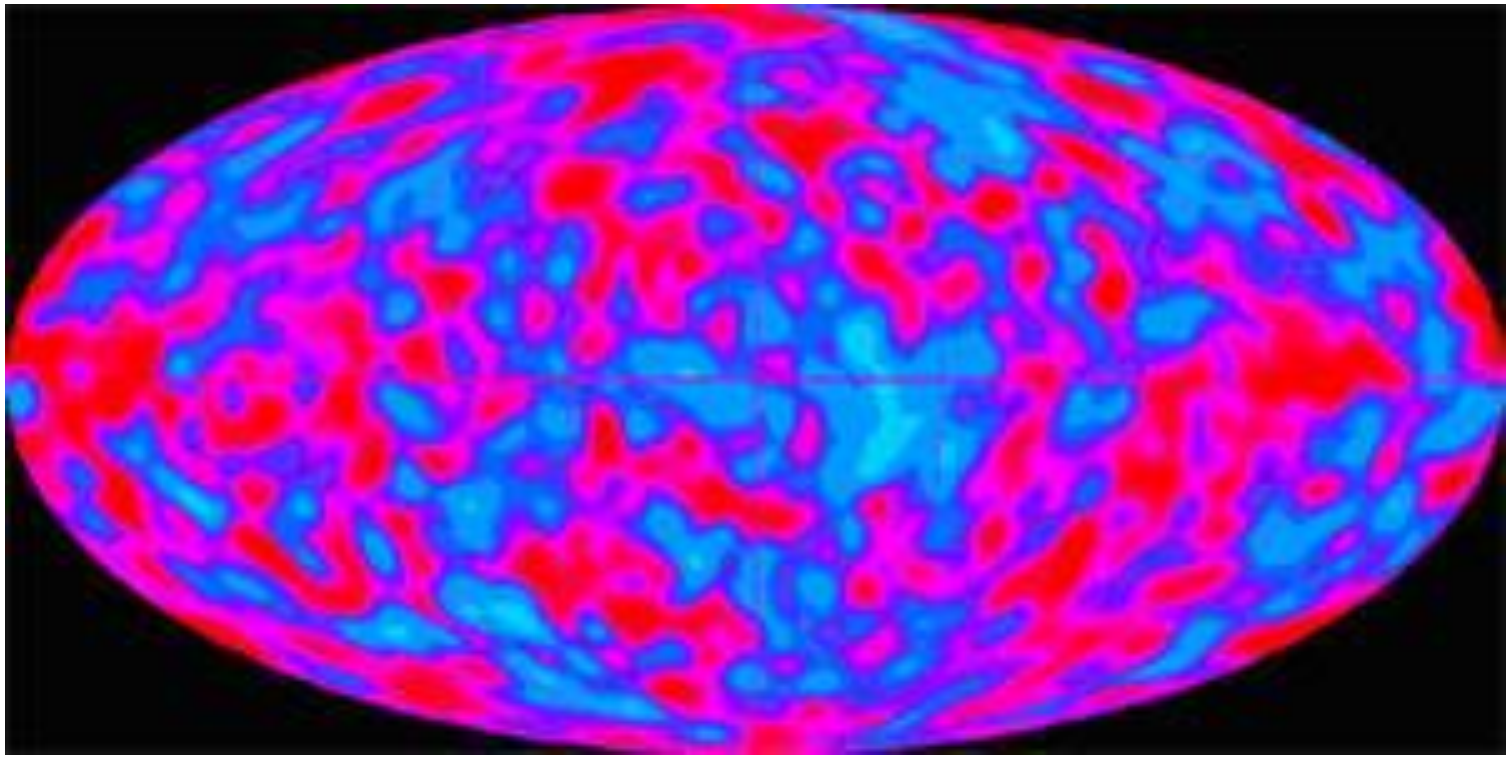
圖VIII：COBE (cosmic microwave background radiation explorer)衛星與COBE所測得的宇宙背景輻射其強度與波長之間的關係圖，這個圖就是引爆量子力學革命的黑體輻射特性圖。



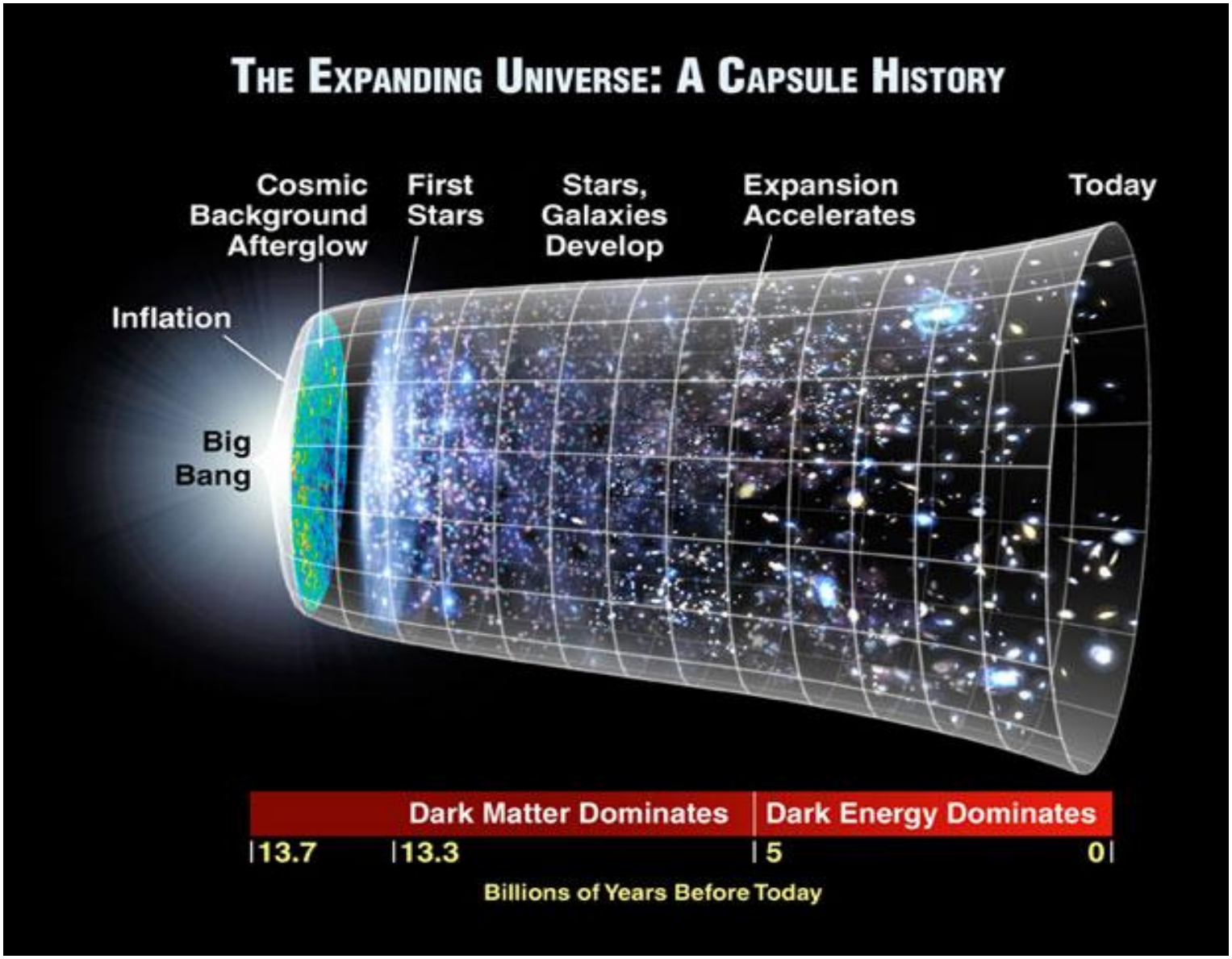


1 Jy(Jansky)=10^{-26} W/m^2/hz

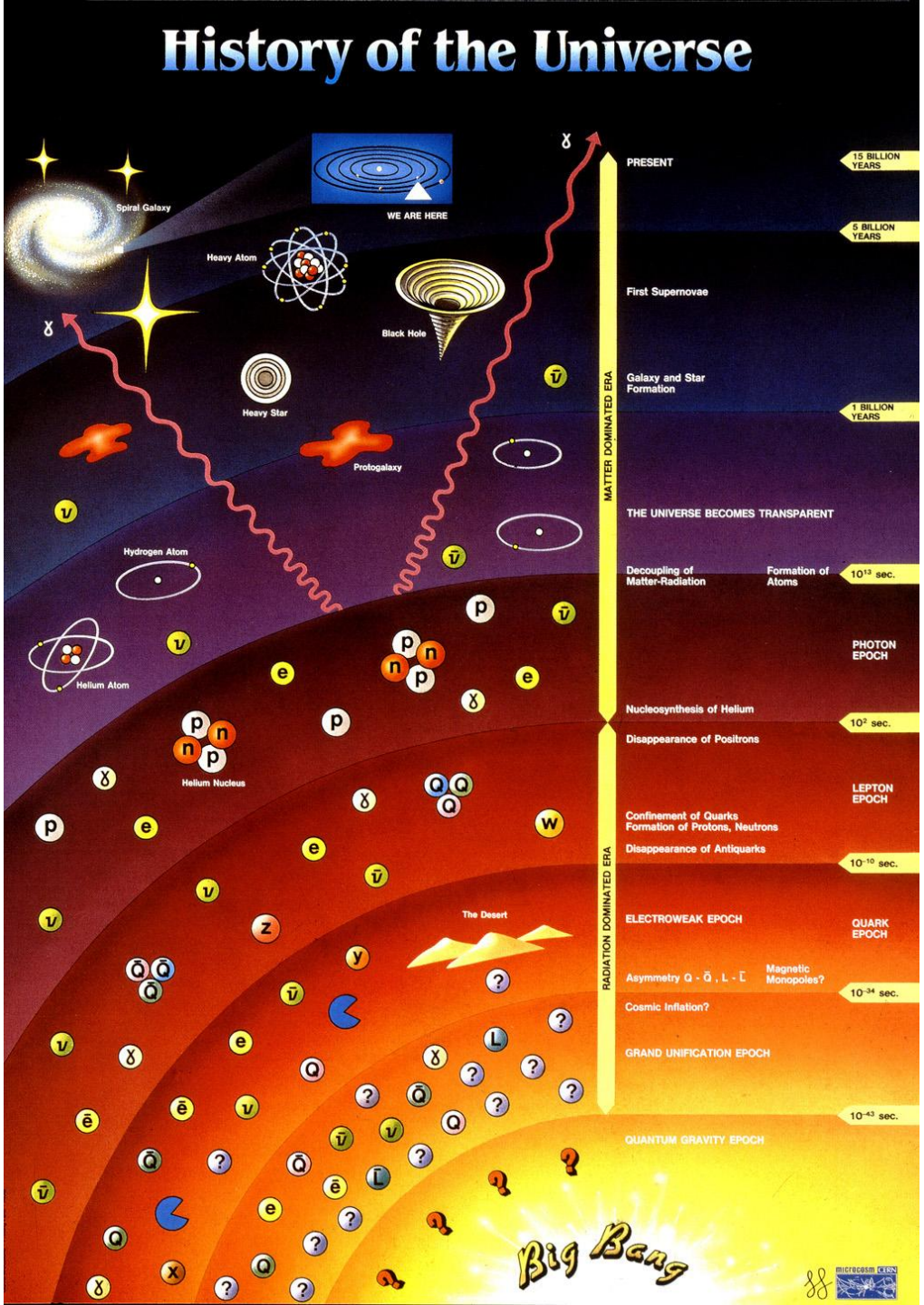
圖IX：COBE所量得的宇宙黑體溫度分布圖，紅色代表溫度較高，其溫差上下僅為10^{-4}K。



宇宙加速膨脹挑戰科學對時空的認識



http://hetdex.org/dark_energy/index.php


History of the Universe
Spiral Galaxy
WE ARE HERE
Heavy Atom
Black Hole
Heavy Star
Protogalaxy
Hydrogen Atom
Helium Atom
Helium Nucleus
The Desert
Big Bang
PRESENT
15 BILLION YEARS
5 BILLION YEARS
First Supernovae
Galaxy and Star Formation
1 BILLION YEARS
THE UNIVERSE BECOMES TRANSPARENT
Decoupling of Matter-Radiation
Formation of Atoms
10^{13} sec.
PHOTON EPOCH
Nucleosynthesis of Helium
10^{2} sec.
Disappearance of Positrons
LEPTON EPOCH
Confinement of Quarks
Formation of Protons, Neutrons
Disappearance of Antiquarks
10^{-10} sec.
ELECTROWEAK EPOCH
QUARK EPOCH
Asymmetry Q - Q̄ , L - L̄
Magnetic Monopoles?
10^{-34} sec.
Cosmic Inflation?
GRAND UNIFICATION EPOCH
10^{-43} sec.
QUANTUM GRAVITY EPOCH
MATTER DOMINATED ERA
RADIATION DOMINATED ERA

Standard Model of
FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model summarizes the current knowledge in Particle Physics. It is the quantum theory that includes the theory of strong interactions (quantum chromodynamics or QCD) and the unified theory of weak and electromagnetic interactions (electroweak). Gravity is included on this chart because it is one of the fundamental interactions even though not part of the "Standard Model."

FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2

Flavor	Mass GeV/c^2	Electric charge
ν_e electron neutrino	$<1\times10^{-8}$	0
e electron	0.000511	–1
ν_μ muon neutrino	<0.0002	0
μ muon	0.106	–1
ν_τ tau neutrino	<0.02	0
τ tau	1.7771	–1

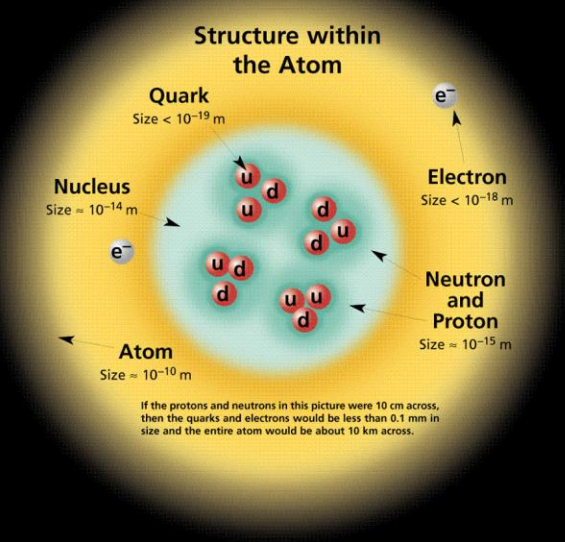
Quarks spin = 1/2

Flavor	Approx. Mass GeV/c^2	Electric charge
u up	0.003	2/3
d down	0.006	–1/3
c charm	1.3	2/3
s strange	0.1	–1/3
t top	175	2/3
b bottom	4.3	–1/3

Spin is the intrinsic angular momentum of particles. Spin is given in units of $\hbar$, which is the quantum unit of angular momentum, where $\hbar = h/2\pi = 6.58\times10^{-25}$ GeV s = 1.05×10^{-34} J s.

Electric charges are given in units of the proton's charge. In SI units the electric charge of the proton is 1.60×10^{-19} coulombs.

The **energy** unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c^2 (remember $E = mc^2$), where 1 GeV = 10^9 eV = 1.60×10^{-10} joule. The mass of the proton is 0.938 GeV/c^2 = 1.67×10^{-27} kg.



If the protons and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the entire atom would be about 10 km across.

BOSONS

force carriers
spin = 0, 1, 2, ...

Unified Electroweak spin = 1

Name	Mass GeV/c^2	Electric charge
γ photon	0	0
W^-	80.4	–1
W^+	80.4	+1
Z^0	91.187	0

Strong (color) spin = 1

Name	Mass GeV/c^2	Electric charge
g gluon	0	0

Color Charge
Each quark carries one of three types of "strong charge," also called "color charge." These charges have nothing to do with the colors of visible light. There are eight possible types of color charge for gluons. Just as electrically-charged particles interact by exchanging photons, in strong interactions color-charged particles interact by exchanging gluons. Leptons, photons, and ***W*** and ***Z*** bosons have no strong interactions and hence no color charge.

Quarks Confined in Mesons and Baryons
One cannot isolate quarks and gluons; they are confined in color-neutral particles called **hadrons**. This confinement (binding) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy in the color-force field between them increases. This energy eventually is converted into additional quark-antiquark pairs (see figure below). The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge. Two types of hadrons have been observed in nature: **mesons** $q\bar{q}$ and **baryons** qqq.

Residual Strong Interaction
The strong binding of color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color-charged constituents. It is similar to the residual electrical interaction that binds electrically neutral atoms to form molecules. It can also be viewed as the exchange of mesons between the hadrons.

PROPERTIES OF THE INTERACTIONS

Property \ Interaction	Gravitational	Weak	Electromagnetic	Strong: Fundamental	Strong: Residual
		(Electroweak)			
Acts on:	Mass – Energy	Flavor	Electric Charge	Color Charge	See Residual Strong Interaction Note
Particles experiencing:	All	Quarks, Leptons	Electrically charged	Quarks, Gluons	Hadrons
Particles mediating:	Graviton (not yet observed)	W^+ W^- Z^0	γ	Gluons	Mesons
Strength relative to electromag for two u quarks at: 10^{-18} m	10^{-41}	0.8	1	25	Not applicable to quarks
Strength relative to electromag for two u quarks at: 3×10^{-17} m	10^{-41}	10^{-4}	1	60	
for two protons in nucleus	10^{-36}	10^{-7}	1	Not applicable to hadrons	20

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$

Baryons are fermionic hadrons.
There are about 120 types of baryons.

Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
p	proton	uud	1	0.938	1/2
$\bar{p}$	anti-proton	$\bar{u}\bar{u}\bar{d}$	–1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	omega	sss	–1	1.672	3/2

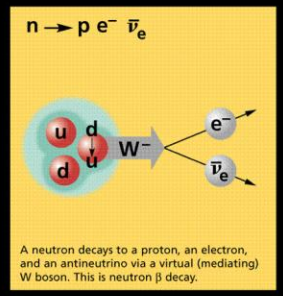
Mesons $q\bar{q}$

Mesons are bosonic hadrons.
There are about 140 types of mesons.

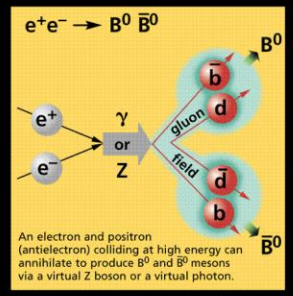
Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
π^+	pion	$u\bar{d}$	+1	0.140	0
K^-	kaon	$s\bar{u}$	–1	0.494	0
ρ^+	rho	$u\bar{d}$	+1	0.770	1
B^0	B-zero	$d\bar{b}$	0	5.279	0
η_c	eta-c	$c\bar{c}$	0	2 .980	0

Matter and Antimatter
For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol (unless + or – charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (e.g., Z^0, γ, and $\eta_c = c\bar{c}$, but not $K^0 = d\bar{s}$) are their own antiparticles.

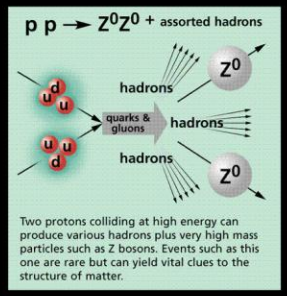
Figures
These diagrams are an artist's conception of physical processes. They are ***not*** exact and have ***no*** meaningful scale. Green shaded areas represent the cloud of gluons or the gluon field, and red lines the quark paths.



A neutron decays to a proton, an electron, and an antineutrino via a virtual (mediating) W boson. This is neutron β decay.



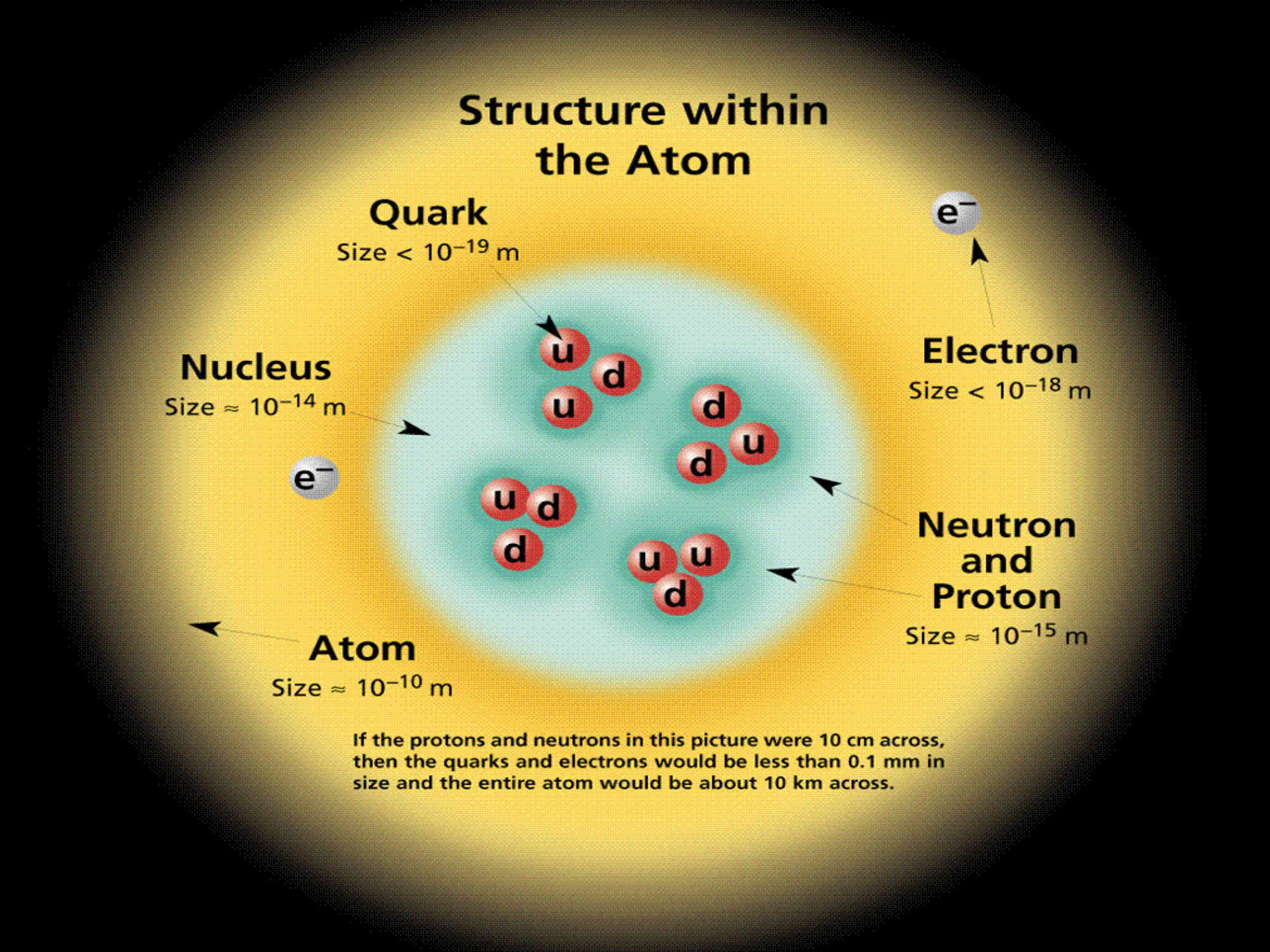
An electron and positron (antielectron) colliding at high energy can annihilate to produce B^0 and $\bar{B}^0$ mesons via a virtual Z boson or a virtual photon.



Two protons colliding at high energy can produce various hadrons plus very high mass particles such as Z bosons. Events such as this one are rare but can yield vital clues to the structure of matter.

The Particle Adventure
Visit the award-winning web feature *The Particle Adventure* at
http://ParticleAdventure.org

This chart has been made possible by the generous support of:
U.S. Department of Energy
U.S. National Science Foundation
Lawrence Berkeley National Laboratory
Stanford Linear Accelerator Center
American Physical Society, Division of Particles and Fields
BURLE INDUSTRIES, INC.


Structure within the Atom
Quark
Size < 10^{-19} m
Nucleus
Size ≈ 10^{-14} m
Atom
Size ≈ 10^{-10} m
Electron
Size < 10^{-18} m
Neutron and Proton
Size ≈ 10^{-15} m
e⁻
e⁻
u
d
u
d
d
u
d
u
d
u
u
d
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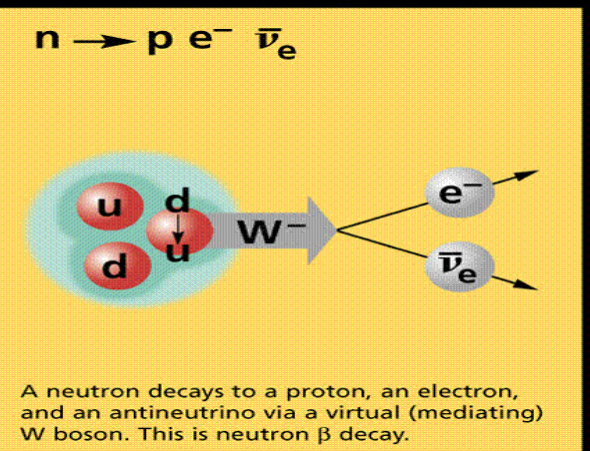
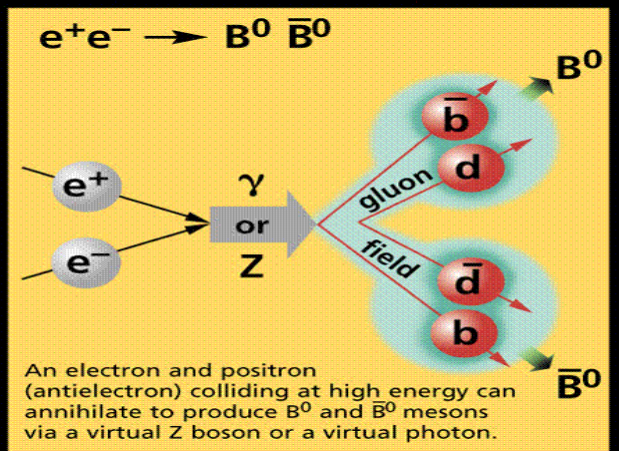
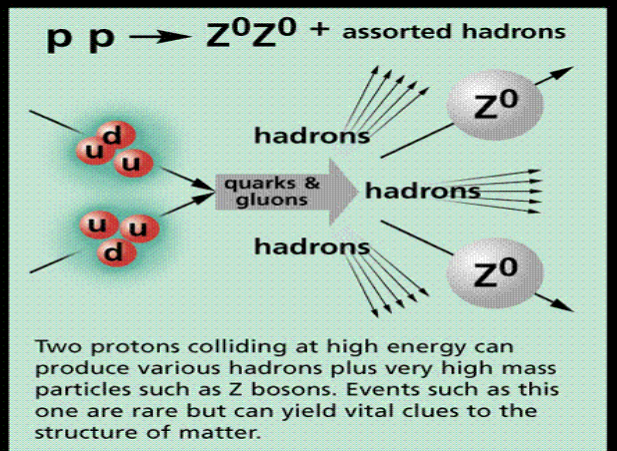


A neutron decays to a proton, an electron, and an antineutrino via a virtual (mediating) W boson. This is neutron β decay.



An electron and positron (antielectron) colliding at high energy can annihilate to produce B^0 and $\bar{B}^0$ mesons via a virtual Z boson or a virtual photon.



Two protons colliding at high energy can produce various hadrons plus very high mass particles such as Z bosons. Events such as this one are rare but can yield vital clues to the structure of matter.

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$

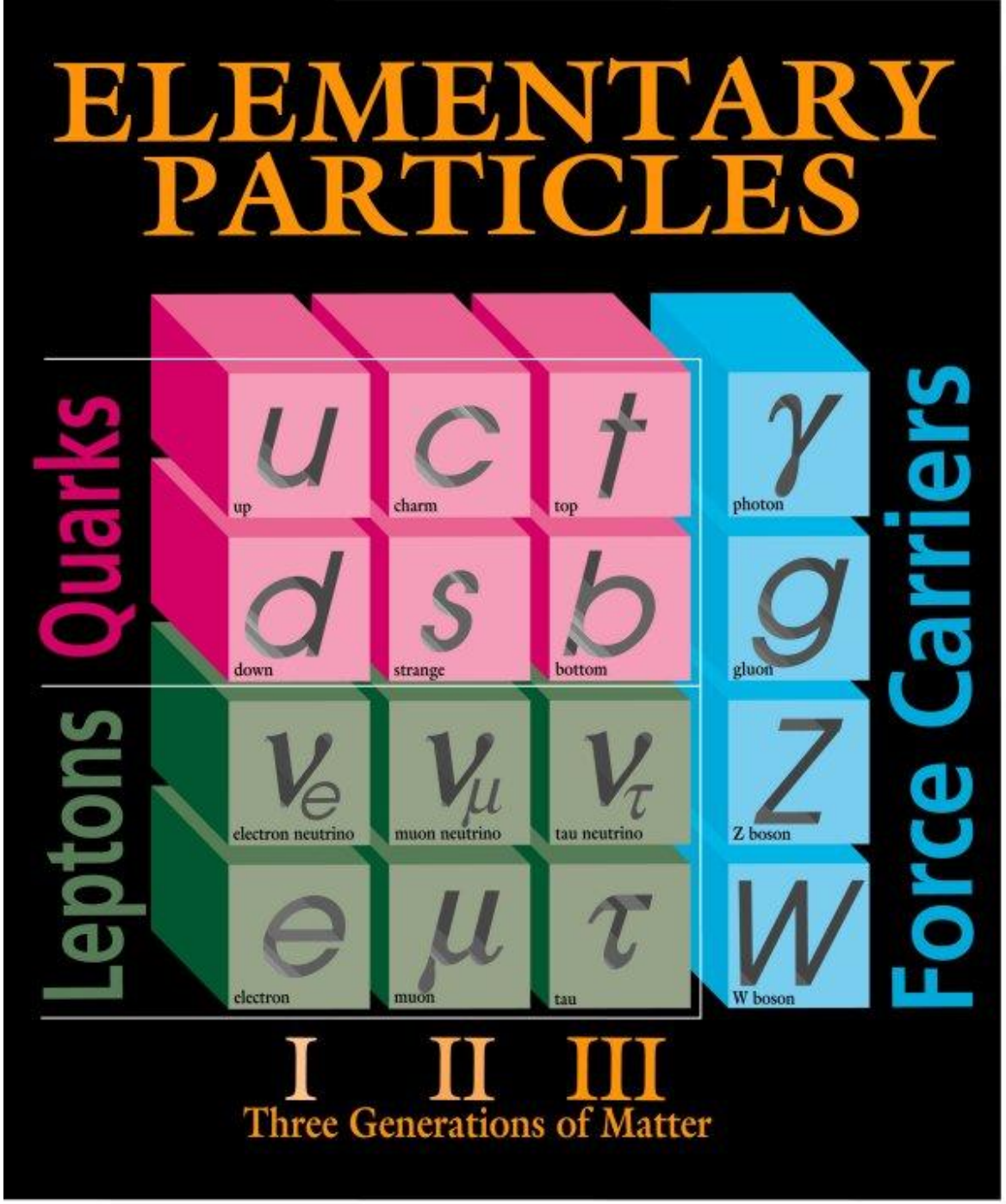
Baryons are fermionic hadrons.
There are about 120 types of baryons.

Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
p	proton	uud	1	0.938	1/2
$\bar{p}$	anti-proton	$\bar{u}\bar{u}\bar{d}$	–1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	omega	sss	–1	1.672	3/2

Mesons $q\bar{q}$

Mesons are bosonic hadrons.
There are about 140 types of mesons.

Symbol	Name	Quark content	Electric charge	Mass GeV/c^2	Spin
π^+	pion	$u\bar{d}$	+1	0.140	0
K^-	kaon	$s\bar{u}$	–1	0.494	0
ρ^+	rho	$u\bar{d}$	+1	0.770	1
B^0	B-zero	$d\bar{b}$	0	5.279	0
η_c	eta-c	$c\bar{c}$	0	2 .980	0



Yang, C. N.; Mills, R. (1954). "Conservation of Isotopic Spin and Isotopic Gauge Invariance". Physical Review 96 (1): 191–195

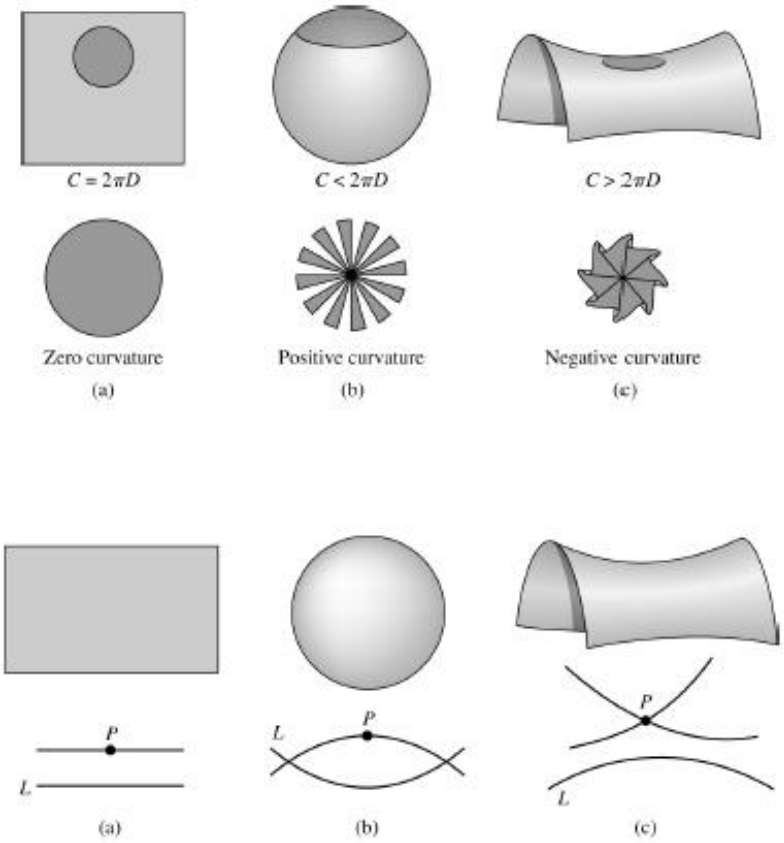
Conservation of Isotopic Spin and Isotopic Gauge Invariance*

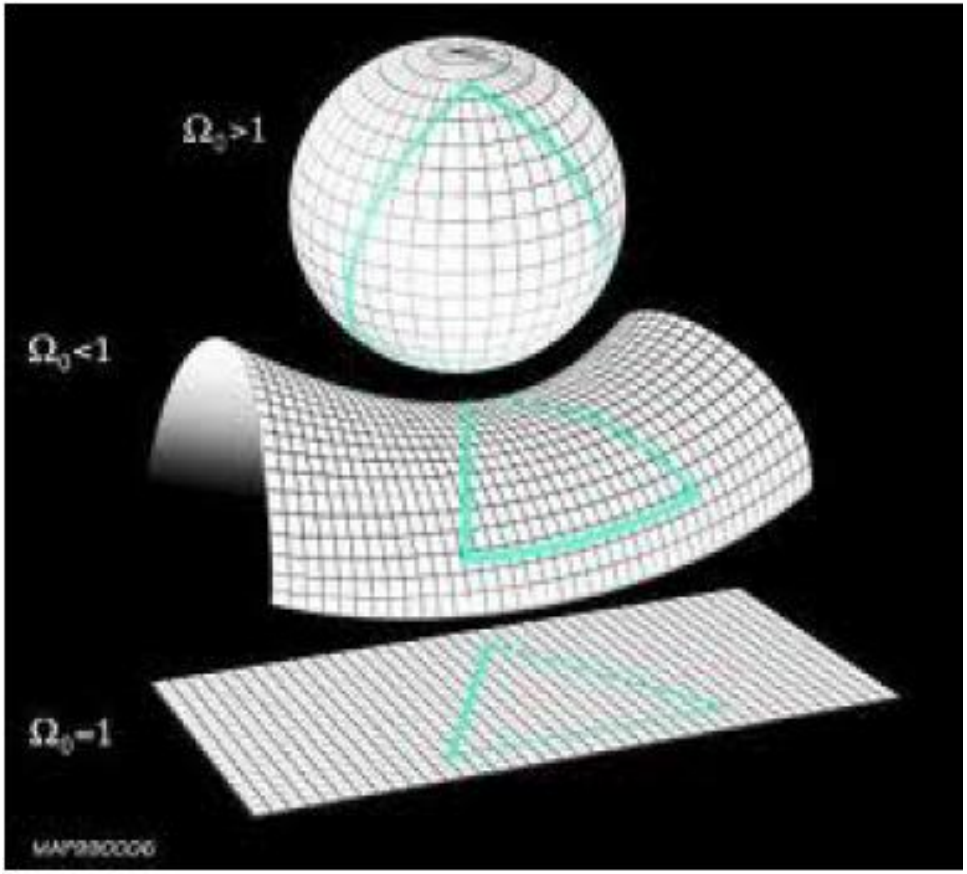
C. N. YANG † AND R. L. MILLS
Brookhaven National Laboratory, Upton, New York
(Received June 28, 1954)

It is pointed out that the usual principle of invariance under isotopic spin rotation is not consistant with the concept of localized fields. The possibility is explored of having invariance under local isotopic spin rotations. This leads to formulating a principle of isotopic gauge invariance and the existence of a **b** field which has the same relation to the isotopic spin that the electromagnetic field has to the electric charge. The **b** field satisfies nonlinear differential equations. The quanta of the **b** field are particles with spin unity, isotopic spin unity, and electric charge $\pm e$ or zero.

C. N. Yang (1922 -) and Robert Mills (1927 - 1999)
at Stony Brook in 1999.

均勻、無向
Friedmann-Robertson-Walker 空間





http://web.it.nctu.edu.tw/~wfgore/cosmology121.pdf

$$X^2 + Y^2 + Z^2 + W^2 = A^2$$
$$X^2 + Y^2 + Z^2 = B^2$$
$$X^2 + Y^2 + Z^2 - W^2 = A^2$$

$$X = A \sin\chi \sin\theta \sin\varphi,$$
$$Y = A \sin\chi \sin\theta \cos\varphi,$$
$$Z = A \sin\chi \cos\theta,$$
$$W = A \cos\chi.$$

宇宙學簡介講義 http://web.it.nctu.edu.tw/~wfgore/cosmology121.pdf

$$X = A \sin\chi \sin\theta \sin\varphi,$$
$$Y = A \sin\chi \sin\theta \cos\varphi,$$
$$Z = A \sin\chi \cos\theta,$$
$$W = A \cos\chi.$$

$$dX^2 + dY^2 + dZ^2 + dW^2 = A^2 \left[d\chi^2 + \sin^2\chi d\Omega \right].$$

$$r = \sin\chi \qquad dr = \cos\chi d\chi$$

$$dr^2/\cos^2\chi = d\chi^2 = dr^2/(1 - r^2)$$

$$\left[\frac{dr^2}{1 - kr^2} + r^2(d\theta^2 + \sin^2\theta \; d\varphi^2) \right]$$

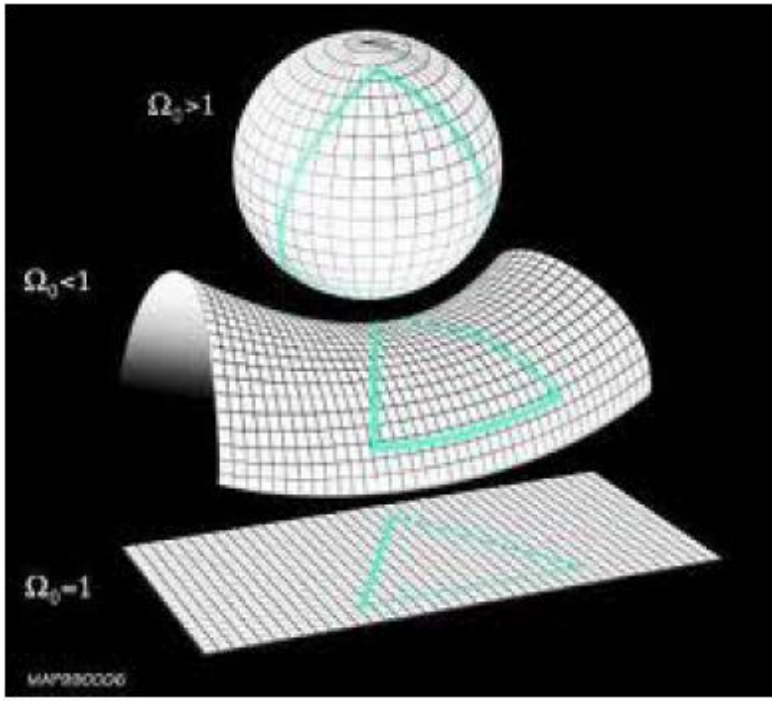
Similarly for the open space with $k = -1$ by replacing $\sin\chi$ ($\cos\chi$) with $\sinh\chi$ ($\cosh\chi$).

$$\left[\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\theta\ d\varphi^2)\right]$$

$$ds_3^2 = g_{ij}dx^i dx^j$$

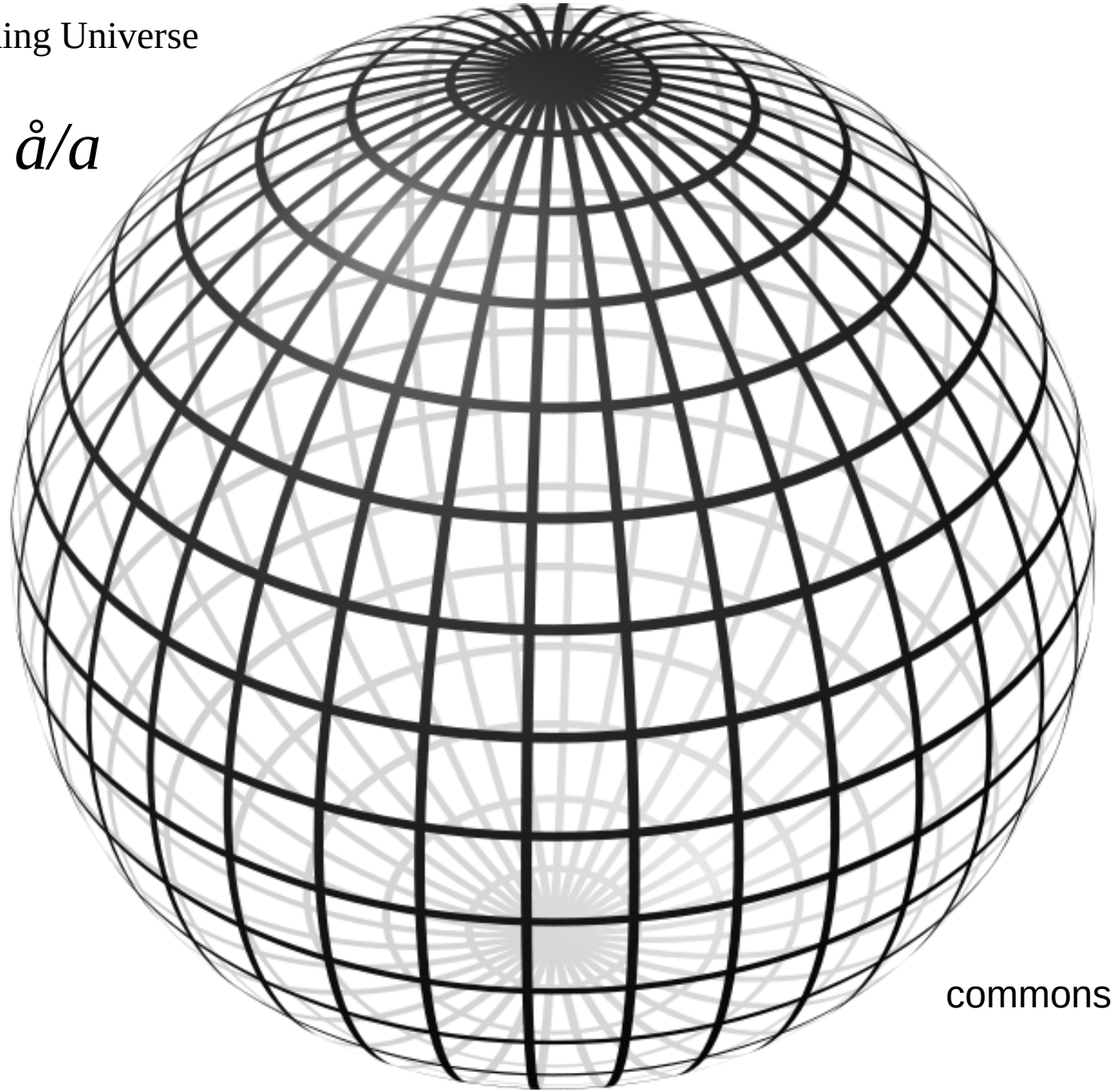
$$= a^2(t)\left[\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\theta\ d\varphi^2)\right]$$

$$ds^2 = dt^2 - ds_3^2.$$



Expanding Universe

$$H = \dot{a}/a$$



commons.wikimedia.org

$$(T^a_{\ b}) = \mathrm{diag}(\rho, -p, -p, -p)$$

$$D_a T^a_{\ b} = 0$$

$$\frac{d\rho}{dt} = -3H(t)(\rho + p)$$

能量守恒定律

$$H^2 + \frac{k}{a^2} = \frac{8\pi G}{3}\rho$$

愛因斯坦方程式

$$R_a^{\ b} - \frac{1}{2}\,\delta_a^{\ b} R = 8\pi G\; T_a^{\ b}$$

$$\frac{d\rho}{dt} = -3H(t)(\rho + p)$$

$H = \dot{a}/a$

$$d\left(\frac{4\pi}{3}a^3\rho\right) = -p\ 4\pi a^2 da$$

$$dU = -pdV + TdS$$

$U = \rho V$, $V = 4\pi a^3/3$, S the entropy

$$TdS = \bar{d}Q$$

volume of the 3-sphere S^3 is $2\pi^2 a^3$ instead of $4\pi a^3/3$.

$$ds^2 = a^2\left[d\chi^2 + \sin^2\chi d\Omega\right]$$

$$H^2 + \frac{k}{a^2} = \frac{8\pi G}{3}\rho$$

$$\frac{1}{2}m\dot{a}^2 - mG\left[\frac{\left(\frac{4\pi}{3}a^3\right)\rho}{a}\right] = -m\frac{k}{2}$$

$$E = T + V = -m\frac{k}{2}$$

$$\frac{d\rho}{dt} = -3H(t)(\rho + p)$$ 能量守恒定律

the equation of state $p = \omega\rho$

we can write $\rho + p = \gamma\rho$

with the relation $\gamma = 1 + \omega$

$$\dot{\rho} = -3H\gamma\rho \ ,$$

$$\rho \propto a^{-3\gamma}$$

For matter dominated (MD) universe $\gamma = 1(\omega = 0)$ $\rho \propto a^{-3}$

For a radiation dominated (RD) universe $\gamma = 4/3(\omega = 1/3)$ $\rho \propto a^{-4}$

for the case of vacuum dominated (VD) $\gamma = 0$ $\rho =$ constant.

For matter dominated (MD) universe $\gamma = 1(\omega = 0)$ $\rho \propto a^{-3}$

$$H^2 + \frac{k}{a^2} = \frac{8\pi G}{3}\rho$$

$H = \dot{a}/a$

For a flat FRW MD universe, $H^2 = 8\pi G\rho/3$ with $\rho = \rho_0/a^3$. Therefore,

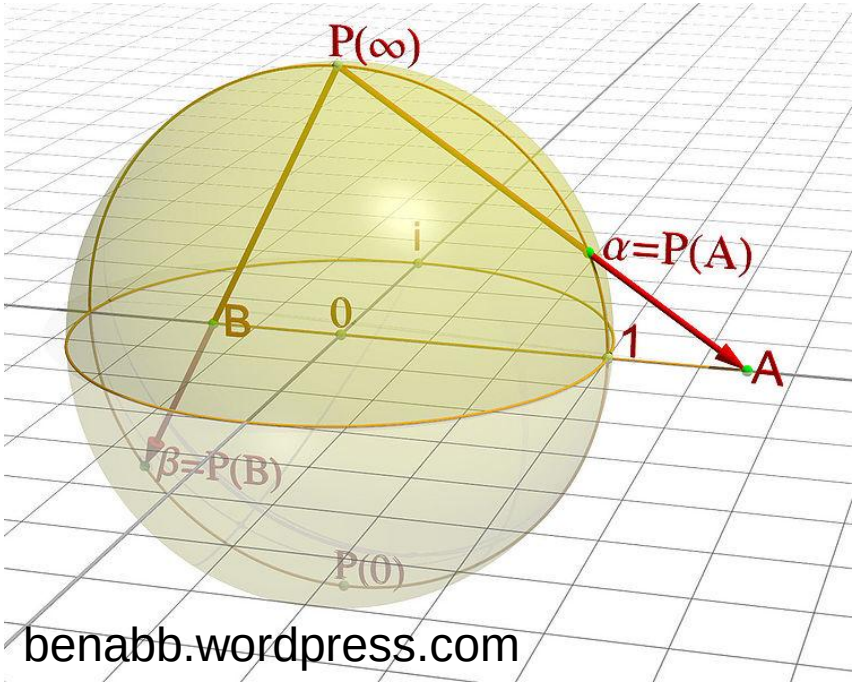
a 以 a_0 為單位
t_0 表示現在時間

$$\dot{a}^2 = H_0^2 \frac{1}{a} . \quad (94)$$

The age of the universe can be integrated from $\int dt = \int da/\dot{a}$. The result is:

$$t = \frac{2}{3H_0} . \qquad H^2 = H_0^2 \frac{1}{a^3}$$

	ρ	a
RD	a^{-4}	$(t/t_0)^{1/2}$
MD	a^{-3}	$(t/t_0)^{2/3}$
VD	constant	$\exp[H_0(t-t_0)]$

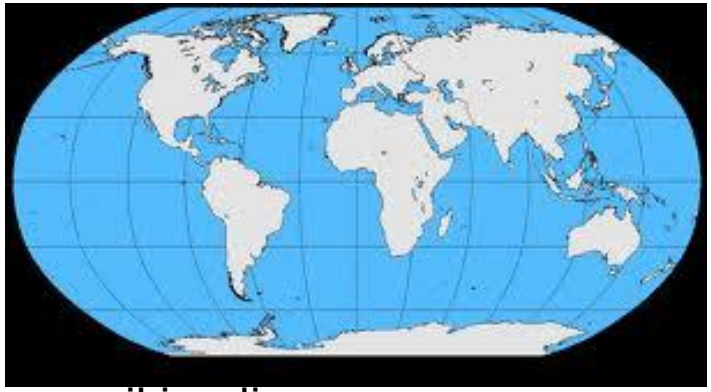


benabb.wordpress.com

$S^2 = R^2 + \{P\}$
原來球面比平面大

manifold 幾河流形
locally R^n

etsy.com



en.wikipedia.org

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數學家的宇宙學和高能物理

- 微積分 --- 牛頓重力場
- 黎曼幾何 –- 愛因斯坦重力場
- 纖維束 Fiber Bundle --- 規範場
- Calabi-Yau 流形 ---- Superstring
- Hyperspace 高空間 / 表面宇宙 (Brane Universe)

Riemann, Georg Friedrich Bernhard 黎曼(1826～1866)

- 生於德國漢諾威 (Hanover)，卒於義大利 Selasca。黎曼在分析與幾何上有極廣泛與深入的貢獻，其空間觀念與方法，影響及於現代理論物理，尤其是廣義相對論。
- 25歲得到哥廷根的博士學位，兩年後提出論文〈**On the representation of a function by means of a trigonometrical series**〉申請哥廷根的(無給)講師職位，**1854年在偉大的高斯面前發表就職演說〈On the Hypothesis that forms the foundation of Geometry〉**。在這篇演說中，黎曼為此後一百五十年的微分幾何大業指出了方向，立下了基礎，論文的本身不僅是個數學史上的一篇傑作，並且在表達上也是一個典範。

統一場論

- 重力
  - 牛頓重力 $F= GMm / r^2$
- 電磁力 SU(1)
  - 庫倫定律 $F= kQq / r^2$

1950-

- 弱交互作用力 SU(2)
- 強交互作用力 SU(3)

Hermann Klaus Hugo Weyl [1885-1955]

- 1918 He produced the first **guage** theory in which the Maxwell electromagnetic field and the gravitational field appear as geometrical properties of space-time.

Gauge/Scale symmetry

規範場

規以畫圓

九尺一範

Fiber Bundle

規範場 Let there be light!

$$d\{\Psi'(x)\}=d\{\exp[\,i\,\theta(x)\,]\,\Psi(x)\}=$$
$$\exp[\,i\,\theta(x)\,]\{\,i\,[d\,\theta(x)]\,\Psi(x)\}$$
$$+\exp[\,i\,\theta(x)\,]\,\{d\,\Psi(x)\}$$

$$(d+A')\{\Psi'(x)\}=(d+\underline{A'})\{\exp[\,i\,\theta(x)\,]\,\Psi(x)\}$$
$$=(d+\underline{A-i\,d\,\theta})\,\{\exp[\,i\,\theta(x)\,]\,\Psi(x)\}$$
$$=\exp[\,i\,\theta(x)\,]\{\,i\,[d\,\theta(x)]\,\Psi(x)\}$$
$$+\exp[\,i\,\theta(x)\,]\,\{d\,\Psi(x)\}$$
$$\underline{-\exp[\,i\,\theta(x)\,]\{\,i\,[d\,\theta(x)]\,\Psi(x)\}}$$
$$=\exp[\,i\,\theta(x)\,]\,(d+A)\,\{\Psi(x)\}$$

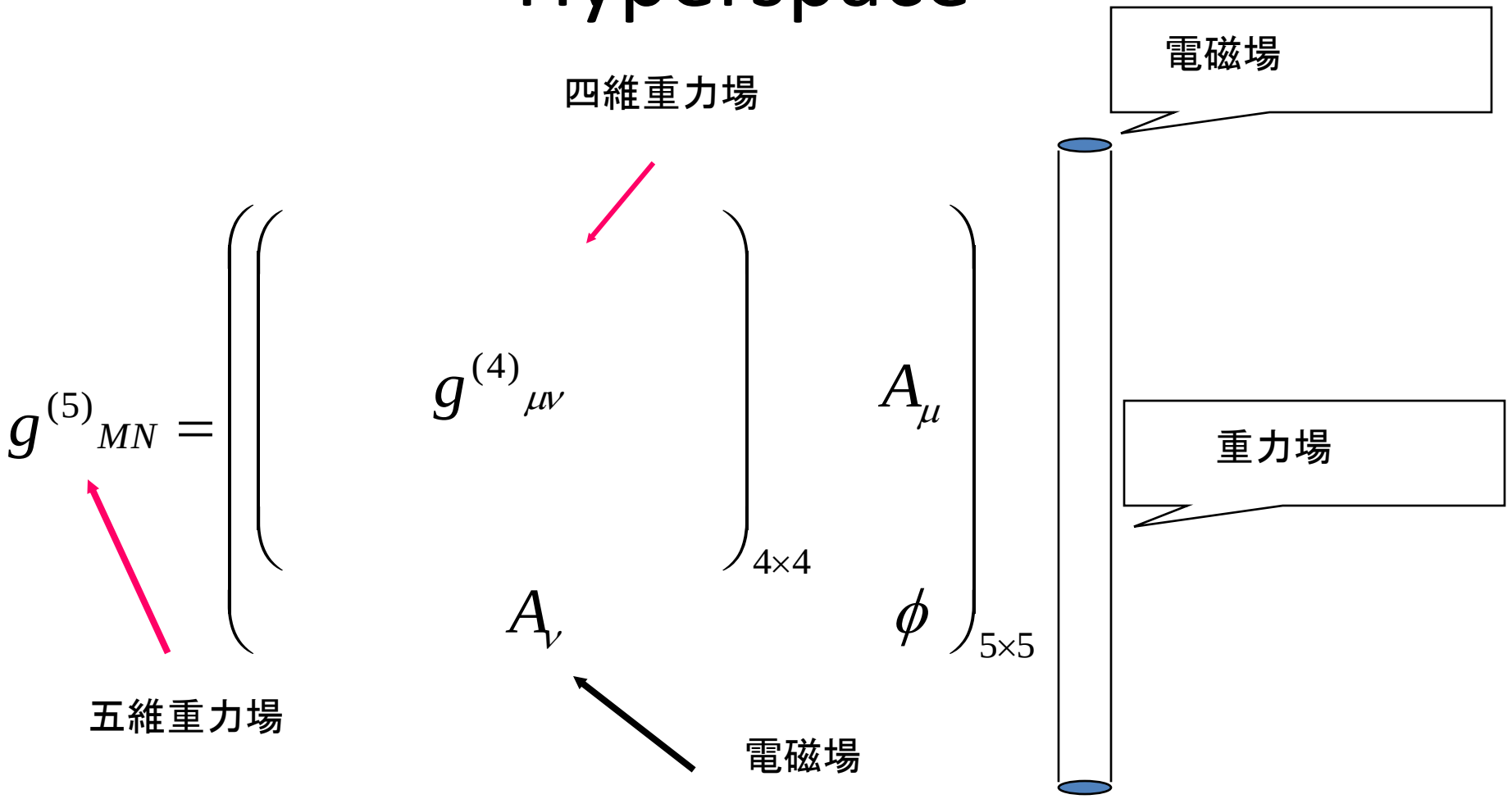
Theodor Franz Eduard Kaluza [1885-1954]

- Kaluza in 1919, sent a paper to Albert Einstein proposing a unification of gravity with Maxwell's theory of light
- This paper was communicated by Einstein himself on 8 December 1921 for publishing

Oskar Klein [1894-1977]

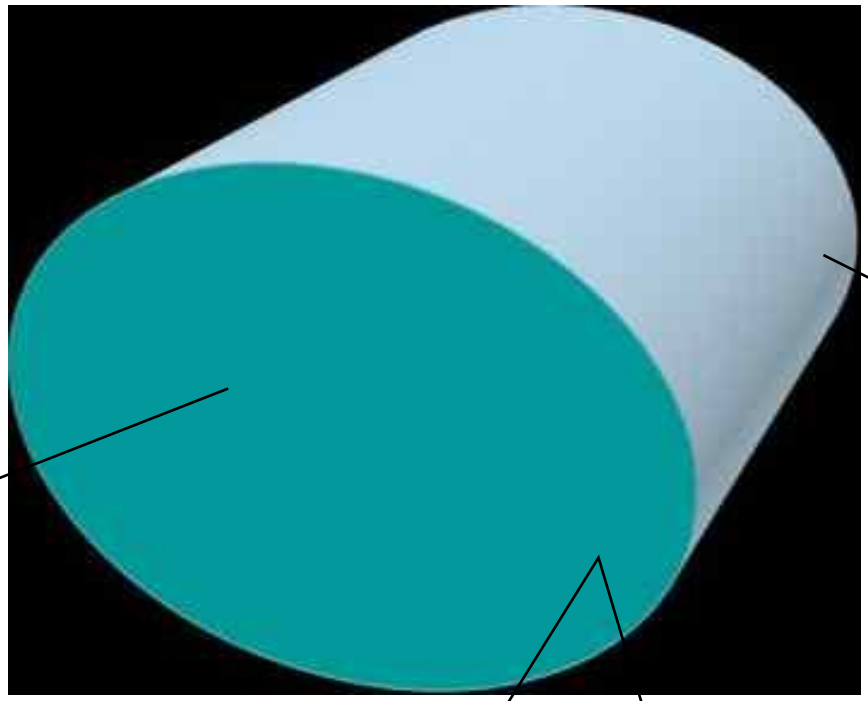
- Klein assumed the fifth dimension to be periodic with a period $l = c(2k)^{1/2}/e$ where e was the charge of the electron and k was Einstein's constant of gravitation. The dimension was on the order of the Planck length.
- Klein's results were published in *Nature* in the autumn of 1926.

Kaluza-Klein Theory of Hyperspace



Randall-Sundrum 1999
高空間表面物理Brane (hypersurface) Physics

Extra dimension 第五維



Bulk

Brane 四維表面

我們住在這裡

$$\mathcal{L}_{\text{gf}} = -\frac{1}{4}\,\text{Tr}(F^2) = -\frac{1}{4}F^{\mu\nu a}F_{\mu\nu}{}^{a} \qquad F_{\mu\nu} = T_a F_{\mu\nu}{}^{a}$$

$$[T_a, T_b] = if^{abc}T_c \qquad D_\mu = I\partial_\mu - igT_a A_\mu{}^{a}$$

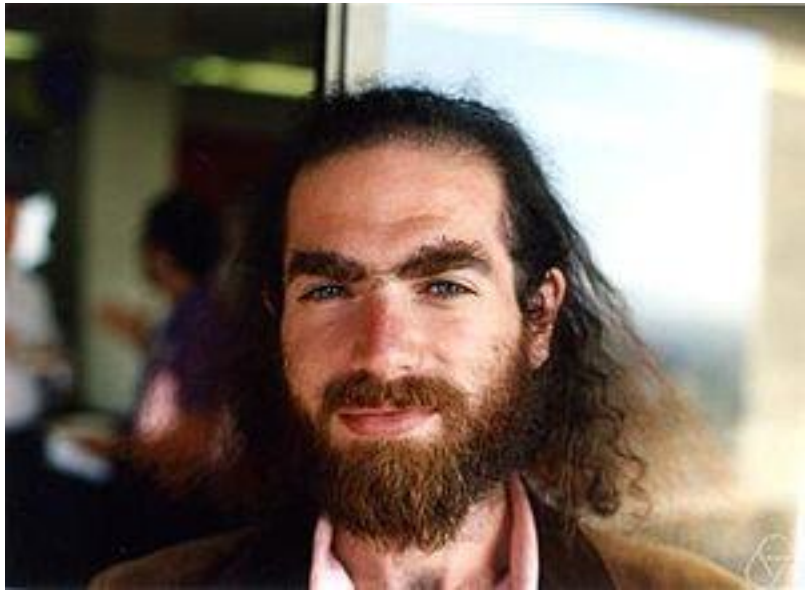
$$F_{\mu\nu}{}^{a} = \partial_\mu A_\nu{}^{a} - \partial_\nu A_\mu{}^{a} + gf^{a}{}_{bc}A_\mu{}^{b}A_\nu{}^{c}$$

$$[D_\mu, D_\nu] = -igT_a F_{\mu\nu}{}^{a}.$$

$$\partial^\mu F_{\mu\nu}{}^{a} + gf^{a}{}_{bc}A^{\mu b}F_{\mu\nu}{}^{c} = 0.$$

$$(D^\mu F_{\mu\nu})^a = 0.$$

數學家也瘋狂



Grigori Perelman in 1993

Born Grigori Yakovlevich Perelman
13 June 1966 (age 45)
Leningrad, Soviet Union

Residence Saint Petersberg, Russia

Citizenship Russia

Nationality Russian

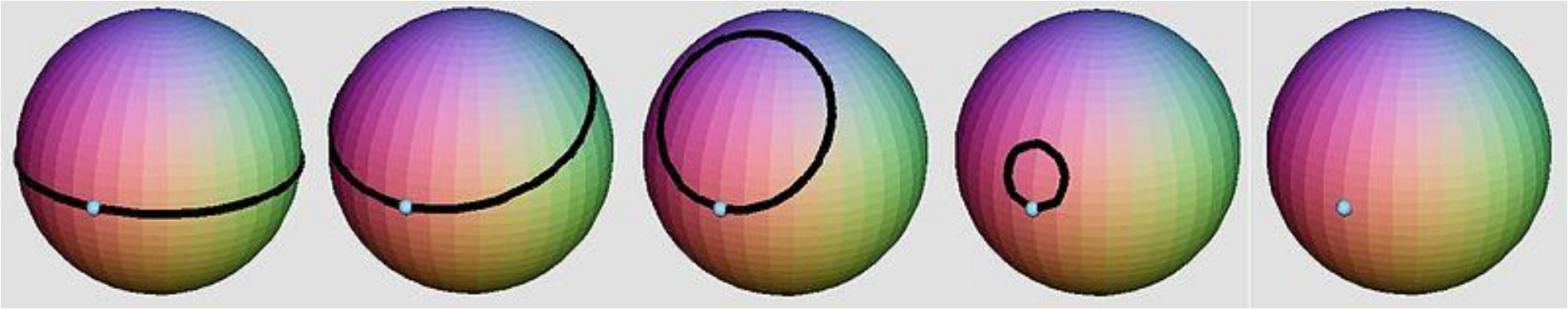
Fields Mathematics

Alma mater Leningrad State University

Doctoral advisor Aleksandr Aleksandrov
Yuri Burago

Known for Riemannian geometry
Geometric topology
Proof of the Poincare Conjecture

Notable awards Saint Petersburg
Mathematical Society Prize (1991), accepted
EMS Prize (1996), declined
Fields Medal (2006), declined
Millennium Prize (2010), declined



For compact 2-dimensional surfaces without boundary, if every loop can be continuously tightened to a point, then the surface is topologically homeomorphic to a 2-sphere (usually just called a sphere). The **Poincaré conjecture** asserts that the same is true for 3-dimensional spaces.

The Fields Medal and Millennium Prize

In May 2006, a committee of nine mathematicians voted to award Perelman a Fields Medal for his work on the Poincaré conjecture.[14] The Fields Medal is the highest award in mathematics ;[citation needed] two to four medals are awarded every four years. However, Perelman declined to accept the prize. Sir John Ball, president of the International Mathematical Union, approached Perelman in Saint Petersburg in June 2006 to persuade him to accept the prize. After 10 hours of persuasion over two days, Ball gave up. Two weeks later, Perelman summed up the conversation as follows: "He proposed to me three alternatives: accept and come; accept and don't come, and we will send you the medal later; third, I don't accept the prize. From the very beginning, I told him I have chosen the third one... [the prize] was completely irrelevant for me. Everybody understood that if the proof is correct, then no other recognition is needed."[14] "'I'm not interested in money or fame,' he is quoted to have said at the time. 'I don't want to be on display like an animal in a zoo. I'm not a hero of mathematics. I'm not even that successful; that is why I don't want to have everybody looking at me.'"[23] Nevertheless, on 22 August 2006, Perelman was publicly offered the medal at the International Congress of Mathematicians in Madrid "for his contributions to geometry and his revolutionary insights into the analytical and geometric structure of the Ricci flow."[24] He did not attend the ceremony, and declined to accept the medal, making him the first person to decline this prestigious prize.[25][26]
He had previously turned down a prestigious prize from the European Mathematical Society,[26] allegedly saying that he felt the prize committee was unqualified to assess his work, even positively.[27]
On 18 March 2010, Perelman was awarded a Millennium Prize for solving the problem.[28] On June 8, 2010, he did not attend a ceremony in his honor at the Institut Océanographique, Paris to accept his $1 million prize.[29] According to Interfax, Perelman refused to accept the Millennium prize in July 2010. He considered the decision of Clay Institute unfair for not sharing the prize with Richard Hamilton,[5] and stated that "the main reason is my disagreement with the organized mathematical community. I don't like their decisions, I consider them unjust."[6]
Perelman's proof was rated one of the top cited articles in Math-Physics in 2008.[30]

Possible withdrawal from mathematics

As of the spring of 2003, Perelman no longer worked at the Steklov Institute.[31] His friends are said to have stated that he currently finds mathematics a painful topic to discuss; some even say that he has abandoned mathematics entirely.[32] According to a 2006 interview, Perelman was then unemployed, living with his mother in Saint Petersburg.[31]

Perelman is quoted in an article in The New Yorker saying that he is disappointed with the ethical standards of the field of mathematics. The article implies that Perelman refers particularly to the efforts of Fields medalist Shing-Tung Yau to downplay Perelman's role in the proof and play up the work of Cao and Zhu. Perelman added, "I can't say I'm outraged. Other people do worse. Of course, there are many mathematicians who are more or less honest. But almost all of them are conformists. They are more or less honest, but they tolerate those who are not honest."[14] He has also said that "It is not people who break ethical standards who are regarded as aliens. It is people like me who are isolated."[14]

This, combined with the possibility of being awarded a Fields medal, led him to quit professional mathematics. He has said that "As long as I was not conspicuous, I had a choice. Either to make some ugly thing or, if I didn't do this kind of thing, to be treated as a pet. Now, when I become a very conspicuous person, I cannot stay a pet and say nothing. That is why I had to quit." (The New Yorker authors explained Perelman's reference to "some ugly thing" as "a fuss" on Perelman's part about the ethical breaches he perceived).[33]

It is uncertain whether his resignation from Steklov and subsequent seclusion mean that he has ceased to practice mathematics. Fellow countryman and mathematician Yakov Eliashberg said that, in 2007, Perelman confided to him that he was working on other things but it was too premature to talk about it. He is said to have been interested in the past in the Navier–Stokes equations and the set of problems related to them that also constitutes a Millennium Prize, and there has been speculation that he may be working on them now.[34]

Ed. Witten [1951-] 通識教育
Fields Medal, 1990 讓歷史系學生換跑道

布蘭代斯大學 (Brandeis) B.A. 1971 歷史系

Princeton M.A. 1974 / Ph.D. in 1976

Harvard 博士後 1976-77; Junior Fellow 1977-80

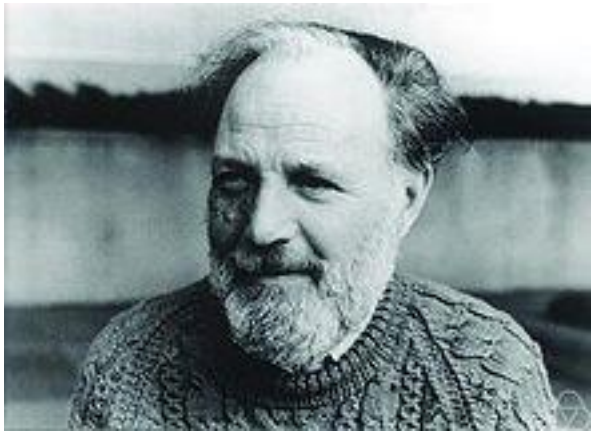
Princeton 物理教授 1980 MacArthur Fellowship 1982

高等研究院(Institute for Advanced Study)

Professor in the School of Natural Sciences 1982

數學是科學之母
物理是科學之父

Atiyah: 雖然他顯然是*物理學家*(從他的著作可知), 然而他主導數學的能力顯然少有數學家可以出其右, 他以數學描述物理觀念的能力也是近乎唯一. 其完美地運用物理直觀, 開創新而深入的數學的**能力, 一再令數學界**嘆為觀止....



Sir Michael Francis Atiyah, OM, FRS, FRSE (born 22 April 1929) is a British mathematician working in geometry. He was awarded the Fields Medal in 1966,

Isadore Manuel Singer (in 1977), who worked with Atiyah on index theory

(born April 24, 1924)

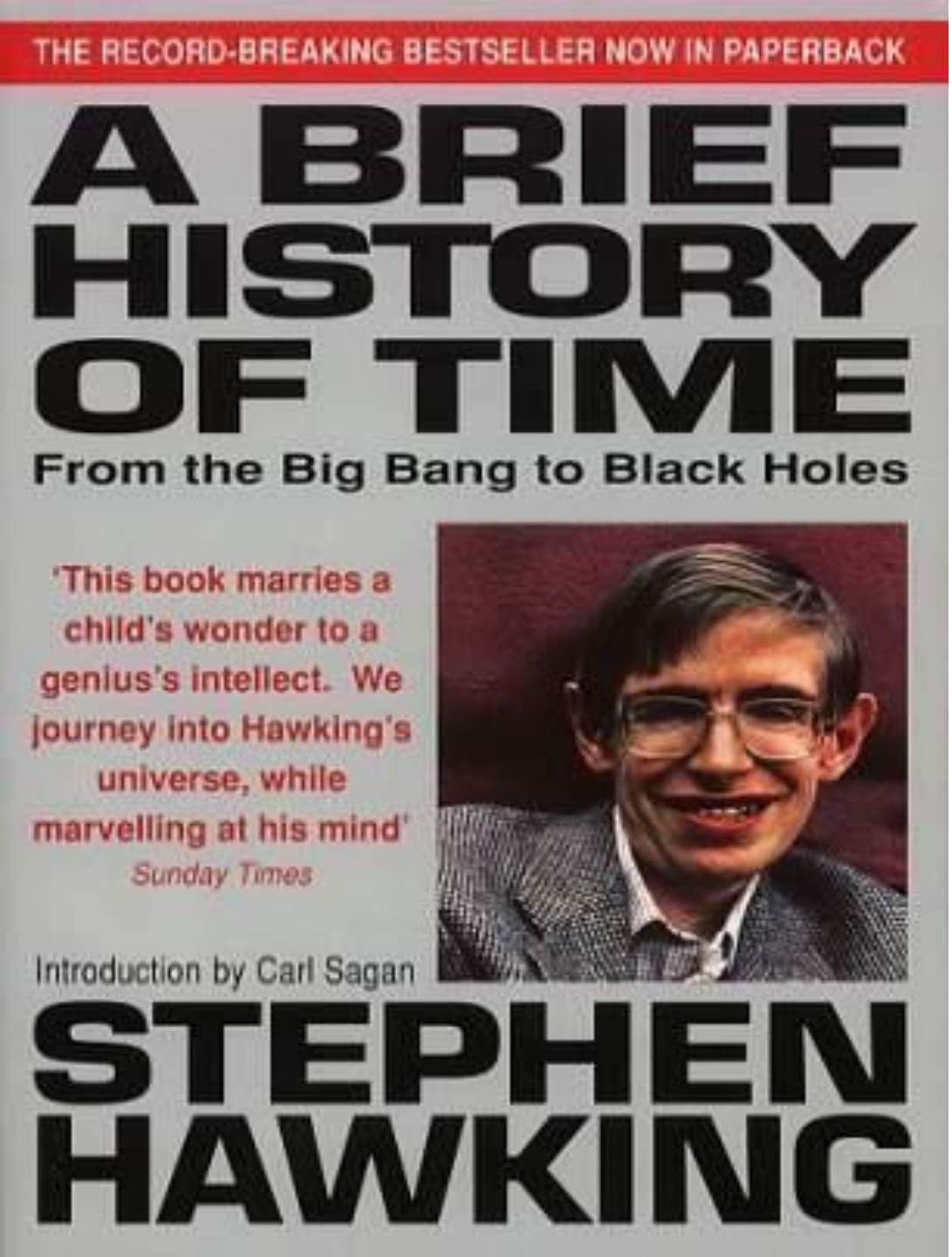
In 1966, when he was 36 years old, he was awarded the Fields Medal, for his work in developing K-theory, a generalized Lefschetz fixed-point theorem and the Atiyah–Singer theorem, for which he also won the Abel Prize jointly with Isadore Singer in 2004.[107]

丘成桐（Shing-Tung Yau，1949年4月4日－），美國人，原籍廣東省梅州蕉嶺縣，客家人，生於汕頭，長於香港。著名數學家。數學界最高榮譽菲爾茲獎及沃爾夫數學獎得主之一。

1982, Fields Medal, for"his contributions to partial differential equations, to the Calabi conjecture in algebraic geometry, to the positive mass conjecture of general relativity theory, and to real and complex Monge-Ampère equations".

1997年，他受台灣新竹清華大學校長劉炯朗邀請，作為講席教授訪問一年。若干年後，他建議已是台灣國家科學委員會主席的劉炯朗，建立理論科學中心。正式成立是在1998年。他擔任理論科學中心顧問委員會主任直到2005年。

學測新方向



Stephen William Hawking was born on 8 January 1942 (300 years after the death of Galileo) in Oxford, England.

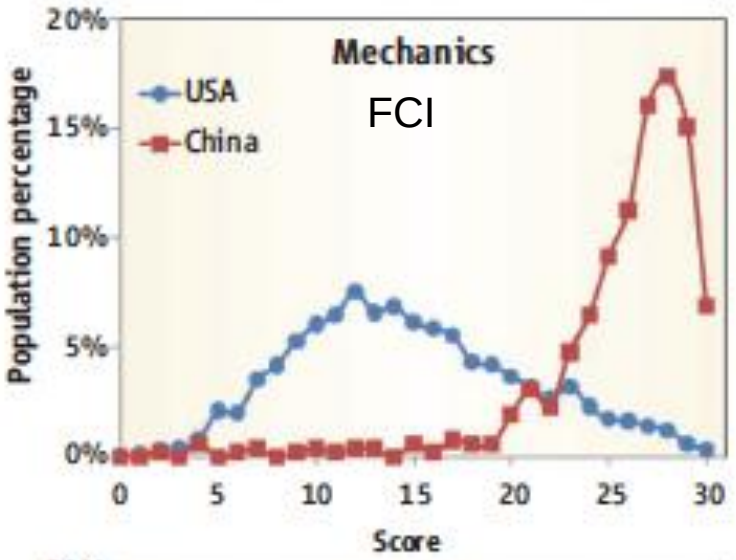
物理是不老仙丹

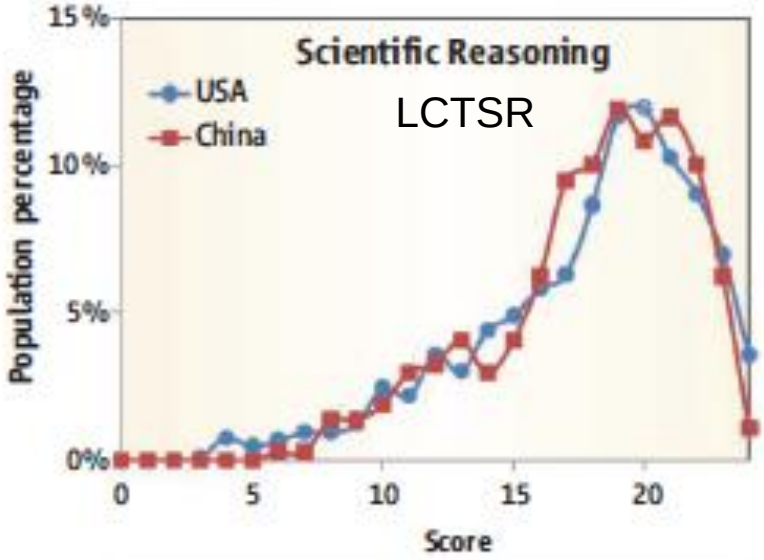
他是如何計算的？

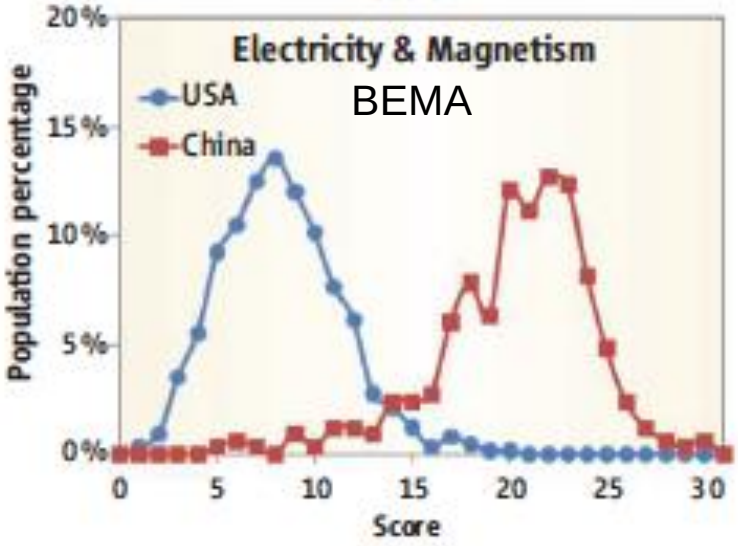
Learning and Scientific Reasoning

Lei Bao, Tianfan Cai, Kathy Koenig, Kai Fang, Jing Han, Jing Wang, Qing Liu, Lin Ding, Lili Cui, Ying Luo, Yufeng Wang, Lieming Li, and Nianle Wu

Science 30 January 2009: 586-587.







TEST SCORES (%)			
Test	*China (n)*	*USA (n)*	*Effect size*
FCI	85.9 ± 13.9 (523)	49.3 ± 19.3 (2681)	1.98
BEMA	65.6 ± 12.8 (331)	26.6 ± 10.0 (650)	3.53
LCTSR	74.7 ± 15.8 (370)	74.2 ± 18.0 (1061)	0.03

U1 is a large research-1 state university, U.S. ranking top 60, acceptance rate 59%.
U2 is a large research-1 state university, U.S. ranking top 60, acceptance rate 60%.
U3 is a large tier-4 state university with an acceptance rate of 84%.
U4 is a large tier-3 state university with an acceptance rate of 69%.

The three Chinese universities are labeled with C1, C2, and C3.
Their national rankings are also given below (based on 2007 ranking from
Sina Educatoin News, http://edu.sina.com.cn).
(A national university is one that is under direct control of the department of education.)
C1 is a top 30 national university.
C2 is a top 60 national university.
C3 is a top 130 national university.

清華大學都會、非都會高中學業成績表現

入學方式	年度	畢業高中	名次百分比平均%	人數
繁星	96～99	都會	20.97%	30
		非都會	40.22%	428
推薦	88～99	都會	35.43%	544
		非都會	42.69%	573
申請	88～99	都會	41.89%	2044
		非都會	46.06%	1175
指考	92～99	都會	52.99%	3455
		非都會	54.04%	2592

非都會高中資優生的表現並不輸都會高中一般學生

不是都會明星高中才能培養優秀的學生

(都會高中為17所"都市明星高中")

清華大學繁星學生各縣市分佈情形

縣市	人數	繁星人數百分比（縣市人數/總人數）	縣市人數百分比（縣市人口/台灣人口）
台北市	76人	17.16%	11.38%
新北市	57人	12.97%	16.86%
桃園縣	25人	5.64%	8.67%
新竹縣市	19人	4.29%	4.03%
苗栗縣	7人	1.58%	2.42%
台中市	54人	12.19%	11.47%
彰化縣	14人	3.16%	5.62%
南投縣	9人	2.03%	2.26%
嘉義縣	20人	4.52%	3.49%
雲林縣	15人	3.39%	3.08%
台南市	34人	7.68%	8.09%
高雄市	63人	14.22%	11.95%
屏東縣	11人	2.48%	3.73%
台東縣	5人	1.13%	0.99%
花蓮縣	10人	2.26%	1.45%
宜蘭縣	21人	4.74%	3.62%
外島	3人	0.68%	0.90%
總計	443人	100%	100%

繁星管道有較佳的地域分布性

頂大第一屆繁星錄取學生97上成績排名(百分比)

							分位值		
分發學校	人數	平均數	中位數	標準差	最小值	最大值	25	50	75
國立中央大學	16	37.21	24.41	31.94	2.04	100.00	11.15	24.41	61.72
國立台灣科技大學	53	50.92	51.00	29.1	2.00	100.00	25.50	51.00	76.00
國立中興大學	39	28.60	28.60	25.16	1.60	89.80	6.80	20.50	45.50
國立中山大學	33	41.22	41.22	28.2	2.00	94.00	17.25	37.00	65.00
長庚大學	28	41.33	41.33	29.01	4.00	98.00	14.00	37.00	69.00
國立台灣大學	26	28.04	28.04	21.23	2.00	68.00	10.00	22.50	45.25
國立陽明大學	4	52.50	28.04	30.35	18.00	86.00	23.00	53.00	81.50
元智大學	25	37.96	52.50	32.55	2.00	100.00	12.25	26.00	66.00
國立政治大學	40	27.98	37.96	23.62	2.00	88.00	9.00	21.00	39.75
國立成功大學	30	27.47	27.98	22.34	1.32	86.67	10.11	19.14	41.74
國立交通大學	84	42.96	42.96	25.63	0.88	100.00	22.36	40.73	60.75
國立清華大學	134	40.87	40.87	26.81	1.45	100.00	16.59	36.55	59.65

各高中均有能力培養出有競爭力的學生，
明星高中不應該是頂大的唯一選擇。

學測新方向與
高中生的夢魘

- 10. 太多必修課、學生沒有時間消化、吸收
- 沒有配套 變成填鴨教學
  - 製造許多不懂就背下來的學生

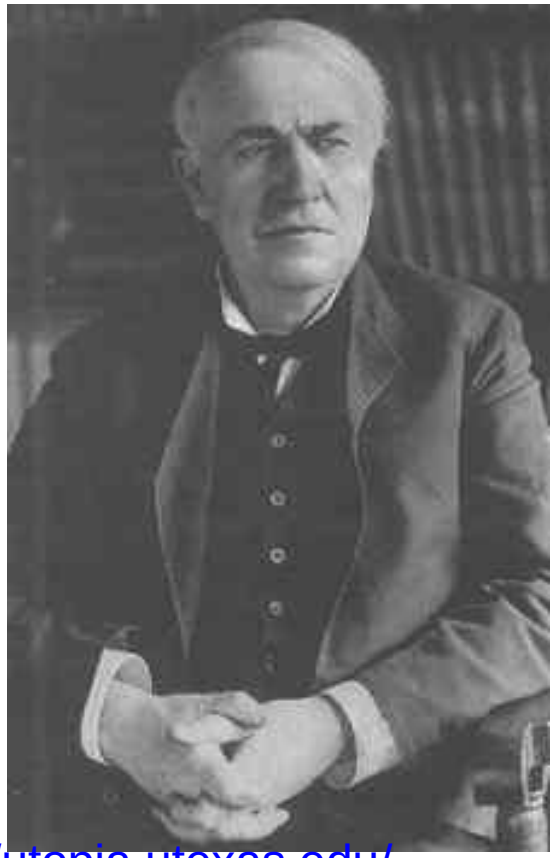
妥協下、可能必須暫時接受的的配套:

- 數理課要把學生當文組教
- 社會課要把學生當理組教
  - 目的:給學生有一點點時間, 停下來、想一想

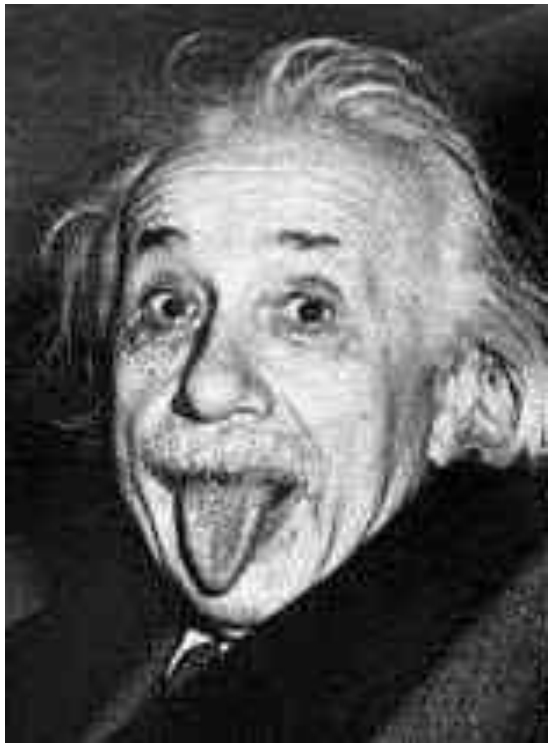
物理像宗教? 真理是?

愛因斯坦

愛迪生

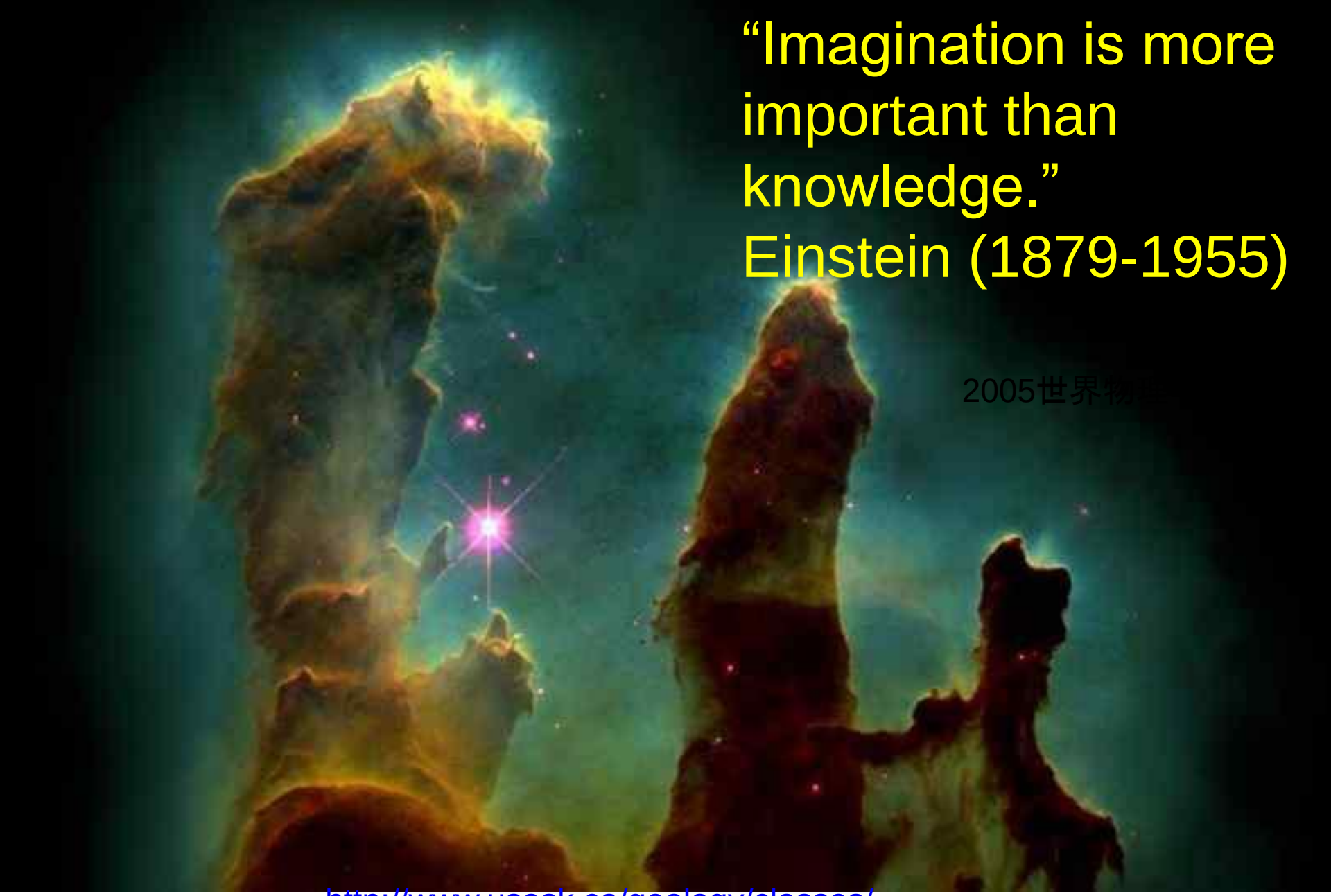


與



http://utopia.utexas.edu/project/portraits/edison.jpg

http://www.cec.mtu.edu/csa/pegasus/einstein.jpg



“Imagination is more important than knowledge.”
Einstein (1879-1955)

2005世界物理

http://www.usask.ca/geology/classes/geol109and122/109_122_A/**Eagle_nebula**.jpg

Everything is physics

舉目所見 皆是物理 J. Schwinger

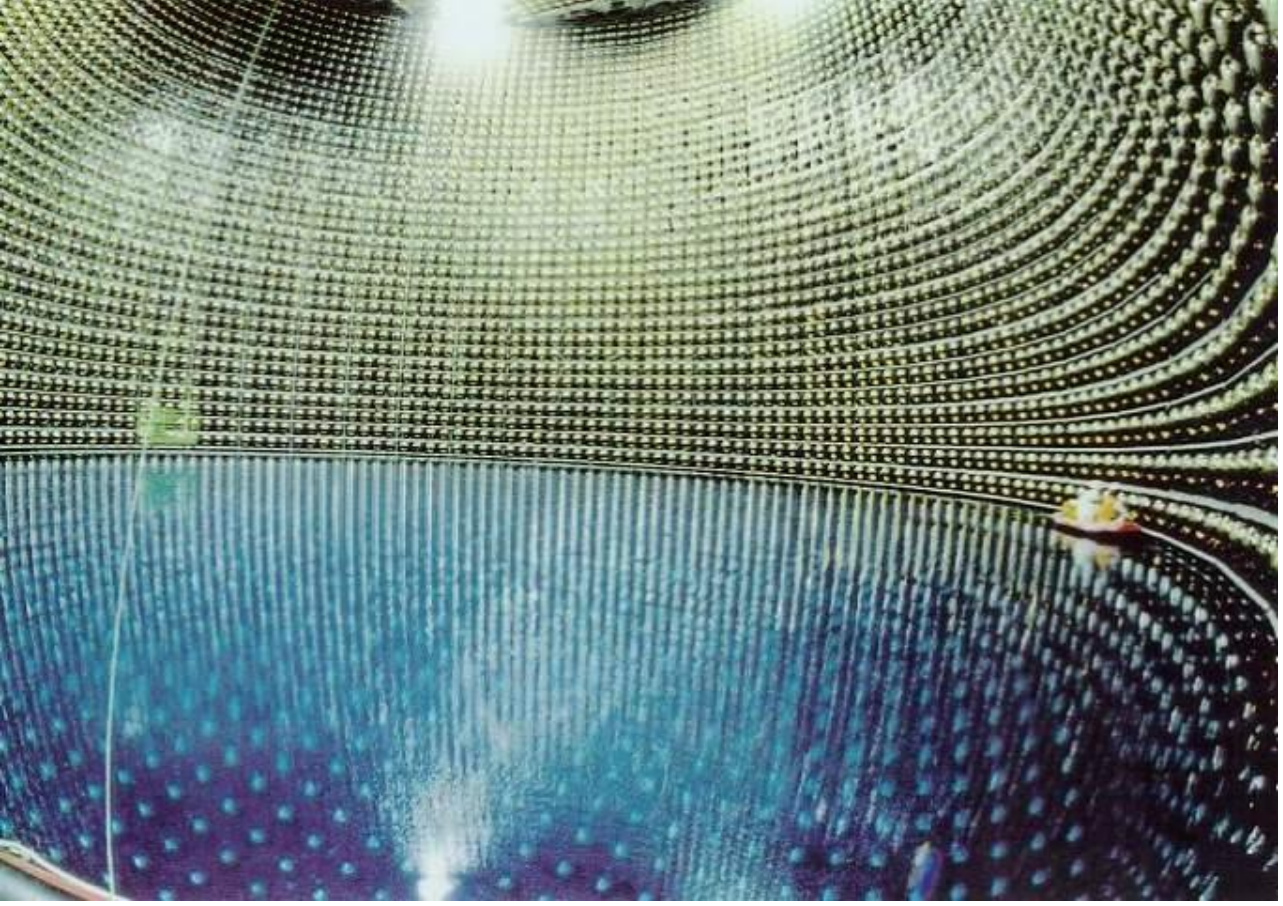
- Matter Physics 物質物理
- Bio-Physics生命物理
- Social Physics社會物理

- [孔德 Auguste Comte，1798-1857]

Auguste Comte:
Weathering a Storm of Change

Social Physics

What sort of person would invent sociology? Certainly someone living in times of momentous change. Comte (1798-1857) grew up in the wake of the French Revolution, which brought a sweeping transformation to his country. And if that wasn't sufficient, another revolution was under way as factories were sprouting up across continental Europe, recasting the lives of the entire population. Just as people enduring a storm cannot help but think of the weather, so those living during Comte's turbulent era became keenly aware of the state of society. Drawn from his small hometown by the bustle of Paris, Comte was soon deeply involved in the exciting events of his time. More than anything else, he wanted to understand the human drama that was unfolding all around him. Once equipped with knowledge about how society operates, Comte believed, people would be able to build for themselves a better future. He divided his new discipline into two parts: how society is held together (which he called social statics) and how society changes (social dynamics). From the Greek and Latin words meaning "the study of society," Comte came to describe his work as sociology.



http://www-sk.icrr.u-tokyo.ac.jp/sk/photo/sk_build44.jpg

The 2002 Nobel Prize in Physics

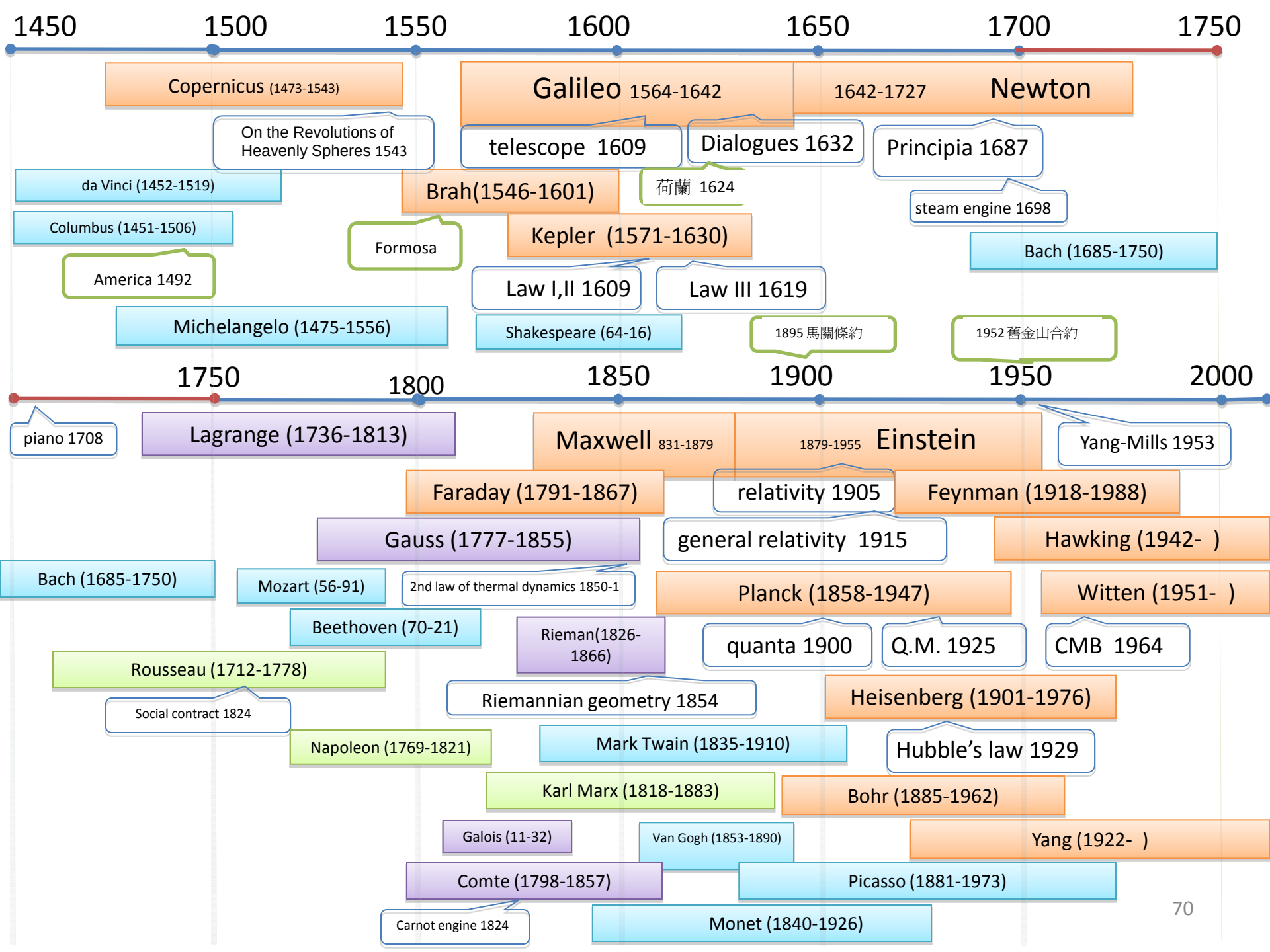
Cylinder of 41.4m (Height) x 39.3m (Diameter)

50,000 tons of pure water

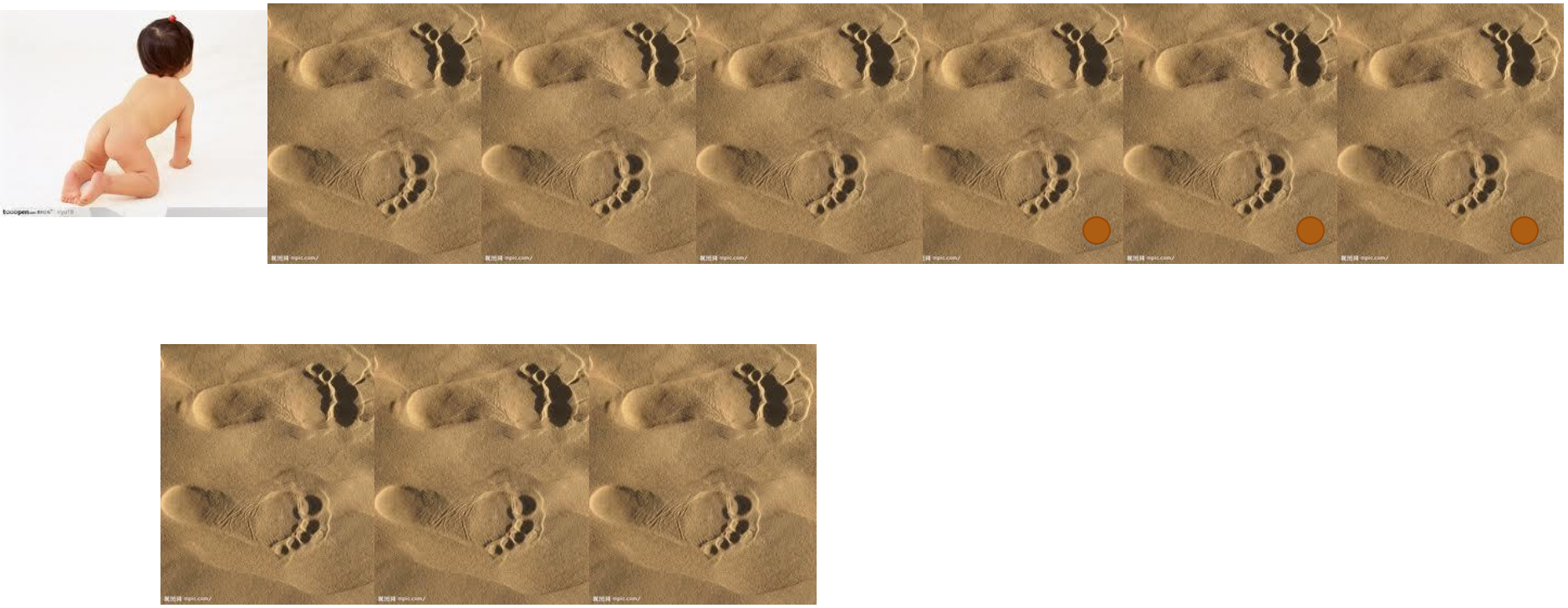
11,200 photomultiplier tubes (50cm each in diameter -the biggest size in the world)

岐阜県吉城郡神岡町(神岡宇鉱業　茂住坑　地下1,000m)

所有大型實驗原始目的皆未達成，但是，都找到更好的。


1450
1500
1550
1600
1650
1700
1750
Copernicus (1473-1543)
Galileo 1564-1642
1642-1727 Newton
On the Revolutions of Heavenly Spheres 1543
telescope 1609
Dialogues 1632
Principia 1687
da Vinci (1452-1519)
Brah(1546-1601)
荷蘭 1624
steam engine 1698
Columbus (1451-1506)
Formosa
Kepler (1571-1630)
Bach (1685-1750)
America 1492
Law I,II 1609
Law III 1619
Michelangelo (1475-1556)
Shakespeare (64-16)
1895 馬關條約
1952 舊金山合約
1750
1800
1850
1900
1950
2000
piano 1708
Lagrange (1736-1813)
Maxwell 831-1879
1879-1955 Einstein
Yang-Mills 1953
Faraday (1791-1867)
relativity 1905
Feynman (1918-1988)
Gauss (1777-1855)
general relativity 1915
Hawking (1942-)
Bach (1685-1750)
Mozart (56-91)
2nd law of thermal dynamics 1850-1
Planck (1858-1947)
Witten (1951-)
Beethoven (70-21)
Rieman(1826-1866)
quanta 1900
Q.M. 1925
CMB 1964
Rousseau (1712-1778)
Riemannian geometry 1854
Heisenberg (1901-1976)
Social contract 1824
Napoleon (1769-1821)
Mark Twain (1835-1910)
Hubble's law 1929
Karl Marx (1818-1883)
Bohr (1885-1962)
Galois (11-32)
Van Gogh (1853-1890)
Yang (1922-)
Comte (1798-1857)
Picasso (1881-1973)
Carnot engine 1824
Monet (1840-1926)

造物主早就告訴我們生存知道



真理無所不在

能源小常識:
各盡所能　各取所需

地球受日照功率約為

1 GW/平方公里

約爲現有核電廠一個機組功率～1 GW

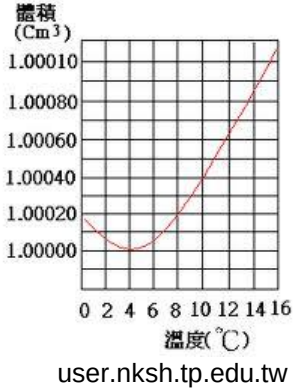
每平方公里太陽能～核電廠功率

Muller: physics for future presidents

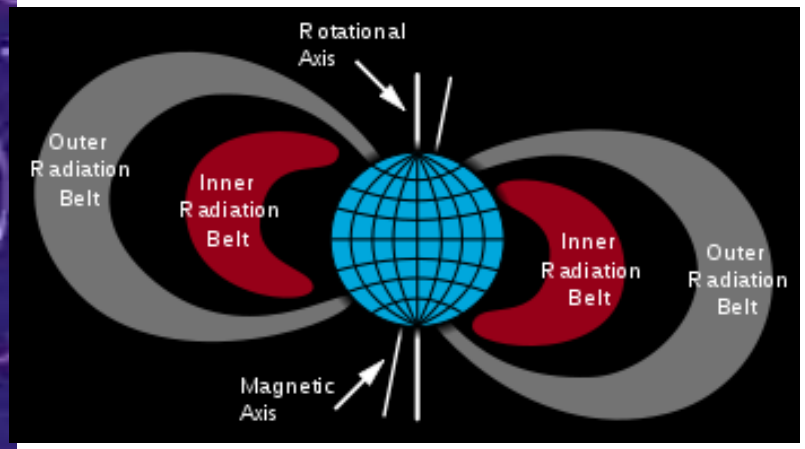
水 4度C 時密度最大
結冰時可以浮在水面上
保護水下生命繁衍

氫(原佔九成)、氦(Helium) 較輕
同溫時
速度是氧氣的四倍
可以大於**逃脫速度**
所以逸離大氣

$E=3kT/2=mv^2/2$
$= GmM/r$



user.nksh.tp.edu.tw



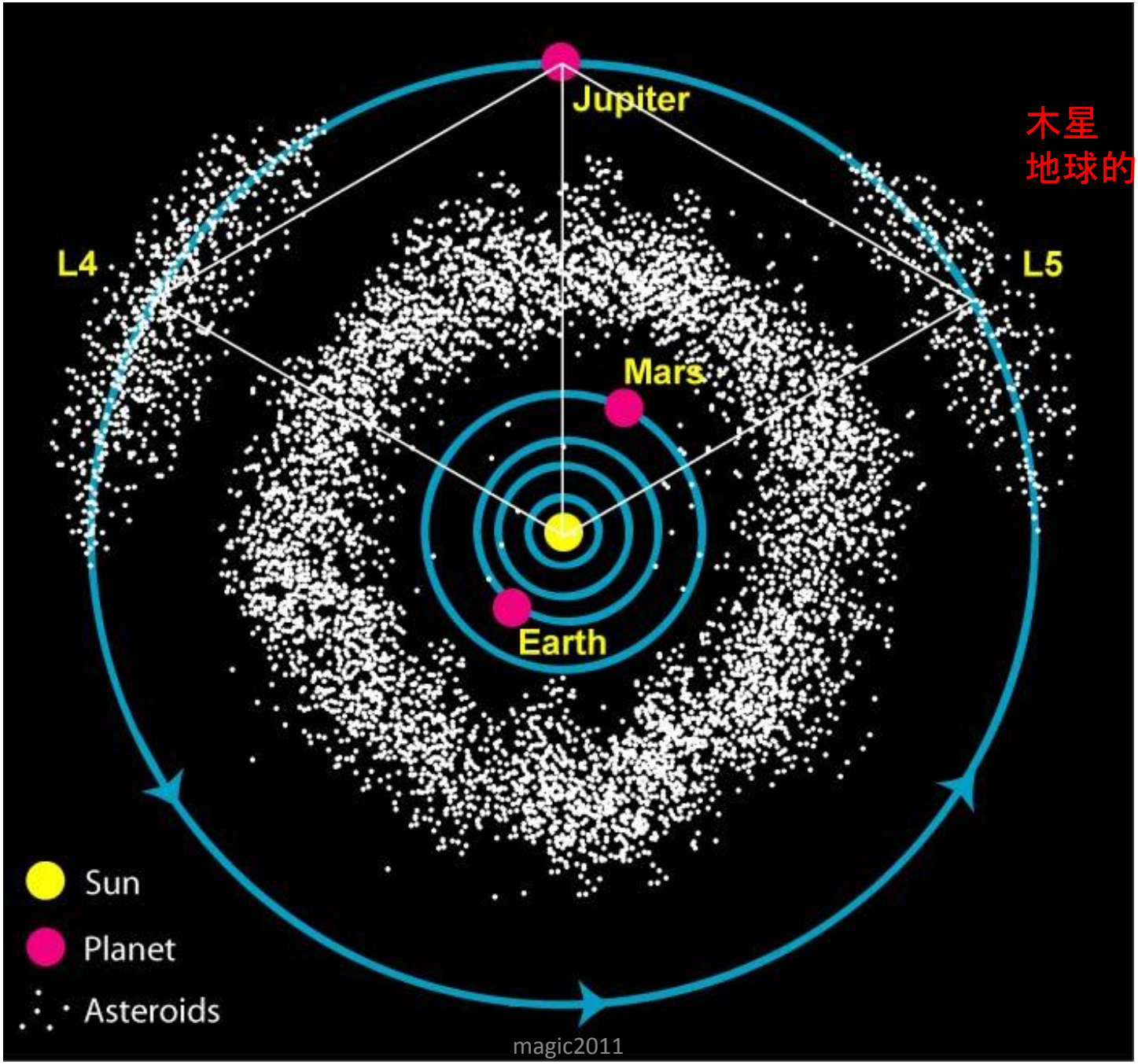
禁衛軍

范艾倫輻射帶
內:100～1萬公里
外:1.3萬~6萬公里

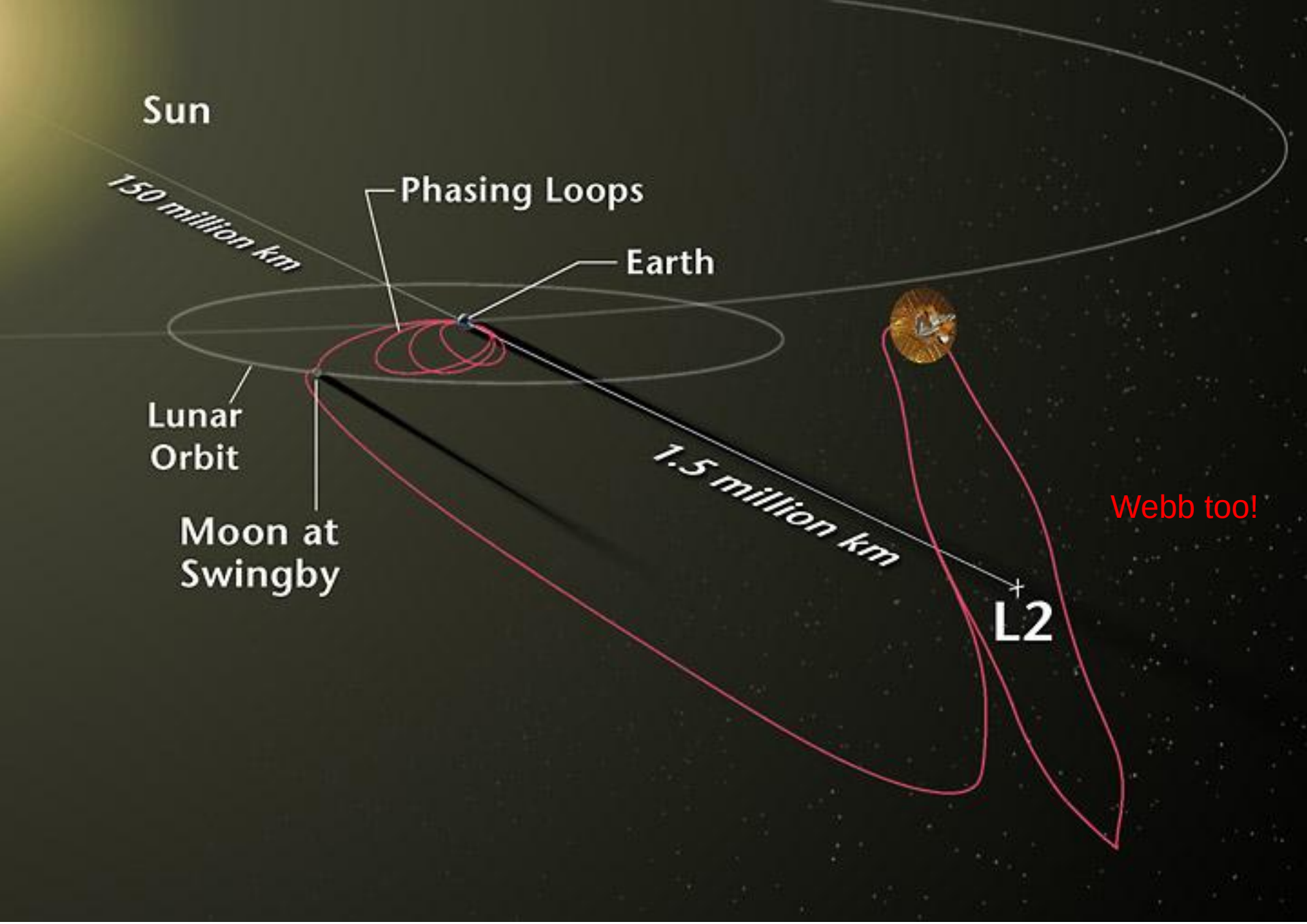
人造磁場~$10^{6\sim7}$高斯
中子星磁場~$10^{12\sim13}$高斯
地表磁場~0.5高斯

地球大氣層外的磁層示意圖

太陽風(是一大群時速達4~500 Km/hr的電漿)



木星
地球的門神



http://en.wikipedia.org/wiki/File:WMAP_trajectory_and_orbit.jpg

如何儲藏能源
上帝的秘方

巧克力～ 8黃色炸藥～5大卡/克
汽油　～15黃色炸藥
氫氣　～40黃色炸藥
～2.6汽油/g
～0.18汽油/cc

燃料	1KWh 的價格	轉換成 1kWh電力
煤	0.4¢	1.2¢
天然氣	0.9¢	2.7¢
汽油	7¢	21¢
電力	10¢	10¢
車用電池	21¢	21¢
Pc電池	$4	$4
AAA電池	$1000	$1000

波音瓦＝747 W~1馬力
（3600J=）1Wh~1大卡 (=4200J)

不休息的鴿子
反應速度的極限

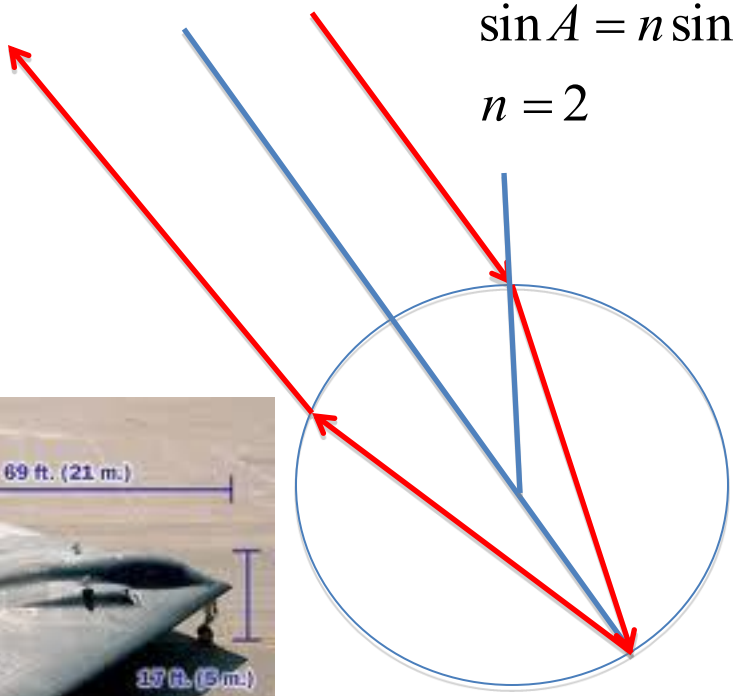
kenming.idv.tw

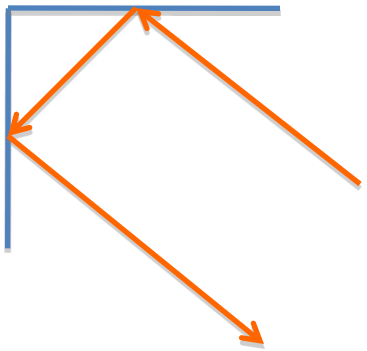
tieba.baidu.com

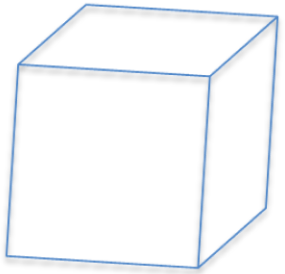
腦筋轉一轉
柳暗花又明

$$\sin A = n \sin B$$

$$n = 2$$

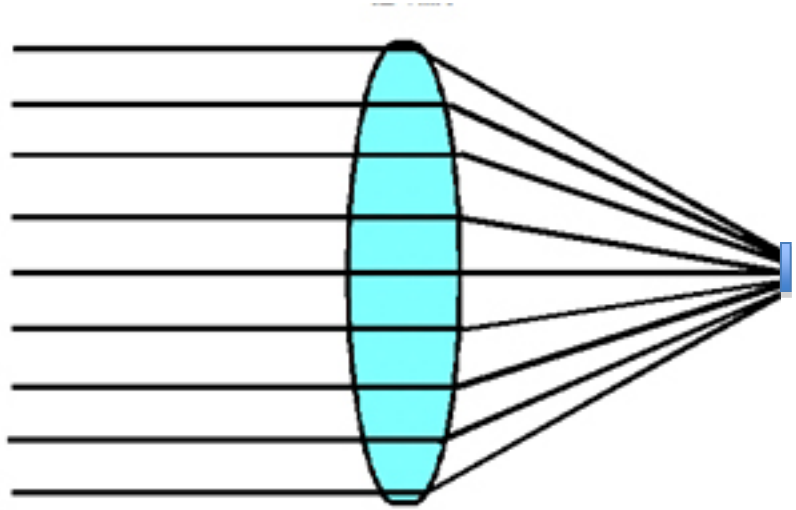




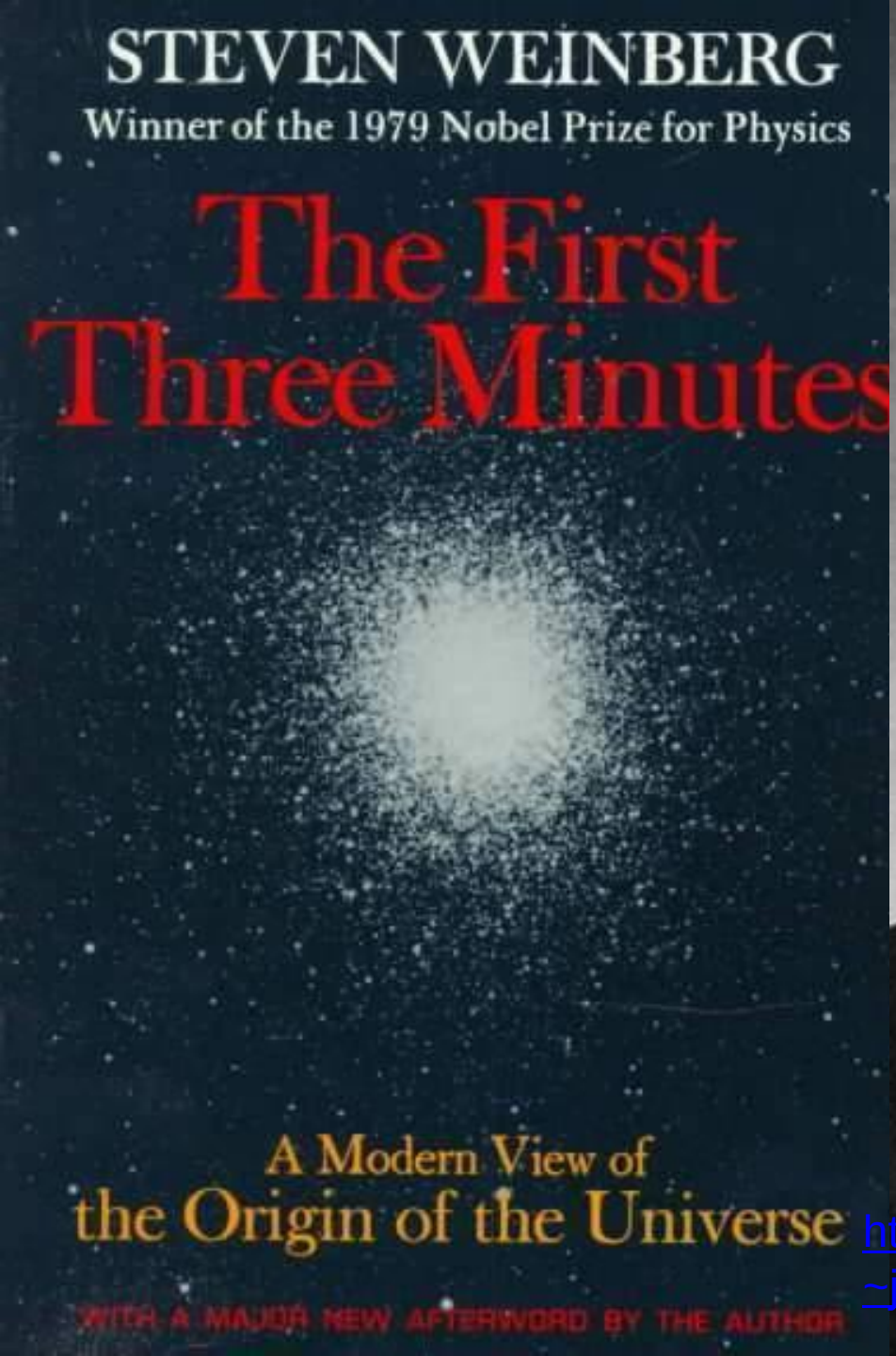


science.howstuffworks.com

gropius-passagen.de

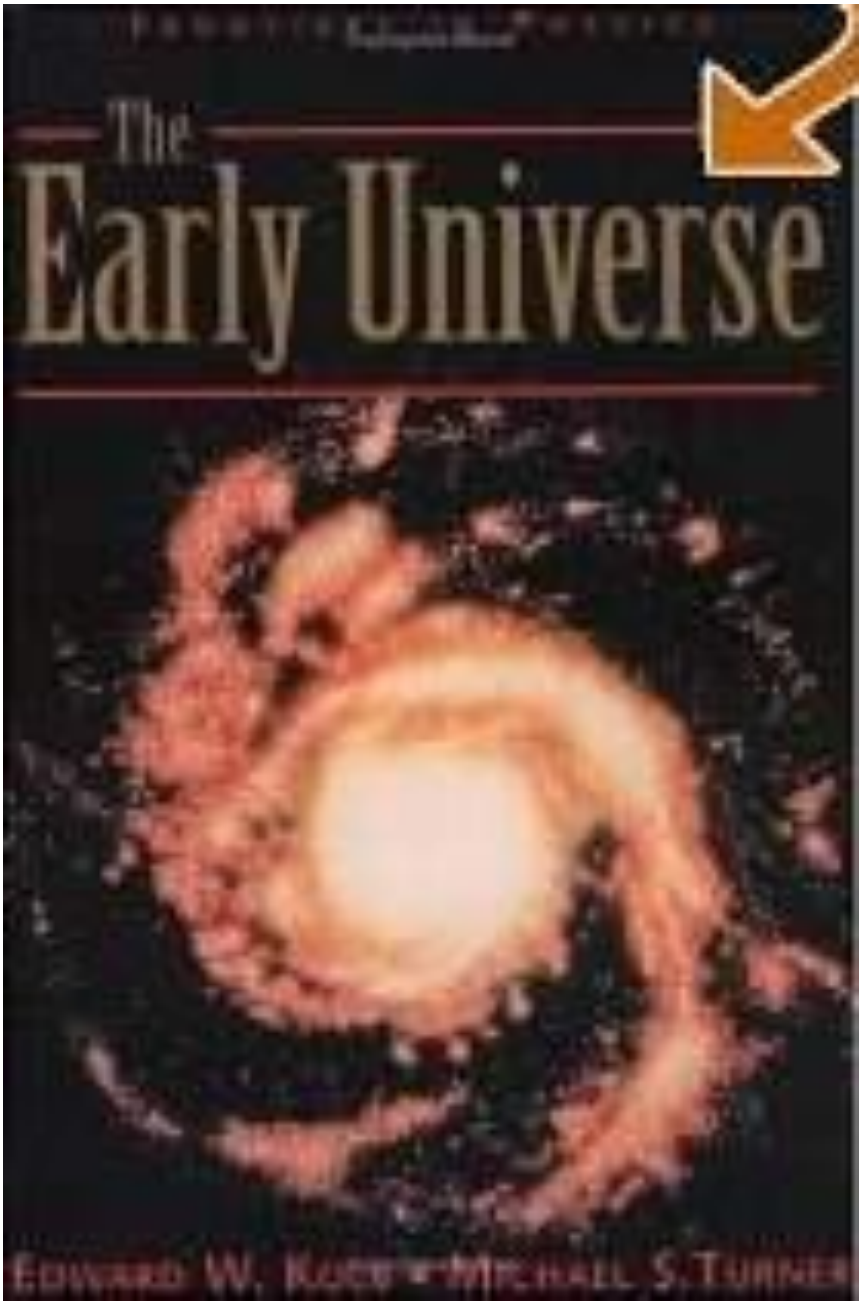


NASA solar cell
40% efficiency



http://www.th.physik.uni-frankfurt.de/~jr/gif/phys/weinberg.jpg

The Early Universe (Frontiers in Physics)

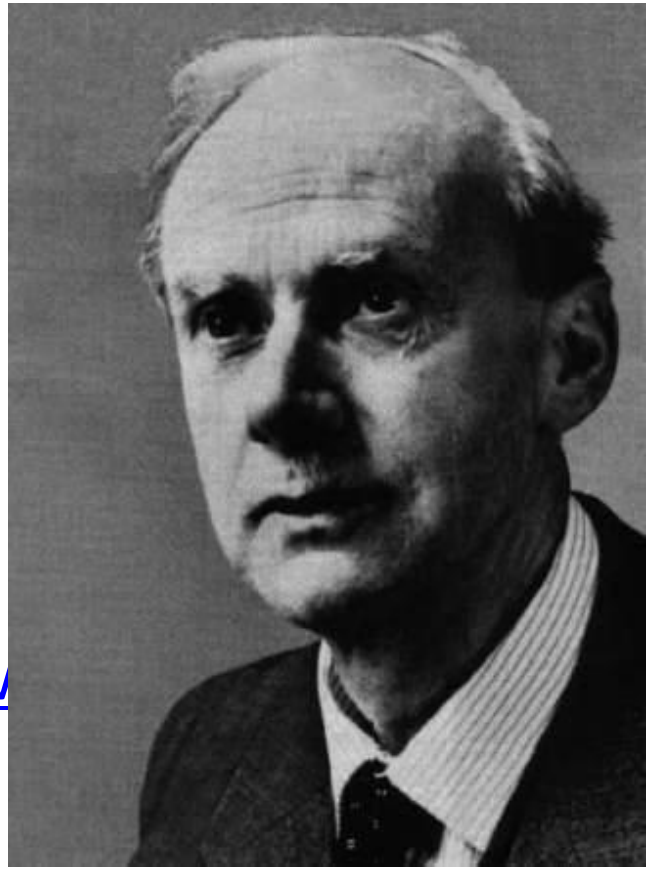


by Edward W. Kolb, Michael S. Turner "Our current understanding of the evolution of the **Universe** is based upon the Friedmann-Robertson-Walker (FRW) cosmological model, or the hot big bang model as it..." (more)

General Theory of Relativity

yes, no, not-a-question

- by Paul Adrien Maurice **Dirac**
  "For the space-time of physics we need four coordinates, the time t and three space coordinates x, y, z..." (more)



- 廣義相對論 講義
  http://www.cc.nctu.edu.tw/~wgore/apple2.htm

一棵開花的樹 /席慕容

如何讓你遇見我
在這最美麗的時刻　為這
我已在佛前　求了五百年
求祂讓我們結一段塵緣

佛於是把我化作一棵樹
長在你必經的路旁
陽光下慎重地開滿了花
朵朵都是我前世的盼望

當你走近　請你細聽
那顫抖的葉是我等待的熱情
而當你終於無視地走過
在你身後落了一地的
朋友啊　那不是花瓣
是我凋零的心

Feynman 說教書
會讓自己覺得自己是有用的人
所以先謝謝大家搭乘企業號
讓我有機會變成有用的人

ladyous.blogspot.com

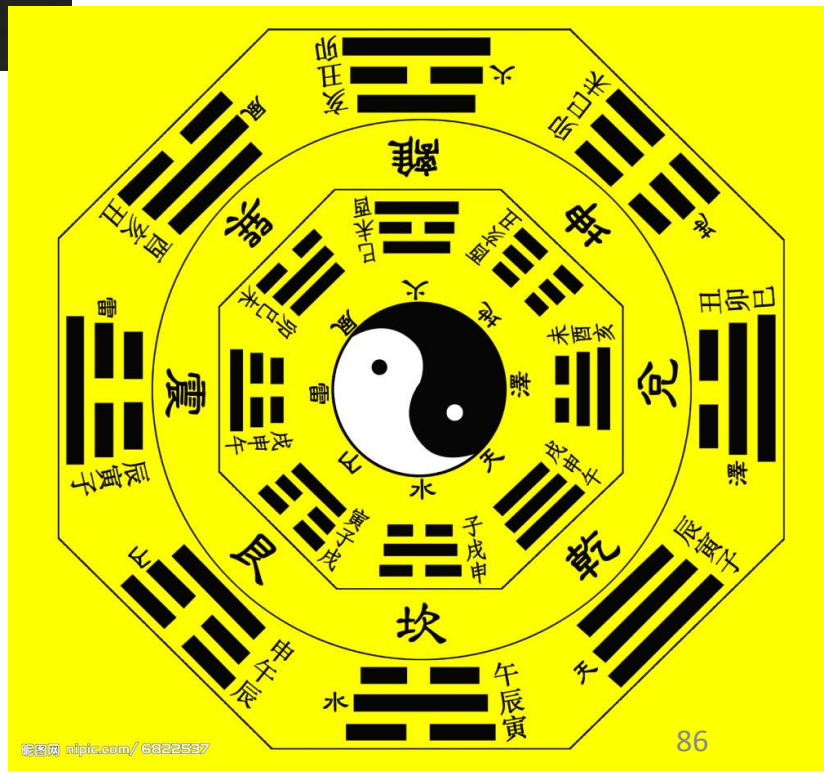
clker.com

forum.mymaji.com

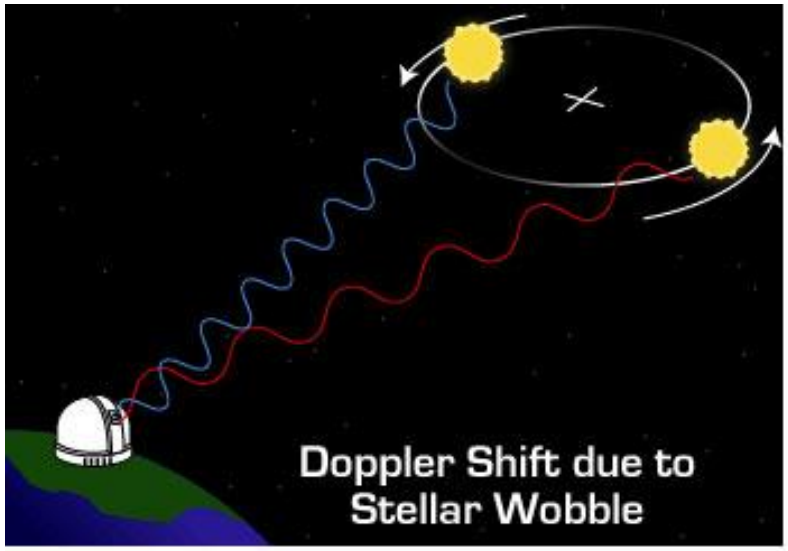
cryptomundo.com

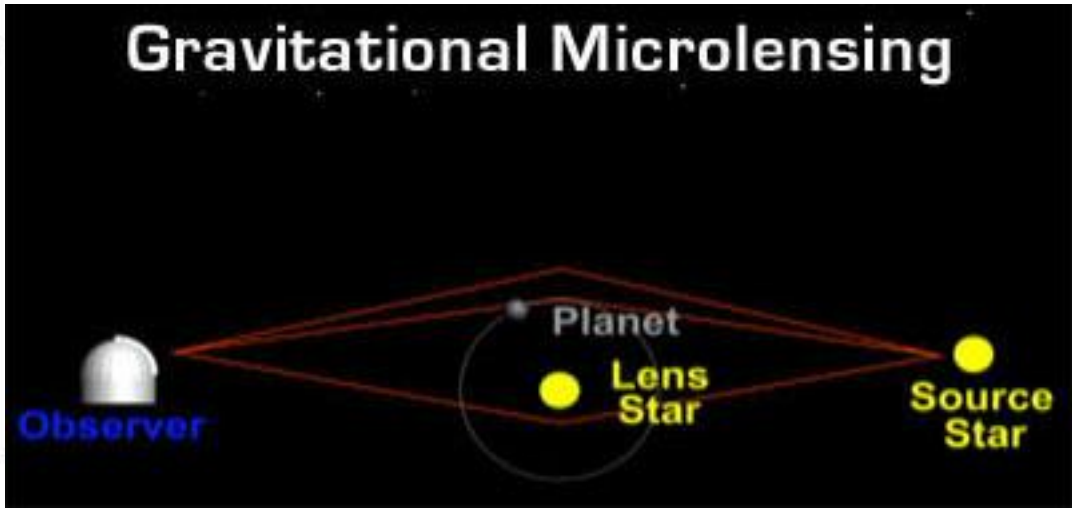
pamibe.com

http://tw.myblog.yahoo.com/jw!y7hFqz.RGhjUF9c.EIA8ztQ-/article?mid=977&prev=978&next=976

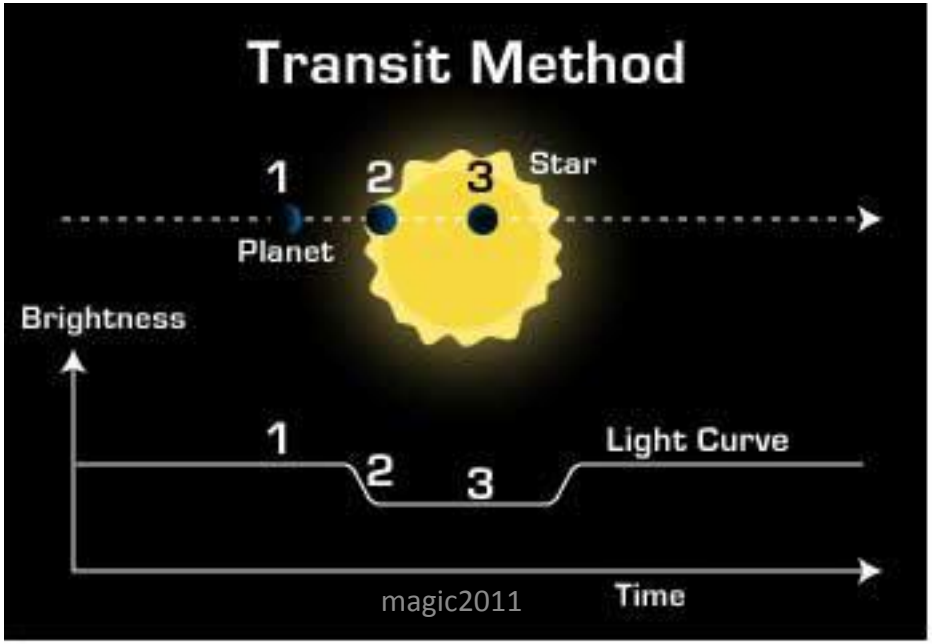


http://eg-land.com/viewthread.php?tid=2727 捷克

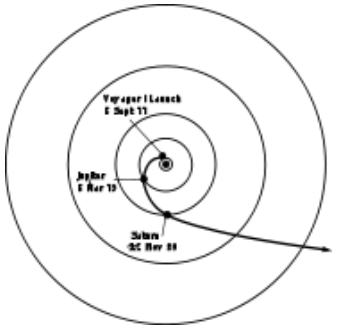




http://planetquest.jpl.nasa.gov/science/finding_planets.cfm

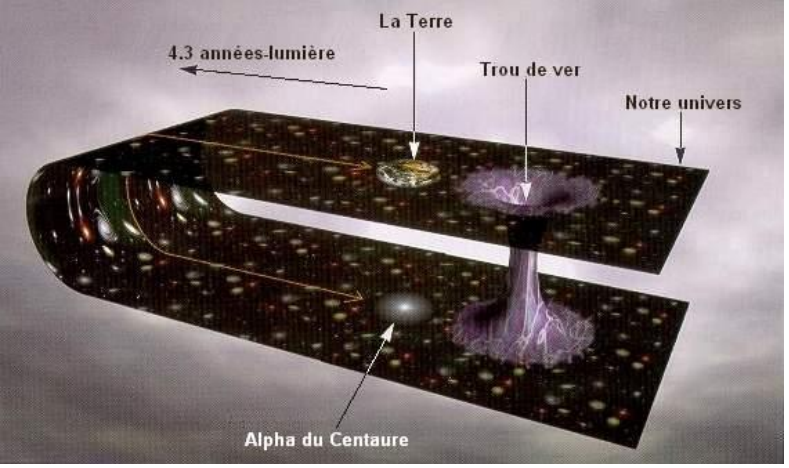


The Voyager 1 spacecraft is a 722-kilogram (1,592-lb) robotic American space probe launched by NASA on September 5, 1977, to study the outer Solar System and eventually interstellar space. Operating for 33 years, 7 months, and 28 days, the spacecraft receives routine commands and transmits data back to the Deep Space Network. It is the first probe to leave the Solar System and is the



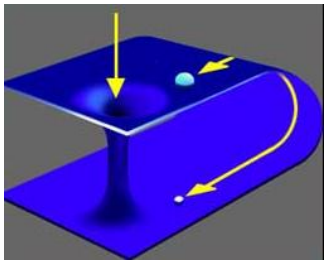
As of April 21, 2011, Voyager 1 was about 116.825 AU, or about 0.00183 light-year from the Sun.

http://en.wikipedia.org/wiki/File:Voyager.jpg

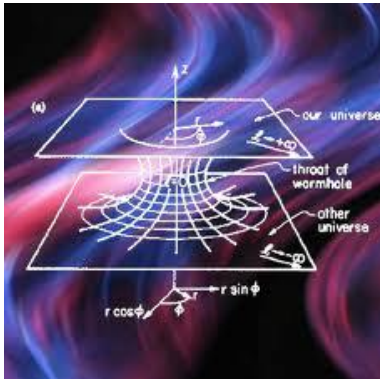


time-travel.over-blog.com

http://www.astrosurf.org/lombry/Physique/wormhole-alpha-centauri.jpg



tribalwar.com



paranormalspy.com

Wormhole 蟲洞

http://idiothink.blogspot.com/2009/09/doraemon-d.html

八里

萬里

景美

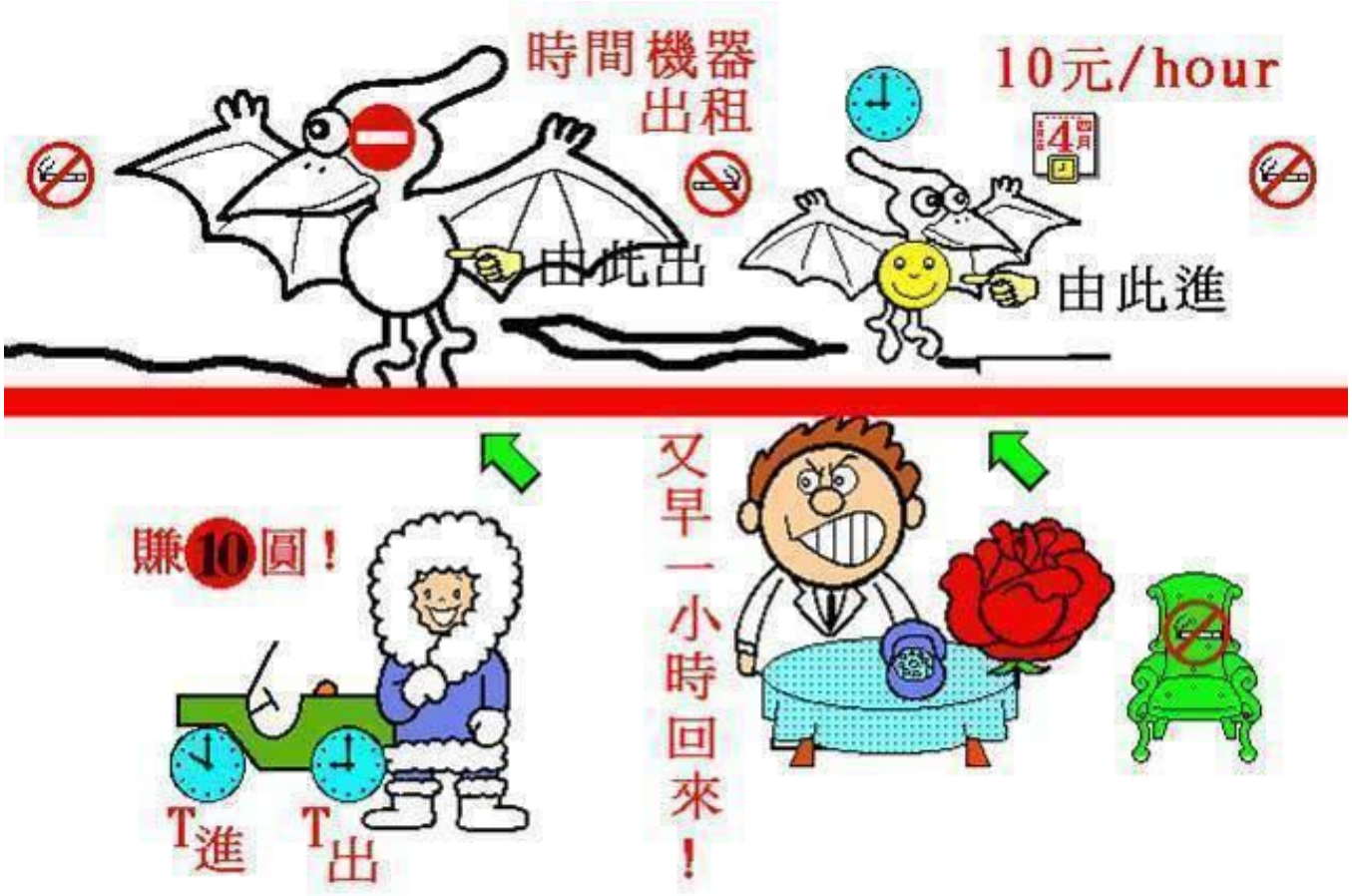
木柵

深坑

石碇

台北八景

http://lh4.ggpht.com/_hLvmUznLxEk/SwDASPSPaFI/AAAAAAAABiU/VUzZX_VeD8k/DSC00772.JPG


時間機器
出租
由此出
10元/hour
由此進
賺10圓！
T進
T出
又早一小時回來！

一棵開花的樹 /席慕容

如何讓你遇見我
在這最美麗的時刻　為這
我已在佛前　求了五百年
求祂讓我們結一段塵緣

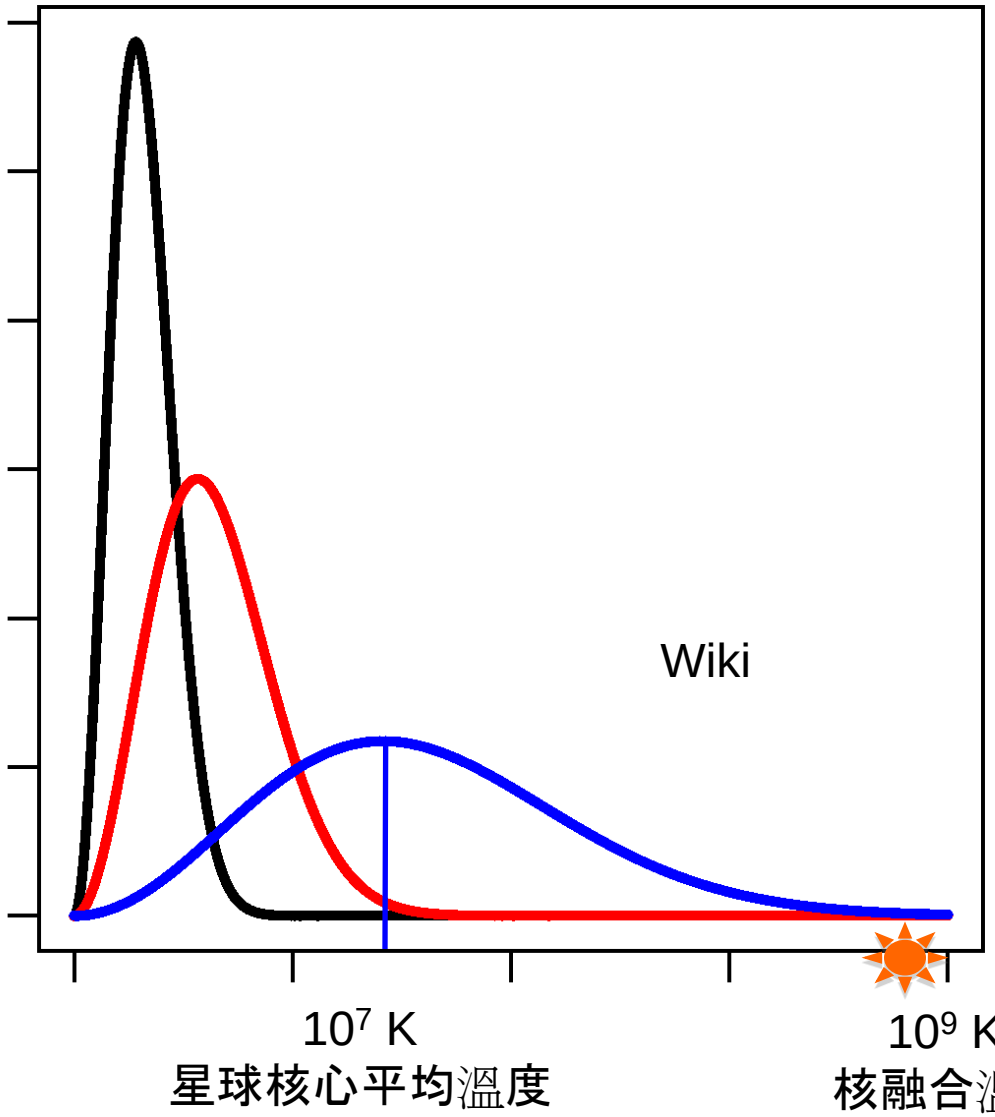
佛於是把我化作一棵樹
長在你必經的路旁
陽光下慎重地開滿了花
朵朵都是我前世的盼望

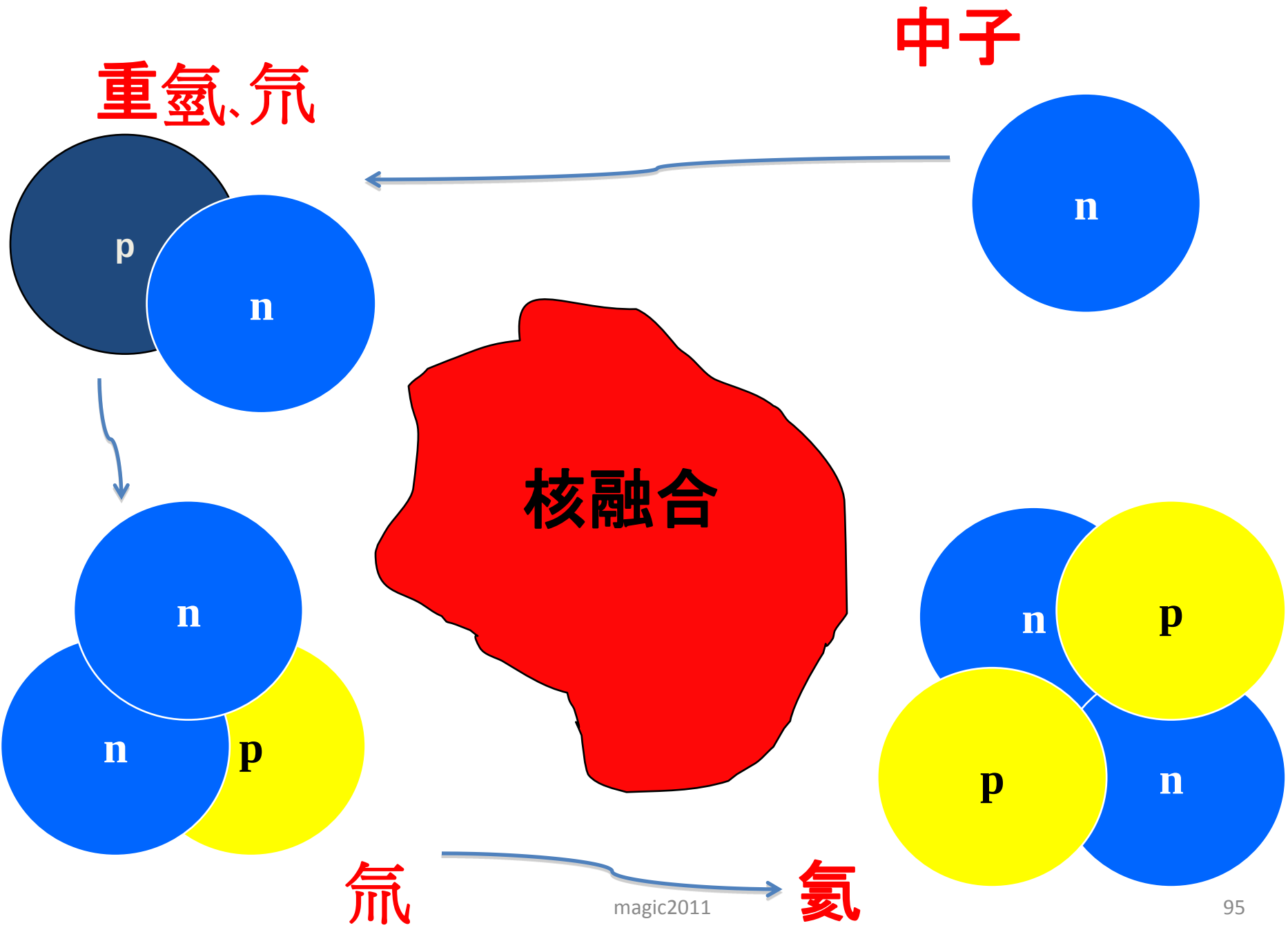
當你走近　請你細聽
那顫抖的葉是我等待的熱情
而當你終於無視地走過
在你身後落了一地的
朋友啊　那不是花瓣
是我凋零的心

Feynman 說教書
會讓自己覺得自己是有用的人
所以先謝謝大家搭乘企業號
讓我有機會變成有用的人

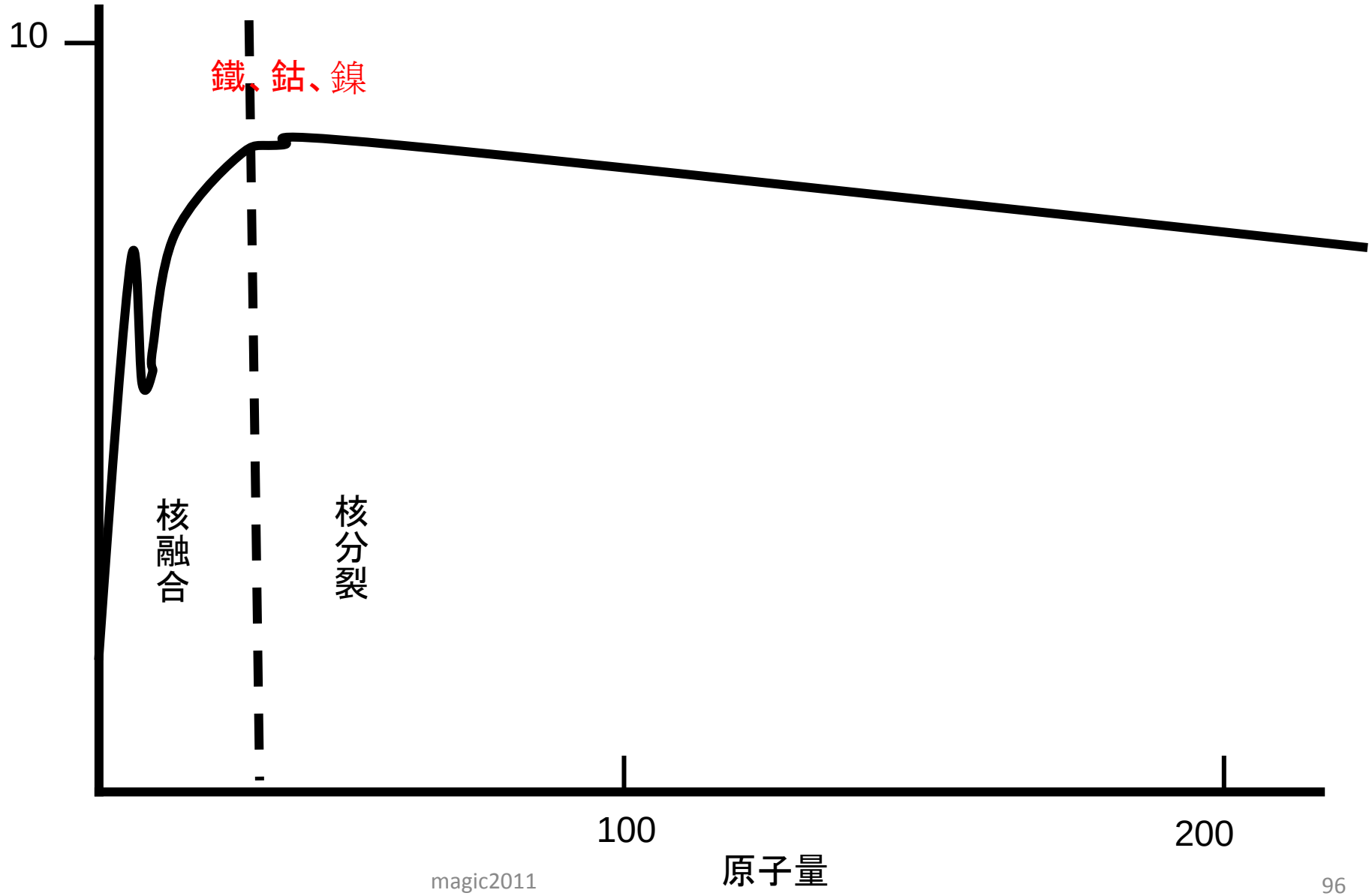
ladyous.blogspot.com

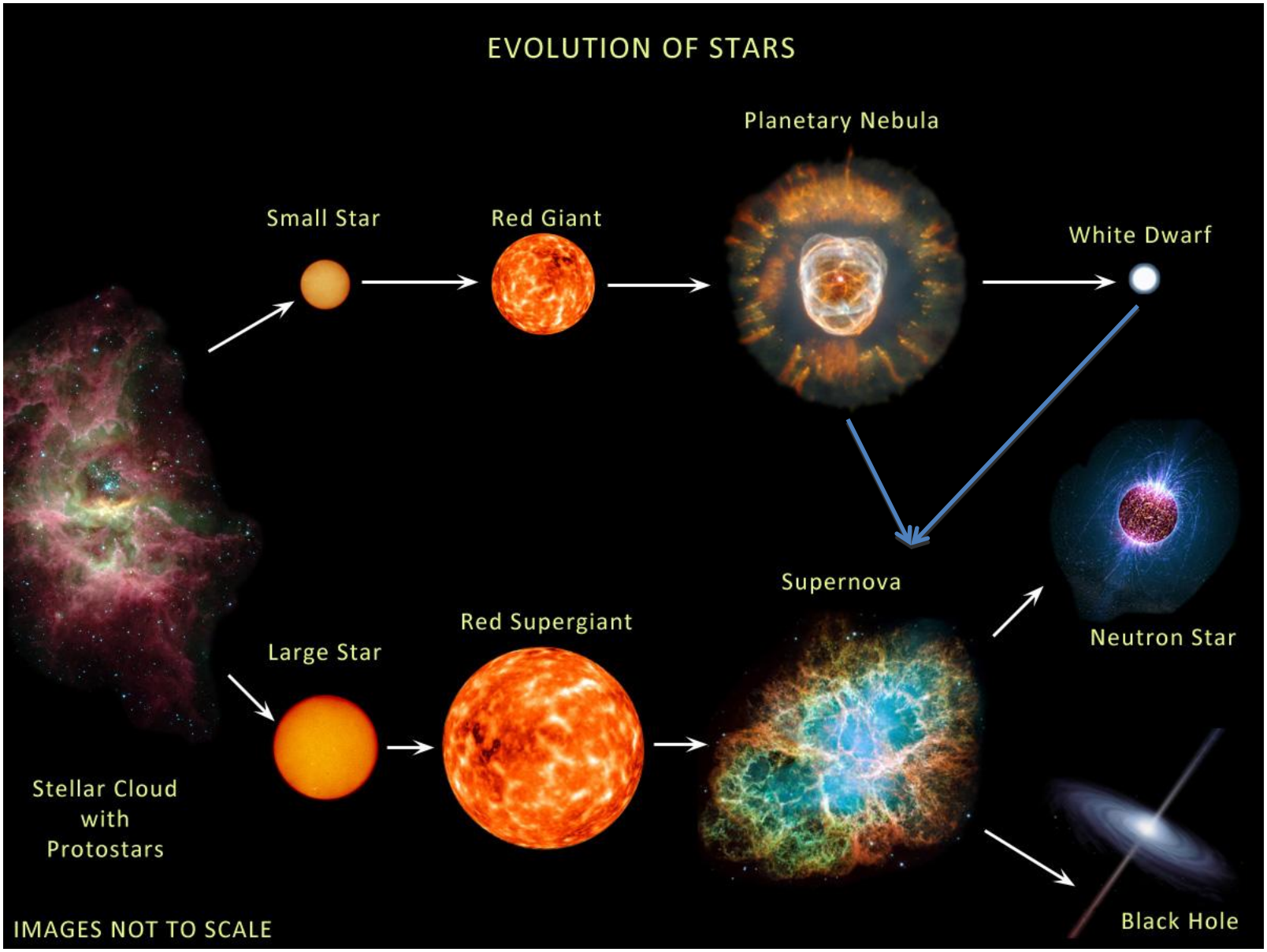
$$f(v) = \exp[-\frac{mv^2/2}{kT}]$$




中子
重氫、氘
n
p
n
核融合
n
n
p
n
p
p
n
氘
氦

束縛能 / 核子數 （MeV)





1.5 $M_\odot$

3 $M_\odot$

http://essayweb.net/astronomy/images/Stellar_Evolution_large.jpg

magic2011

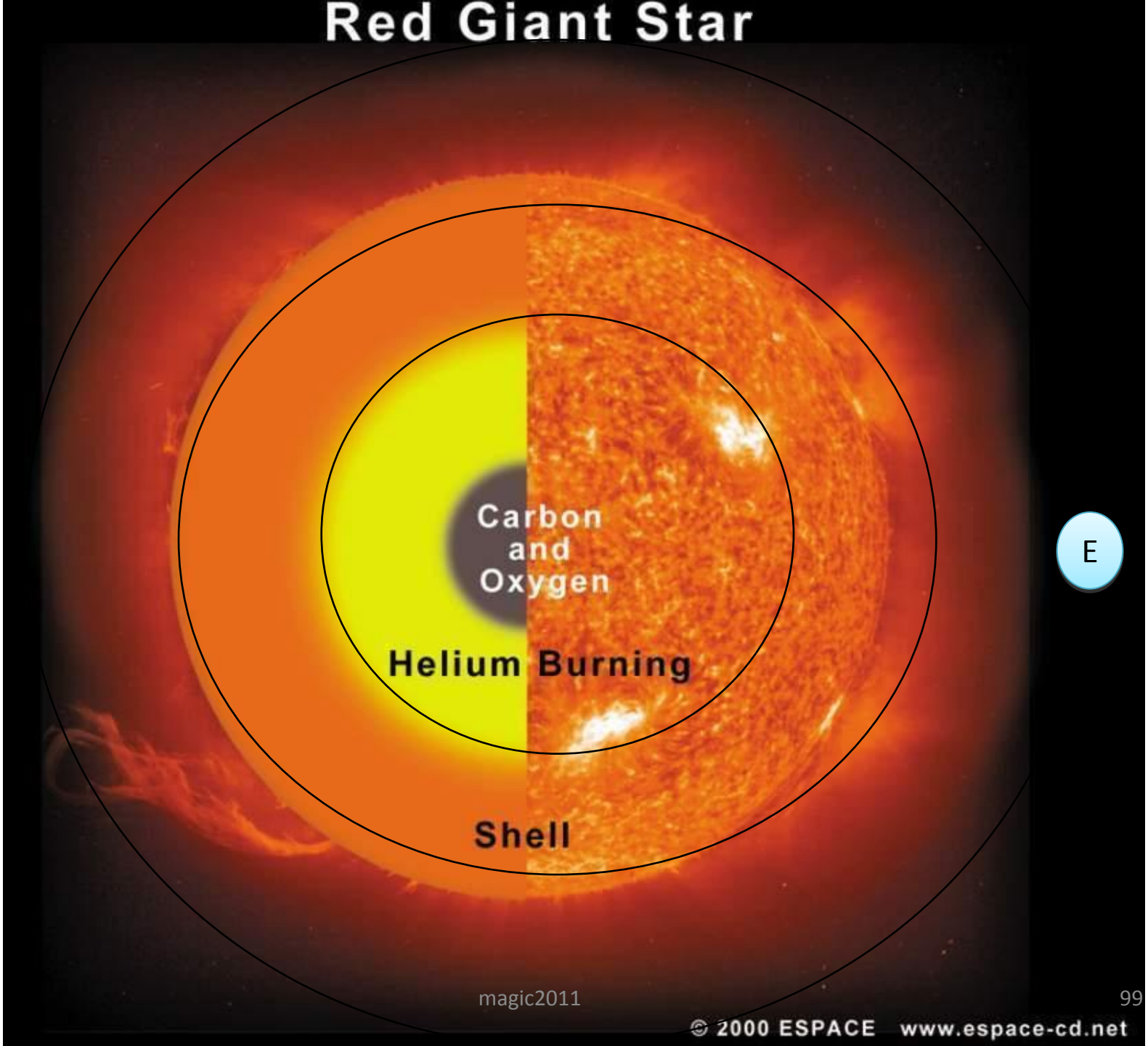
■包利 (Pauli)作用力或稱簡併力: 兩個費米子(fermion)無法處於同一個量子態

Compton Wavelength
康卜吞波長

電子 electron
$\lambda_e = h/m_e c$
$\sim 2.426 \times 10^{-12}$ m

中子 neutron
$\lambda_p = h/m_n c \sim 1/2000\ \lambda_e$
$\sim 1.319 \times 10^{-15}$ m

http://www.strangecosmos.com/images/content/108046.jp


Red Giant Star
Carbon and Oxygen
Helium Burning
Shell
© 2000 ESPACE www.espace-cd.net

E

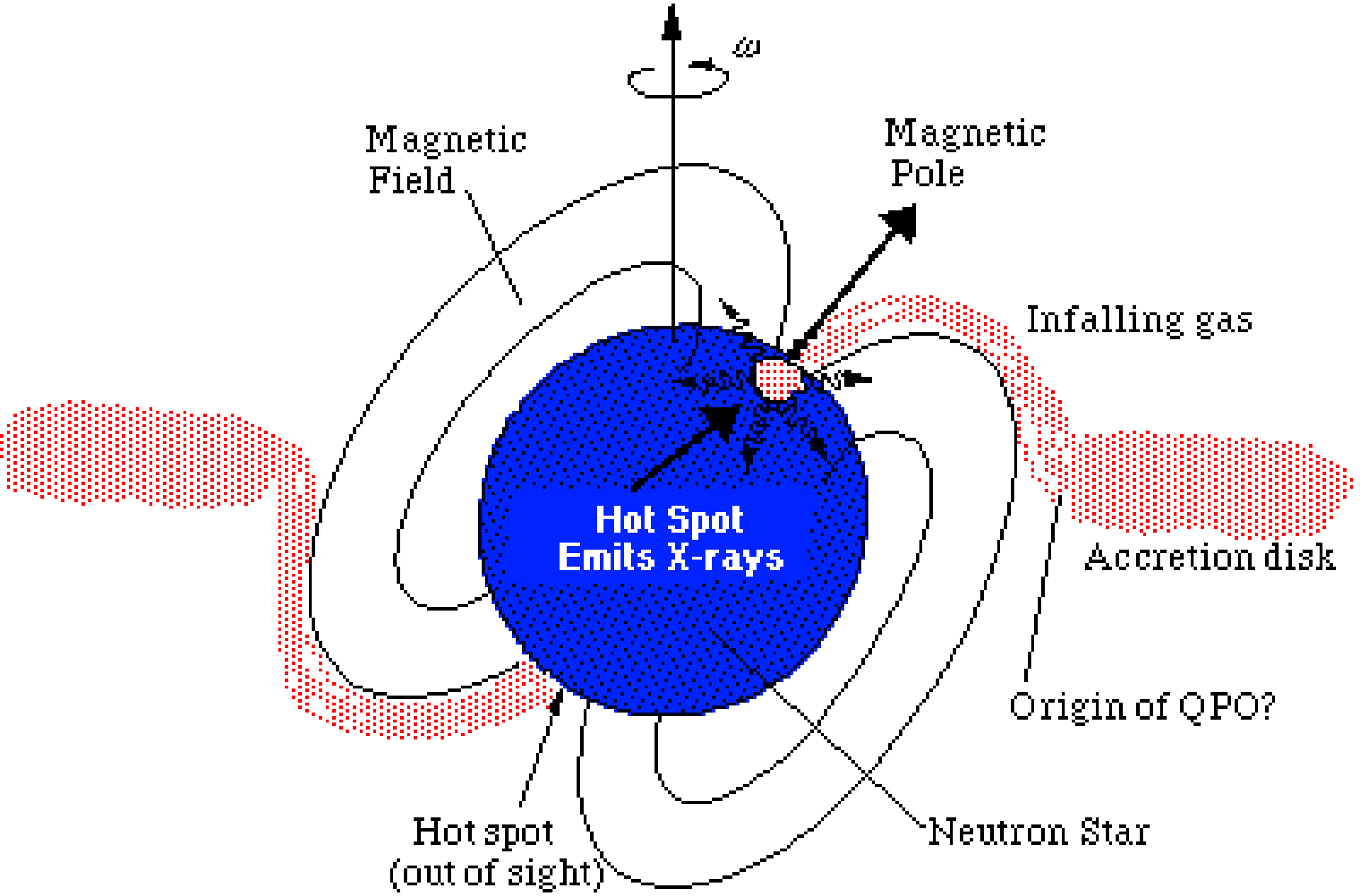
沙漏星雲

星雲中心的熾熱天體就是白矮星行星狀星雲通常在數千年後就會消散掉留下一顆暗、冷的白矮星

(HST/NASA)

太陽若形成。。。其半徑約為

- 白矮星　　地球大小
- 中子星　　6公里
- 黑 洞　　3公里



http://imagine.gsfc.nasa.gov/Images/advanced/xray/xray_pulsar.gif

he Nobel award to Ryle and Hewish without the inclusion of Bell as a co-recipient was controversial, and was roundly condemned by Hewish's fellow astronomer Fred Hoyle. Others, however, have noted that the prize was given to Ryle and Hewish for their work across the field of radio-astronomy as a whole, with particular mention of Ryle's work on aperture-synthesis, and Hewish's on pulsars.

http://www.lbl.gov/Science-Articles/Archive/sb/Nov-2004/03-Bell_radiotelescope.jpg

Jocelyn Bell Burnell

Antony Hewish

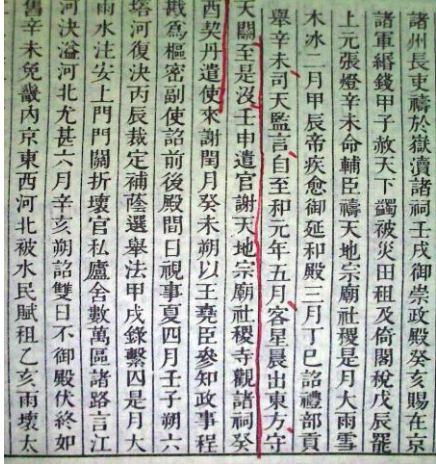
Nobel Prize for Physics (1974)

客星-蔡氏星雲; Crab Nebula-超新星 super nova

http://rst.gsfc.nasa.gov/Sect20/crab.jpg


凡十一日没三年三月乙巳出東南方大中祥符
年五月丁丑見南斗魁前天禧五年四月丙辰出軒轅
前星西北大如桃速行經軒轅太星入太微垣右執
法犯次將歷屏星西北凡七十五日入濁没明道元
年六月乙巳出東北方近濁有芒彗至丁巳凡十三
日没至和元年五月己丑出天關東南可數寸歲餘
稍没熙寧二年六月丙辰出箕度中至七月丁卯犯
箕乃散三年十一月丁未出天困元祐六年十一月
辛亥出參度中犯掩側星壬子犯九游星十二月癸
酉入奎至七年三月辛亥乃散紹興八年五月守婁
宋史志卷九
三五

http://aeea.nmns.edu.tw/geo_home/geo_93/126.jpg

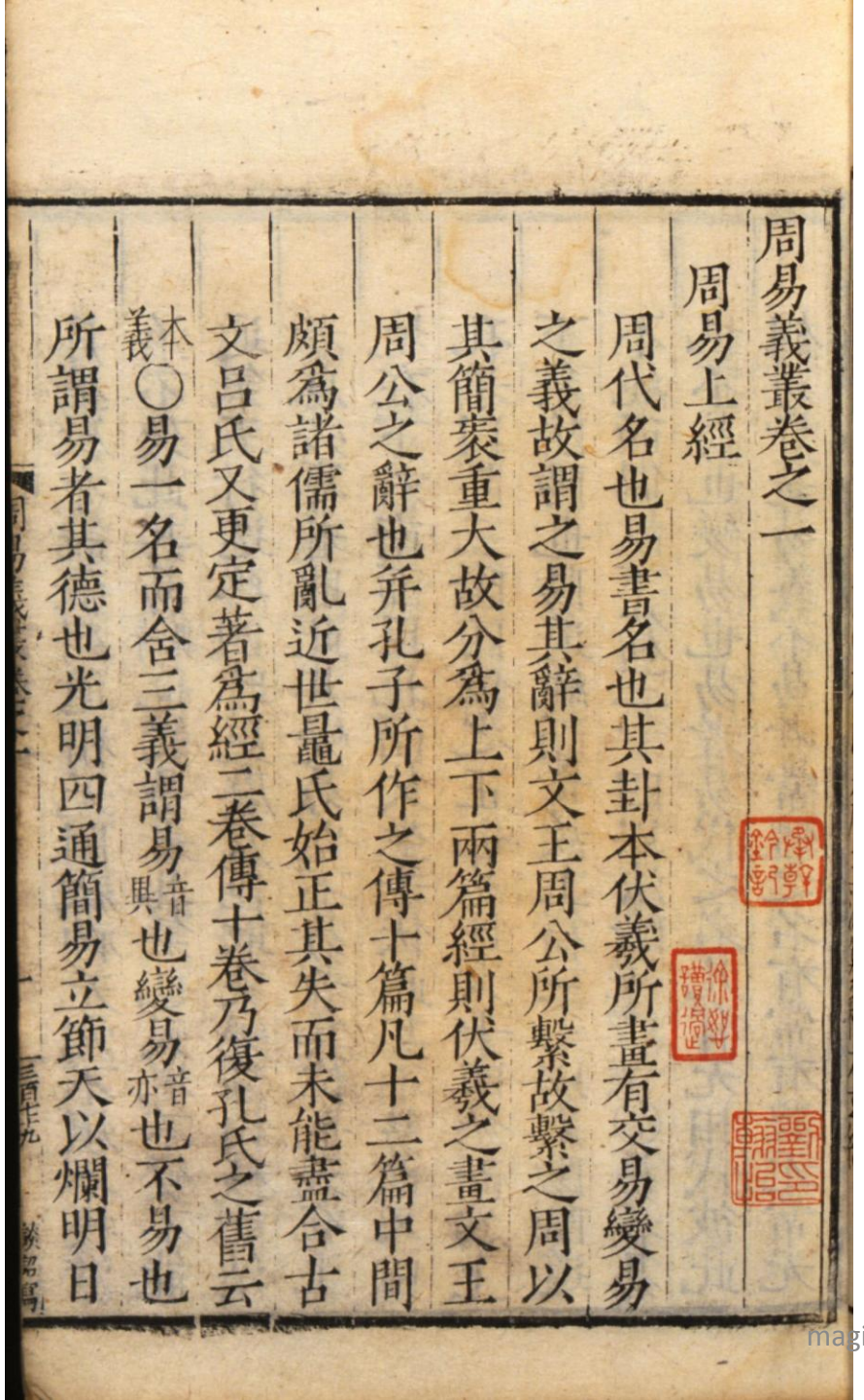

諸州長吏禱於嶽瀆諸祠壬戌御崇政殿癸亥賜在京
諸軍緡錢甲子赦天下蠲被災田租及倚閣稅戊辰罷
上元張燈辛未命輔臣禱天地宗廟社稷是月大雨雪
木冰二月甲辰帝疾愈御延和殿三月丁巳詔禮部貢
舉辛未司天監言自至和元年五月客星晨出東方守
天關至是沒壬申遣官謝天地宗廟社稷寺觀諸祠癸
酉契丹遣使來謝閏月癸未朔以王堯臣參知政事程
戡爲樞密副使詔前後殿間日視事夏四月壬子朔六
塔河復決丙辰裁定補蔭選舉法甲戌錄繫囚是月大
雨水注安上門門關折壞官私廬舍數萬區諸路言江
河決溢河北尤甚六月辛亥朔詔雙日不御殿伏終如
舊

http://hanyu.iciba.com/wiki/44562.shtml

西元1054年

宋史

客星 至和元年五月已丑，出天關東南，可數寸，歲餘稍沒


周易義叢卷之一

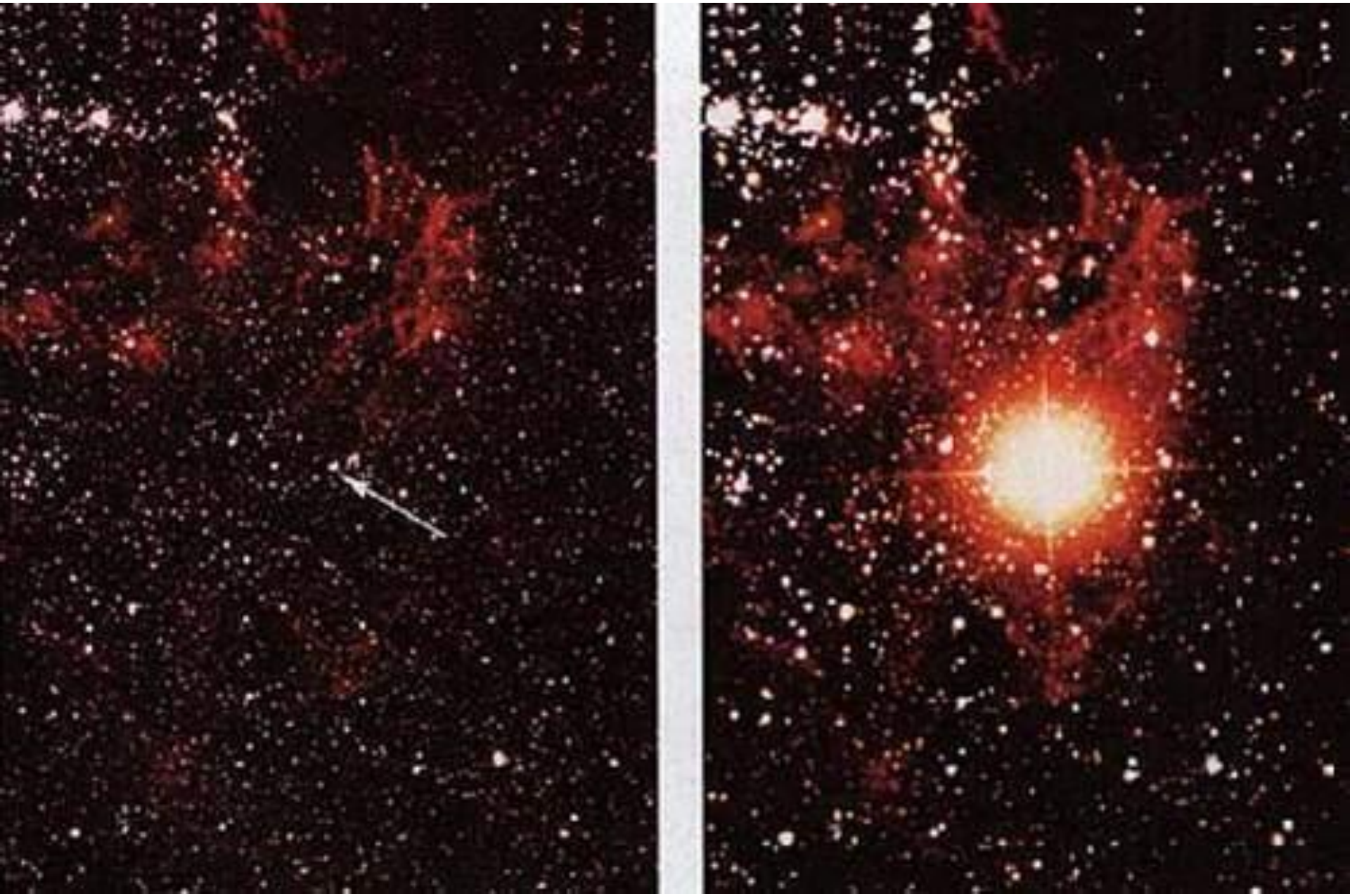
周易上經

周代名也易書名也其卦本伏羲所畫有交易變易之義故謂之易其辭則文王周公所繫故繫之周以其簡褒重大故分爲上下兩篇經則伏羲之畫文王周公之辭也并孔子所作之傳十篇凡十二篇中間頗爲諸儒所亂近世鼂氏始正其失而未能盡合古文呂氏又更定著爲經二卷傳十卷乃復孔氏之舊云本義○易一名而含三義謂易音異也變易音亦也不易也所謂易者其德也光明四通簡易立節天以爛明日

西元1054年 宋至和元年五月已丑

・宋史

客星出天關東南，可數寸，歲餘稍沒



HST/NASA http://rst.gsfc.nasa.gov/Sect20/sn87ba.jpg


STARCHILD
presents...
NASA
BLACK HOLES
http://starchild.gsfc.nasa.gov/

Paycheck 記憶裂痕

預知未來，就不會有未來

預知戰爭，想阻止戰爭，就會引發戰爭

預知疾病，集中管理，最後引發瘟疫失控

- 物理最美好的一面，

就是無法

確定預知未來

最美好的記憶，

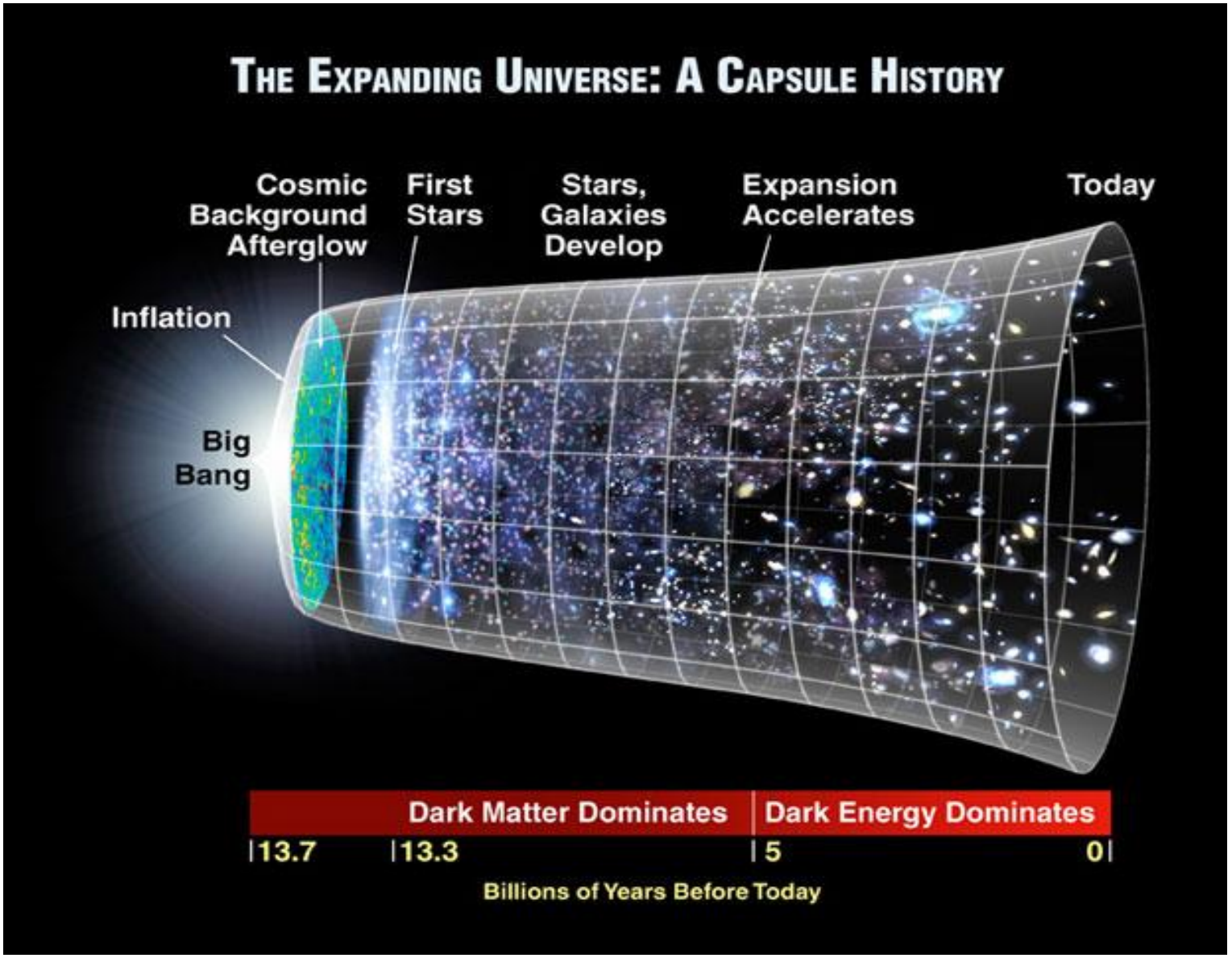
就是自己的缺點

長度/Mikowski vs Friedmann-Robertson-Walker Spacetime

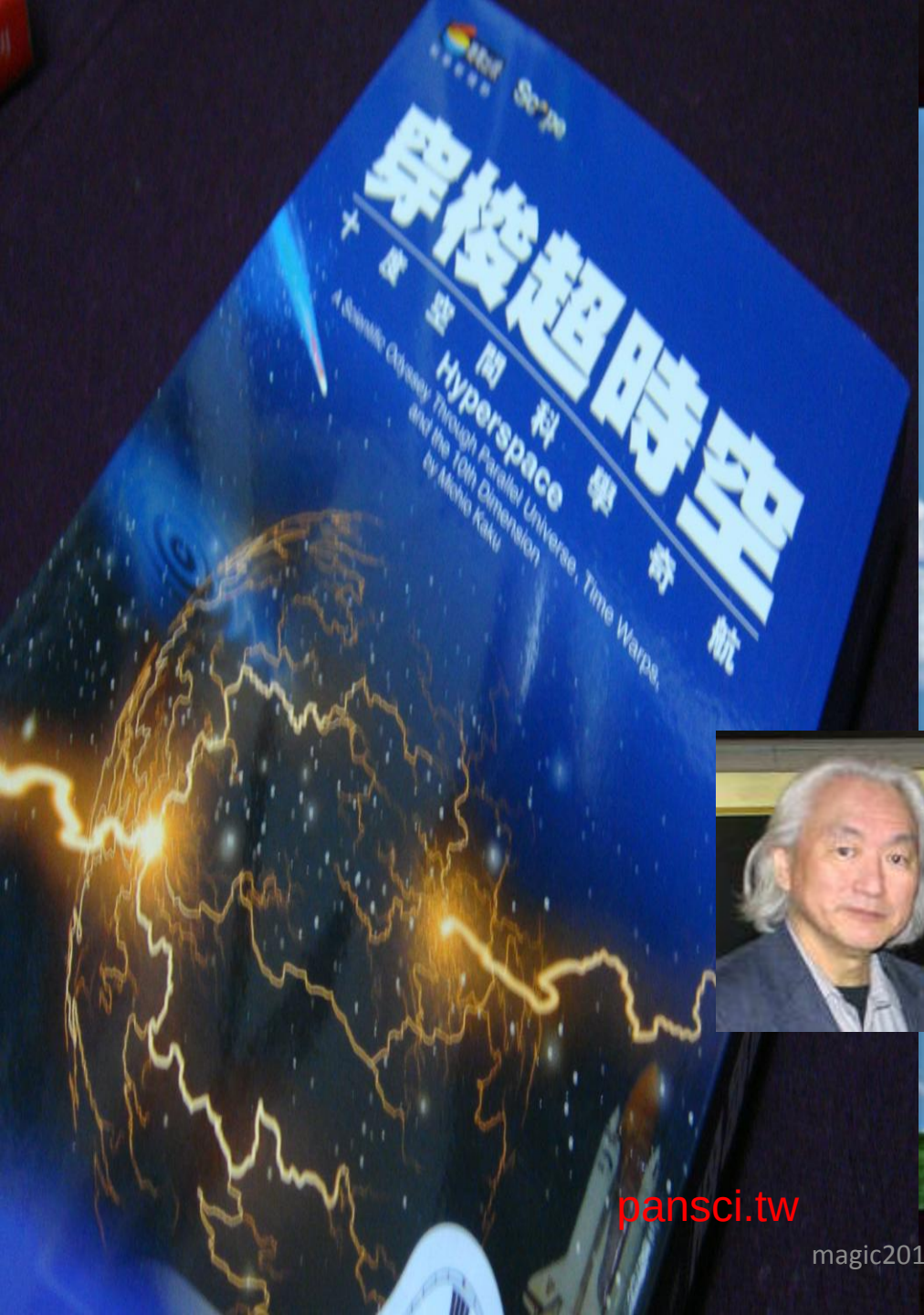
$$ds^2 = -c^2dt^2 + dx^2 + dy^2 + dz^2 = -dt^2 + dr^2 + r^2d\theta^2 + r^2\sin^2\theta d\varphi^2$$

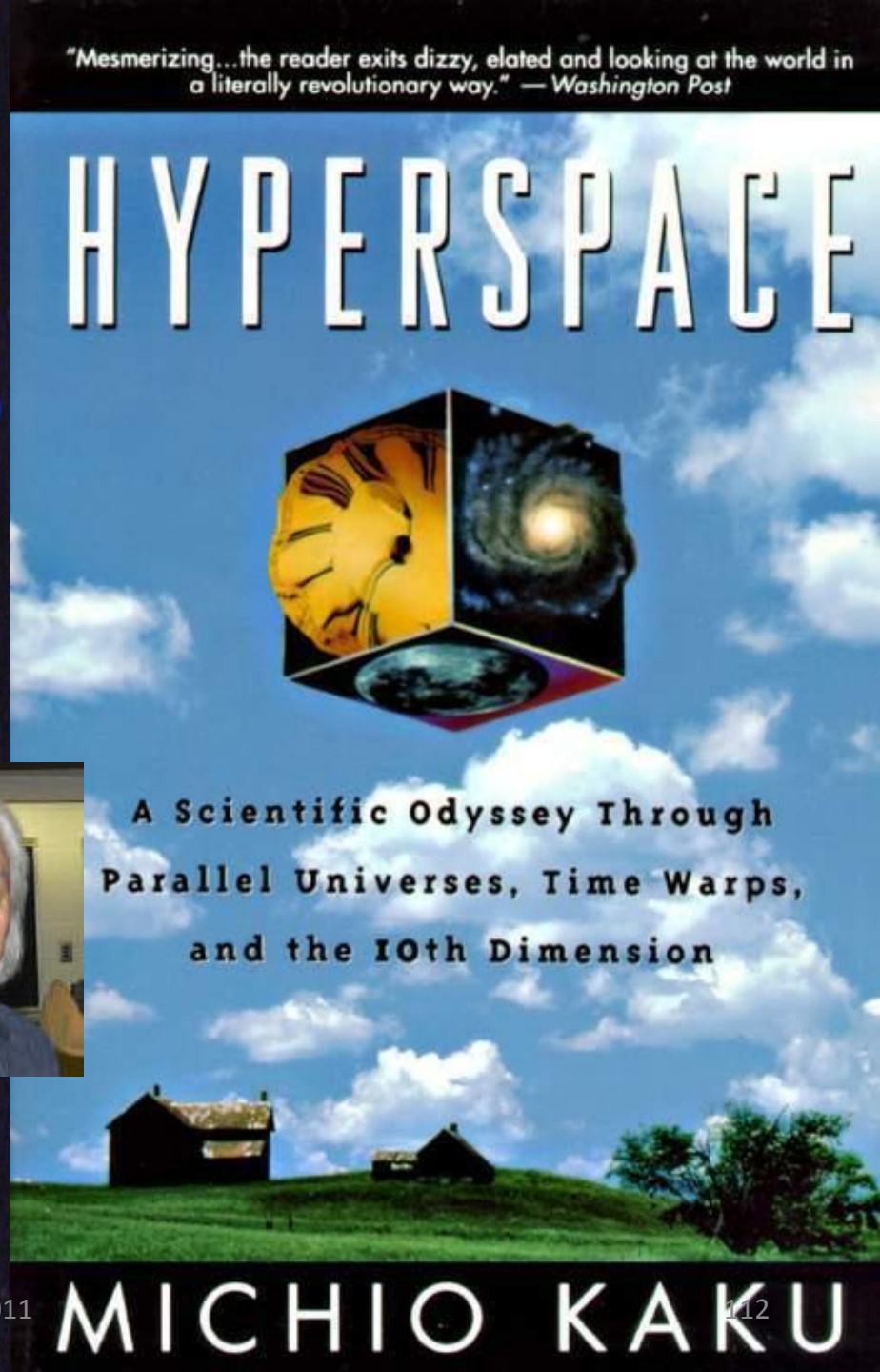
$$= -dt^2 + a^2(t)\left(\frac{dr^2}{1-kr^2} + r^2d\theta^2 + r^2\sin^2\theta d\varphi^2\right)$$

宇宙加速膨脹挑戰科學對時空的認識



http://hetdex.org/dark_energy/index.php


穿梭超時空
十度空間科學奇航
Hyperspace
A Scientific Odyssey Through Parallel Universe, Time Warps, and the 10th Dimension
by Michio Kaku


"Mesmerizing...the reader exits dizzy, elated and looking at the world in a literally revolutionary way." —Washington Post
HYPERSPACE
A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension
MICHIO KAKU