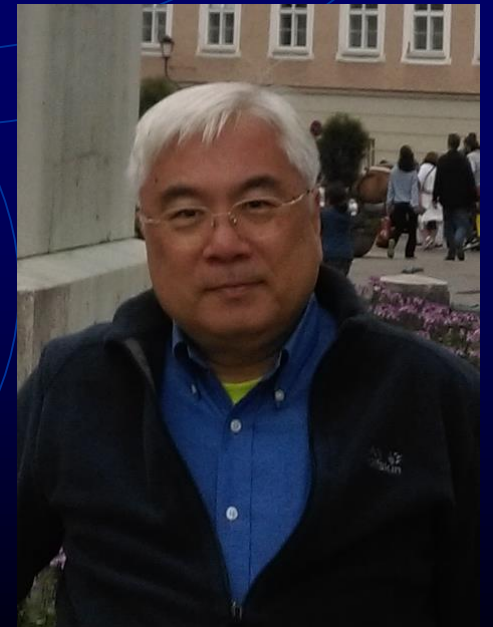
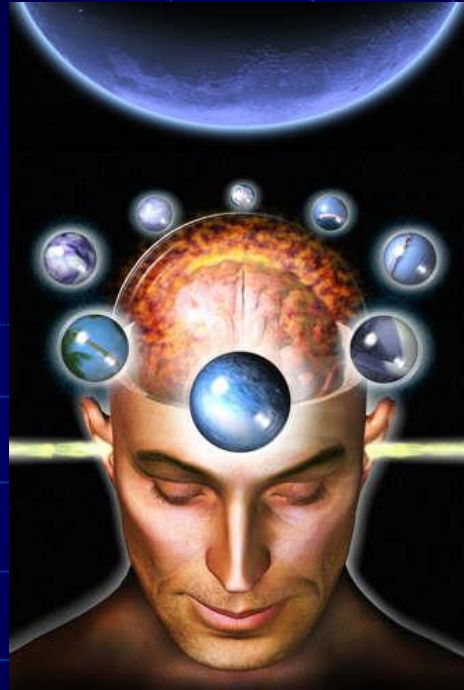


外星人哪去了？



陳文屏

中央大學 天文所、物理系

2020.05.31 to XJTLU

Astrobiology

天文生物學已是顯學

A legitimate discipline

- NASA Astrobiology Institute (NAI)
- Penn State, Stanford, U Washington, UCLA, UT Austin, Arizona State, U Colorado, Cornell, U Edinburgh, Stockholm U., U New S Wales, McGill U, etc.

To look out for extraterrestrial life and intelligence, and to facilitate terrestrial life in space ...

尋找外星人；尋找地球人的下一站

What will **NOT** be covered (much)...

- Space travel 時空旅行 金字塔、麥田圈 ...
- Pyramids, crop circles, paranormals
- The Roswell event, Area 51, UFOs ... 51區
- Alien abduction 被外星人綁架



Outline

◆ Making sense 講講道理

◆ What is life? 找什麼?
(Search for what?)



尋找 外星 生命

◆ The extraterrestrial worlds
(Where to search?) 往哪找?



◆ “Where is everybody?” 怎麼找?
(How to search? Are they here? Are we they?)



◆ Do you believe in aliens? 相信外星人嗎?

the existence of

somewhere,
sometime



Anything's possible, but only a few things actually happen.
RICH ROSEN, USENET COMPUTER BULLETIN BOARD, 1985

There is no right or wrong for what you believe.

Yes or no, though, you should have a reason.

*If you believe they should exist, then, how
many kinds of aliens are there?
1 million? 1 thousand? 1?*

◆ Do you believe in ghosts? 相信鬼嗎？



Is it “safer” to say yes?

*If not, what about those “stories”
that we have seen in the news, that we
heard from a friend who allegedly heard
it from a relative of her friend ...*

*When this were asked two hundred years ago?
Higher-up all-mighty savior who knows it all ...
rainfall, thunders, rotten food ...*

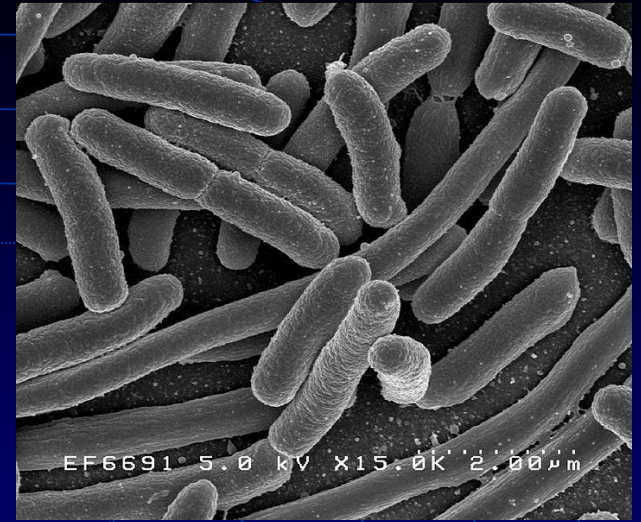
「相信」沒有對或錯
但是為什麼信呢？

*Legitimate questions, legitimate answers.
(What is the purpose of life?)
Religion, philosophy, science*

◆ Do you believe in bacteria?

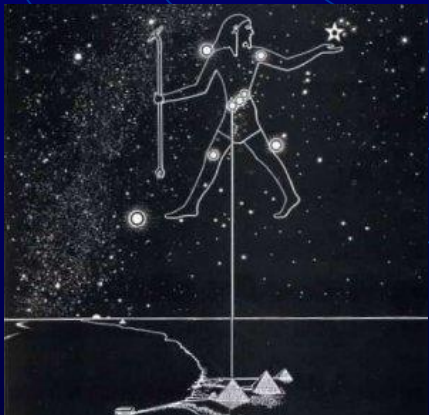
Is to see to believe?

I've never met my great-great grand mother, but never ever doubted her existence.



「眼見為憑」?

“Our knowledge is limited. There are still a lot of things we do not know, so we should be humble confronting Nature.” --- so they say



But science is not to play safe, it is seeking *veritas*.

◆ 你相信外星人存在嗎？理由是什麼？



為什麼信鬼神？細菌真的存在嗎？
曾曾曾祖母存在過嗎？
憑什麼「寧可信其有」？

◆ 如果相信，你猜想有多少（種）外星人呢？

為什麼外星生物這麼像「人」？

上億個？千百個？還是…只有一個？

就是我們自己！



◆ 為何尋找外星生命？

找救贖、找救兵，還是找麻煩？

多半人相信外星人存在，因為 …



Jodie Foster as “Ellie” in
Contact (接觸未來，1997)



If we are alone in the Universe, then it is an awful waste of space.

— Carl Sagan

要是宇宙中只有我們，那真是太浪費空間了。

— 卡爾·沙岡

多半人相信外星人存在，因為...

迷思：宇宙無窮大、歲月無限長

... 因此甚麼都有可能

事實——宇宙年齡有限（137億年）

並非甚麼都有可能

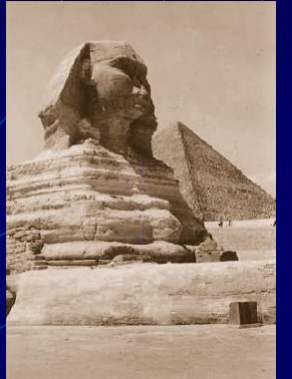
某件事...很可能、可能、不太可能、絕無可能...

事實——有些事雖然不太可能，但

未抵觸任何**已知**科學定律

有些卻違背**現有**知識，因此**目前**絕無可能

事實——如何證明「沒有」？



宇宙現在處於**膨脹**狀態——越遠的星系，離我們遠去的速度越快

哈伯定律

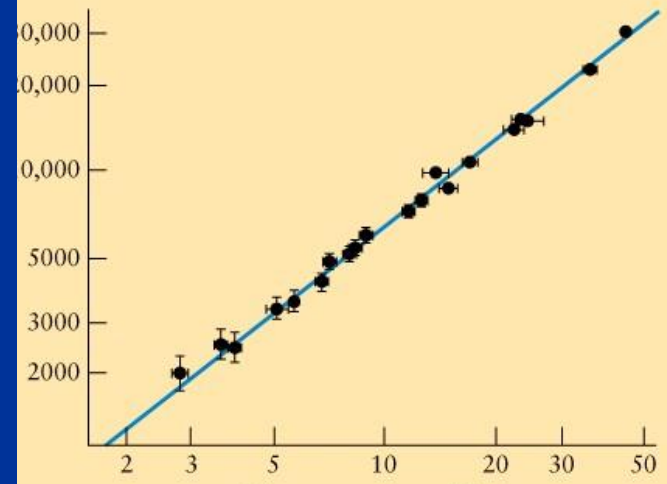
宇宙微波背景輻射 充斥在太空中，支持宇宙始於一團高熱
(大霹靂)

輕元素的宇宙含量 最老的天體氦元素仍占 25%

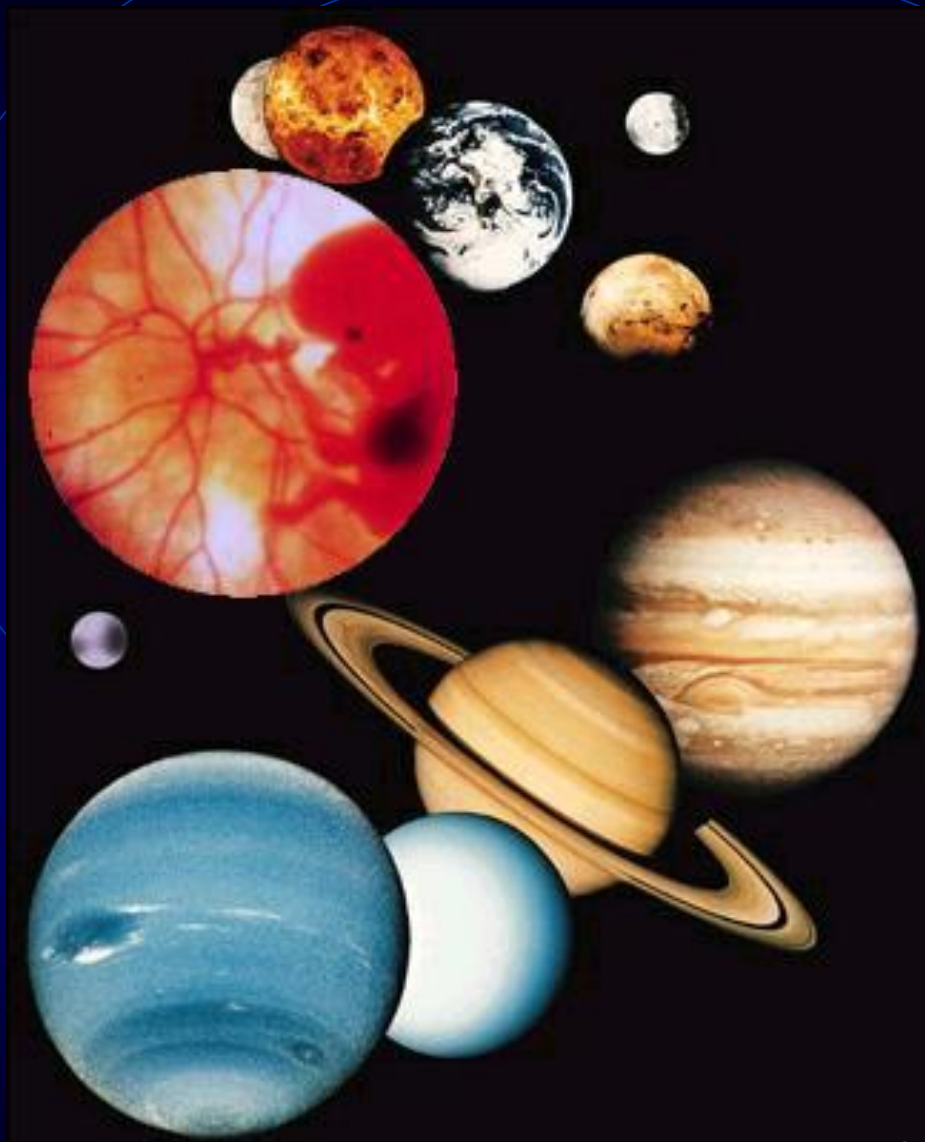
沒有發現「極其古老」的天體

原來這上下古今，稱做「宇宙」的東西居然有起點！

後退速度 (km/s)



星系離我們距離 (3百萬光年)



事實——地球是目前太陽系中
唯一已知有（智慧）生命存
在的天體

會是宇宙中唯一的嗎？

應該不～會～吧？

哪些是「應該」的事情？

一切都是機率問題 ...

- 如果彩券中獎機率是1000萬分之1
- 那麼買1張、1000張、1萬張、1000萬張？
- 一次買1張，買1000萬次？
 - ✓ 適合生命誕生的太空環境（比例）
 - ✓ 環境對了，實際生命可以誕生的機率
 - ✓ 生命出現後可以維持下去，發展出文明的機率
 - ✓ 有了文明，可以（願意）溝通
 - ✓ 讓我們碰到了（去找，還是讓它們來找？）

Fact: Probability can be misleading.

*Unlikely, but no violation
of any physical laws ...*

*If someone challenges you for 100
times straight heads in tossing a coin.*

$$P = \left(\frac{1}{2}\right)^{100}$$



Do you bet?

“No way”

*Obvious violation of
currently known laws ...*

*If someone asks to trade you with \$2
for his \$1 coin that will become
a \$10 coin when dropped to ground.*

$$P = 0$$

Do you trade?

“No way”

“medicine in the air?”

隔空抓藥?

古書可以測命?

These are at different levels of no way.

Fact: One cannot prove inexistence.



*One person asserts that ghosts exist,
while the other insists not.*

Which side are you on?

Equal (50%) chances?

The person who bets on existence shall never lose.

The person who bets on nonexistence can never win.

How can one prove that ghosts do not exist anywhere, any time?

- ✓ **Extraordinary claims require extraordinary evidence.**
- ✓ **The burden of proof falls upon the positive.** Alan Hale

There has been a long record of aliens in human history ...
Why not? Every “new world” seemed populated.

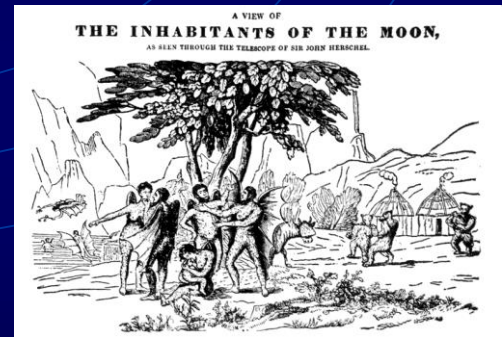
Moon people (selenites)

The Great Moon Hoax (1835)

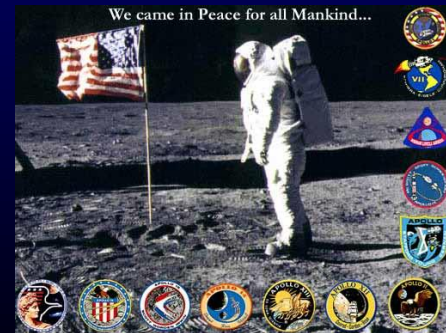
Media (!) had it that Sir John Herschel (a creditable source!) saw lunar civilization (published in a scientific journal!) using a new and novice telescope (so was not known before!)

Nowadays, some still claimed Apollo landings were faked.

Aliens have moved from center of the Earth (the Bermuda Triangle), to the farside of the Moon, then to the center of the Moon.



1835 lithograph



Martians



Astronomer Schiaparelli (1877) claimed to have seen “canali” (nominally “channel” in Italian) under exceptionally good sky condition (!). It was mistranslated to “canal”.

H. G. Wells (1898) “*War of the Worlds*”

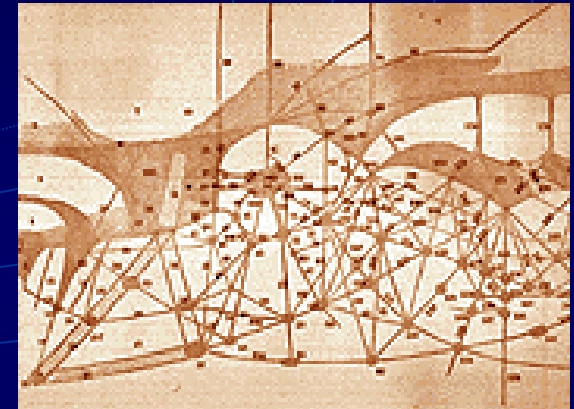
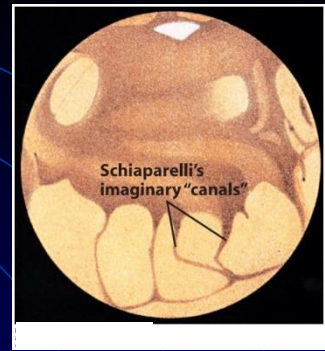
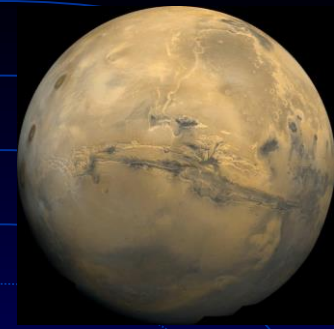
Edgar Rice Burroughs (1912)

“*Under the Moons of Mars*” → The little green men

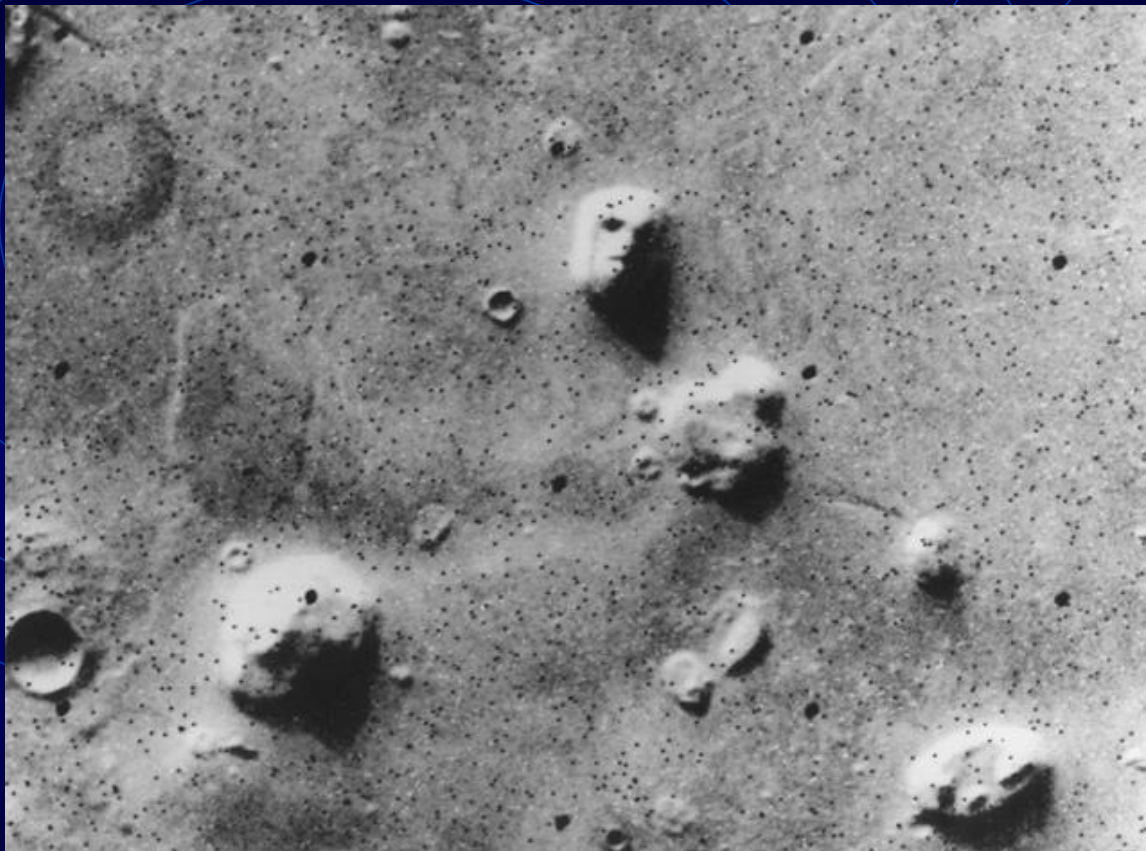
Percival Lowell (1855-1916) was fascinated by, so started to chart out, the canals. There was good scientific reasoning for the canals, because Martian poles were known to freeze out.

Orson Welles (1938) radio show dramatized landing of Martians.

火星正式進入地球人歷史



- *Mariner 4* in 1965, none of the two *Viking* orbiters in 1976 saw Martians, but ...



Scientists view haunting pictures sent from the dying planet

Stone face on Mars beams TV warning to Earth

Face-shaped Mars rock is a puzzler

Doomsday images are 500,000 years old!

Creeps kick blind dad to death

Yuppies spark bourbon boom



MILE-LONG monument, center of photo, shows the Martian television transmitter that has been sending the Earth such images of a long-dead civilization. Scientists who have seen the nightmarish pictures beamed from the gigantic face say they were made by a race hunting a deadly plague.

By RAGAN DUNN
A gigantic stone face on the surface of Mars houses a TV transmitter that has been signaling Earth for at least 500,000 years.

That's the claim of Swiss astronomer Ludin Pasche, who says the ancient but ongoing Martian signal presents a grim warning to the people of Earth.

"The programming is a chilling look at a civilization in total decline," the expert told reporters in Zurich. "It shows thousands and thousands of wretched souls dying in the streets. It's nothing short of a doomsday warning — recorded and beamed to a neighboring planet. We must take heed."

The suggestion is that the planet had been stricken with a horrifying thing to see. Dr. Pasche claims to be one of 50 scientists worldwide who have seen the mind-boggling Martian television, transmit also appears to be warning a...

He says that Soviet and American scientists have been monitoring the fuzzy black-and-white signals for more than two years, but have less than 30 seconds worth of clear, undistorted pictures on videotape.

The signal is weak but constant, which is a miracle because the transmitter is at least half a million years old," he said.

"It is beamed within the great stone face photographed by America's Viking probe in 1976."

"And it proves that the face is not a trick of nature or light, as some have said, but genuine work of a lost race which once dominated the planet."

"The face itself is clearly a humanoid, with eyes, nose, mouth and chin," Dr. Pasche continued.

The milestone monument appears to be warning a...

and record the Martian transmission at their source for re-broadcast back to a scientific team on Earth.

"Contrary to what the public has been led to believe, the signal is not a warning. It is the people's grim reaper for being," he said. "The lost Martian civilization will remain a mystery until we receive its message clearly."

"Let us all hope that we can learn from what we hear and see."

Privately, however, they acknowledged that Dr. Pasche has worked closely with both Dr. Larry Starr, Carlisle, the noted Swedish astronomer, also claims to have knowledge of the Martian TV signal.

And he flatly stated that the Russian unmanned space probe, launched last month, is specially equipped to receive the signal.

his studies at San Jose State University when the savage thugs attacked him.

King, who suffered multiple skull fractures, was pronounced dead an arrival at Santa Cruz Memorial Hospital.

A teenage witness described the four killers as "mountain men types."

Fashion-conscious professionals are tired of wine coolers and Corona beer, according to a new survey that found young professionals are drinking bourbon these days.

The study found that Jim Beam is now the favorite beverage among young professionals.

WEEKLY WORLD NEWS
August 1, 1981

Human brain → connecting dots to lines, and associating with something we are familiar with.

Cydonia City?

A Near Decade Old Prediction Successfully Confirmed--
The Feline Half of the Face

Viking Data - 1976

Mars Global Surveyor - 2001

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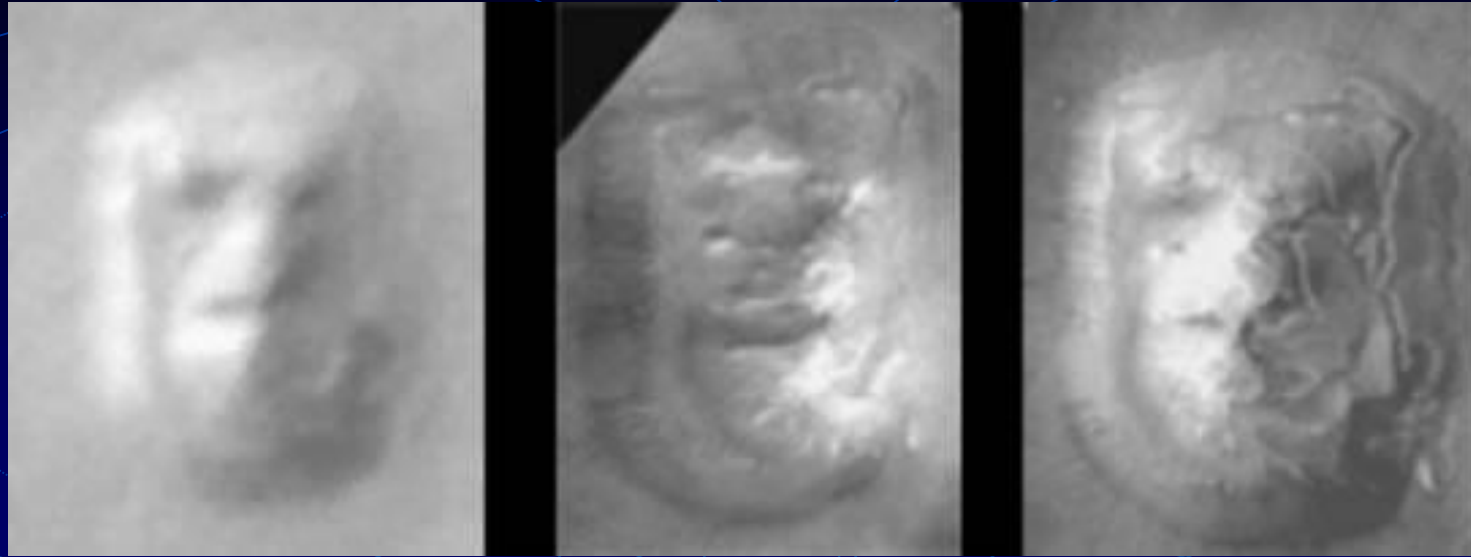
City

Face

Pyramid

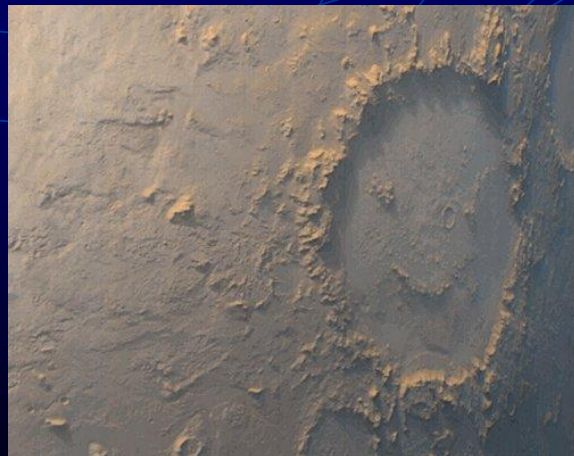
Richard Hoagland analysis of Cydonia region imaged by NASA
www.enterprisemission.org





Viking (1976)

Mars Orbiter Camera (MOC) onboard Mars Global Surveyor in 1998 (left) and 2001 (right)



Conscious recognition tends to make association with human faces.

pareidolia



Orchis italica



New York Time article http://www.nytimes.com/2007/02/13/health/psychology/13face.html?pagewanted=1&_r=1



<http://educ.jmu.edu/~johns2ja/illusion/illusion.htm>



<http://thesituationist.wordpress.com/2008/02/23/seeing-faces/>



What is life? 何謂生命?



- An assembly of atoms and molecules? *What kinds?*
Fundamentally all physics and chemistry? *How about "Spirits"?*
- Any definition finds counter examples, but we know it when we see one?

To reproduce 複製

To evolve 演化



Necessary (but not sufficient) properties

恆星璀璨多姿的一生

耀眼
命短



雲氣收縮 → 分裂 →
各自形成恆星 → 星團

- 星球質量越大、越明亮、
溫度越高、呈藍白色
- 星球質量越小、越微暗、
溫度越低、呈橙紅色



我們真該慶幸
平庸
命長

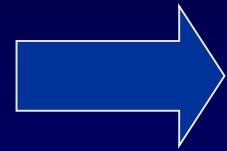


活生生的天體

—— 恆星靠核反應發光，
並且製造複雜元素

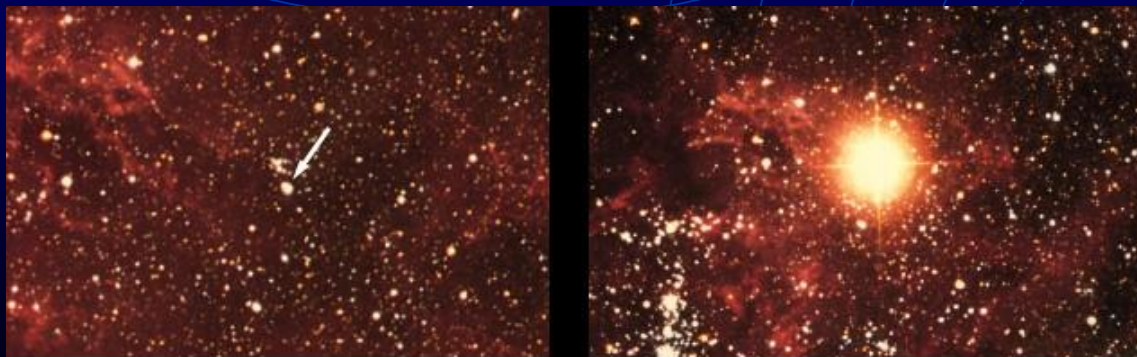
有些星球在核燃料用罄後，

將一生積蓄的複雜元素緩緩拋回太空



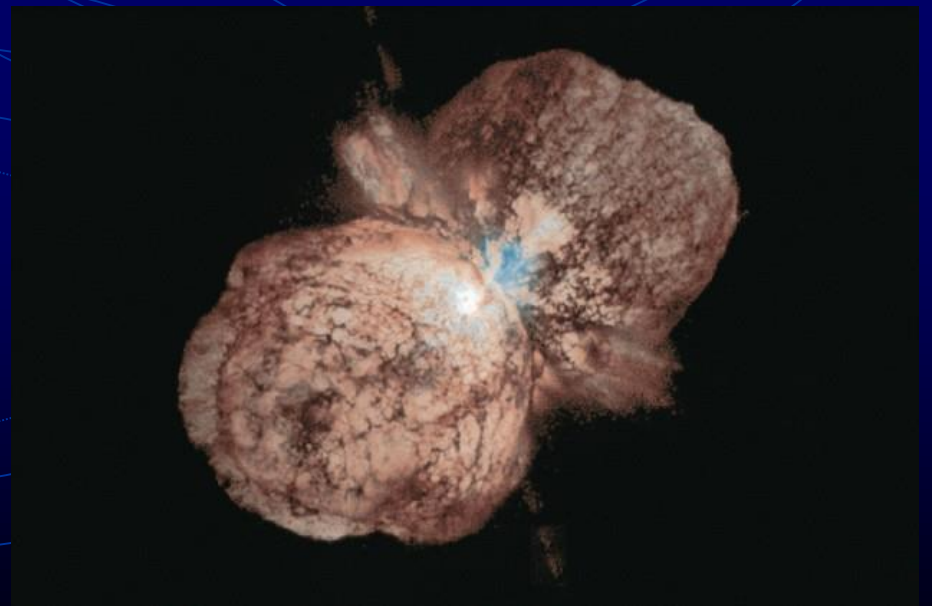
大型星球臨死前爆發，將豐富複雜
元素回歸星際太空

→ 下一代星球的原料



a

b



生命的特徵



- 找外星生命 ... 找什麼呢？
- 生命是一堆原子、分子（**哪些原子、分子呢？**）
只是物質形態的一種，以致在根本上可以用物理、
化學來描述（**哪些化學反應呢**）
還是得有「靈氣」才行？
- 生命是什麼？一說就錯，卻看了就知道？
- **繁衍** (to reproduce)
演化 (to evolve)？



不同環境的成分 (原子數目)

太陽		地球		地殼	
氫	90.99%	氧	50%	氧	47%
氦	8.87	鐵	17	矽	28
氧	0.078	矽	14	鋁	8.1
碳	0.033	鎂	14	鐵	5.0
氬	0.011	硫	1.6	鈣	3.6
氖	0.010	鎳	1.1	鈉	2.8
地球大氣		細菌		人類	
氮	78%	氮	63%	氮	61%
氧	21	氧	29	氧	26
氫	0.93	碳	6.4	碳	10.5
碳	0.03	氮	1.4	氮	2.4
氬	0.0018	磷	0.12	鈣	0.23
氖	0.00052	硫	0.06	磷	0.13

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Life ... as we know it (Earthlings) in terms of chemical composition

宇宙其他角落生
命材料不虞匱乏

- It resembles more the Sun than the Earth; it is made up of the most ordinary, and hence most abundant, elements in the Universe

... so are universally available

Life is precious but Mother Nature did not make us with "precious/rare" elements.

- Other parts of the Universe seem to obey the same set of physical and chemical laws.

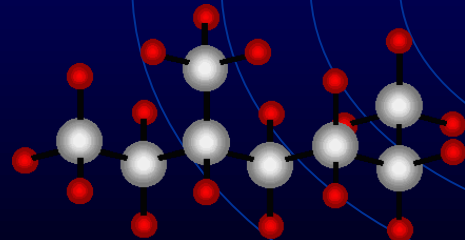
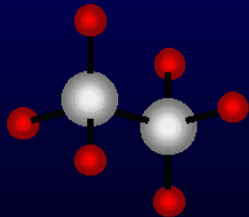
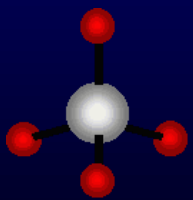
... so space really should be teeming with life.

□ Most life forms on Earth are composed of a few simple kinds of molecules, operated in complex and selective ways.

- Carbon atoms (valence of 4)
- ✓ *strong, yet still readily breakable*
 - ✓ *long, complex molecules (info carriers)*
- *diversity and versatility of life*

成分簡單
運作複雜

... Legos



Making sense

Life

Space

Search

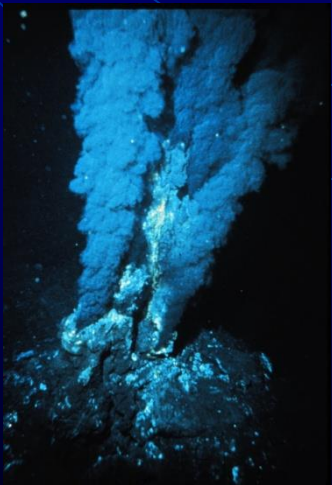
□ How about silicon? (also valence of 4)

非碳不可?

- ✓ OK, (*Is computer a life form? Why not?*)
- ✓ CH_4 , CO , CN , CO_2 ... but SiO_2 (silica) is solid
- ✓ Si is less abundant than C. Normally if Si can do it, C would have done it.

陽光、空氣、水

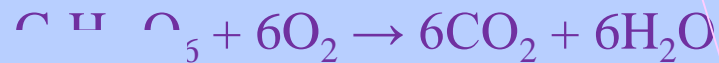
□ Essences of life: sunshine, air, & water 哪個絕對必要



“Black Smoker”
hydrothermal vents

To extract energy

Respiration



Some organisms do not
respire.

Energy source

Plants → photosynthesis
→ glucose

But Sun is not the only
possibility, e.g., deep
ocean ecology



Anaerobic bacteria

How about water?

四價元素

週期表

說明

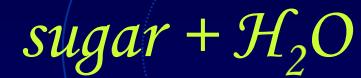
- 原子序
- 元素符號
- 元素名稱
- 原子量

 氣體
 液體
 固體
 人造元素

1 I A	金屬										非金屬					18 VIII A 惰性氣體	
1 氫 1.008	2 II A	過渡元素										13 III A	14 IV A	15 VA	16 VI A	17 VII A	2 氦 4.003
2 3Li 6.941	4Be 9.012											5B 硼 10.81	6C 碳 12.01	7N 氮 14.01	8O 氧 16.00	9F 氟 19.00	10Ne 氖 20.18
3 11Na 22.99	12Mg 24.31	3 III B	4 IV B	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13Al 26.98	14Si 28.09	15P 磷 30.97	16S 硫 32.07	17Cl 氯 35.45	18Ar 氬 39.95
4 19K 39.10	20Ca 40.08	21Sc 44.96	22Ti 47.88	23V 50.94	24Cr 52.00	25Mn 54.94	26Fe 55.85	27Co 58.93	28Ni 58.69	29Cu 63.55	30Zn 65.39	31Ga 69.72	32Ge 72.59	33As 74.92	34Se 78.96	35Br 79.90	36Kr 83.80
5 37Rb 85.47	38Sr 87.62	39Y 88.91	40Zr 91.22	41Nb 92.91	42Mo 95.94	43Tc 98.91	44Ru 101.1	45Rh 102.9	46Pd 106.4	47Ag 107.9	48Cd 112.4	49In 114.8	50Sn 118.7	51Sb 121.8	52Te 127.6	53I 碘 126.9	54Xe 氙 131.3
6 55Cs 132.9	56Ba 137.3	57-71 鐳系元素	72Hf 178.5	73Ta 180.9	74W 183.9	75Re 186.2	76Os 190.2	77Ir 192.2	78Pt 195.1	79Au 197.0	80Hg 200.6	81Tl 204.4	82Pb 207.2	83Bi 209.0	84Po (210)	85At 砹 (210)	86Rn 氡 (222)
7 87Fr (223)	88Ra (226)	89-103 鐳系元素	104Unq (261)	105Unp (262)	106Unh (263)	107Uns (262)	108Uno (265)	109Une (266)									
鐳系元素		57La 138.9	58Ce 140.1	59Pr 140.9	60Nd 144.2	61Pm 144.9	62Sm 150.4	63Eu 152.0	64Gd 157.3	65Tb 158.9	66Dy 162.5	67Ho 164.9	68Er 167.3	69Tm 168.9	70Yb 173.0	71Lu 175.0	
錒系元素		89Ac (227)	90Th 232.0	91Pa (231)	92U 238.0	93Np (237)	94Pu 239.1	95Am 243.1	96Cm 247.1	97Bk 247.1	98Cf 252.1	99Es 252.1	100Fm 257.1	101Md 256.1	102No 259.1	103Lr 260.1	

□ Life is a (con)sequence of chemical reactions.

□ Liquids react as efficiently as gases, and can be easily confined (controllable) as solids.



□ Some kind of a liquid goes a long way.

□ **Water** serves well. It is copious (*availability*), has a high heat capacity and latent heat, a wide temperature range in liquid form (*stabilizing surroundings*), and expands when freezing.



液態化學
是關鍵

As a pond froze out, primordial life forms under the ice layers could be spared.



哪種恆星較有機會孕育智慧生物？

- 行星與母恆星

距離適中 → 液態水

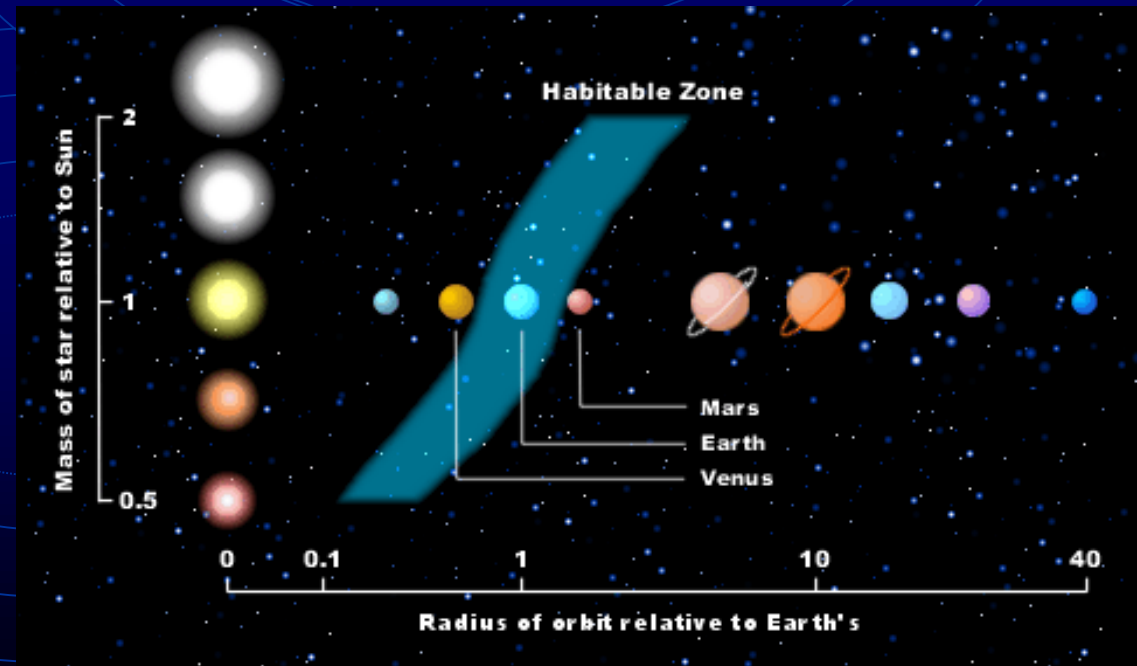
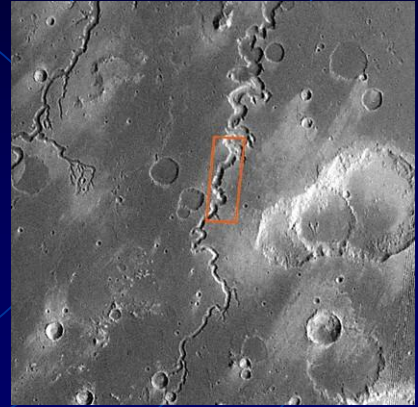
圓形軌道 → 溫度變化小

- 每顆恆星周圍可以定出「適居區」(habitable zone)

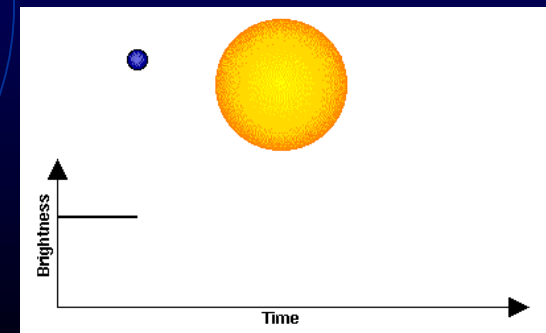
，在這當中存在某種液體

大質量恆星 → 寬廣

小質量恆星 → 窄小

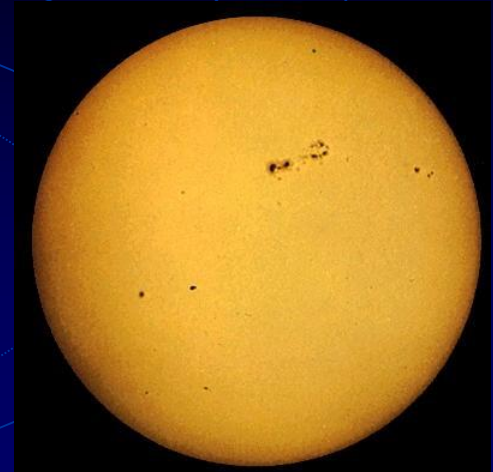


- 若母恆星質量太小，適居區內恰好有行星的機會不大
- 若恆星質量太大，則壽命太短
地球上的生命花了 35~40 億年才發展出現存的文明
- 所以**類似太陽的恆星機會比較大**，它們供應光與熱的生命期夠長，適居帶也夠寬廣
- 圍繞在恆星周圍的行星，是生命誕生、演化的好地方
液態化學的燒瓶
- 目前已經在超過4000顆恆星周圍找到行星



Life in terms of energy source

- ✓ Our life and ecology relies on energy ultimately from the Sun.
- ✓ The Sun produces energy in interior by thermonuclear fusion reactions.
- ✓ Plants store energy in chemical bonds.
- ✓ We eat plants (or eat the animals which eat plants) to take out the energy.
- ✓ The processes (life) undergo at atomic and molecular levels.



太陽也是食物鏈的一環

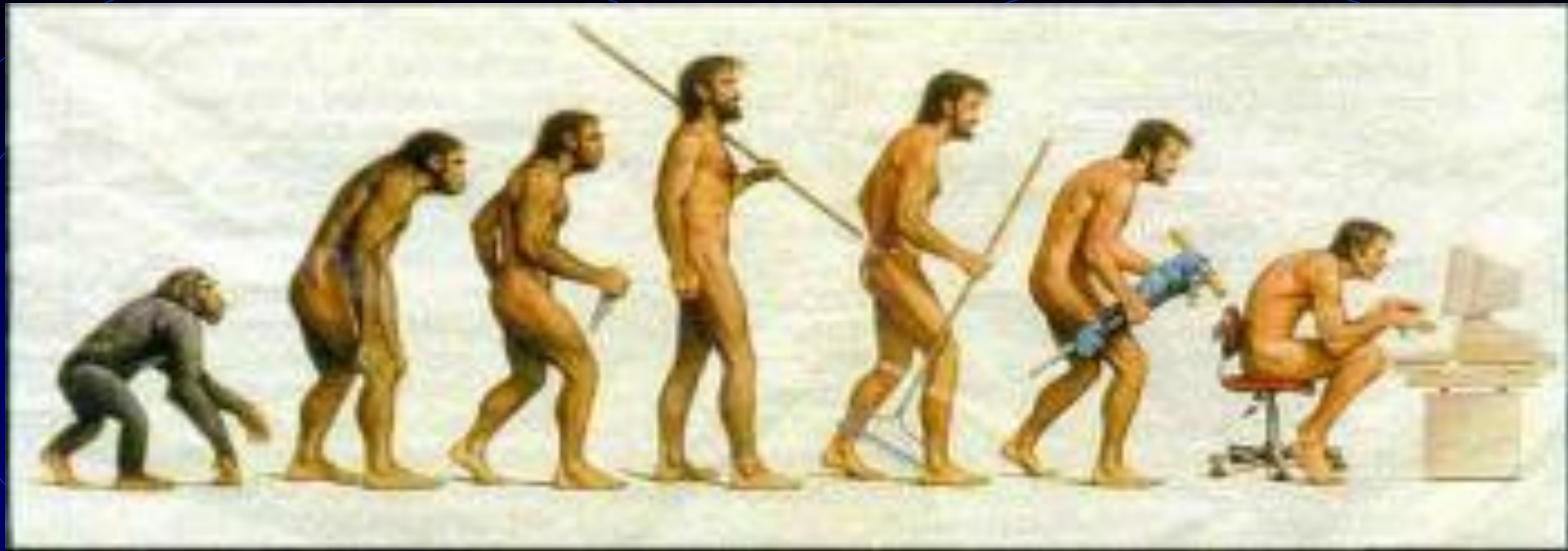


We eat chicken, but do not end up looking like a chicken!

- ✓ 生命在極微觀的原子層面交換、運作
塵歸塵、土歸土，在這個層面那有生死之別
- ✓ 生命很早就出現在地球
超過35億年前，比很多恆星壽命都還長
- ✓ 能夠延續的動力在於源源不斷的能量供應
- ✓ 這歸因於光合作用，及生物巧妙地取自來自太陽的能量
(原子核強作用力、弱作用力；電磁力、萬有引力)

這使得生命得以宇宙
天體的時間尺度維續





地球形成後最初幾億年，仍處於熔融狀態，但不久生命就出現了，隨後展開漫長演化

這一路走來好辛苦，但運氣真好！

生命活動為連串的化學反應

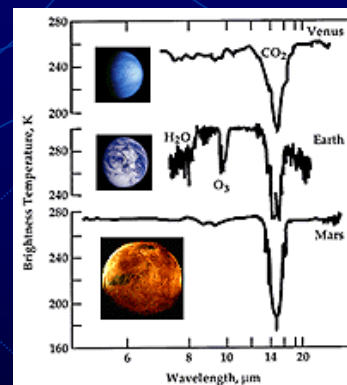
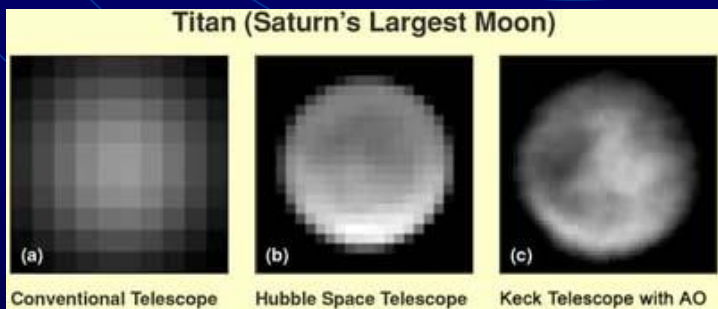
液態化學快速而穩定

行星地表提供穩定化學反應的環境

早年地球環境可以讓生命「土生土長」

所以，尋找外星生命，或是地球2.0，
目標應該是圍繞在恰當的恆星周圍的
恰當行星

越來越大的
望遠鏡

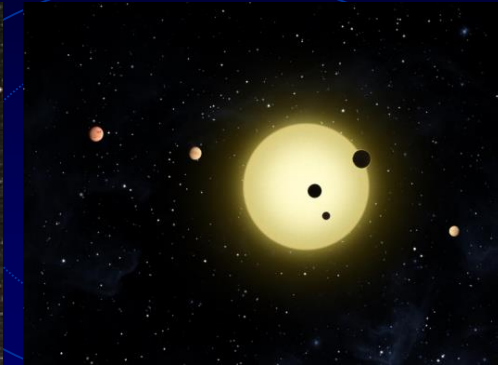
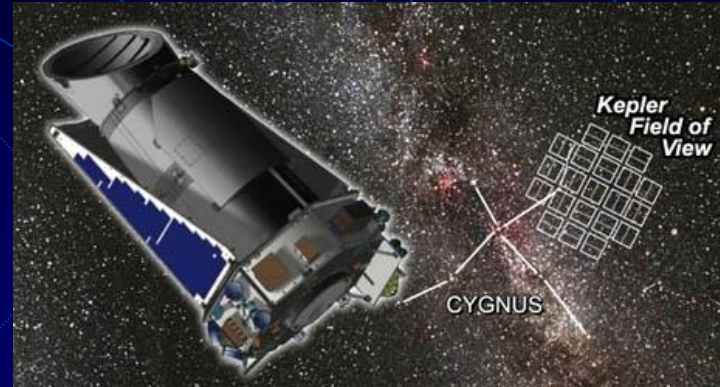


看得越來越清
楚的觀測技術

越來越靈敏
的偵測儀器

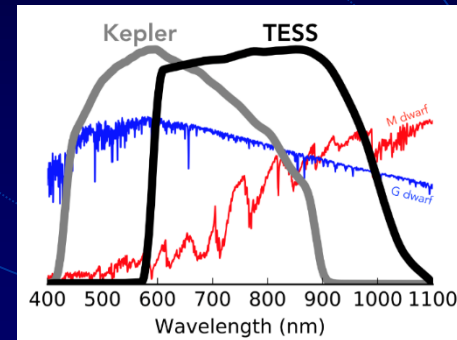
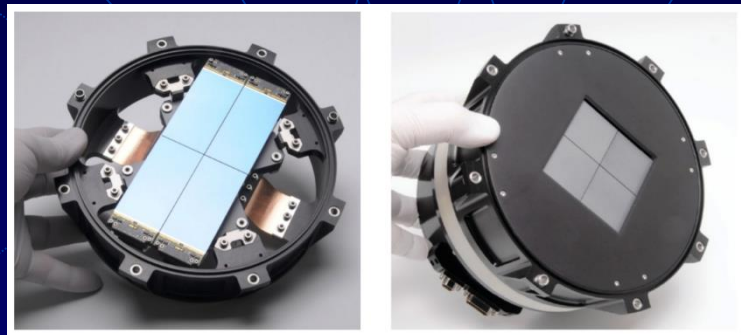


克卜勒太空望遠鏡 (Kepler Space Telescope)



- 利用掩星方式尋找（地球般大小）的系外行星
- 2009.3發射；同樣天區監測15萬顆恆星，預計3.5年壽命，實際已經超過10年
- 望遠鏡口徑0.95 m；位於地球 L2 軌道
- 發現數千顆可能的系外行星

TESS (Transiting Exoplanet Survey Satellite)



- 利用掩星方式尋找M型恆星周圍的類地系外行星
- 2018.4發射；四個10.5 cm 鏡頭；視野 $24^{\circ} \times 96^{\circ}$ 為 *Kepler* 太空望遠鏡的400倍
- 可監測85%天空，任務預計2年，預期發現超過2萬顆系外行星

✓ 相信有「其他的世界」，其實順理成章。
近代科學不斷證明「我們很普通」

✓ 地球乃太陽系眾行星之一

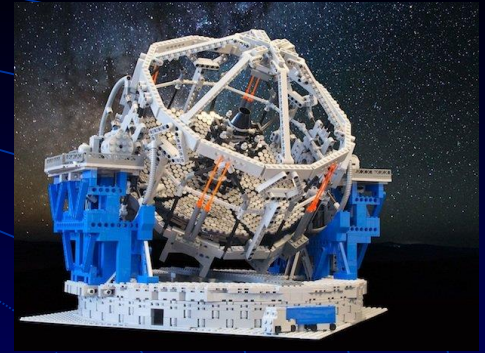
✓ 恆星不過是宇宙其他角落的太陽罷了，其周圍已經發現
4000多個系外行星 當中總有合適的吧

✓ 連銀河系都不過是宇宙億萬星系之一

✓ 甚至宇宙本身都可能並非唯一
universe → multiverse

✓ 生命雖然複雜，但以物理、化學來說，並不特殊

既然如此，宇宙不是應該充斥了生命嗎？



- 物理學家費米 (Enrico Fermi) :

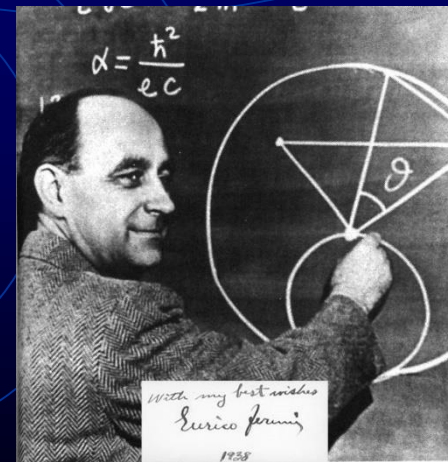
「假如外星人存在的話，他們在哪呢？」

(“Where are they?”)

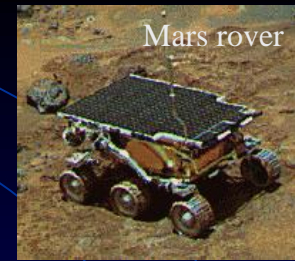
- 「有」不奇怪，就是因為到現在都「沒有」，才奇怪！
- Absence of Evidence \neq Evidence of Absence
沒有證據並不表示沒有
但也不表示「因此就應該有！」

- 確定真要找嗎？
- 萬一真找著了呢？
- 我們準備好了嗎？
- 準備什麼呢？

MIB
MEN IN BLACK



About the Search



- Efforts in the solar system in vain
... gratifying even with microorganisms
- Really want to go and meet in person the “little green men”
Or, do we? risky, dangerous, and costly ... what about problems at home?
- Current (and foreseeable future) technology
→ face-to-face contact unlikely. *... unless they come to visit us.*
- radio contact (1) *“Hello, here we are!”* to broadcast
(2) *“Where are you?”* to listen

有關「尋找」



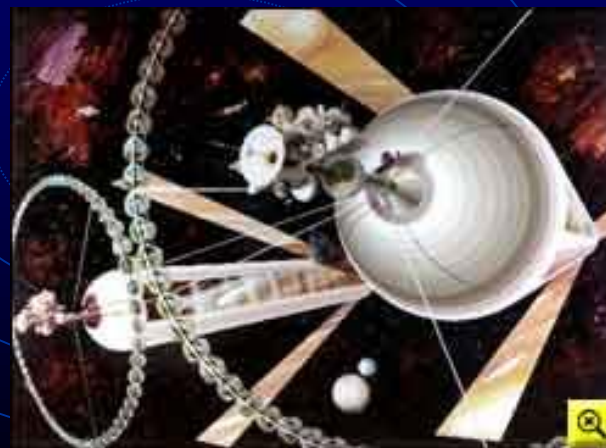
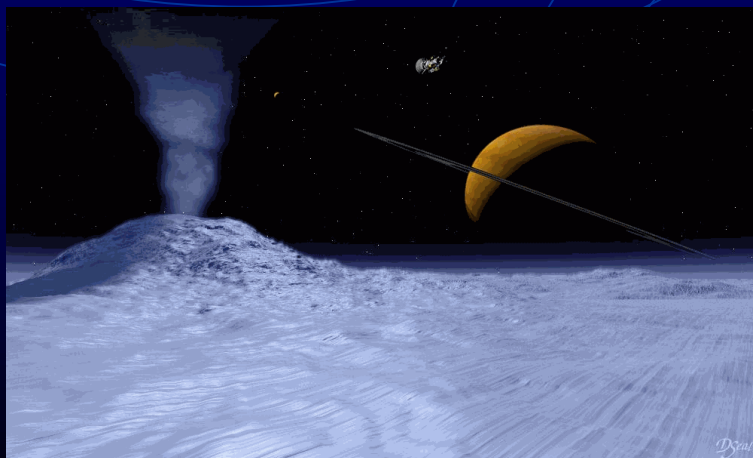
□ 最期望的當然是「登門拜訪」咳，是吧？

□ 就現有的知識、技術（及可見的未來），面對面的接觸不可能

→ 電訊接觸

(一) 「嘿，我們在這！」 to broadcast

(二) 「喂，你們在哪？」 to listen



浩瀚的宇宙

- ❖ 光在真空中速度為每秒 300,000公里
 - ❖ 這樣的速度到月球只需1秒多 (眨眼時間)
 - ❖ 到太陽需約500秒 (下課時間)
 - ❖ 到半人馬座 α 星須 4.3 年 (讀大學時間)
 - ❖ 跨越銀河系約需 10 萬年 (人類演化時間)
 - ❖ 到鄰近星系費時數百萬年 (大地演化時間)
 - ❖ 而目前已知星系超過數千億個 ...
-

星際旅行？



✓ 現有科技

	速度	最近的恆星	最近的生命
噴射客機	1000 km/h	4百萬年	10倍？1百萬倍？
夢幻火箭	10% c	> 40年	10倍？1百萬倍？

速度快 → 所需時間短，且時間過得慢，

但同時質量（抗拒變動的趨勢）增大，
加速困難 → 需龐大能量

相對論可載舟 也可覆舟

✓ 但星際旅行並非不可能

只要有方法取得能量，並且延長人類壽命；
或是利用機器人

現有的太空技術已經快能夠太空旅行了，
只是還不夠安全（也太寒酸）

據估計如果使用類似 von Neumann 機器，
約200萬年可以「銀河系走透透」

✓ 何況還有（可見）未來（未知）的科技

但是太空旅行到底要去哪？去幹嘛？



還是，他們已經來過了？

不明飛行物
(Unidentified Flying Objects)

(還在?)

空軍用語

UFOs → 幽浮



UFO 是什麼？

事實——

天上有很多東西 ...

很多會飛 ...

有些無法一下認出來 ...

UFO 影片



小心，外星人就在你身邊？



埃及金字塔



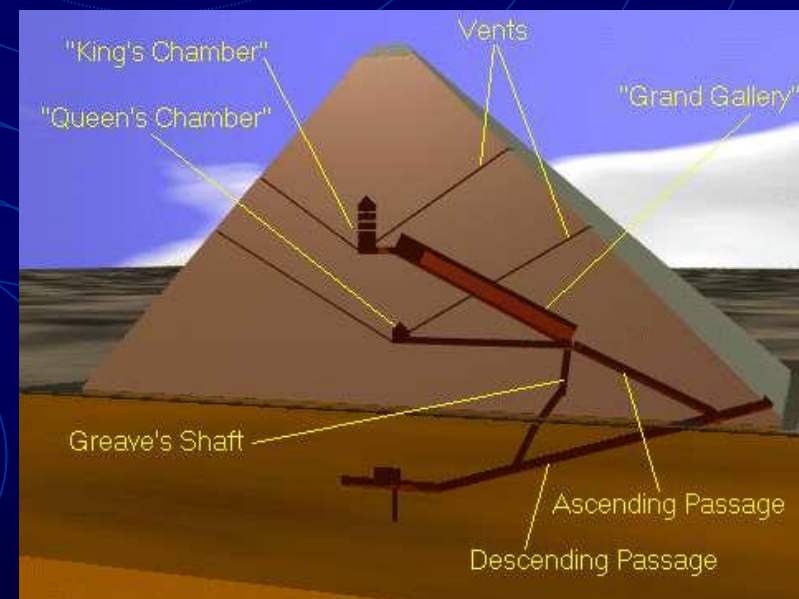
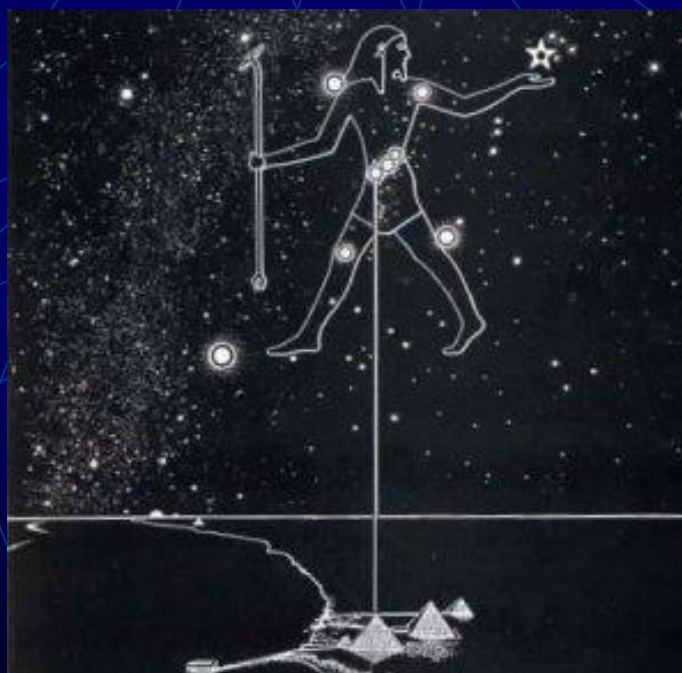
© John Goldsmith / Celestial Visions

金字塔有何神秘？

到底有多難，以致古人蓋不出來？
科技先進的外星人就這點能耐？

何謂金字塔？

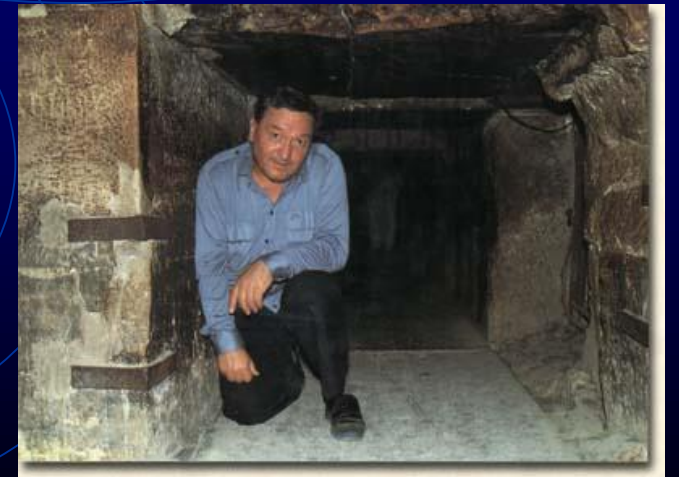
有了就表示
外星人來過？



孟丹尼根 (Erich Von Daniken)

- *Chariots of the Gods* (1968) 暢銷4千萬冊，認為外星人曾在1萬到4萬年前來到地球，在埃及建了金字塔，在秘魯建了登陸基地，並且以生物技術培養出現代人類
- 之後又有系列書籍出版，都很暢銷

<http://unmuseum.mus.pa.us/aastro.htm>



為了加強我們認定「落後」的埃及人根本不可能建造大金字塔，孟丹尼根問：

這會是巧合嗎？如果我們將 Khufu 金字塔的高度乘以十億——98,000,000 英哩，居然約略等於地球與太陽間的距離！

這真不可思議…怎麼回事？

首先，地日距離應該是 930,000,000 英哩

關鍵在於乘上極大數字

一支普通原子筆要是乘以一兆，會**正好**等於地日距離！

秘魯高原的神秘線條



<http://unmuseum.mus.pa.us/nazca.htm>

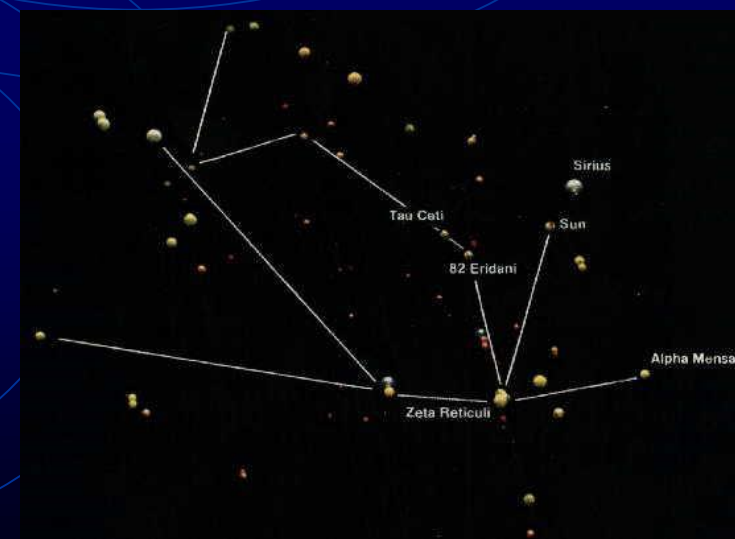
畫線有那麼難嗎？為什麼非要從飛機
（太空船）上面看，就是在高原呀？



Alien Abduction --- Betty and Barney (1961)



- 心證最麻煩
- 誤證不一定是詐騙，也可能真心相信，但要查證極為困難，需要大量資源
- 之後綁架、性侵 ... 然後呢？



孫中山先生（1916年）遊浙江普陀山

「轉行近，益瞭然，見其中有一大圓輪盤旋極速，莫識其成以何質？運以何力？方感期間，忽杳然無跡，則已過其處矣。遂詫以奇不已。余腦臟中素無神異思想，竟不知是何靈境？」

ufo.avi

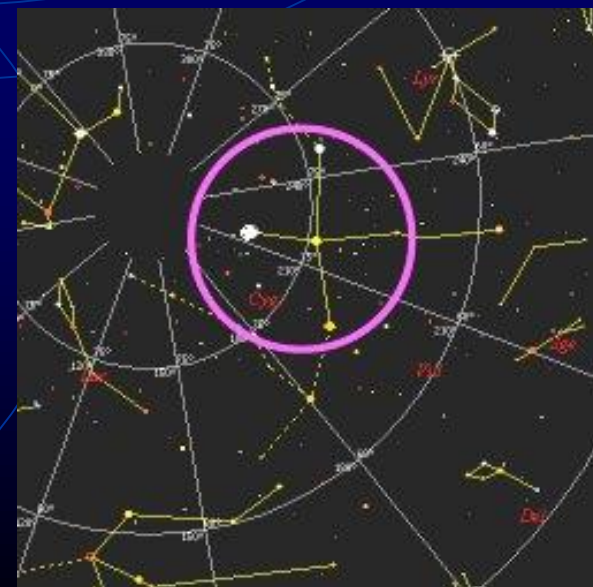
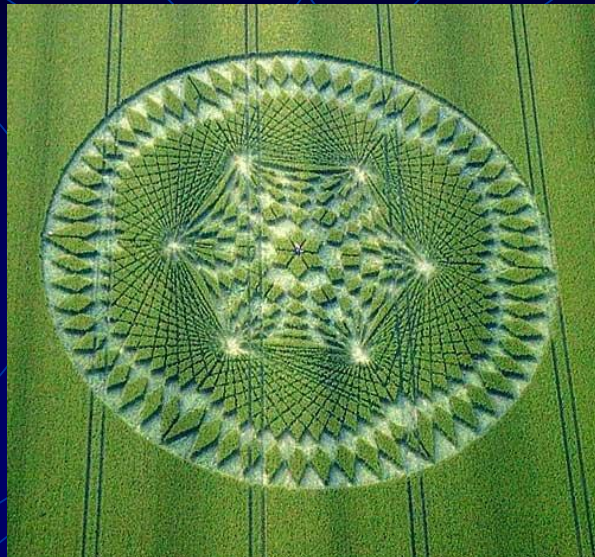


神秘的麦田圈

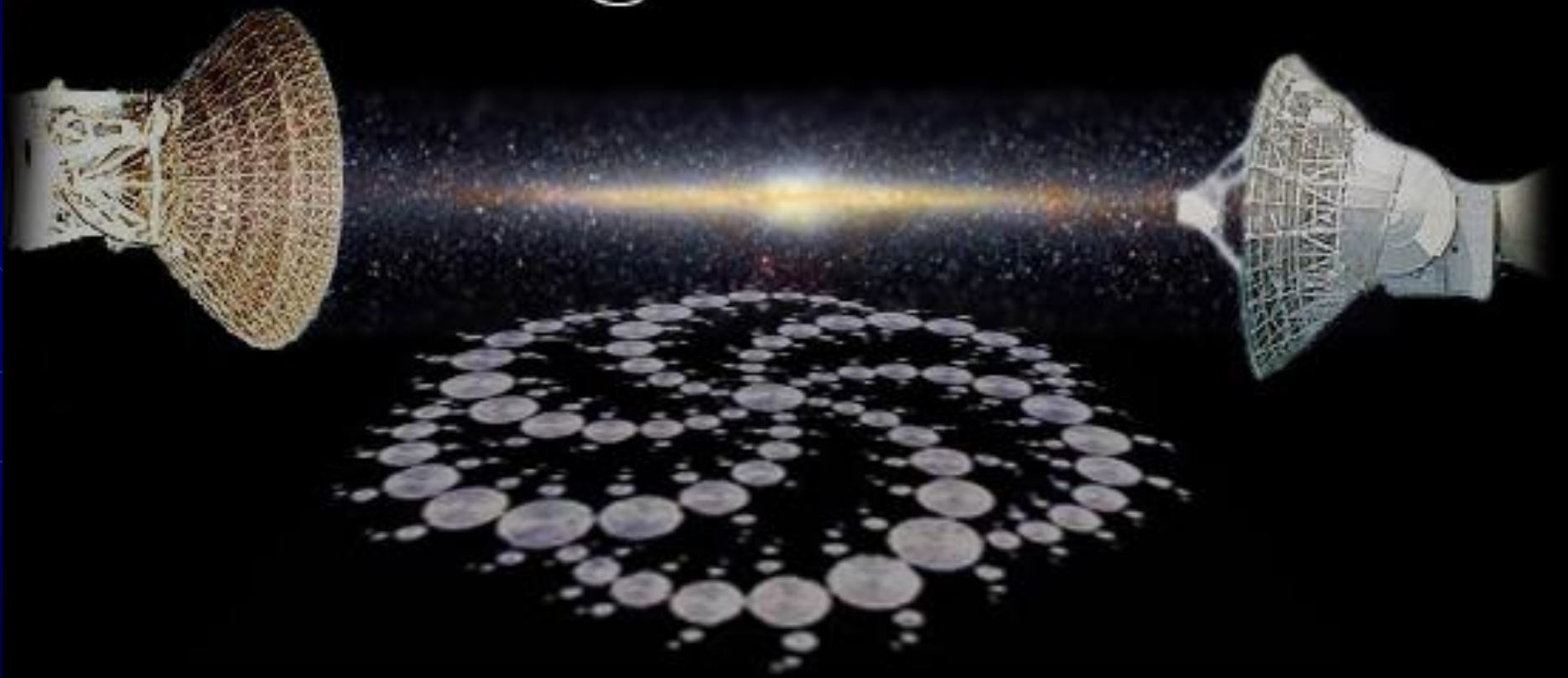


Original formation, Longwood Warren, Hampshire, July 1995 (Steve Alexander) for a movie

<http://www.osfa.org.uk/cropcircles.htm>



Message d'adolescents



Panspermia 學說

20世紀初瑞典化學家 Svente Arrhenius 主張地球上的細胞生物來自外太空，藏身於隕石當中而來到地球，這樣可以倖免於太空的惡劣環境，甚至進入地球後受到的衝擊。太空裡可能很多這種 germs（細菌）、spores（孢子）



http://www.chem.duke.edu/~jds/cruise_chem/Exobiology/sites.html

怎麼知道別的文明在發訊號呢？

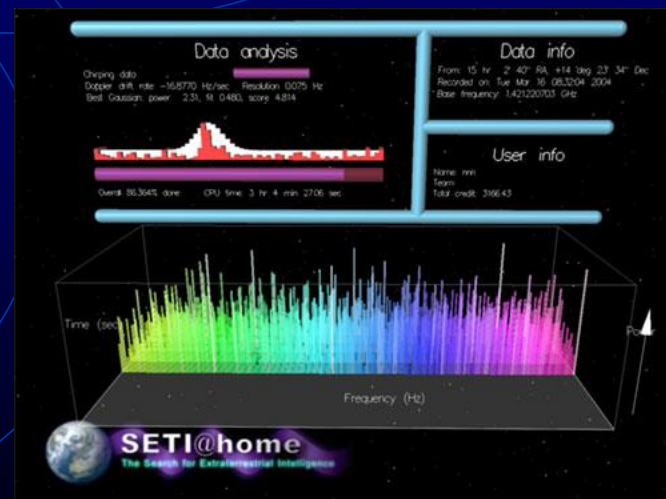
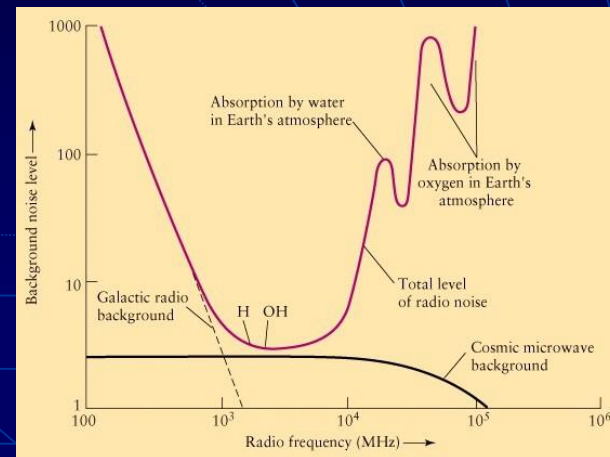
- SETI (Search for Extraterrestrial Intelligence) 計畫

在雜訊低的波段（例如在微波 H 以及 OH 譜線，所謂的「水洞」(water hole) 波段附近，搜尋「可疑訊號」

怎麼才算可疑？

Eavesdropping

先要知道何謂「自然」訊號，才可能判斷是否「人為」訊號



到底聽到了什麼？

- 1977.08.15 --- The 'Wow!' signal 6EQUJ5
非自然、來自天外，但來源不明



Ohio State Univ. Big Ear Obs.

<http://www.bigear.org/6equj5.htm>

Project Phoenix

<http://www.seti.org/science/ph-bg.html>



MCSA complex amplitude	MCSA superband	SCS 10 MHz	File
subband 2001 frame	MCSA band	SCS 50 kHz	Help
BF -3 110419.5 Hz	MCSA complex	SCS 350 MHz	Print
right 1 Hz	MCSA waterfall	MCSA all subs	Quit
mean pwr = -0.245613			

-30 db

This was *Pioneer 10*.
We detected our own civilization.

- 1995.02 開始
- 南北半球天線定點監聽
- 還真聽到了！

2004.03 → no evidence of ET signals after monitoring 800 nearby (< 200 ly) sun-like stars

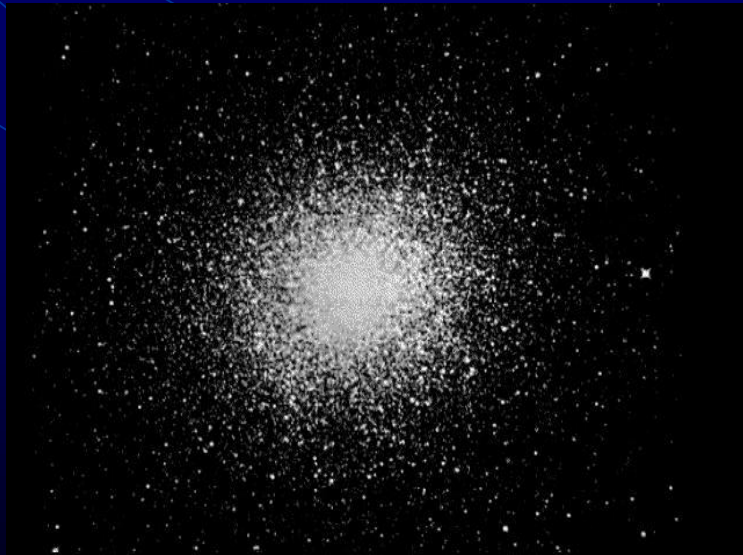
Let us make the call

1974.11.6

Arecibo antenna in Puerto Rico
($D = 300$ m)

10^6 W @ 2.38 GHz (width 10 Hz)

To globular cluster M13 25,000 ly
away, with 300,000 old stars



*Before we ask
What/who/where are you?*

*We have to answer
What/who/where are we?*

Arecibo message (by F. Drake, C. Sagan et al.)

1679 “zeros” and “ones”;
transmitted at 10 bits/s; duration < 3 min

1679: a semiprime = a prime number × a prime number

```
0000001010101000000000000101000001010000000100100010001000100101100101010101010101010100100100  
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00000000010101000000000000000000000000000000000000000000000000000000000000000000000000000000000  
10000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000  
11111011111011111011111000000000000000000000000000000000000000000000000000000000000000000000000  
00001000001100000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00010000001100000001000000011000011000000100000000000000000000000000000000000000000000000000000  
00000011000100001100000000011000011000000100000001000000100000000000000000000000000000000000000  
01000000001100000000100010000000001000000010000001000000100000001000000010000000000000000000000  
00001100000000110000000001000111010110000000000010000000100000000000000000000000000000000000000  
0010000101110100101101100000010011100100111111011100001110000011011100000000010100000111011  
00100000010100000111111001000000101000001100000010000011011000000000000000000000000000000000000  
00111000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00000000111110000000000000000000000000000000000000000000000000000000000000000000000000000000000  
00110100000000010110000011001100000001100110000100010100000101000100001000100100010010001000  
00000100001000010000000000000000000000000000000000000000000000000000000000000000000000000000000
```

Will they understand it?

If we receive this, will we understand it?

Numbers of 1 to 10

Atomic number of key biological elements

Formulas for sugars and bases in nucleotides of DNA

If ... civilization there

If equipment sensitive

ix of DNA.

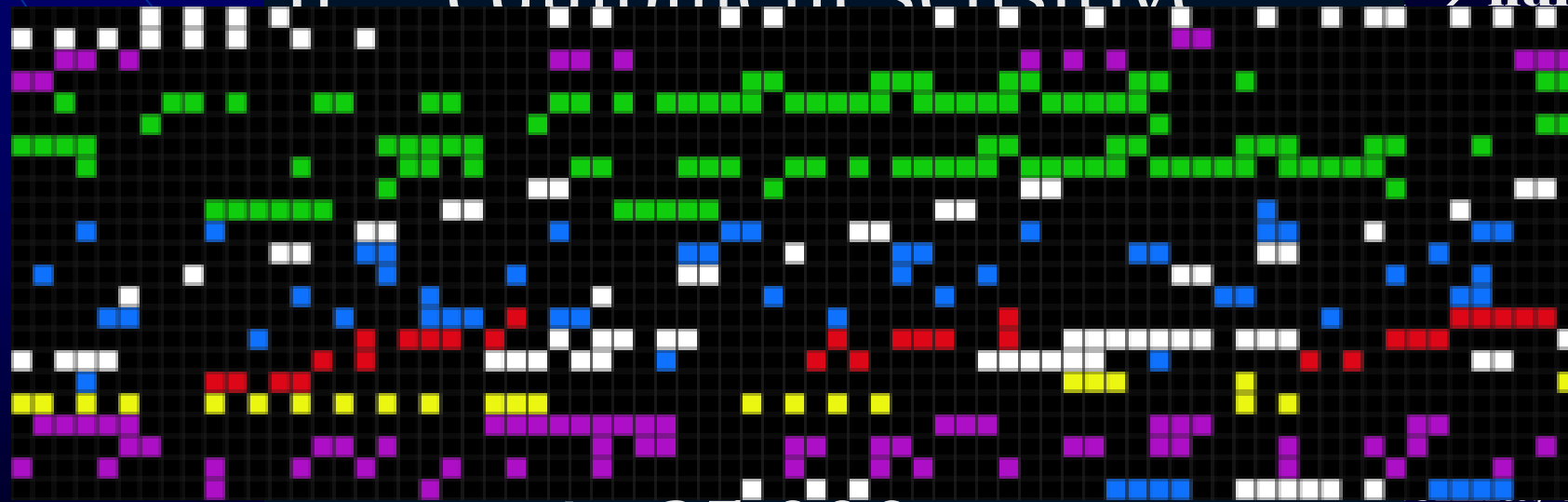
• → number of

A

ght of
pulation

Earth

with



if 23×73 ... scrabbling

in 25,000 years

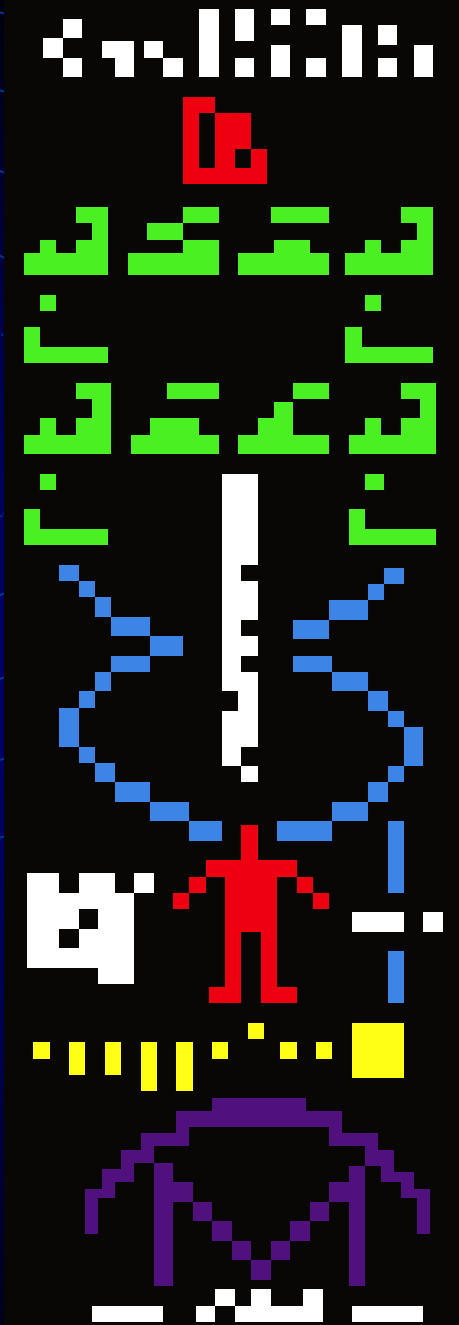
if 73×23

Making sense

Life

Space

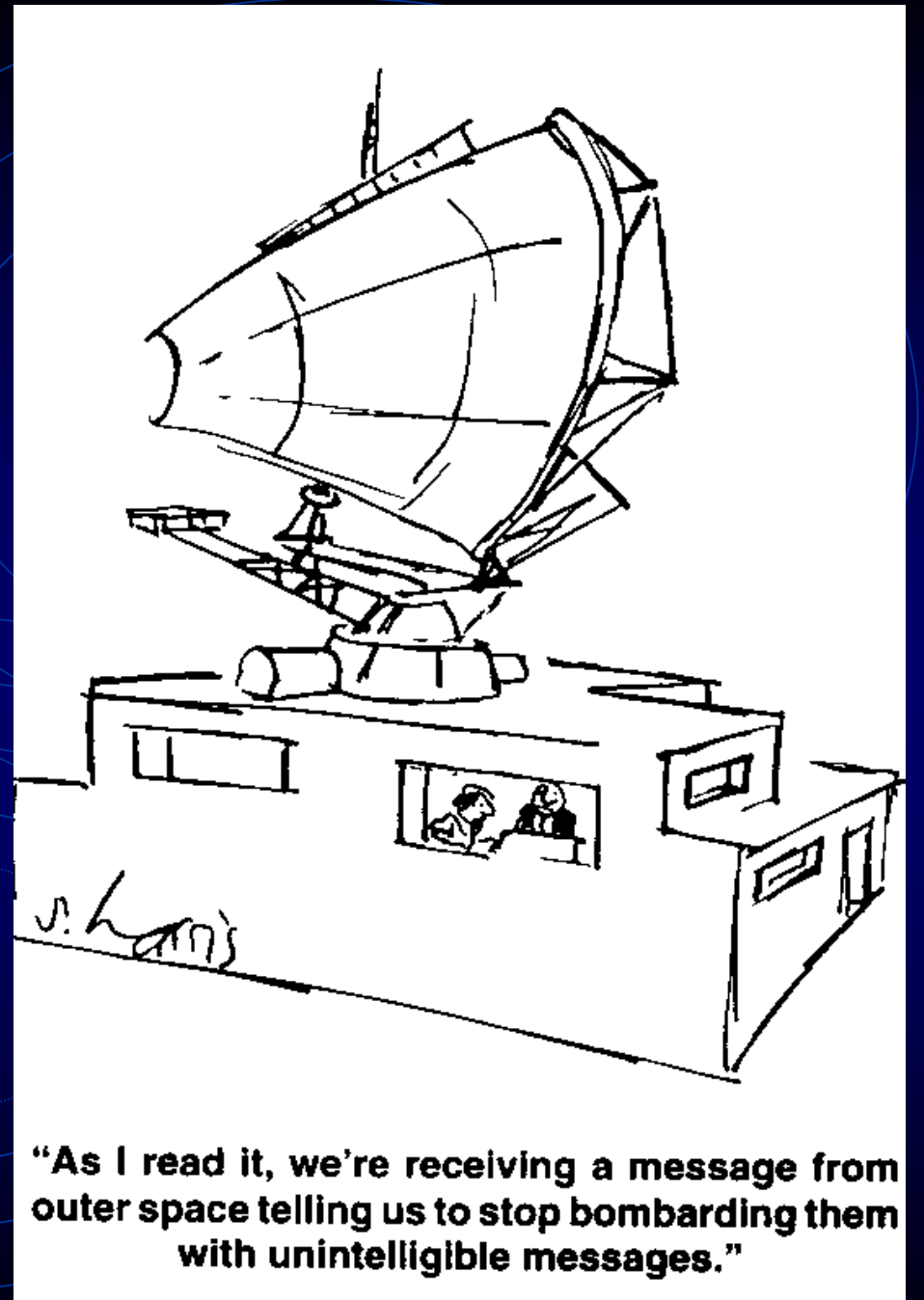
Search



地球文明的廣播、電視、 手機訊號已經出去了...



By Sydney Harris



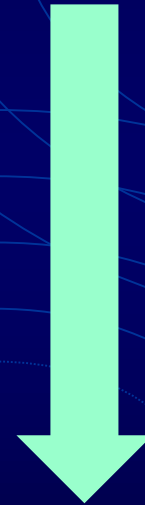
All boils down to probability ...

If chance of winning a lottery is 1 in 10 millionth, buying 1 ticket ...
1000, 100,000, 10 million tickets?

Drake Equation (1961 by Frank Drake)

$$N = N_* f_s f_p f_e f_l f_i f_c L/L_{\text{MW}}$$

- ✓ How many stars in the Milky Way ...
- ✓ Among these, the fraction suitable for life (proper planets) ...
- ✓ ... the fraction to actually bear life ...
- ✓ ... the fraction to develop civilization ...
- ✓ ... the fraction to be communicable ...
- ✓ ... how long the civilization lasts
- ✓ ...
- number of communicable civilization now in the Milky Way



More
uncertain

Conditional probability ... subjective ... a guesstimate?

Were they here? Are they still here?

UFO clip



UFO sightings



Roswell event



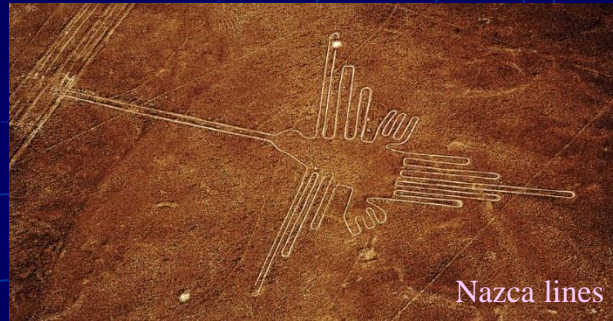
Alien capture



Pyramids



Project Blue Book



Nazca lines



Crop circles



Abduction

Why do they all look so much like humans?

Often the evidence is circumstantial.

One should not attempt to explain an unknown with another unknown.

在我們問
「你們是誰？」
之前

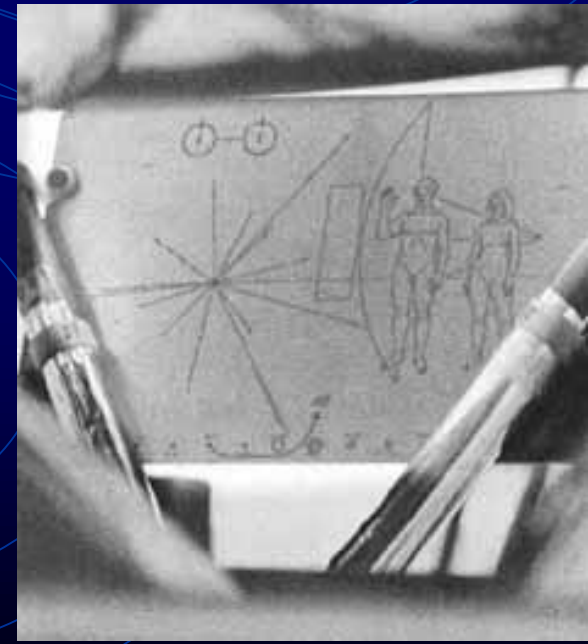
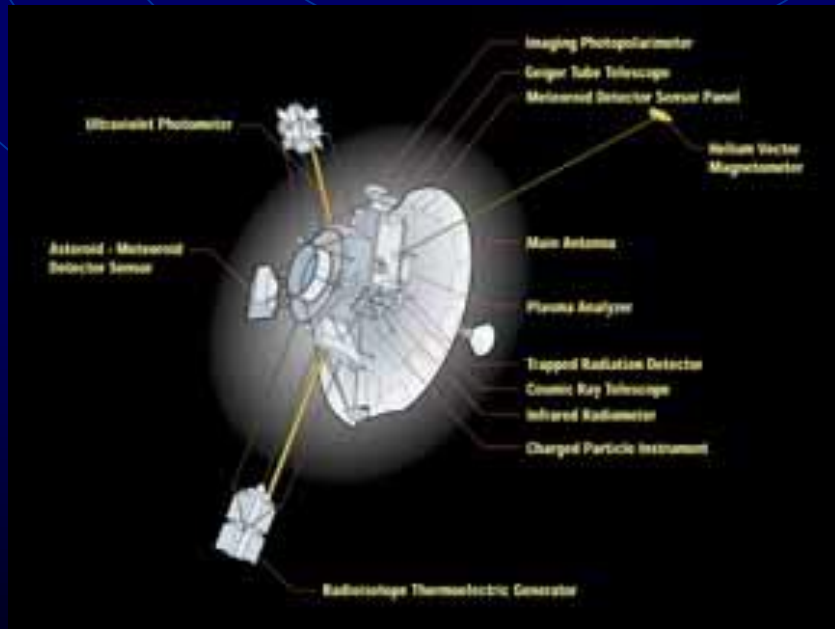
我們其實應該想清楚
「我們是誰？」

Message out in a bottle

瓶中信

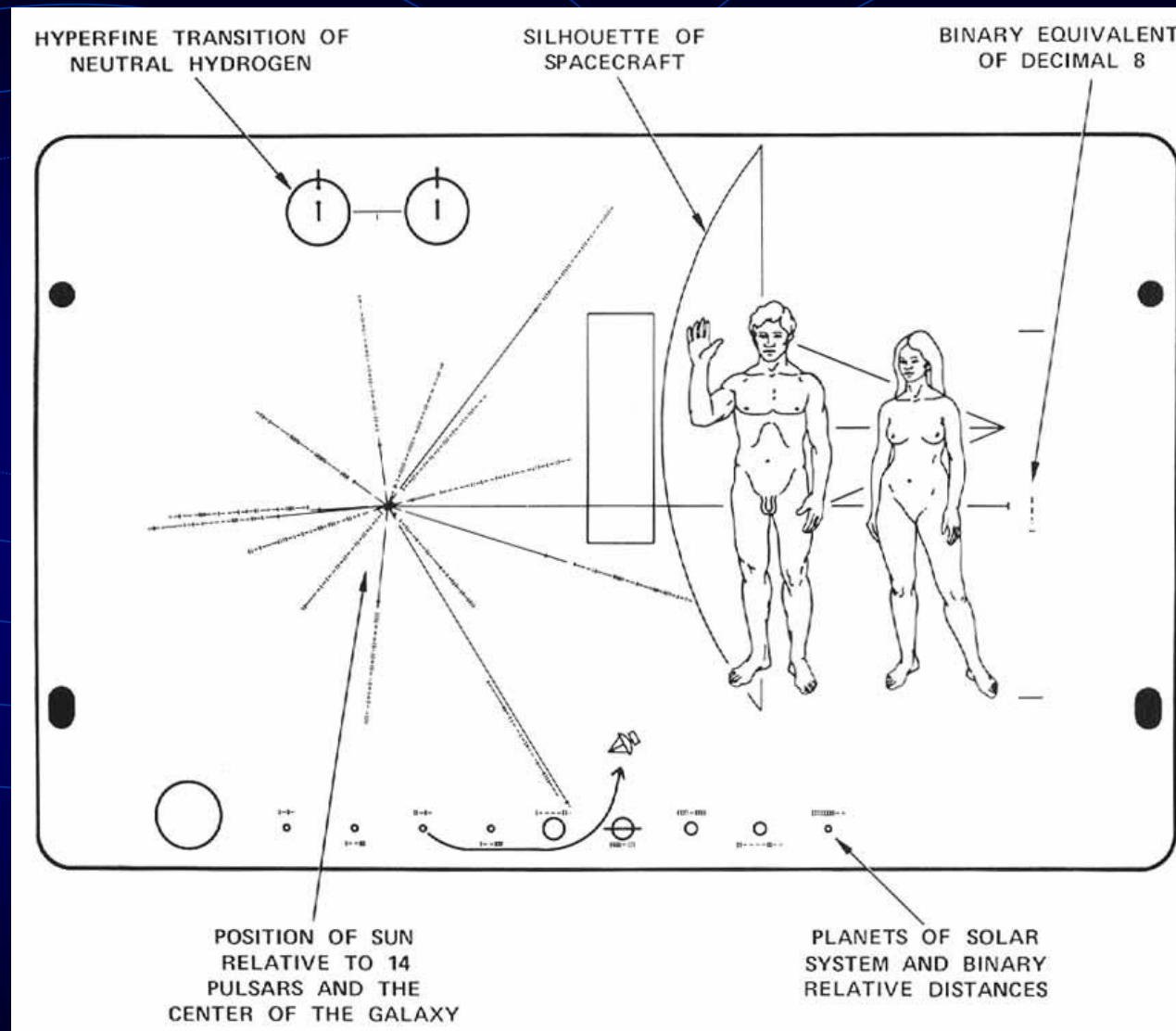
- Onboard *Pioneer 10* (1972) and *Pioneer 11* (1973) 6" × 9" (15.2 cm × 22.8 cm) plaques (0.13 cm thick), designed by C. Sagan & F. Drake

“Who we are, where we live, when we live, how much we know ...”



氫原子的超精細結構 襯景的太空船身 相當於8的二進位碼

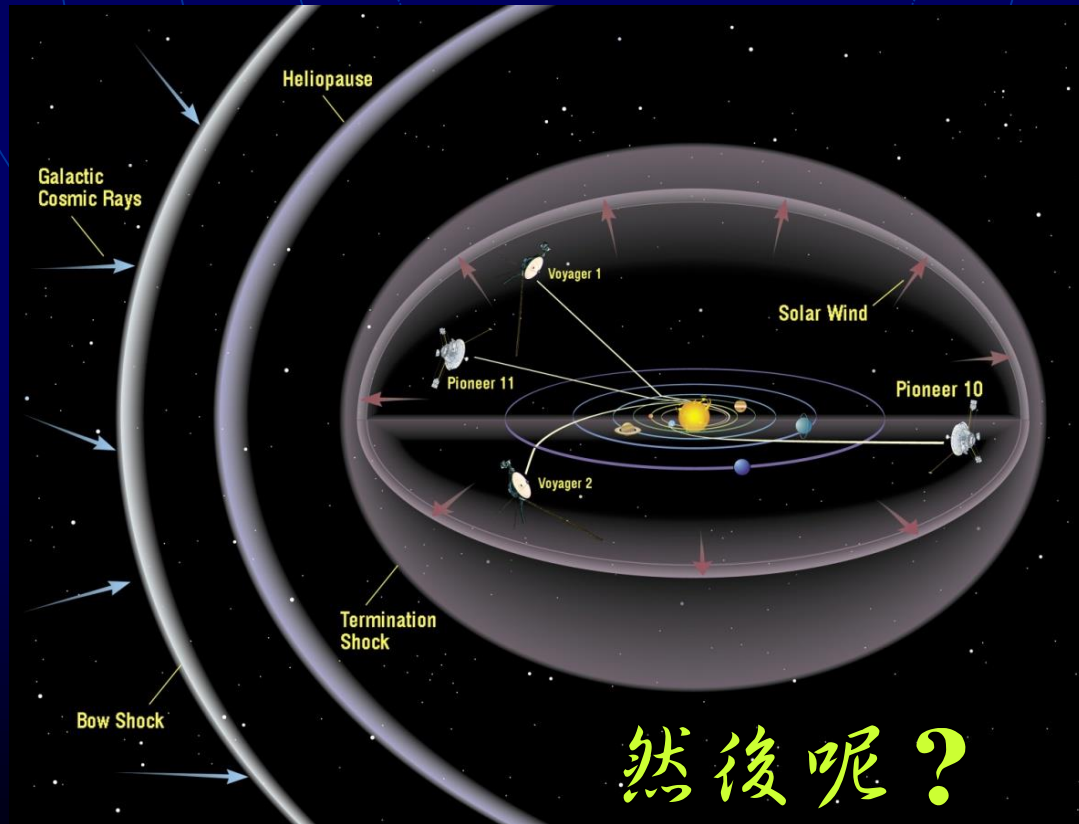
太陽相對於 14 顆
脈衝星及銀河系中
心的位置



人類姿體與太
空船大小相比

太陽系行星及相對
距離的二進位碼

- 先鋒10號被木星甩了一下，10萬年後會到達金牛座方向的鄰近恆星
- 億萬年後說不定會被外星文明找到（也就是「說不定不會」的意思）



- *Pioneer 10* was swung by Jupiter to fly outwards, and will reach a “nearby” star toward Taurus in 100,000 years
- Will it be picked up by a civilization? Will they understand our message? Will they look for us? Will we be around if and when they do?

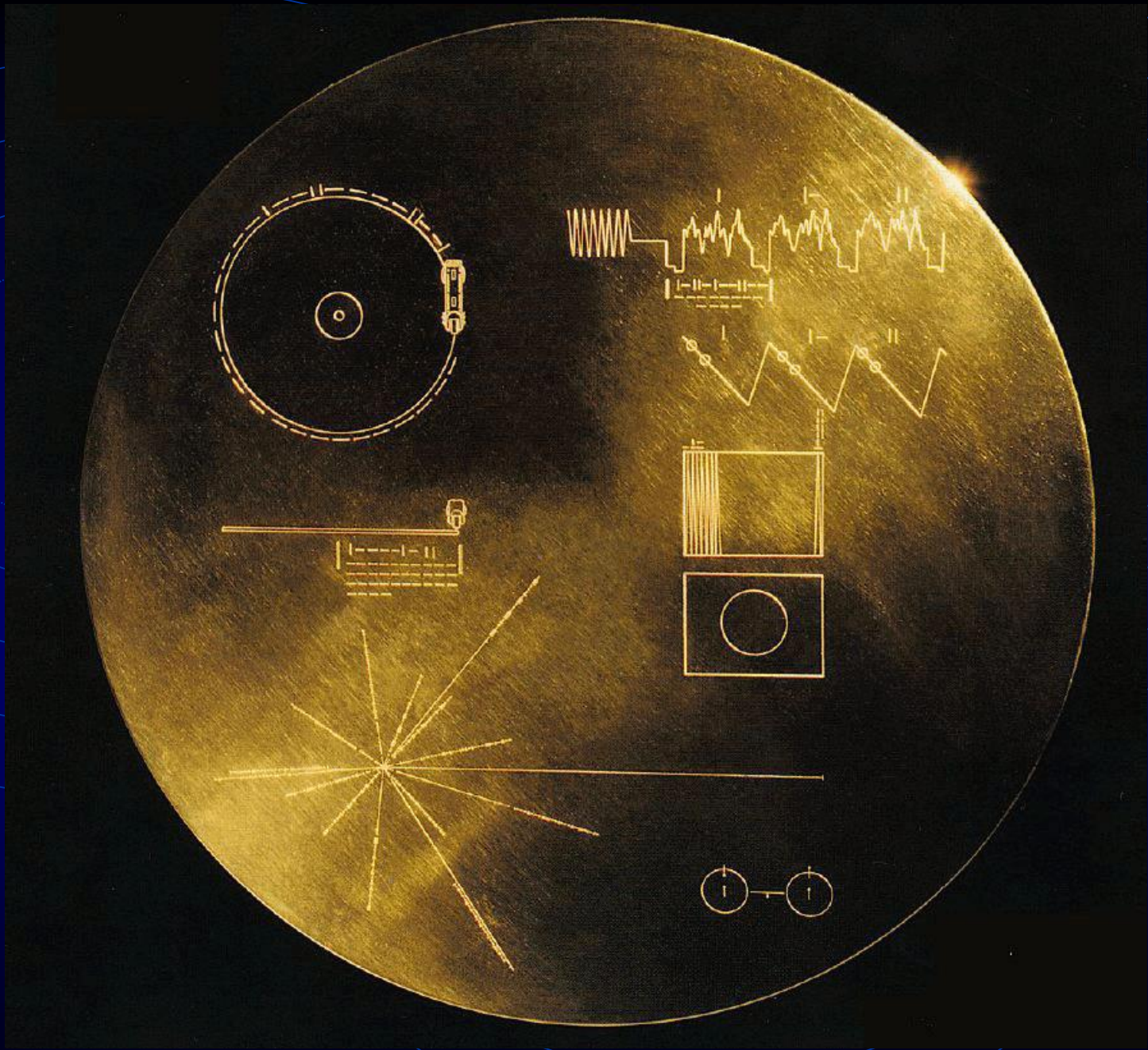
人類的足跡 II

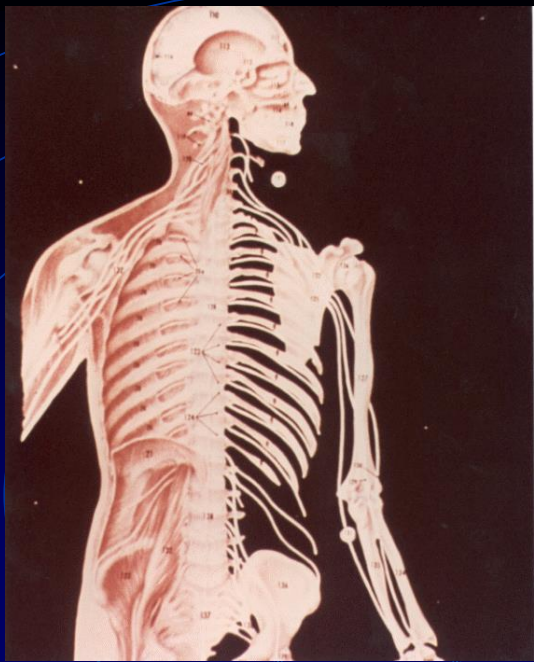
- Voyager 1 及 Voyager 2 (late 1970s) 上的唱盤
(正在離開太陽系~~)
- 2 吋直徑的銅盤，裝在鋁盒中，內有116 張圖像；用 55 種語言問好；各種地球上的聲音（天然的或人工的）；27 種音樂（古典、搖滾、非洲土著民謠等）

<http://re-lab.net/welcome/>

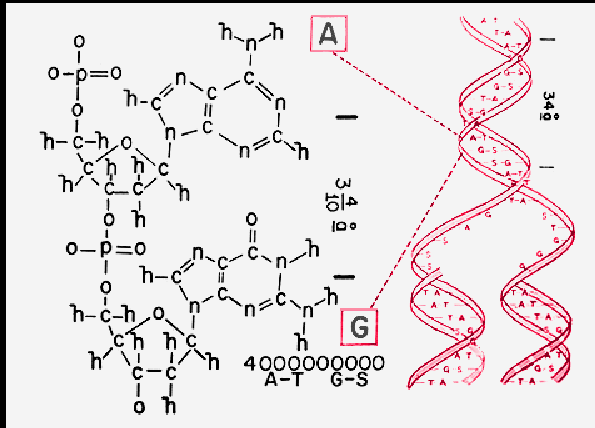
[in Chinese](#), [French](#), [English](#), [Spanish](#), [Japanese](#), [Korean](#) ...

- 表面甚至電鍍了鈾238

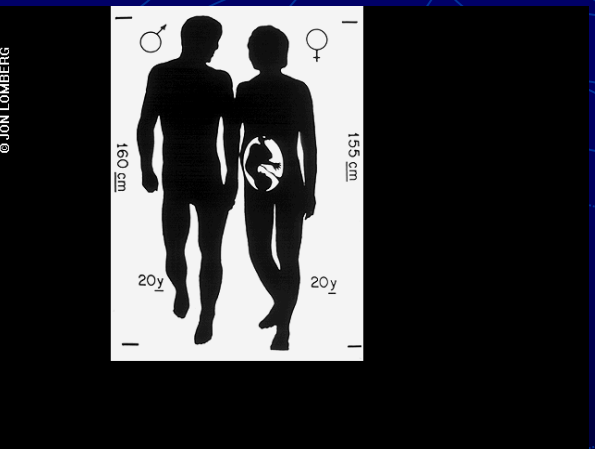




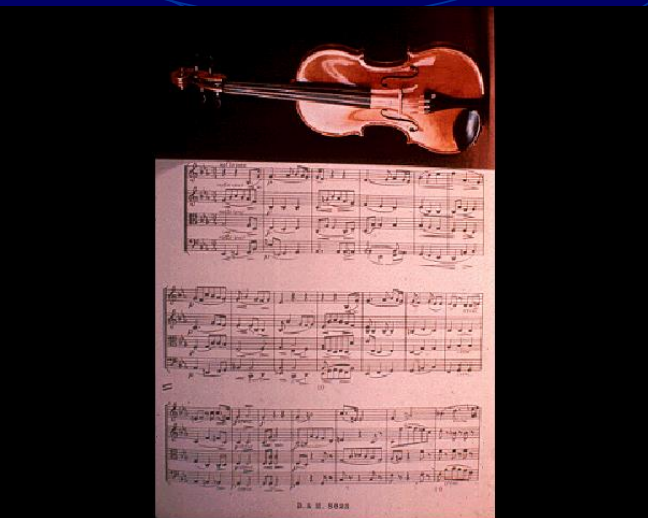
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要是外星人發現這些瓶中信，
他們應該有能力檢視各種證據
希望他們認為 ...
這東西來自有思想、文明的世界！
值得他們聯絡

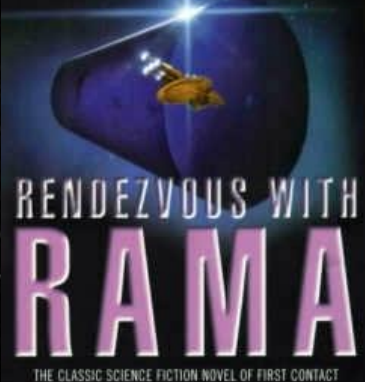
你同意嗎？



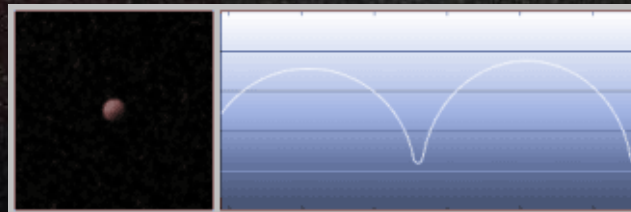
C/2017 U1 → A/2017 U1 → **1I/2017 U1 ('Oumuamua)**

(Hawaiian “scout”, first distant messenger)

ARTHUR C.
CLARKE



2017/10/19 found by PS1, at first classified as a comet, then, with a hyperbolic trajectory, as an interstellar object, the first of its kind



人類的足跡 III

◆ Breakthrough Listen

到2019年6月為止，在160光年之內（1,327顆星）沒有發現任何可能的訊號。
繼續10年，電波監測一百萬顆星，以及一百個星系，繼續找尋來自文明的訊息

◆ Breakthrough Watch

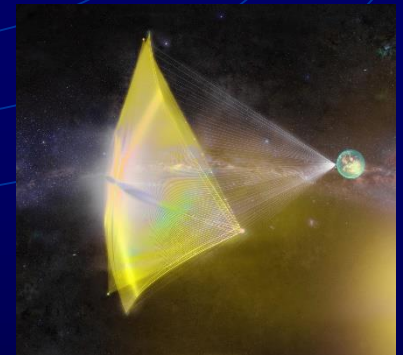
在地球周圍20光年內的恆星尋找有「生物標記」的類地行星

◆ Breakthrough Starshot

以雷射加速配有光帆的「超微太空船」，預期數十年內能夠以時速超過一億公里（光時速10億公里），前往南門二星（> 20年）

◆ Breakthrough Message

討論如何跟外星文明以數位資訊（數學、物理學、語言學、心理學）溝通（介紹地球、文明）。
真要嗎（科學、政治、社會、宗教）？



□ 除了地球，目前尚未在其他天體發現生命

□ 這些有如丟入汪洋中的「瓶中信」，攜帶了我們對自己的瞭解，也攜帶了盼望別人瞭解的期待

地球生命真是多樣呀！

□ 只是宇宙這個汪洋大得多得多（得多）

□ 象徵的意義大於實質意義，因為被找到的機會微乎其微

花多少資源算合理？



□ 完全沒有證據顯示外星人來過地球

「宇宙那麼大、時間那麼長」外星生物有很多種可能，
即使來了，我們多半認不出來 (生化) 機器人？

□ 不能把無法解釋的現象，都推給外星人來地球搞鬼

□ 地球上最早的證據已不復尋 → 向外找

□ 尋找外星生命不只是找高等文明

□ 在其他天體看到「風吹草地見牛羊」的感動

VS

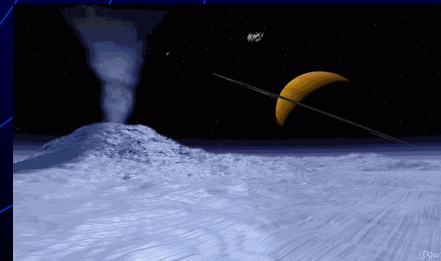
接收到第一筆「外太空訊號」的震撼與恐懼

其他世界最原始的生命一樣動人心弦！

外星生命當然存在，
我們就是～

結論

- ✓ 科學家從未停止想像，且盡力實踐想法
科學家想辦法證明自己對
狂想者等着別人證明他錯
- ✓ 科學以嚴謹手段解決特定問題
不是萬能，但是科學態度與方法很有用
- ✓ 追求科學真理的過程，其精彩程度絕不下於奇幻小說
- ✓ 連江湖郎中都必须多讀書、多思考！
- ✓ 有外星生物不奇怪；就是因為到目前都沒找到，才讓人納悶！怎麼了？
- ✓ 避免以「未知」解釋「未知」！
- ✓ 學而不思則罔；思而不學則殆



繼續尋找吧！

永保好奇的心 然後理性批判

繼續找吧 ~
找其他人 找下個家

找了
不見得找得到

但是不找
必定找不到

