

我們怎麼知道別的文明 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’附近）搜尋「可疑訊號」

人 (who)、事 (what)、時 (when)、
地 (where)、物 (how)

要在哪個波段搜尋 外星文明訊號呢？

這麼說好了，若是我們要發射訊號，應該在哪个波段發射？

條件：（1）傳得遠、干擾少
（2）認得出是非自然的訊號

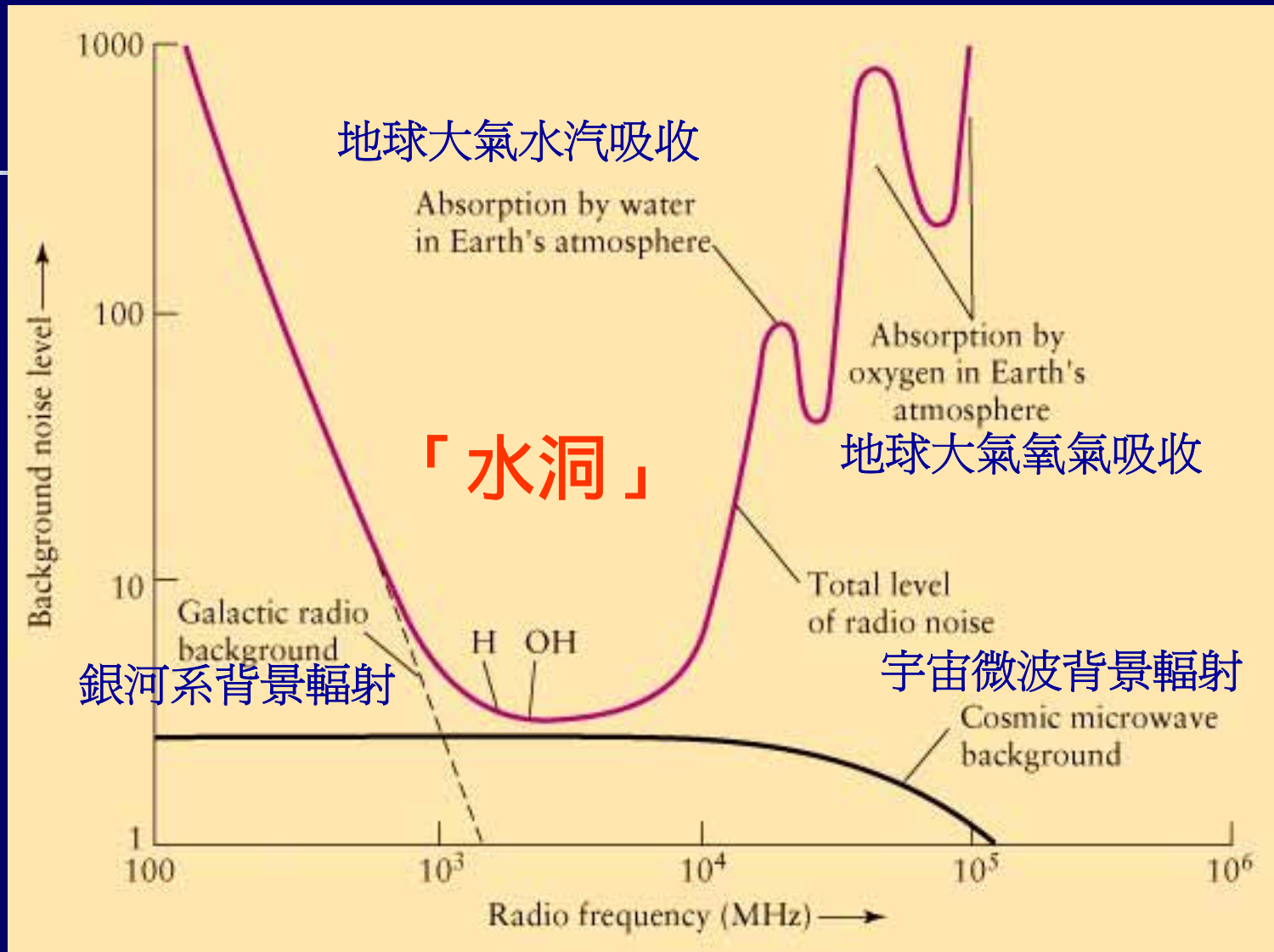
- 氫原子發射波長為 21 公分的輻射
- OH (hydroxyl) 分子發射的波長為 18 公分
- $\text{H} + \text{OH} \rightarrow \text{H}_2\text{O}$ ：生命的要素
- 該波段地球大氣或宇宙背景干擾都小
- 星際太空灰塵的吸收弱

科學家把**18~21公分**波段戲稱為「水洞」
(**Water Hole**)，認為這是星際通訊最佳波段

水洞與水無關！

'Water Hole'

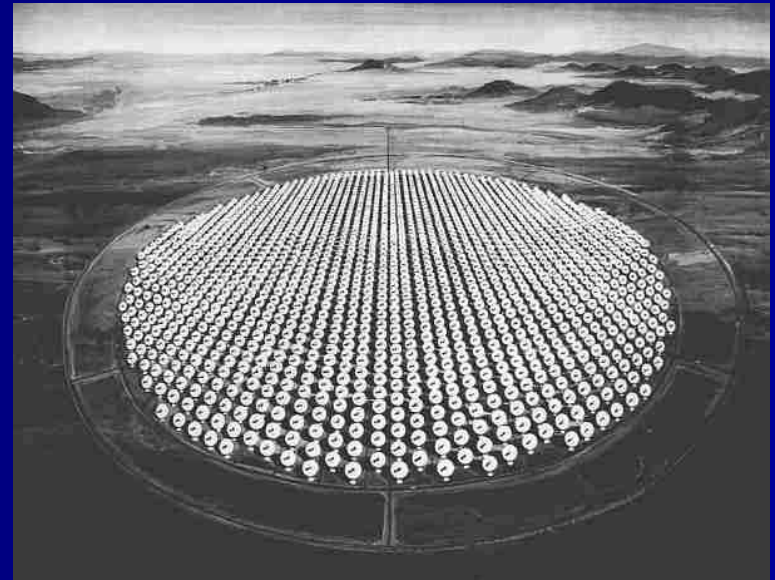
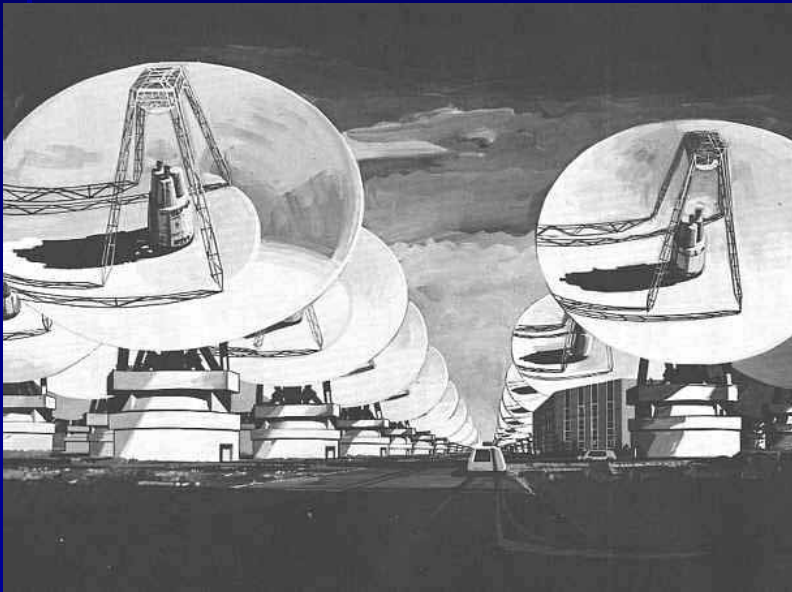
背景雜訊



無線電波頻率

The Project Cyclops

- 1,000 ~ 2,500 無線電波天線所構成的陣列，每個直徑達30公尺



結果：經費沒有通過！

Microwave Observing Project

- 1992 年10月開始
- 定點目標：約 800 顆鄰近類似太陽的恆星，在「水洞」的長波端監測
- 全天搜尋：NASA 的 Deep Space Network



ATA (Allen Telescope Array)

Paul Allen+SETI Inst+UCB

350 x 6.1 m (inexpensive) antenna elements

0.1 – 11 GHz simultaneously

SETI + Astronomy



<http://www.seti-inst.edu/science/ata.html>

我們也可以主動 發訊號啊！

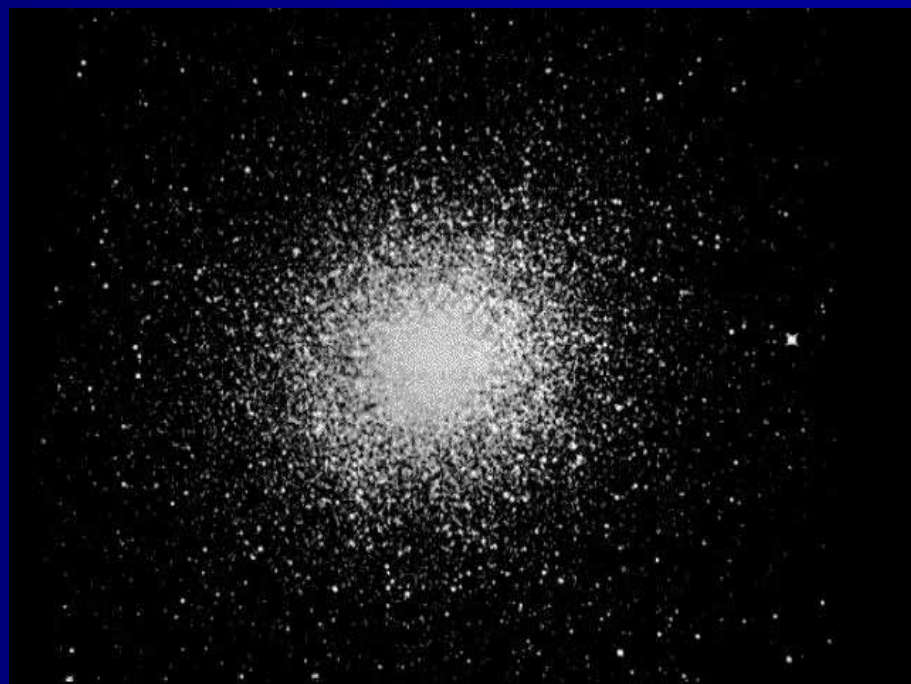


嗯，訊號往
哪送呢？

1974 年11月16日
波多黎各的
Arecibo 天線（直
徑 300公尺），在
頻率 2.38 GHz，
頻寬 10 Hz，發射
了一個三兆瓦
(3×10^{12} W) 的訊號
—— 人類有史以
來發射最強的訊
號！

目標 M13（武仙座 Hercules 方向的一個星團；距離 25,000 光年，包含約 300,000 顆星），發射的電波束到達時（25000年後）恰涵蓋整個星團

喔，要送什麼
訊號呢？



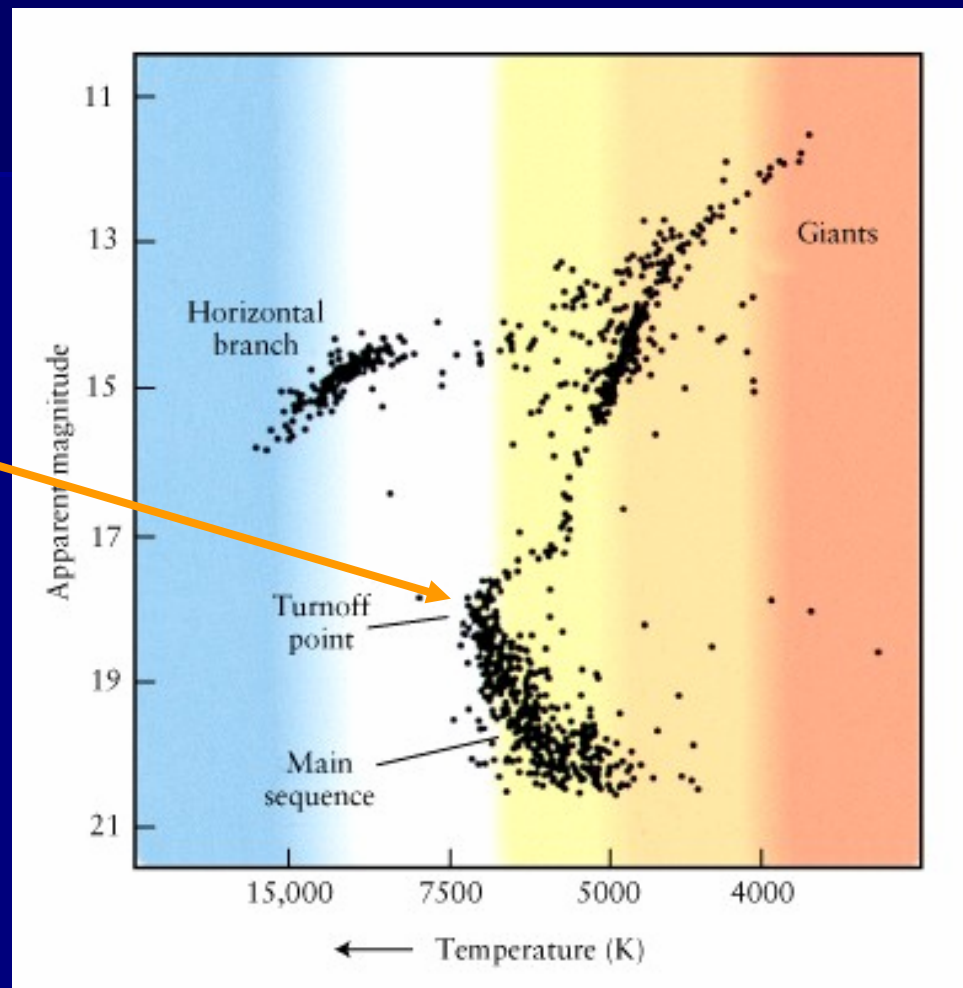
星團中的恆星同時、從
同一團雲氣形成

→ 年齡、距離、
成分都相同

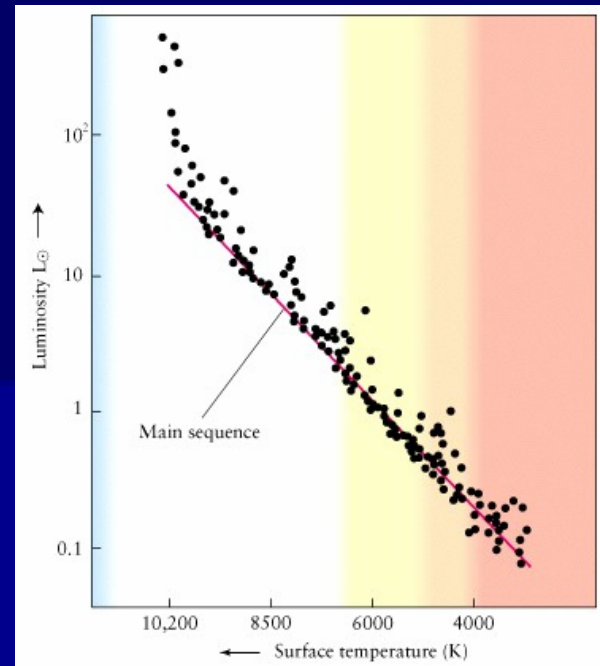
轉折點 (turnoff point)

以上，質量比較大的主
序星已經衰亡，成為紅
巨星

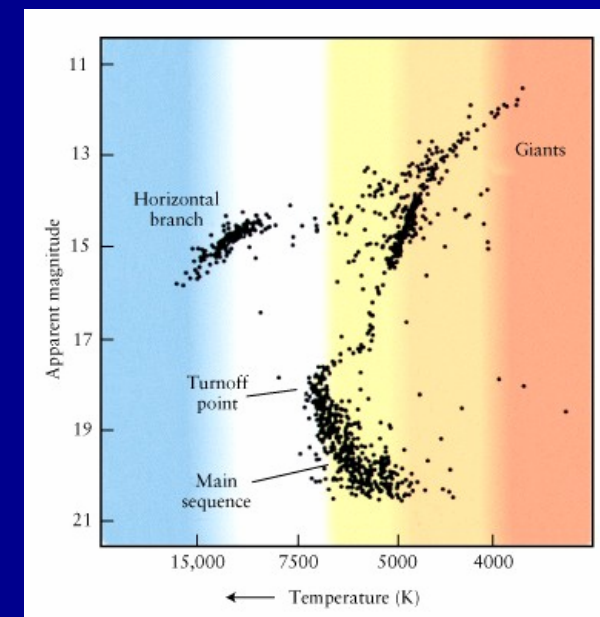
→ 轉折點的恆星壽
命，就是該星團的年齡



- **年輕星團：**
有各種質量成員星，分佈在赫羅圖主序上



- **年長星團：**
大質量恆星首先衰亡，然後輪到中等質量恆星，接著依照質量陸續離開主序



嗯，所以 M13 夠老，因此當地如果有文明，可能會是很老、很先進的文明

宇宙形成之初，只有氫、氦等簡單的元素，其他元素是恆星的產物

因此宇宙越早期形成的天體，越缺乏複雜的元素

沒有這些「重元素」恆星周圍就無法有足夠塵埃等固體物質，形成類似地球的行星

也就不會有我們這種生物

一共送出1679個0或1

[illegible]

1679?

Arrange bits into 73 rows and 23 columns – A Pictogram!



Numbers 1-10 in binary



Atomic numbers of C, H, O, N and P



Formulas for the sugars and bases making up DNA



The double helix of DNA and the number of nucleotides it contains



An image of a human and its height



The solar system with the Earth identified

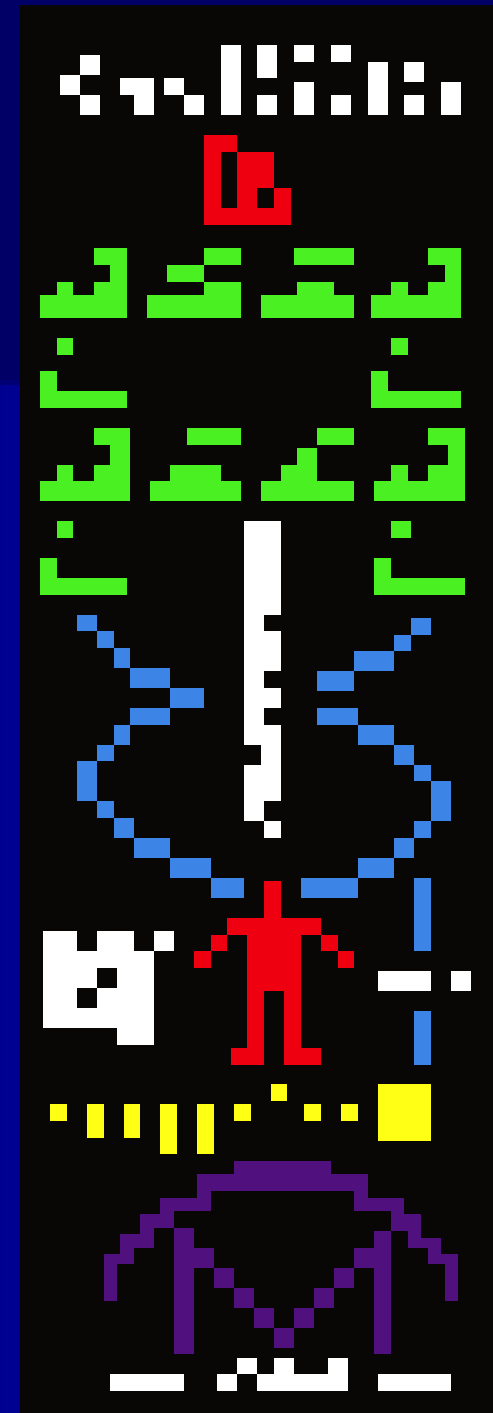


A picture of the Arecibo Telescope



The diameter of the Arecibo Telescope

The Population of the Earth at the time the message was sent



- 如果那兒有文明
 - 如果他們有夠靈敏的天線
 - 如果他們正在聽
 - 如果他們朝我們這個方向聽
 - 如果他們選對了頻率收聽
- 他們就**有可能**聽到這個訊號

他們能懂嗎？

我們要是收到這樣的訊號，我們懂嗎？

會是這樣？



還是這樣？



© PWCPhoto.com

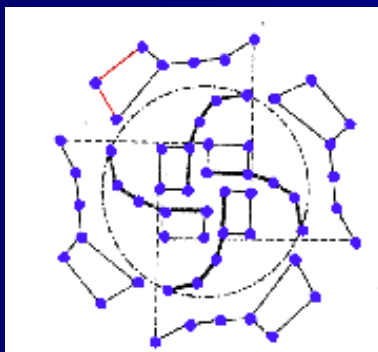
古文明受外星文明影響？



Basque



有想像力沒什麼不好，關鍵在不能空有想像力



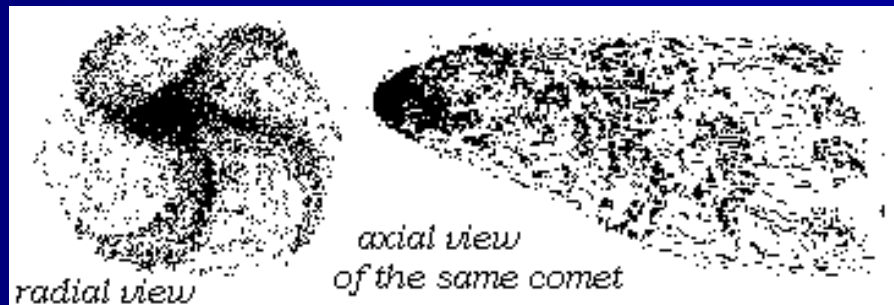
swastika



hakaristi



counter-clockwise





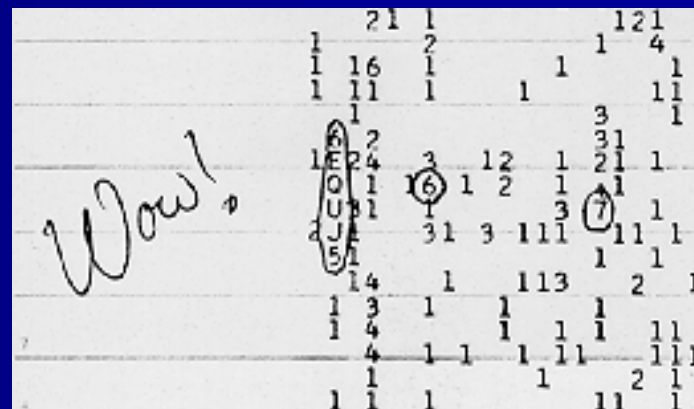
How did the glyph artists create "pixels" in a wheat field to produce this stunning photographic effect?

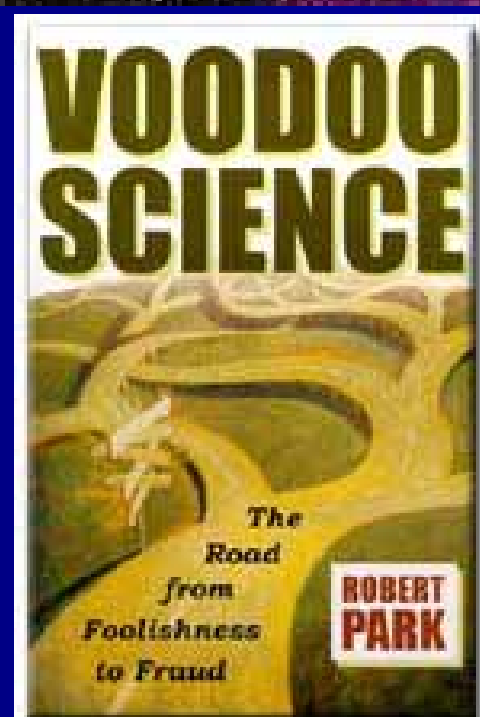
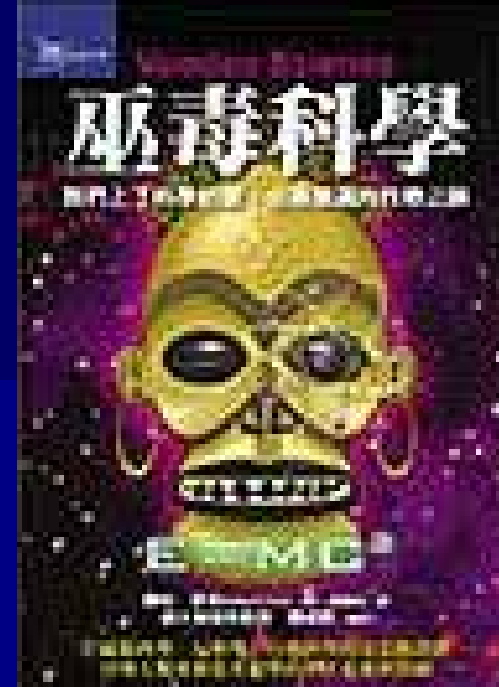
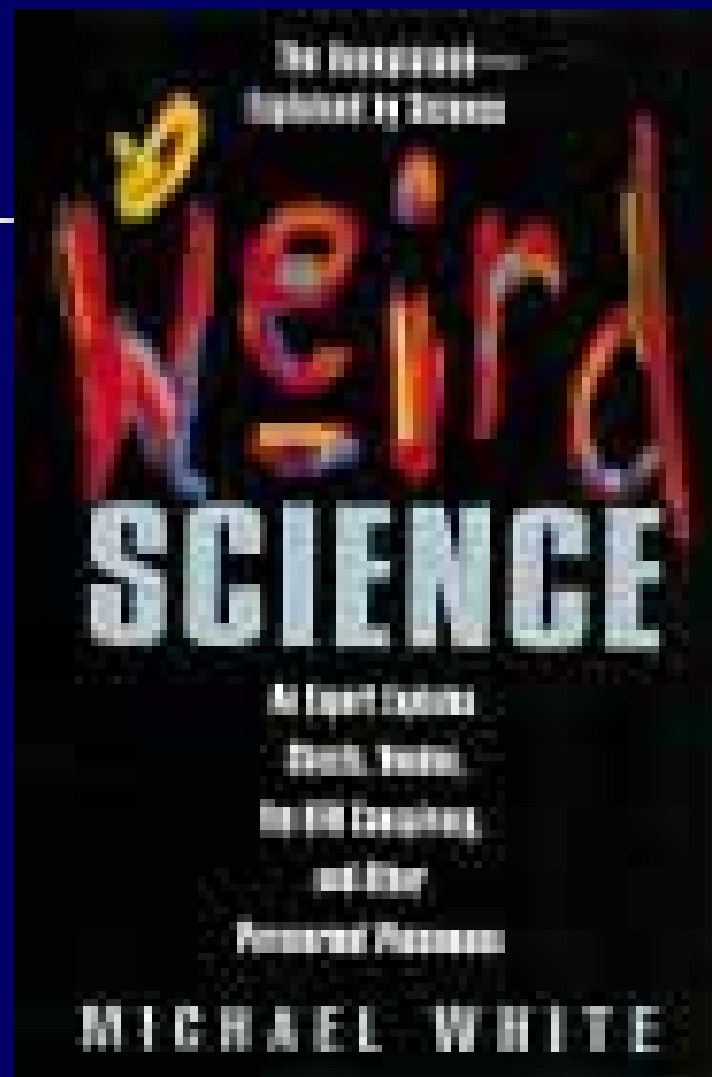


2001.08.21 英國 Chiboton 無線電望遠鏡附近的 glyph 「麥田圈」 顯示「1974年 Arecibo Message」及「人臉」圖樣

我們到底聽到了什麼？ (嘿，嘿，嘿？)

- 1977 年8月15日 --- ‘Wow!’ 訊號
6EQUJ5
非自然、來自天外，但來源不明





Home

What's New?

Bad

Astronomy

Misconceptions

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Astronomy

In Print

Mad

Science

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Book Store

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Store

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Board

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The Apollo Moon Hoax?	Planet X?	The "Coast to Coast AM" July 5th writeup?
... or the Hoagland Debunking?		

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February 17, 2005

You may have heard that a pair of NASA scientists said that they have found evidence for life on Mars... *current* life. Well, don't believe everything you hear. I was on [Coast to Coast AM](#) talking about [this story from Space.com](#) (mirrored at [Yahoo](#) and [MSNBC.com](#)). An interesting follow-up has been posted on the [Australian Broadcasting Corporation's website](#) as well.

This topic is being discussed [on my discussion forum](#), and [here is my post on the board that has specific info about this story](#).

January 27, 2005

I've been on a tear of getting public talks set up for the next few months. I'm giving one in Fort Worth, a second in Los Altos Hills (California), another in Las Cruces, New Mexico, then one in New York State and another a week and a half later in Newark! If you live in those areas and you want to hear me lambaste the Face on Mars or talk about the astronomy of Hollywood movies, then [take a look on my calendar page](#) to get more information!

January 24, 2005

I wrote up a travelog about James Randi's "The Amazing Meeting 3". It's in the [Fun section](#) of the site. Don't know what a skeptic is? Find out there!

January 23, 2005

In Memoriam

I am terribly sad to write that we have lost a great skeptic, humanist, and rationalist. Johnny Carson died Sunday morning. Most people think of him as the host of [the Tonight Show](#), but he was actually a driving force behind the scenes in the skeptic movement. By having [Carl Sagan](#) on his show, he catapulted Sagan to fame, and gave Sagan the chance to inspire a generation of astronomers, including me. [James Randi](#) was also a regular guest, and the Tonight Show was the first time I ever saw Randi. Johnny felt skepticism was so important that on many occasions [he donated money to Randi's foundation](#). At Randi's second [Amazing Meeting](#), Johnny donated a check (through Penn and Teller) for \$100,000! Randi and Johnny were close, and Randi [has written an eloquent and moving essay about his friend](#).

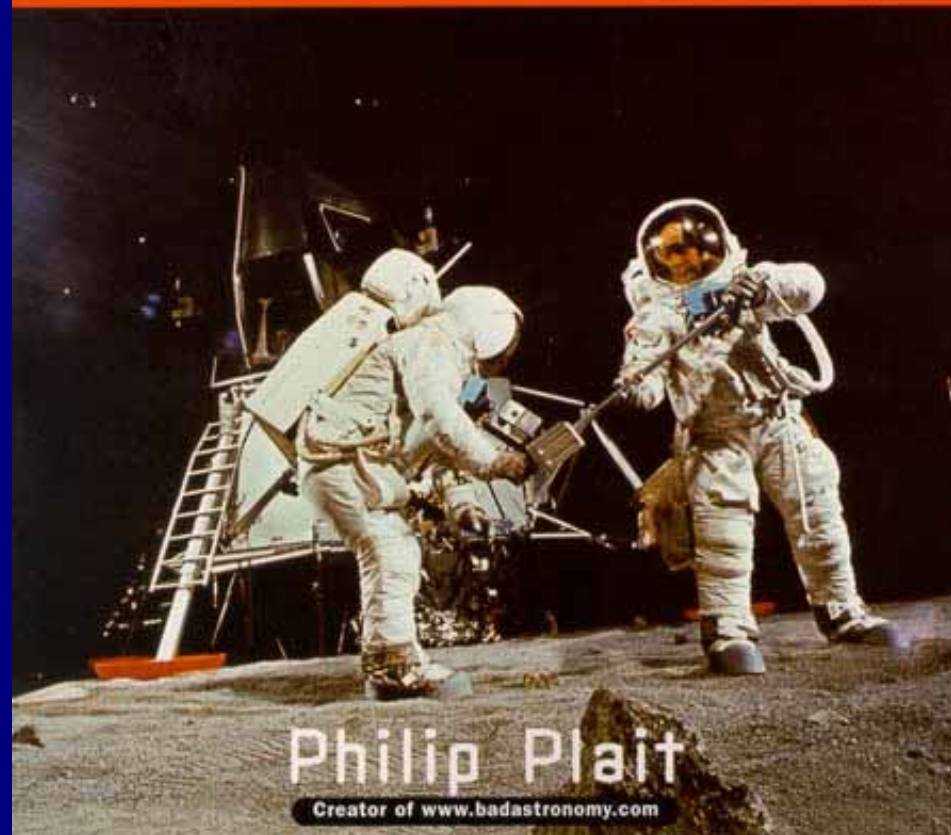
Johnny did more for people than they know. He'll be missed.



[Check out my](#)
[book "Bad](#)
[Astronomy"](#)

BAD Astronomy

Misconceptions and Misuses Revealed, from Astrology to the Moon Landing "Hoax"



<http://www.badastronomy.com/>

James Randi Educational Foundation

an educational resource on the paranormal, pseudoscientific and the supernatural



SWIFTonline

March 11, 2006



Yet Another Psychic Failure, A Praiseworthy Epiphany, Silly Stuff News, Hungarian Prize-Winner, More Psychic Hikers, Faith-Based Comparison, Not Enough Evidence, Watery Coffee From Starbucks, Pet Not-So-Psychic, More Fishy Science, A Goddess Is Attacked, John-Of-God Again, and In Conclusion...

Search

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Help support the JREF through donations, grants, gifts and memberships. [Click here to learn more.](#)

Reader and contributor Claus Larsen in Denmark tells us: *On March 3rd, the Danish National Radio had a half-hour show about police use of psychics. The background was a sad one: A 17-year old boy, Nicholas Povlsen from Svendborg had gone missing after a night of partying. The police strongly suspected that he had fallen in the nearby harbor, but couldn't locate the body.* [Read More.](#)

[Read this week's Commentary](#) | [View the Commentary archive](#)

Million Dollar Challenge



One Million Dollars awaits the individual that can prove, in a controlled setting, that they have "super" powers. [Click here.](#)

TAM3: A Success



The Amazing Meeting 3 is over and it was a success! We will have a few updates here with articles and such.

- [Randi's Recap in his January 21 Commentary](#)
- [From Las Vegas Weekly](#)

Other Information

[\\$1 Million Paranormal Challenge](#)

Learn more about the JREF's famous challenge.

[JREF Library](#)

Peek inside the work of James Randi.

[About the Foundation](#)

Information about the JREF, its mission and contact information.

[About James Randi](#)

A brief biography on James Randi.

[Randi's Calendar](#)

Important dates on Randi's lectures and other JREF activities.

[Learning Resources](#)

Educational and other useful links related to critical thinking. Scholarships and Awards information.

[Press Center](#)

Information and Graphics for the Media.

[Contact Information](#)

Email, address and phone numbers.

Sylvia's Clock - Update



On September 3, 2001, **1287** days

Browne agreed on the protocol for a definitive test for the JREF million-dollar challenge, on Larry King Live. This shows the number of days that have passed since her acceptance. It has been 1103 days since she first agreed to take the test!

[Sylvia's updated response](#) | [Read more](#)

DVD from TAM2



Here is the complete DVD set from the second Amazing Meeting! [Click here to order.](#)

JREF Store



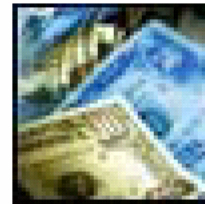
As part of our fund raising efforts, the JREF is offering certain products related to our efforts. [Click here.](#)

JREF Forum



Be part of the JREF web community by engaging in intelligent discussions with both skeptics and non-skeptics from around the

Million Dollar Challenge



One Million Dollars awaits the individual that can prove, in a controlled setting, that they have

"super" powers. [Click here.](#)

誰要能在「實驗控制」的環境下證明有「超」能力，便能獲得一百萬美金。

<http://www.randi.org/>

「偽科學」的七項特徵

By Robert Clark

<http://chronicle.com/free/v49/i21/21b02001.htm>

1. 「發現者」直接將「發現」成果訴諸媒體
(冷核融合)
2. 發現者宣稱受到打壓 (以水當燃料的引擎)
3. 證據總在偵測極限 (尼斯水怪照片從來不清楚)
4. 證據來自密聞 (雙盲實驗很重要)
5. 某現象已經流傳千百年了
6. 發現者孤立獨行
7. 必須創立新的自然法則來解釋

✓ 科學家從來沒有停止想像

科學家想辦法證明自己是對的
狂想者等著人家證明他是錯的

✓ 科學不是萬能，必須以嚴謹手段，解決特定問題

但是科學態度與方法很有用

✓ 目前科學知識有限，但追求科學真理的過程，其精彩程度絕不下於奇幻小說

✓ 這年頭連江湖郎中都必须多讀書、多思考！

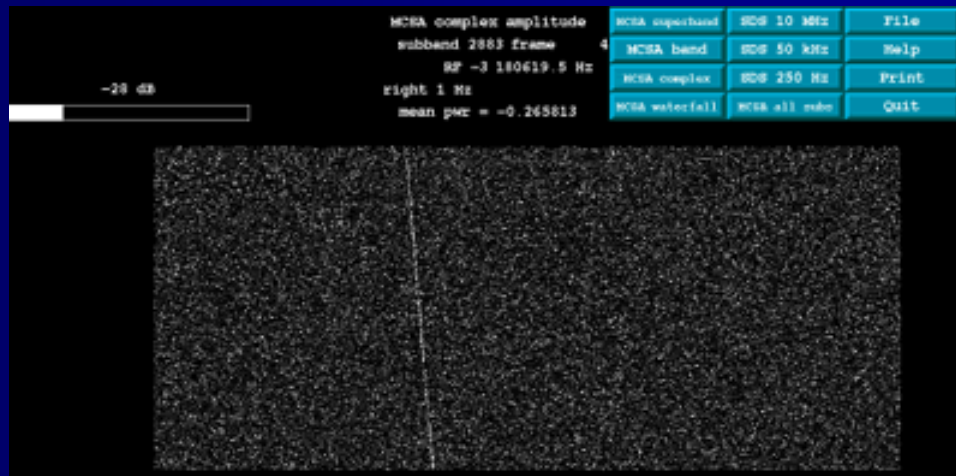
✓ 以未知解釋未知要很小心！

✓ 學而不思則罔；思而不學則殆

學習：資訊→知識 思考：知識→常識

Project Phoenix

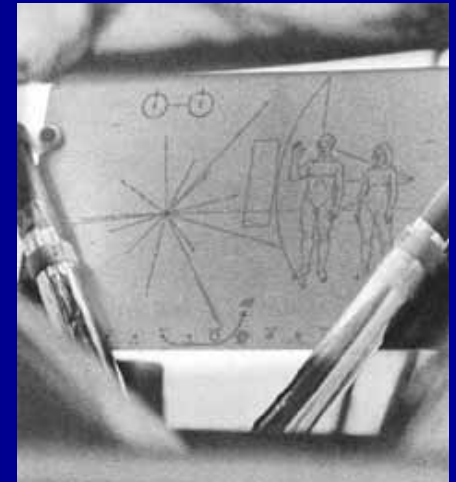
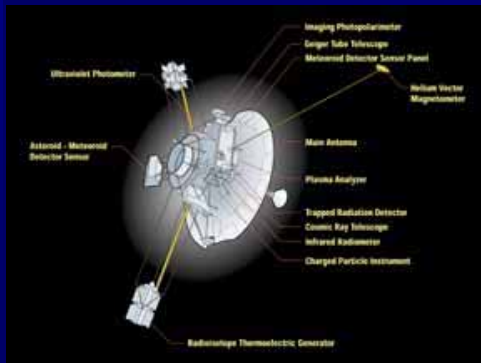
- 1995.02 開始，南北半球天線定點監聽
<http://www.seti.org/science/ph-bg.html>
- 還真聽到了！！！！



這是先鋒10號 (Pioneer 10) 的訊號。我們聽到了自己！

人類的足跡 I

- 鑲在 Pioneer 10 (1972 年) 及 Pioneer 11 (1973) 太空船身上的訊息—— 6 吋 x 9 吋 (15.15 cm x 22.8 cm) 的鍍金鋁版，厚 0.127 公分，由 C. Sagan 及 F. Drake 設計
- 我們是誰、居住在哪個時間、哪個地方、我們懂多少



在我們問
「你們是誰？」
之前，

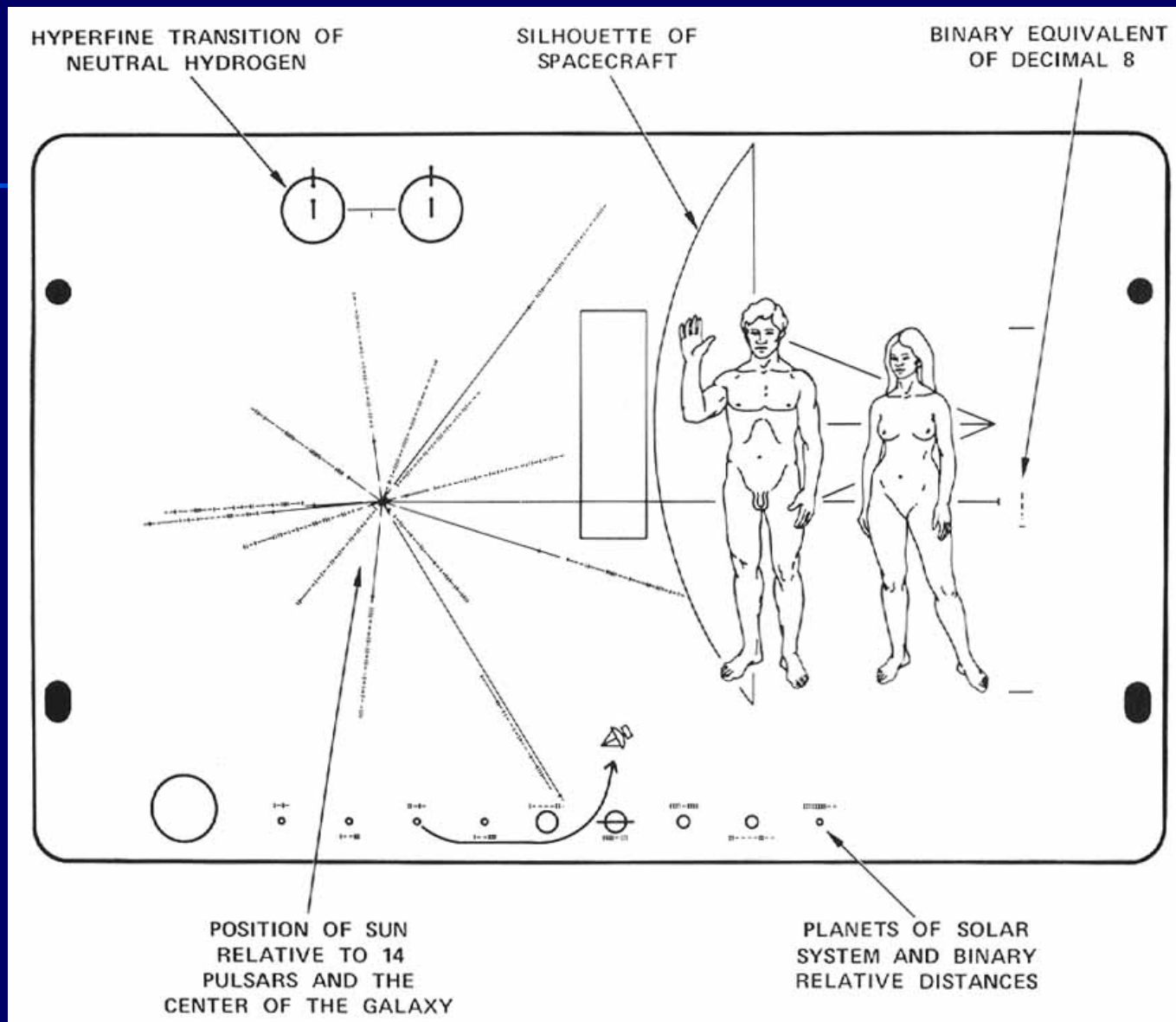
我們應該好好想想！
「我們是誰？」

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

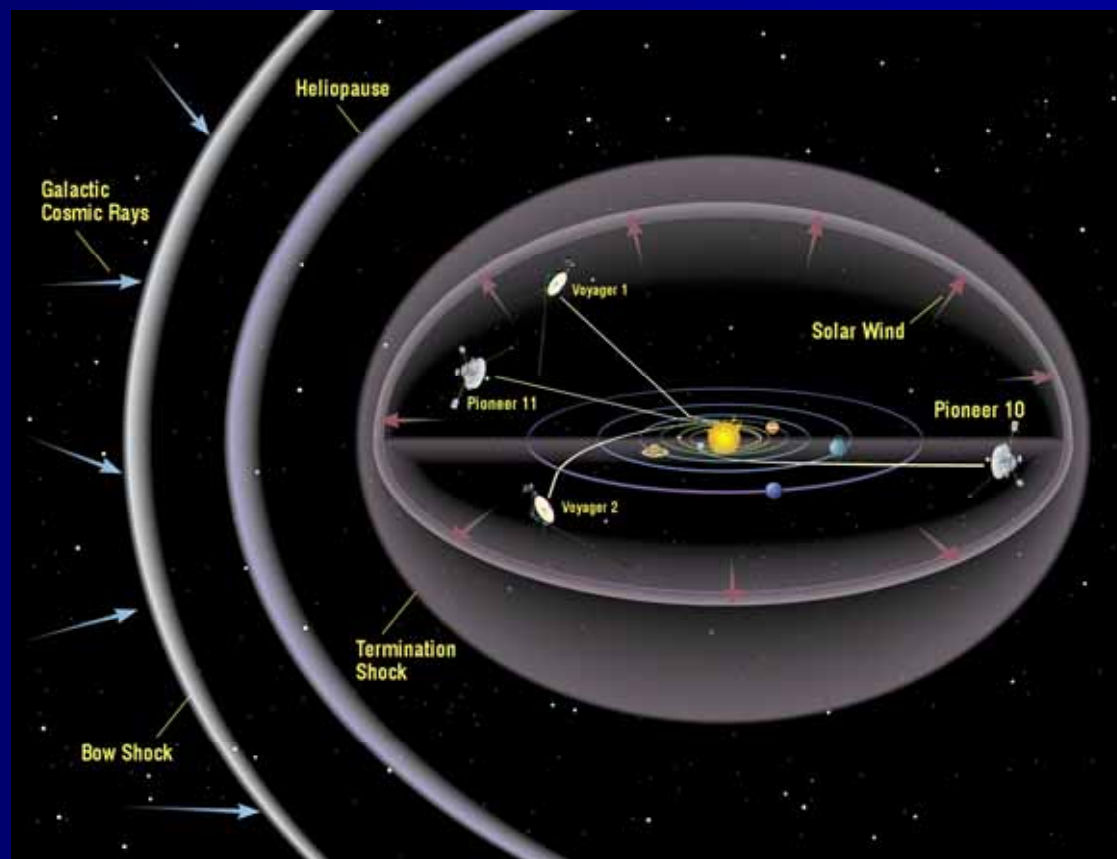
太陽相對於14顆脈衝星以及銀河系中心的位置



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
- 誰知到，億萬年後說不定會被外星文明找到



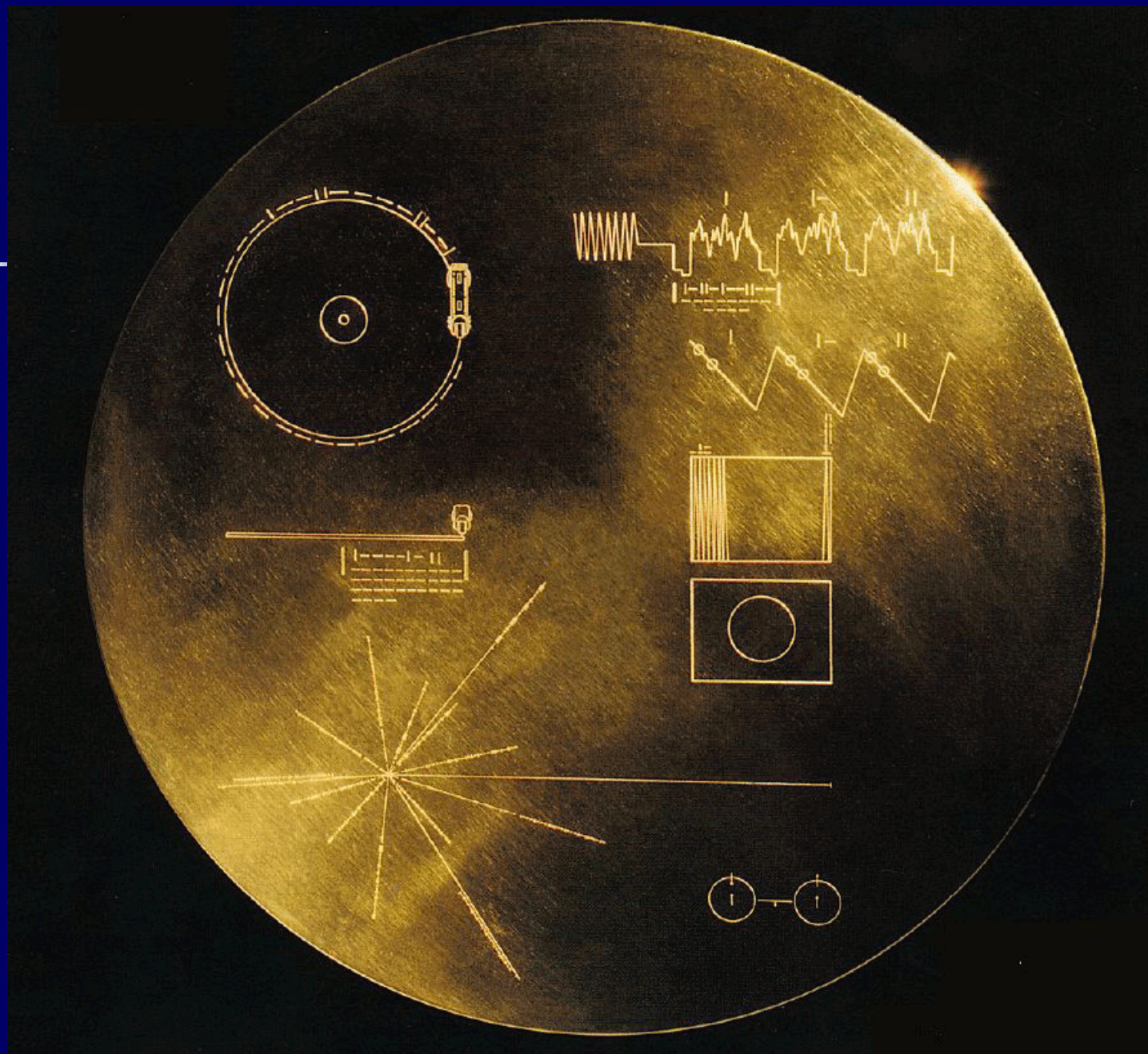
人類的足跡 II

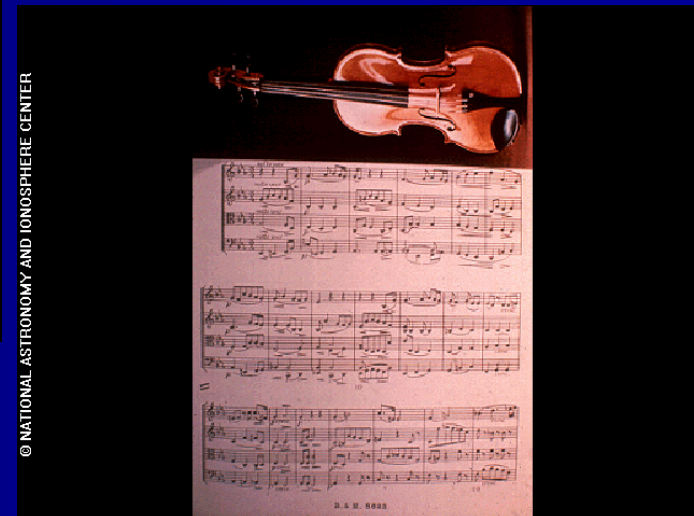
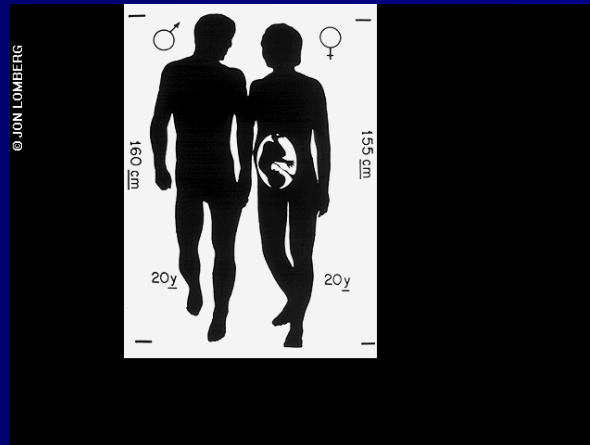
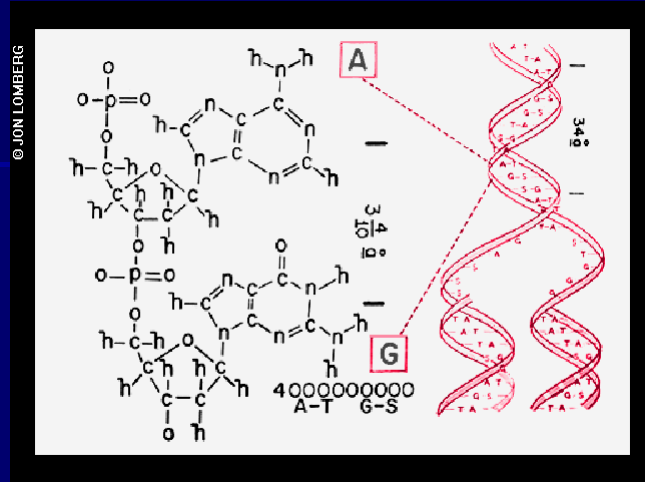
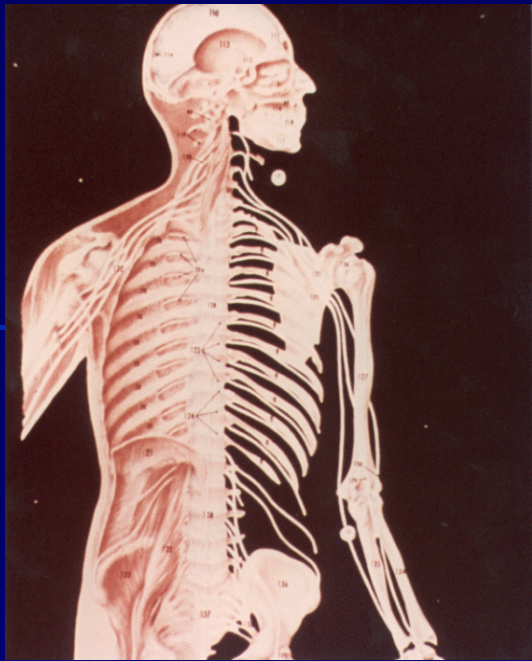
- Voyager 1 及 Voyager 2 (late 1970s) 上的唱盤
- 2 吋直徑的銅盤，裝在鋁盒中，內有116張圖像；用 55 種語言問好；各種地球上的聲音（天然的或人工的）；27 種音樂（古典、搖滾、非洲土著民謠等）

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

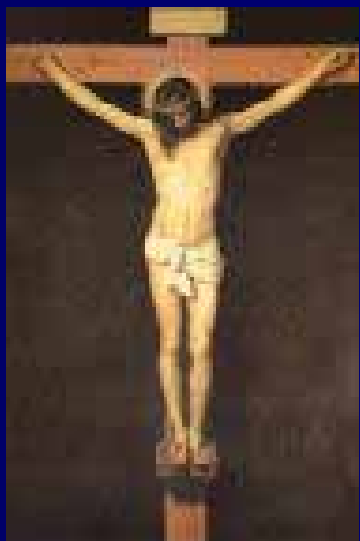
in Chinese, French, English, Spanish, Japanese, Korean ...

- 表面甚至電鍍了鈾238





要是外星人找到這些太空船，
他們應該有能力檢視各種證據
希望他們會同意 ... 你同意嗎？
這東西來自有思想、文明的世界！
值得他們聯絡



- 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

**找了，不一定找得到，
但不找絕對找不到！
花多少資源找算是合理？**



- 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
- 飛越其他行星時，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

其他世界上最原始的生命一樣動人！

尋找其他的世界



如何知道恆星周圍有行星？

困難：行星不發光！

→ 擋光或 反光 或者 對發光體的影響



恆星太亮、
太近

位置變化

亮度變化

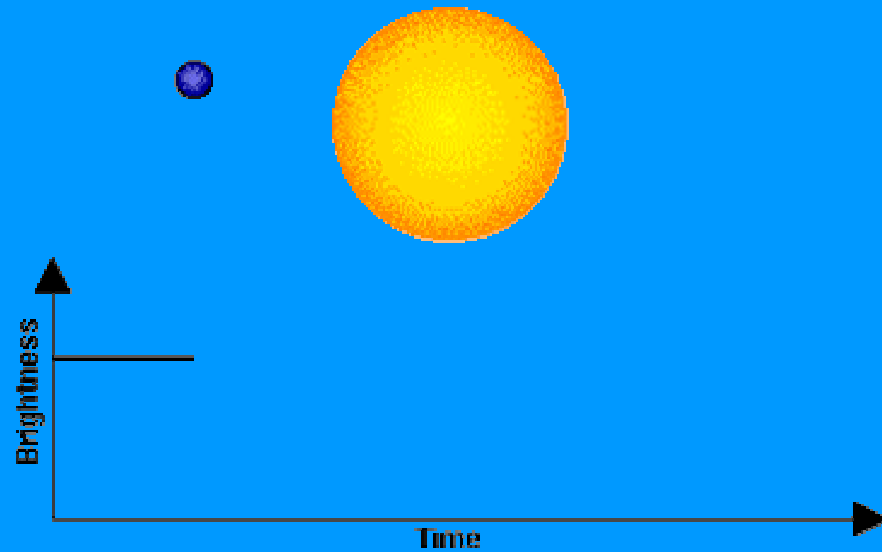
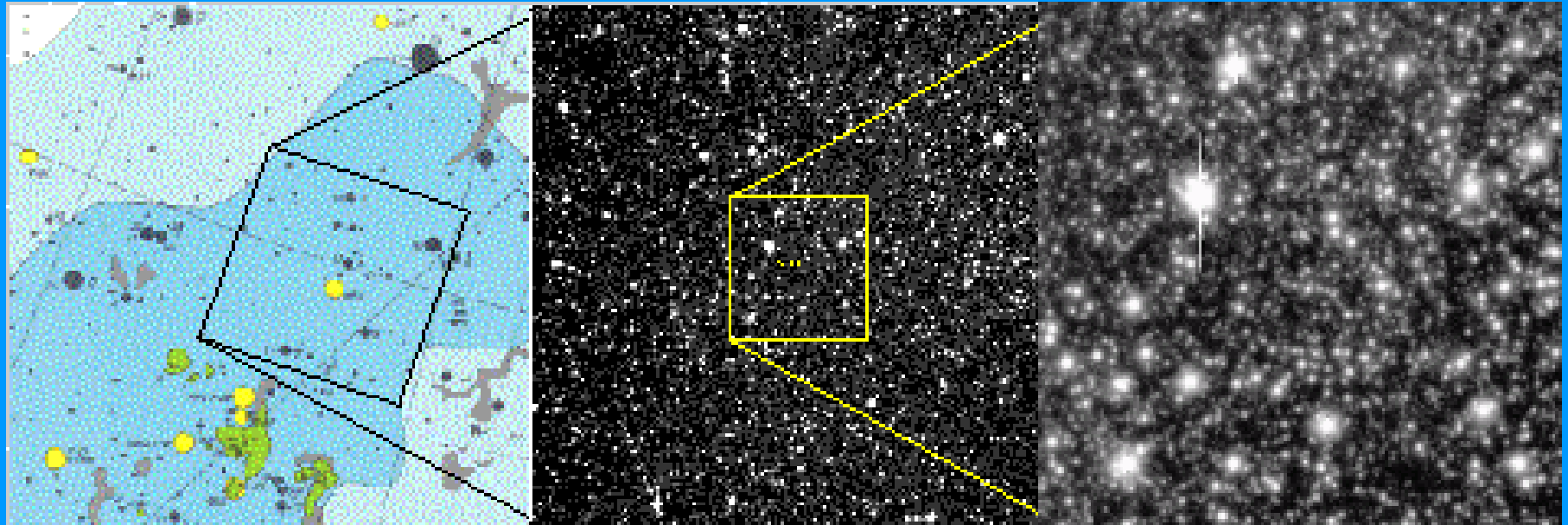
否則，直接看

偵測行星存在的方法

1 一凡走過的必留下痕跡

若行星繞恆星時，恰巧擋住恆星的光（像日食般），那麼恆星的**亮度**會以特別的方式變化





偵測行星存在的方法

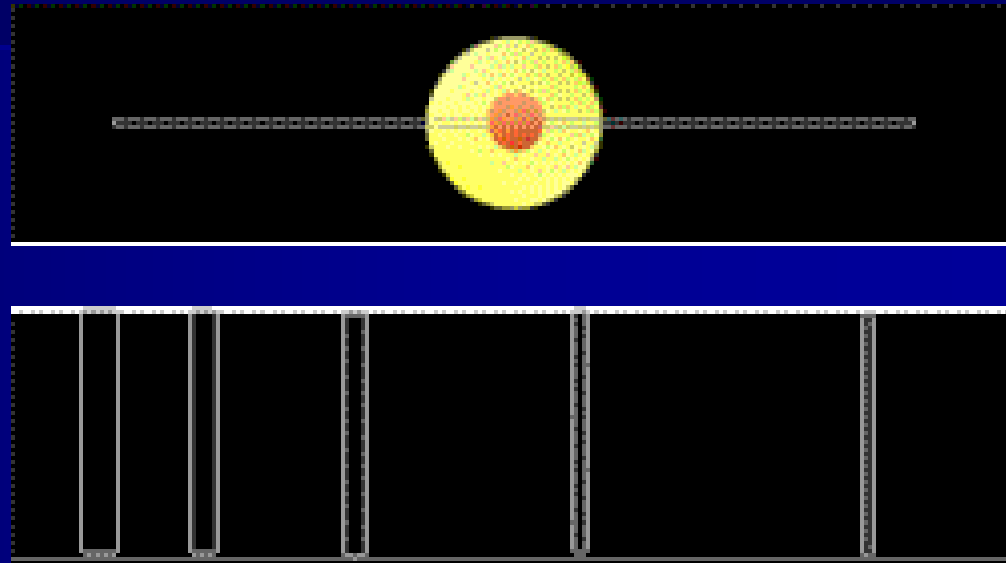
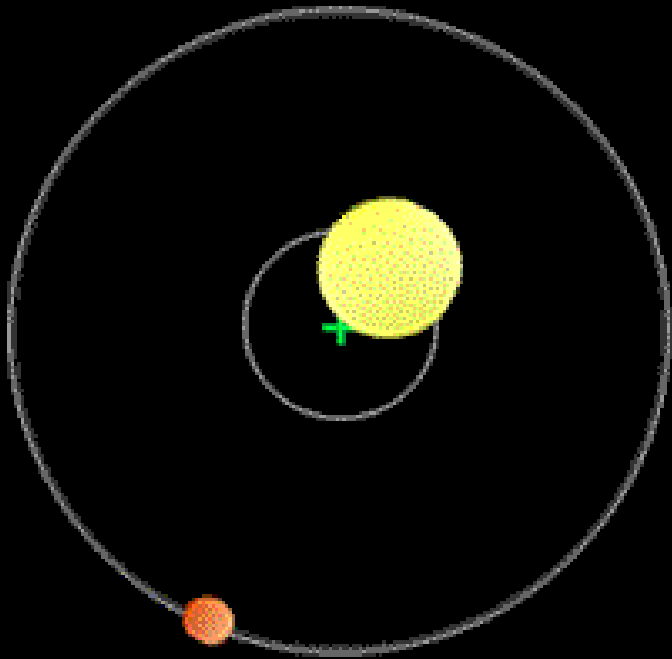
2 — 若要人不知，除非己莫爲

如果恆星周圍有行星，那麼恆星的**位置**與**運動**就會受到行星（萬有引力）的影響



Hammer throw

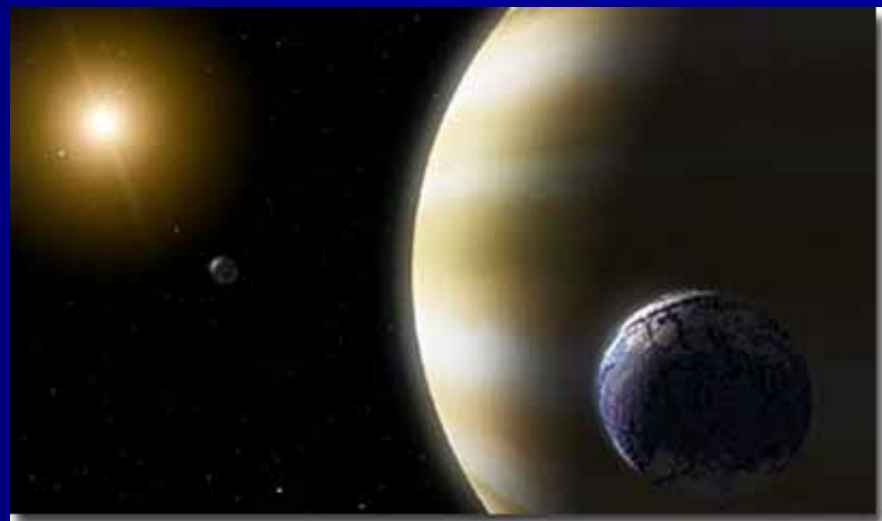
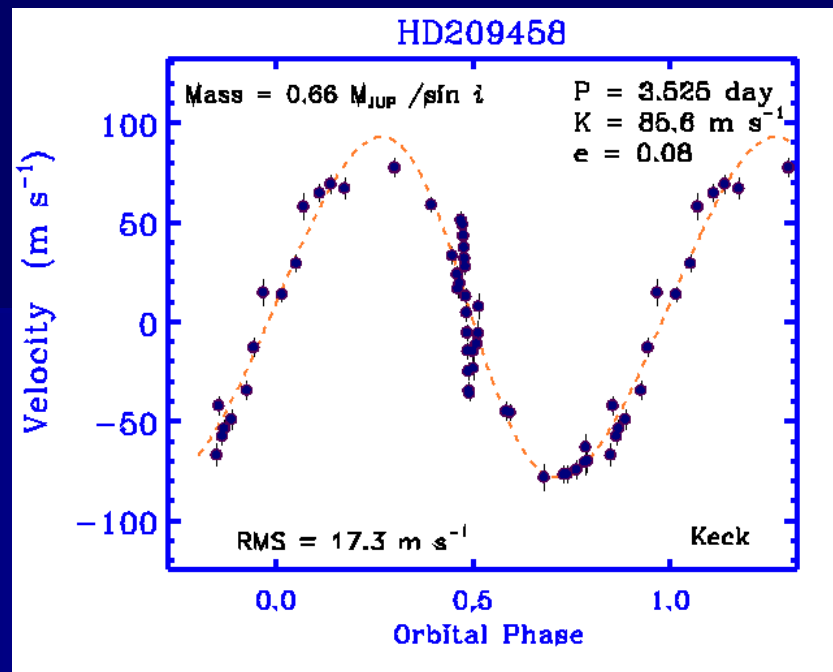
都卜勒效應



原本在太空中走直線的恆星，因為與行星互繞，而有「走螺線」的現象。

恆星因為與行星互繞，而在沿「視線」方向有「前後擺動」的運動

目前已經在太陽系以外共
發現超過100多個恆星
周圍有行星（**系外行星**
extrasolar planets;
exoplanets），絕大多
數是利用「前後擺動」
的原理所發現
（**為什麼？**）

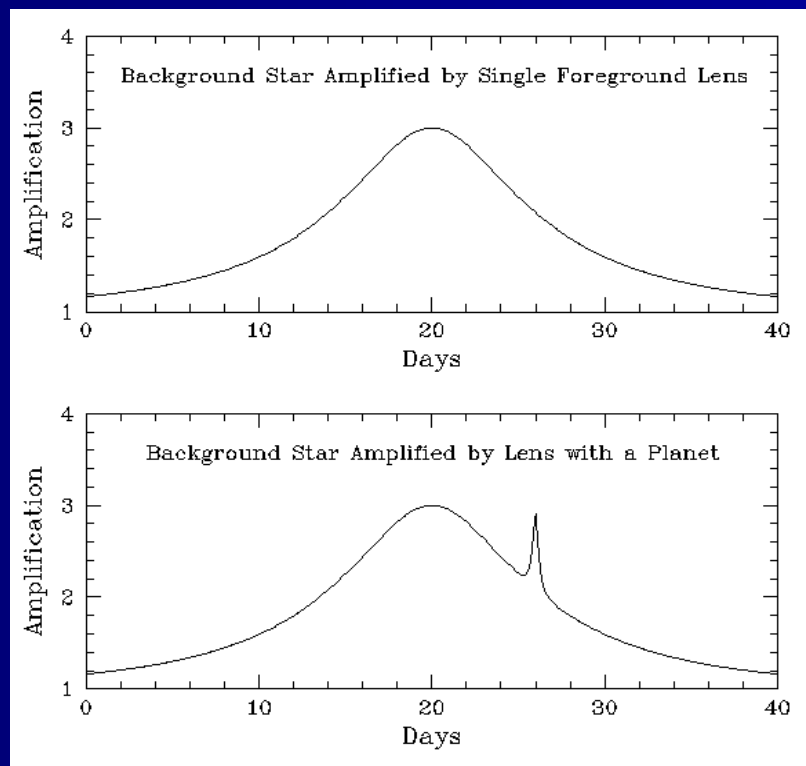


偵測行星存在的方法

3 — 擋住了，但更亮！

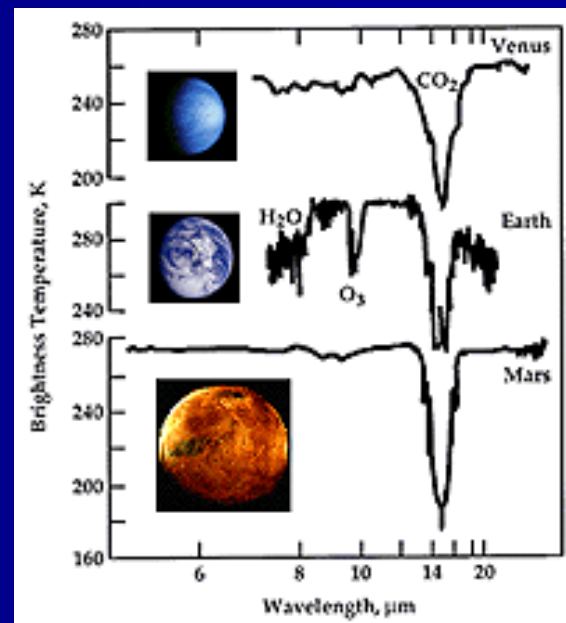
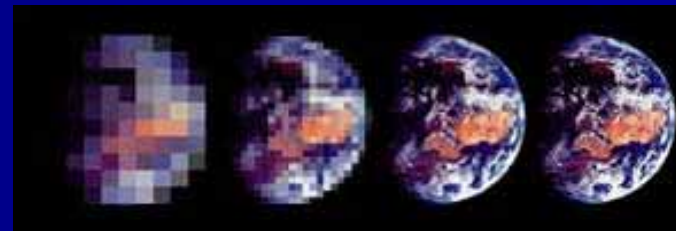
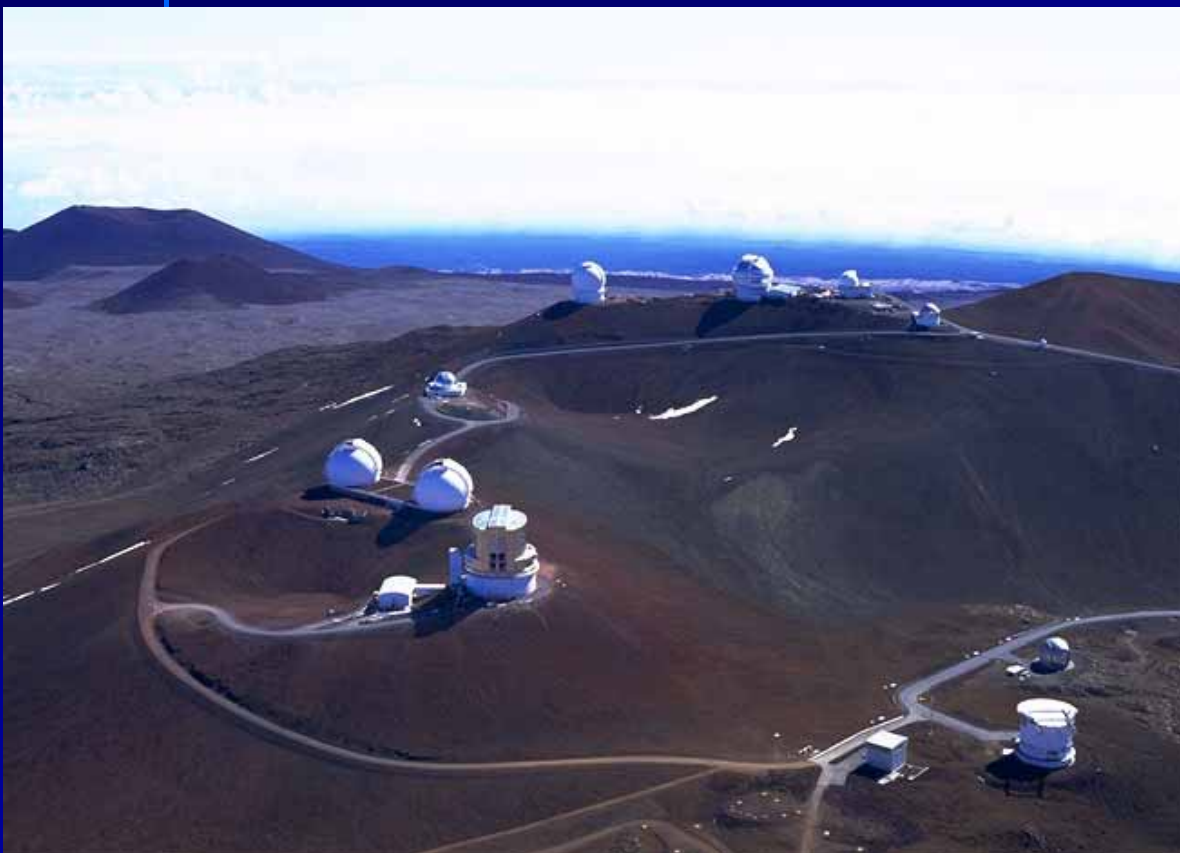
如果行星（前景）精準地正好在我們和遙遠恆星（背景點光源）之間，那麼恆星的亮度會增加

「重力透鏡」效應
gravitational lensing



鱗光片羽勝過千言萬語

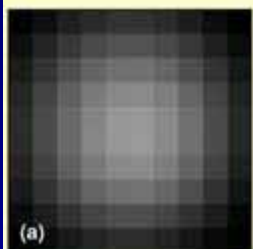
—— 要是能直接看到就更棒啦



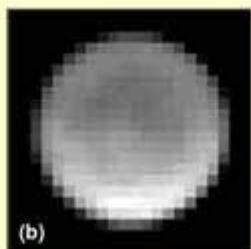


越來越大的望遠鏡

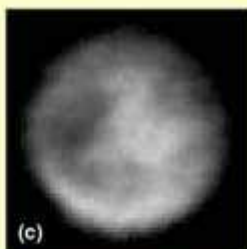
Titan (Saturn's Largest Moon)



Conventional Telescope



Hubble Space Telescope



Keck Telescope with AO



看得越來
越清楚的
觀測技術

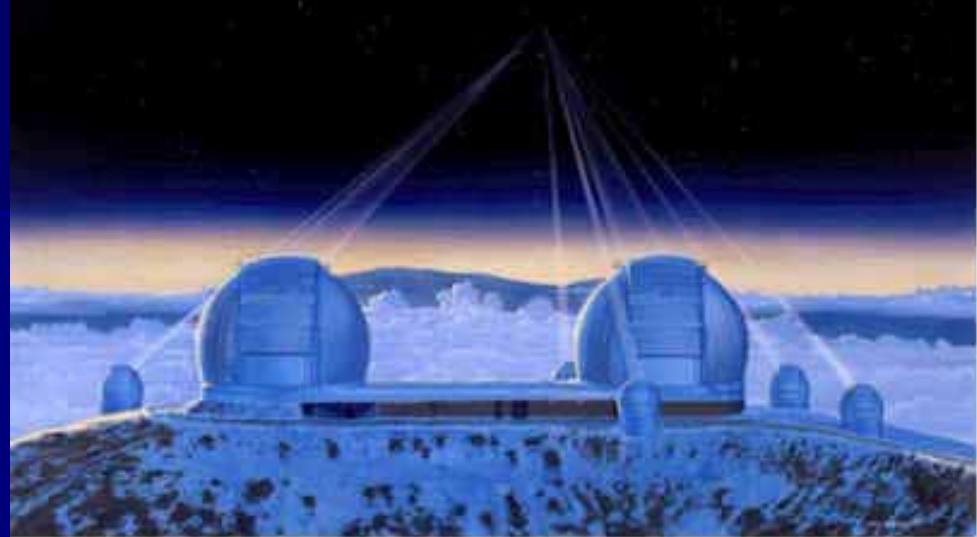
越來越靈敏
的偵測儀器



LBT in Arizona, USA

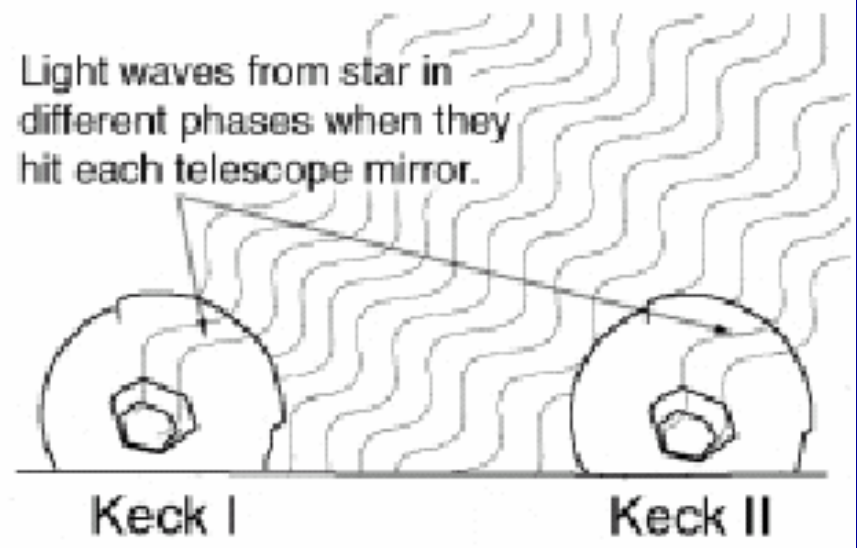


Keck in Hawaii, USA

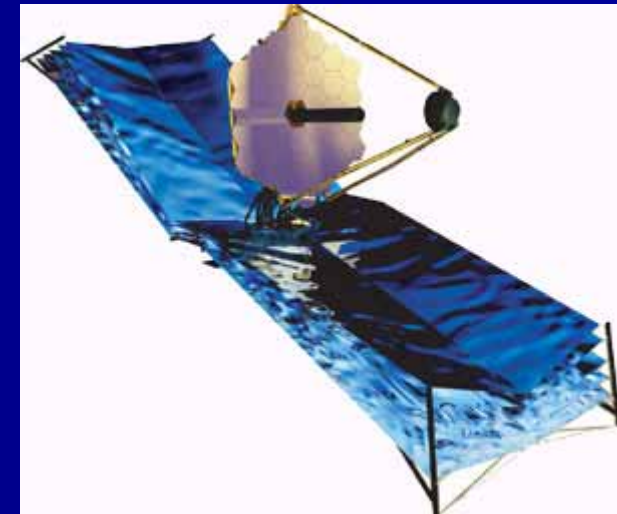
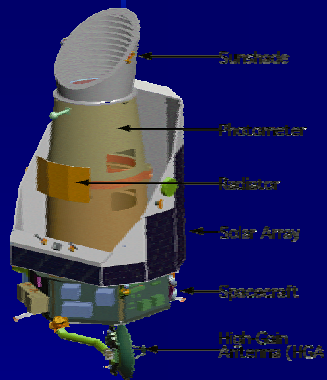


Keck Telescopes as part of an interferometer

利用干涉技術把恆星的光減弱，增加看到行星的機會



上太空去！
前面說的都能做，
而且做得更好得多



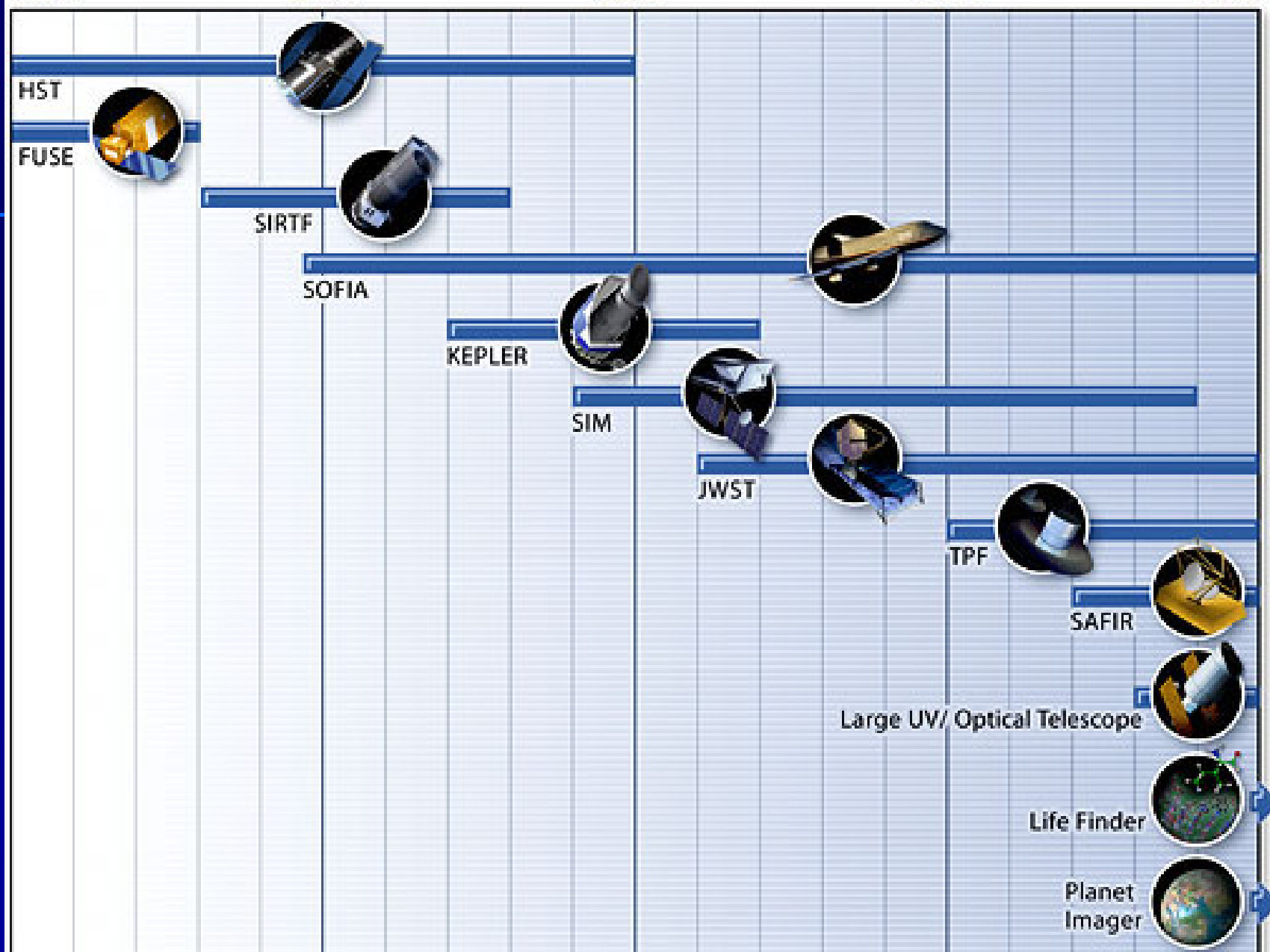
2000

2005

2010

2015

2020



開始尋找吧！

找了，不見得找
得到

但是不找，一定
找不到

