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General Physics

Fall 2026 Revised Sep 6

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微分與速度加速度 [投影片](#) [pdf](#)

微積分講義

Reading: Ch. 3 3.1, 3.2

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物理好好玩

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節目 知識好好玩

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物理好好玩【第二季】

亞里斯多德所說：「人本性就渴求去理解。」因此，理解會帶來莫大的滿足。這樣的享受，不能只有科學家知道。

主持人 | 張嘉泓

節目總長 | 02:53:59 開播日期 | 2022-01-11 更新日期 | 2022-08-09

#張嘉泓 #物理好好玩 #物理好好玩第二季



我要贊助

前往試聽 >

 張嘉泓

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<https://www.mirrorvoice.com.tw/podcasts/140>

EP09 | 莊子與愛因斯坦的淵源：淺談宇宙論

主持人 | 張嘉泓

單曲長度 | 00:27:54 發布時間 | 2021-09-07

#張嘉泓 #物理好好玩 #海龜 #宇宙論 #逍遙遊 #菌菰 #銀河系
#宇宙背景輻射 #大霹靂



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開始播放



張嘉泓

張嘉泓的專長是理論粒子物理，現任教於臺灣師範大學物理系。

追蹤 8 作品 1

追蹤

貝叭

《莊子》的第一篇〈逍遙遊〉，是這樣開始的：「北冥有魚，其名為鯢，鯢之大，不知其幾千里也。」說的是一條大魚，大到無法言說。大就是〈逍遙遊〉的重點，在短短兩千字的文章中，出現了23次：大知、大樽、大樹、大若垂天之雲。莊子的意思是：胸懷能大，眼光能大，細微、短暫的現象，才不會拘泥你的心靈，人才能自由逍遙、遊於無窮。

在文章中，莊子順手提到了一個很特別的想法：當我們望向浩大的天空，天色蒼茫、整齊平靜無瑕，這是天空真實的樣貌嗎？現代的我們知道上空的風可是劇烈又多變，用莊子自己的語言，天空該是充滿塵埃、野馬似的生物之息。因此，蒼蒼天色，並不是真的因為天空沒有變化，其遠而無所至極也。實在太大，太遠到無法言說，以致看的人無法分辨而已。

愛因斯坦的宇宙論原則



物理好好玩

節目
物理好好玩【第一季】

★★★★★

5 (2)

同專輯的其他音檔

EP00 | 科學太有趣，不能只有科學家知道

EP01 | 這個方程式太美了，不可能會錯！

能力

大學學習的重點是能力，不是知識

知識已經太過複雜，但容易取得，還有AI幫忙，
而且許多人未來的發展還有各式各樣的可能！

知識

但培養能力，必須透過知識的學習

只有透過知識的**學習、思考、討論、掙扎、挫折**，
才能培養思考與解決問題的能力！

思考力的重訓！

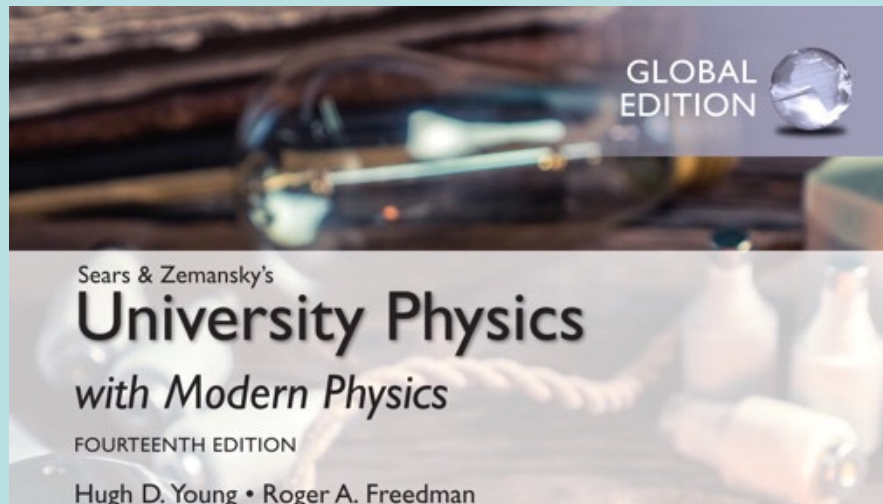


希望能在這個課程中，讓你在重訓後感覺到物理思考的 **fun**—樂趣。

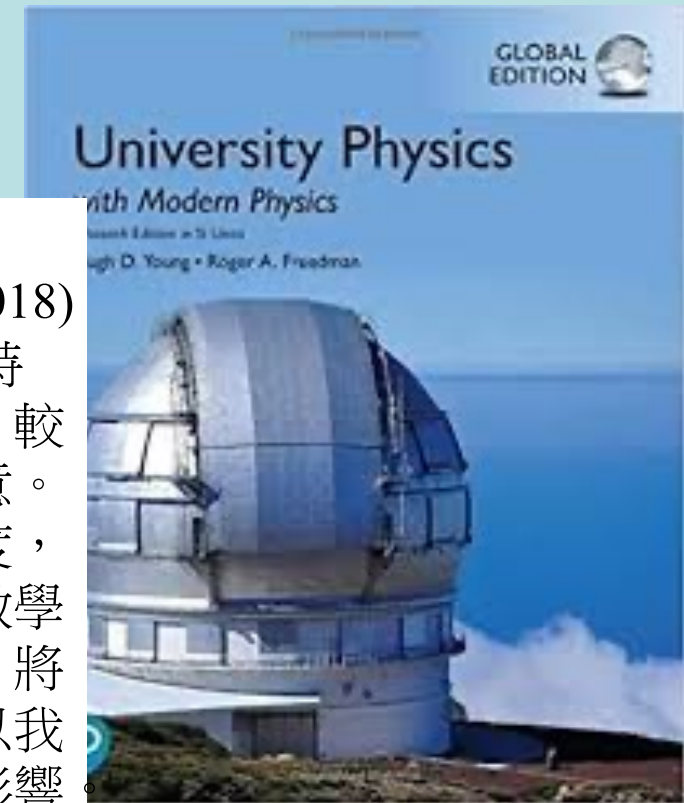
了解物理是一種有系統而且理性的思考方式
提供了我們面對自然世界，一個珍貴而不可或缺的觀點。

以這個觀點來了解自然，是充滿了 **fun** 樂趣。

而且非常有用！



Young and Freeman, Sears and Zemansky's University Physics with Modern Physics 15th Ed., Addison-Wesley (2018) 這是一本經過時代淬鍊（原型的第一版在1949年推出時是一個大突破）卻完全以現代方法呈現的普物教科書，較一般市面上的普物教科書來得深且廣，對細節非常注意。新的作者將編排方式及輔助題材完全帶到最即時的程度，在所有教科書中幾乎是最新最能反應時代精神的。在教學上處處為讀者著想，非常用心地運用各種教學的技巧，將觀念中的細微之處都盡量發掘出來。雖然我上課仍會以我自己的觀點與順序為主來進行，但一定會受到此書的影響。



Sears and Zemansky's University Physics with Modern Physics 15/E
H. D. Young and R. A. Freedman

General Physics

Fall 2026 Revised Sep 6

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微分與速度加速度 [投影片](#) [pdf](#)

微積分講義

Reading: Ch. 3 3.1, 3.2

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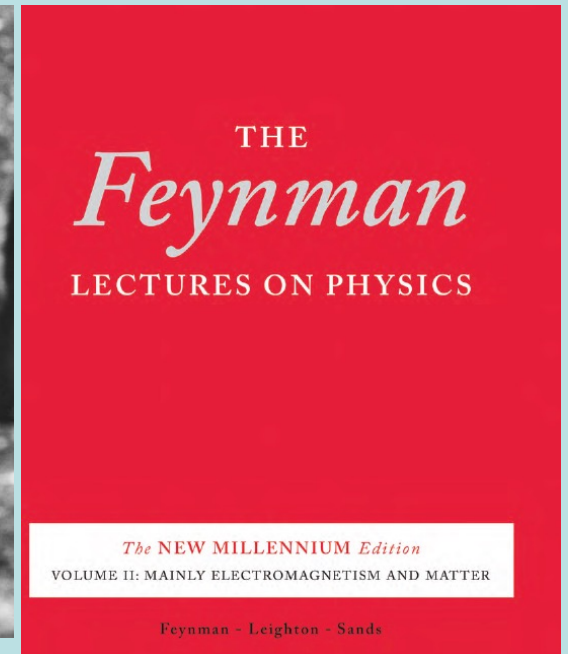
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參考講義

Reading: Ch. 4 4.3, 4.6



R. Feynman, The Feynman Lectures on Physics, 1-3

經典中的經典，當年(1970s)加州理工學院的大一二教科書，把物理的fun和精采，表現的淋漓盡致，至今無人能超越。範圍很廣，而且寫得都非常精采，在普物的題材中，如果想要再深入多了解一些，都可以先從這本書開始。當然全讀不易，挑著念即可。新的中譯本由天下文化出版「費曼物理學講義」，I是力學光學熱學II是電磁學，III是量子物理，其中除了量子物理比較個人風格，（建議先讀其它教材），其餘兩冊都是十分精采。中文翻得不錯。天下另外出版了精選集：費曼的6堂Easy物理課，費曼的6堂Easy相對論。



費曼物理學講義I+訣竅（共7冊，平裝版）

作者：理查·費曼、羅伯·雷頓、馬修·山德士、麥可·高利伯、拉夫·雷頓 [追蹤作者](#)

原文作者：Richard Feynman, Robert B. Leighton, Matthew Sands, Michael A. Gottlieb, Ralph Leighton

譯者：師明睿、田靜如、高涌泉

出版社：天下文化 [訂閱出版社新書快訊](#)

出版日期：2019/12/26

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Spring 2026 Revised June 12 2026

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預計6月19日繳出成績，請把握時間。

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第一周 Feb 23 氣體動力論 [投影片](#) p1-50 [pdf](#)

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Reading: Ch. 4 4.3, 4.6

Mechanics 力學 運動



微分、牛頓運動定律

狹義相對論。原子能。

運動方程式（微分方程式）

重力、廣義相對論、黑洞。

簡諧運動、運動方程式

能量守恆、積分

波動：波函數與波方程式

Thermal Physics 熱物理



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固體與液體的熱物理

熱力學第一定律

氣體的熱物理

熱力學第二定律與熵

氣體分子理論

統計力學初步

熱平衡

熱作用就是熱量交換。

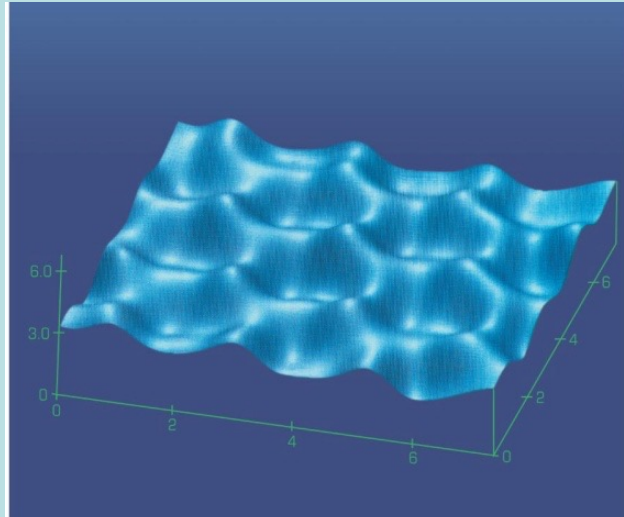
熱量與功都是能量！

但熱量與功是不一樣的！

原來熱學就是力學！

微觀統計導致巨觀的熱現象

Quantum Physics 量子物理



光子

原子結構：光譜與波爾原子模型

物質波

薛丁格波方程式

波與粒子的二重性

光是波也是粒子。

電子是波也是粒子。

Electricity and Magnetism 電磁



靜電場

高斯定律

電位

靜磁場與安培定律

變化的電磁場：電磁感應

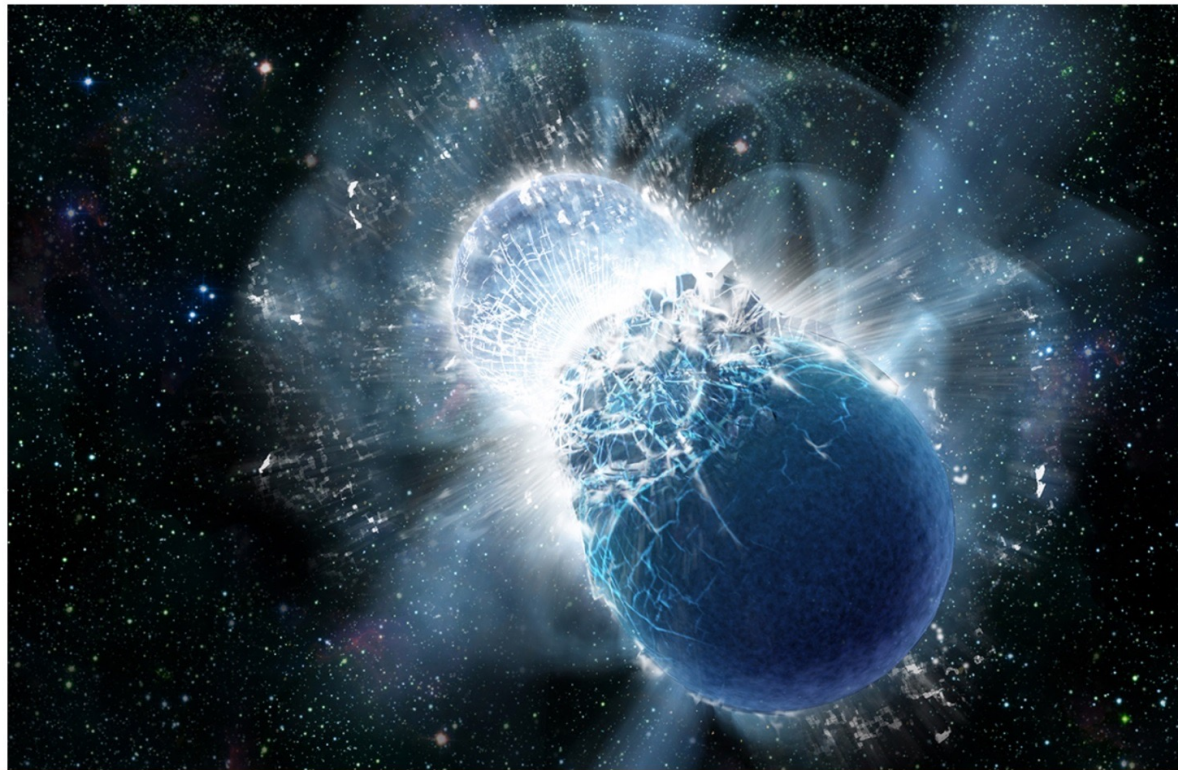
Maxwell Equations

電磁波

電磁場與電磁波

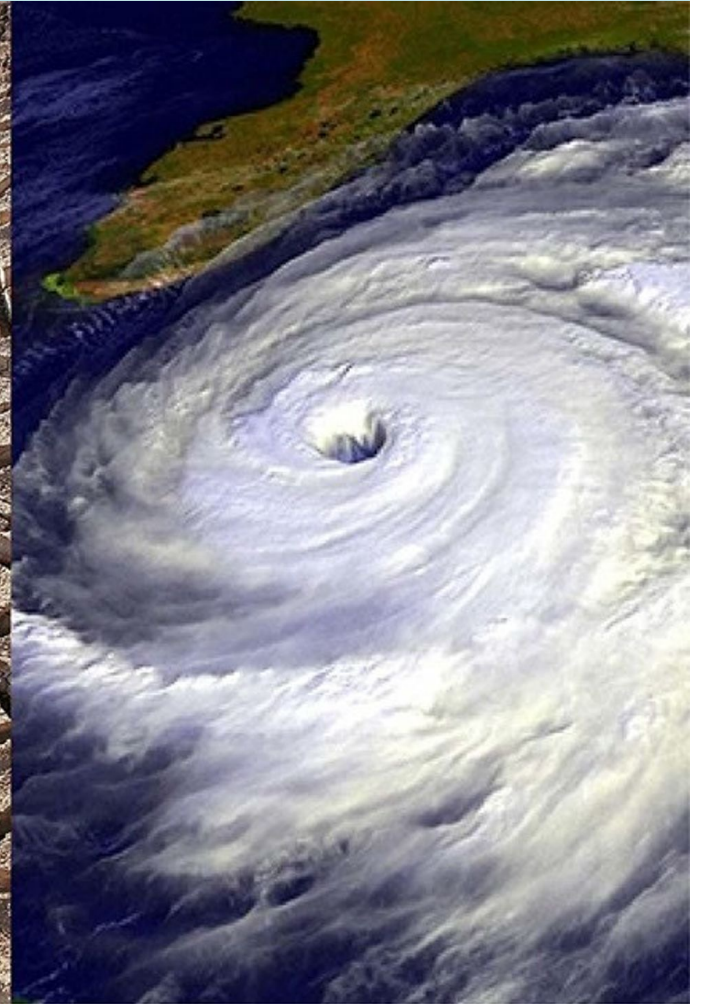
DAILY NEWS 23 August 2017, updated 23 August 2017

Exclusive: We may have detected a new kind of gravitational wave



科學正進入快速發展、時時有驚奇的階段！而物理可以幫大家的忙！

氣候變遷

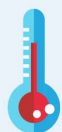


SOCIAL AND ECONOMIC IMPACT OF CLIMATE CHANGE



The cost of adapting coastal areas to rising sea levels

Relocation of whole towns



Loss of the capacity to work due to heat

Shrinking productivity of harvests



More wars to gain access to limited resources

Prices of basic foodstuffs and consumer goods will rise



Fresh water will be in short supply in some areas

Extreme meteorological phenomena will cause widespread poverty



Diseases will spread due to higher temperatures



The Nobel Prize in Physics 2021

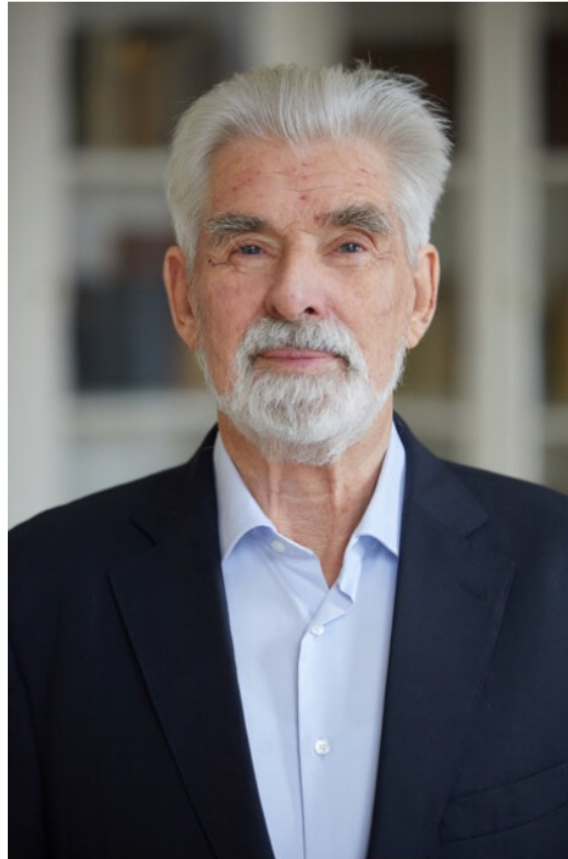


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Risdon Photography

Syukuro Manabe

Prize share: 1/4

Screenshot



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Bernhard Ludewig

Klaus Hasselmann

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© Nobel Prize Outreach. Photo:
Laura Sbarbori

Giorgio Parisi

Prize share: 1/2

“for groundbreaking contributions to our understanding of complex physical systems”

with one half jointly to

Syukuro Manabe

Princeton University, USA

Klaus Hasselmann

Max Planck Institute for Meteorology, Hamburg, Germany

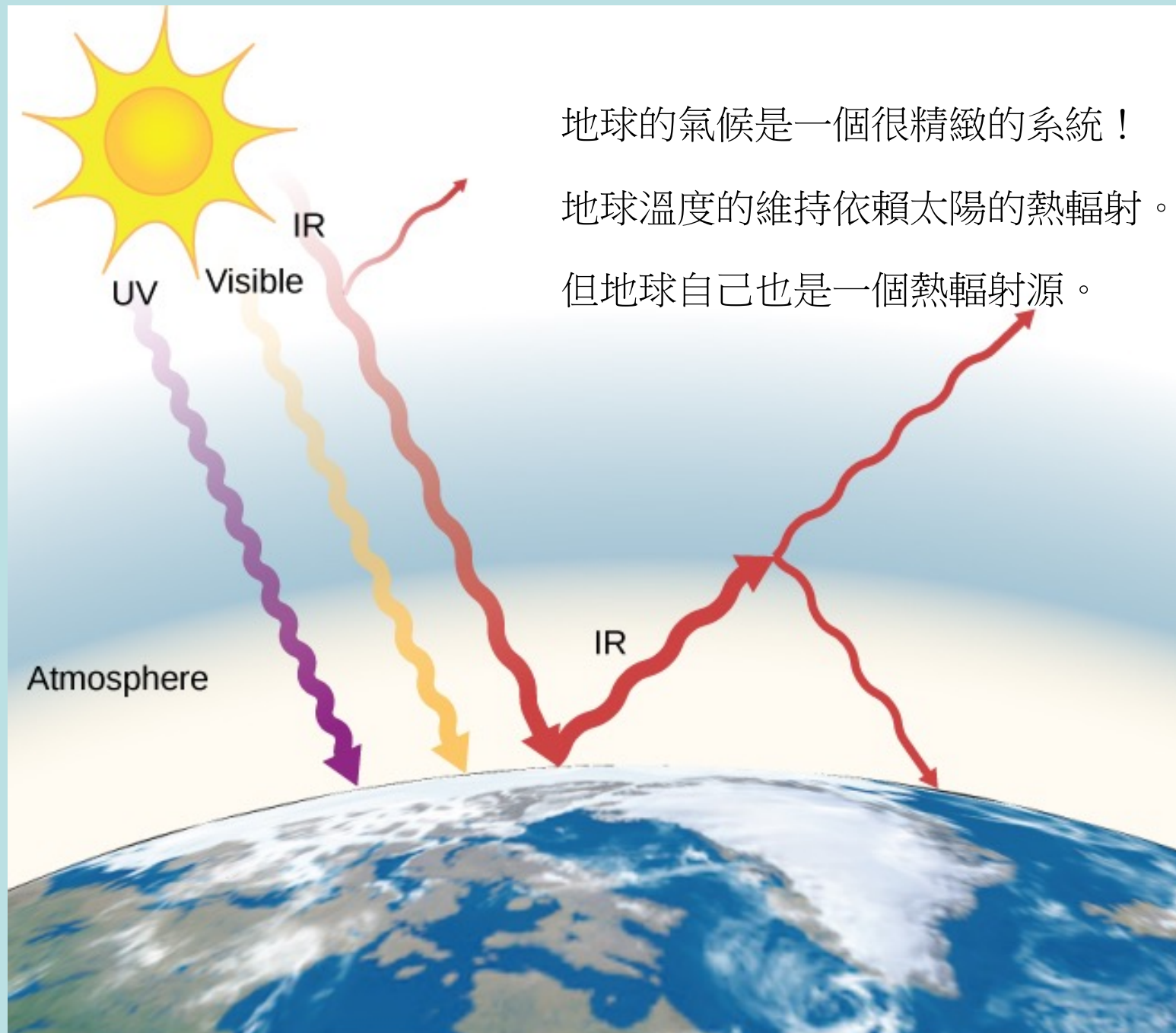
“for the physical modelling of Earth’s climate, quantifying variability and reliably predicting global warming”

and the other half to

Giorgio Parisi

Sapienza University of Rome, Italy

“for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales”



地球的氣候是一個很精緻的系統！

地球溫度的維持依賴太陽的熱輻射。

但地球自己也是一個熱輻射源。

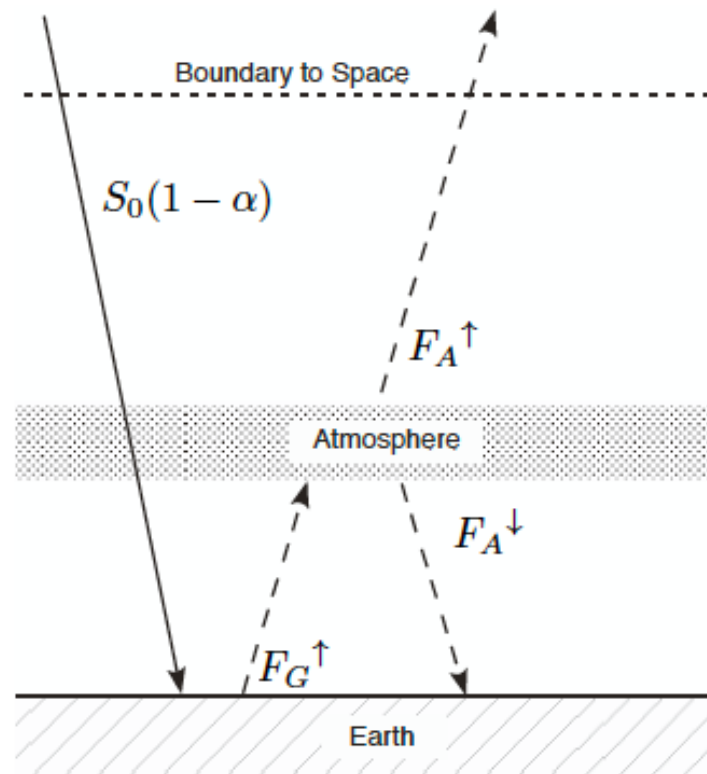
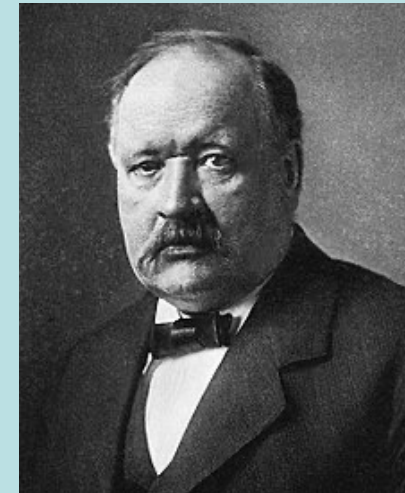
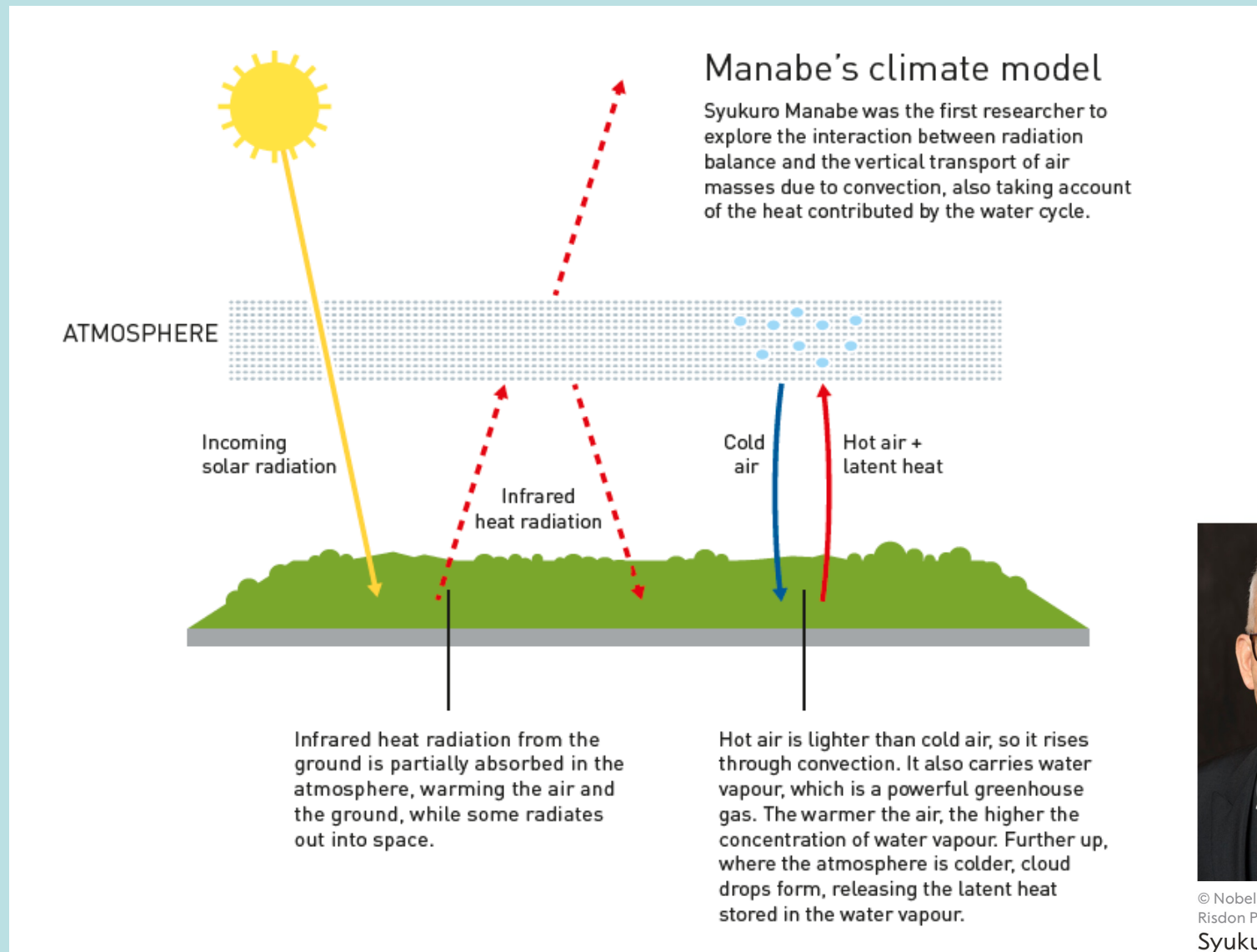


FIG. 5. Approximately as envisioned by Svante Arrhenius in 1896 [6], a “one-layer atmosphere” over Earth that absorbs and emits the outgoing infrared radiation from the surface $F_G^\uparrow$. We assume the outgoing atmospheric infrared emission is the same as the incoming, and that the atmosphere is isothermal, so that $F_A^\downarrow = F_A^\uparrow \equiv F_A$. Modified from [5].

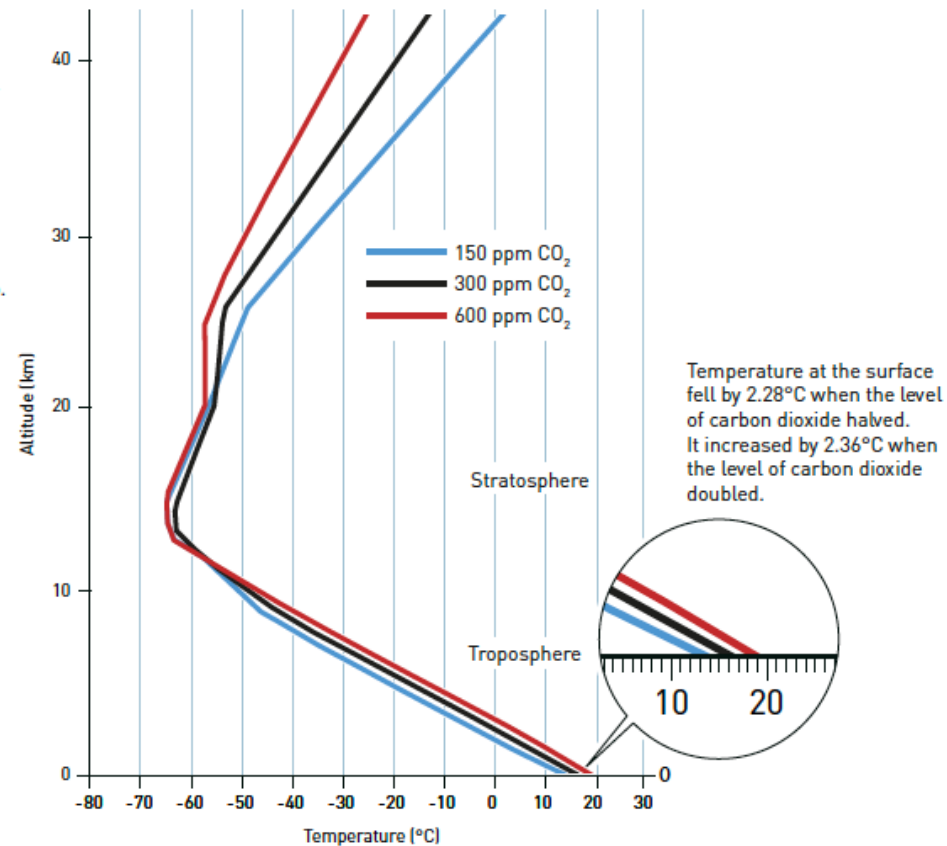




真鍋先生的模型將溫度隨高度的變化考慮進去，以數值模擬大氣的流動與熱導：

Carbon dioxide heats the atmosphere

Increased levels of carbon dioxide lead to higher temperatures in the lower atmosphere, while the upper atmosphere gets colder. Manabe thus confirmed that the variation in temperature is due to increased levels of carbon dioxide; if it was caused by increased solar radiation, the entire atmosphere should have warmed up.



Source: Manabe and Wetherald (1967) Thermal equilibrium of the atmosphere with a given distribution of relative humidity, *Journal of the atmospheric sciences*, Vol. 24, Nr 3, May.

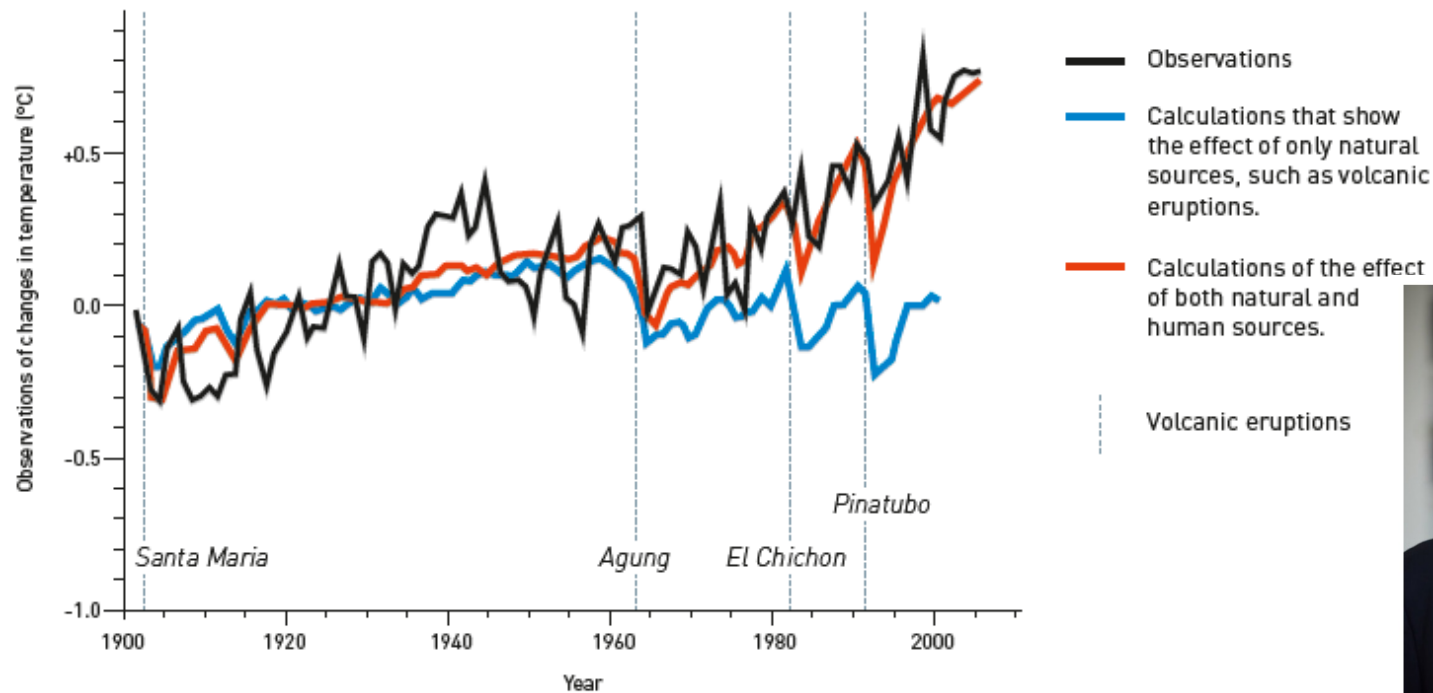
模擬不同的溫室氣體濃度下，不同高度的大氣溫度。

溫室氣體濃度增加一倍，地表溫度增加約2°C。

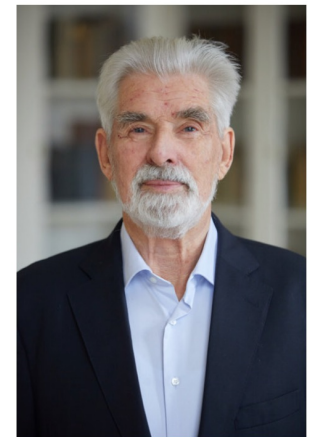
高層溫度反而降低。這是因地球反射的熱被溫室氣體束縛在低層。

Identifying fingerprints in the climate

Klaus Hasselmann developed methods for distinguishing between natural and human causes (fingerprints) of atmospheric heating. Comparison between changes in the mean temperature in relation to the average for 1901–1950 (°C).



Source: Hegerl and Zweirs (2011) Use of models in detection & attribution of climate change, *WIREs Climate Change*.



© Nobel Prize Outreach. Photo: Bernhard Ludewig

Klaus Hasselmann

模擬有溫室氣體(紅)與無溫室氣體(藍)時，地表溫度的歷史變化。

與實際觀測比對，如此才能在科學上以數值確立溫室氣體對氣候變遷的影響。

Catastrophic Flood Hits Nepal, Engulfing Crowds and Causing Quake

The authorities reported hundreds of people missing and at least 160 people killed in the border region of Nepal and Tibet, where an avalanche of mud, water, ice and rocks smashed down.

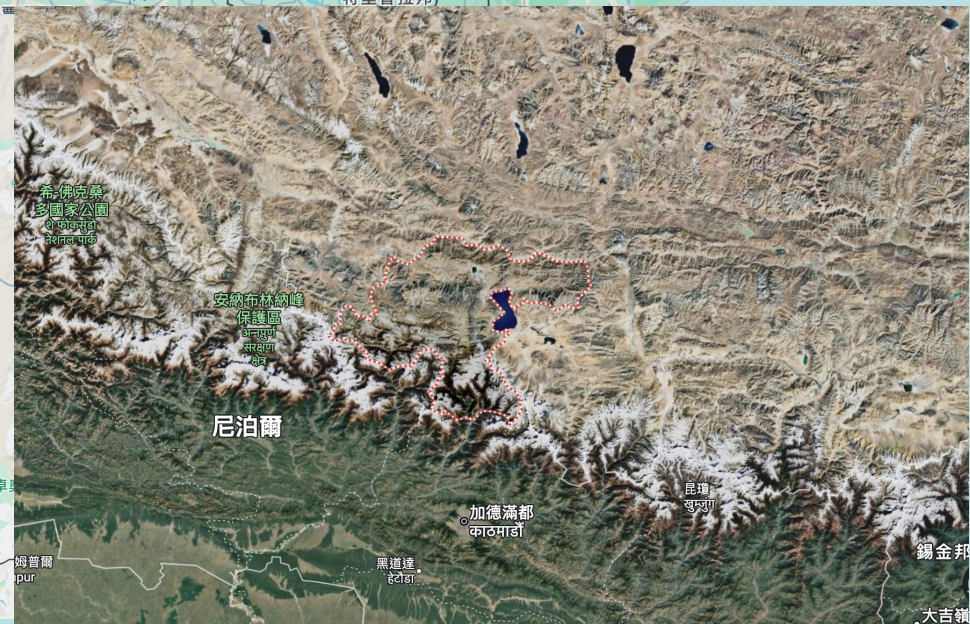
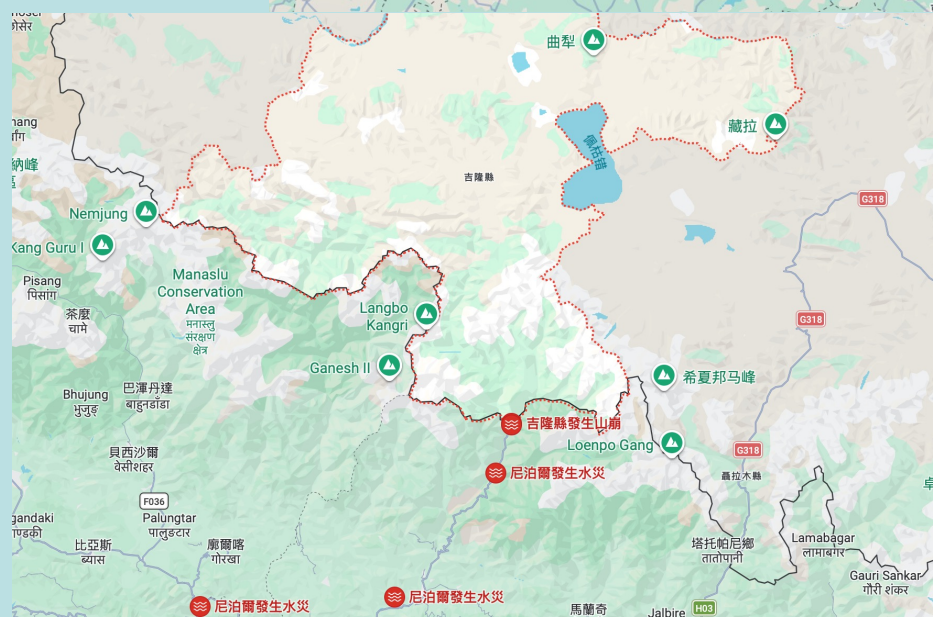
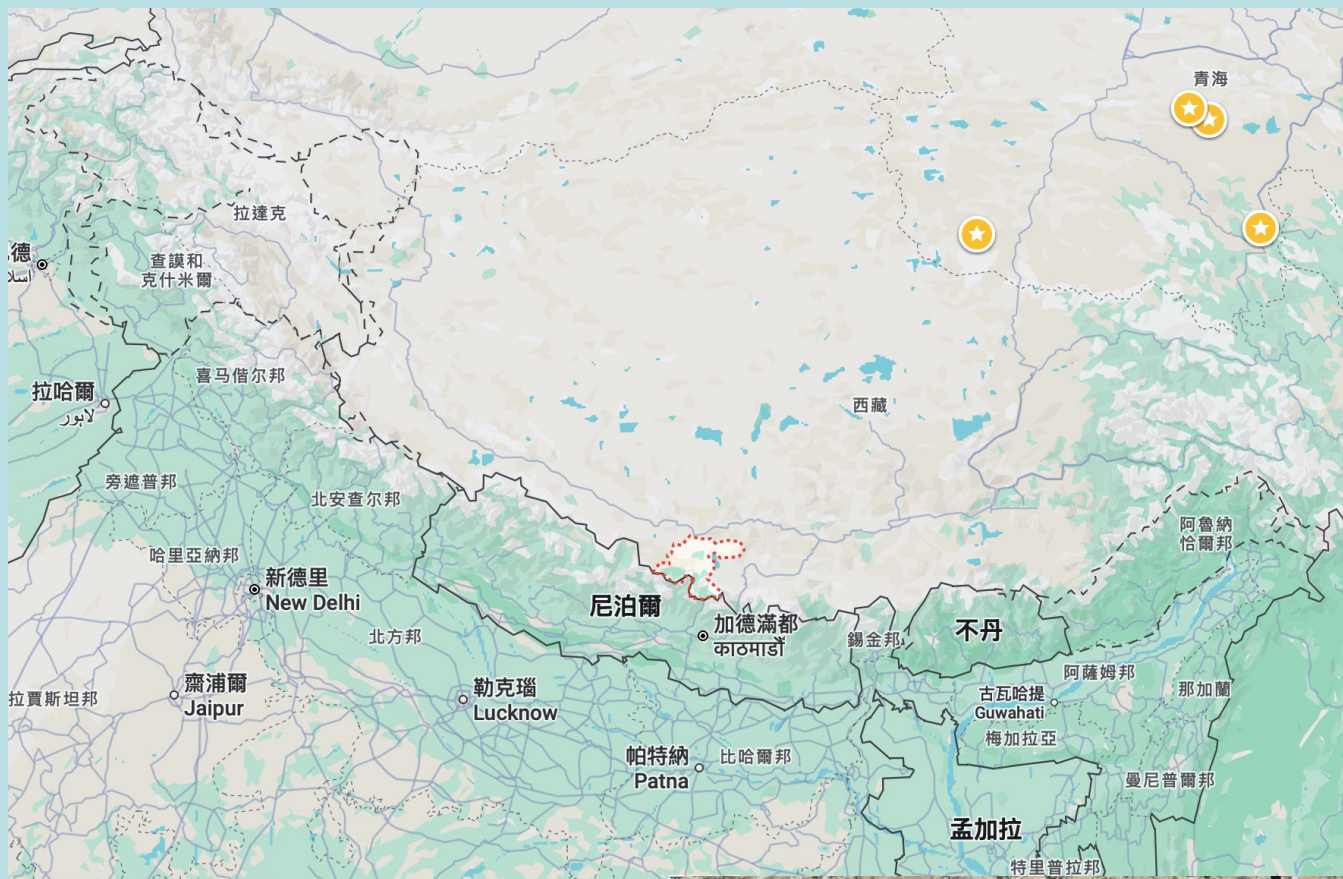




Agence France-Presse via Getty Images

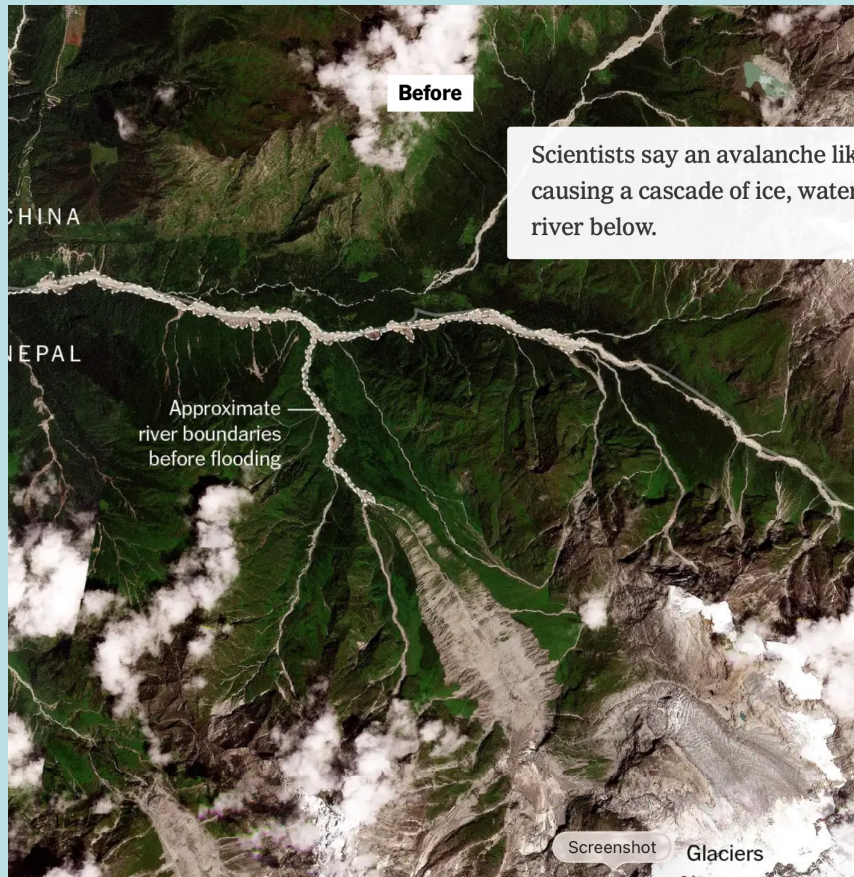
CCTV footage shows a wave of mud and water destroying buildings in Gyirong Port.



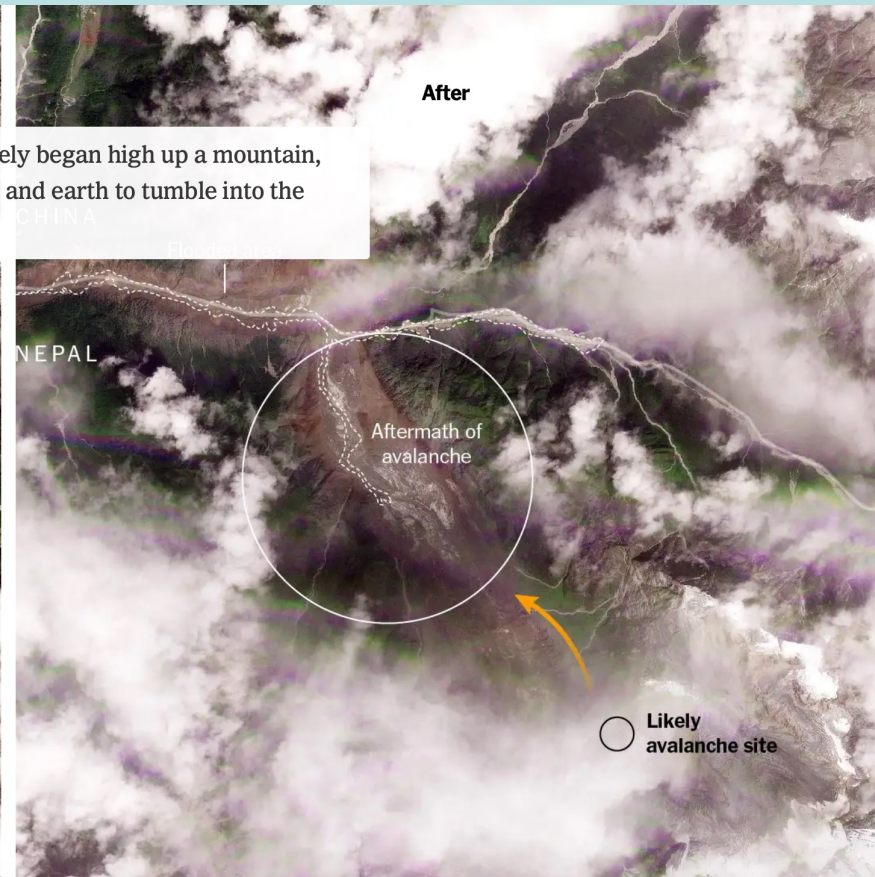


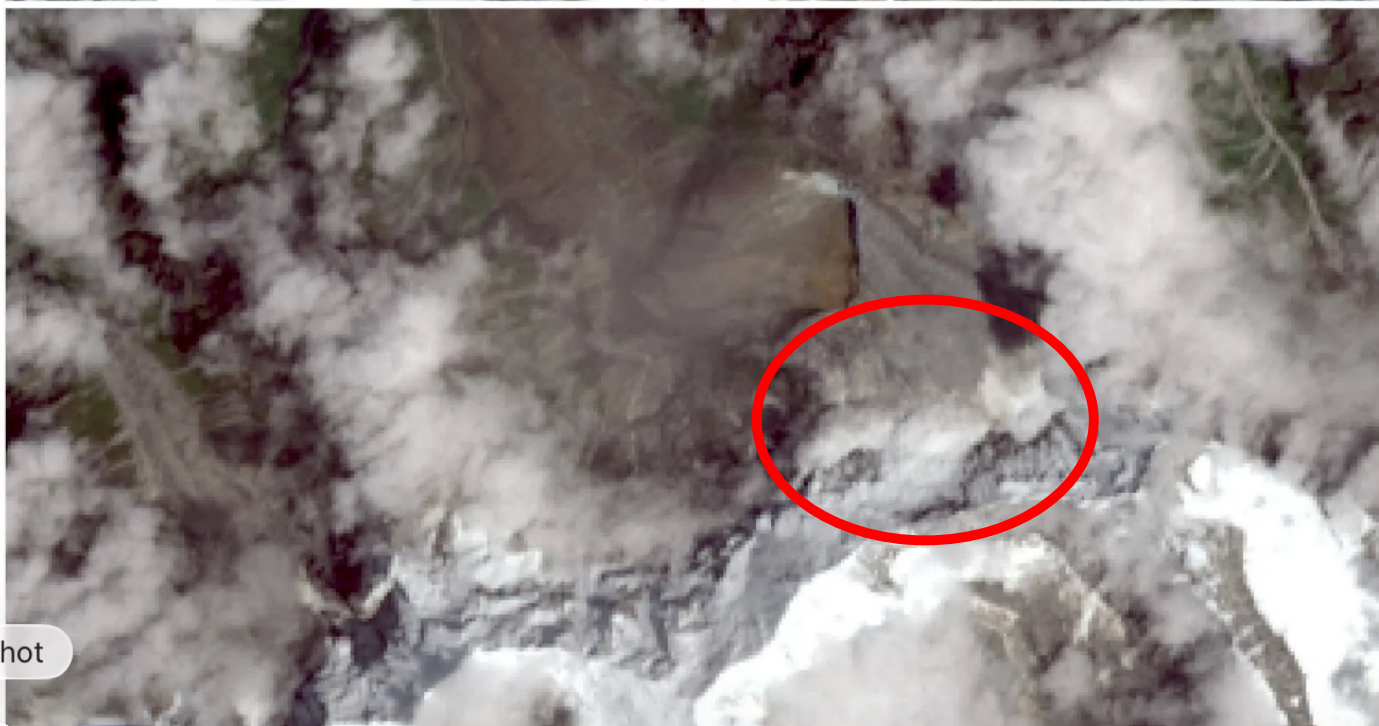
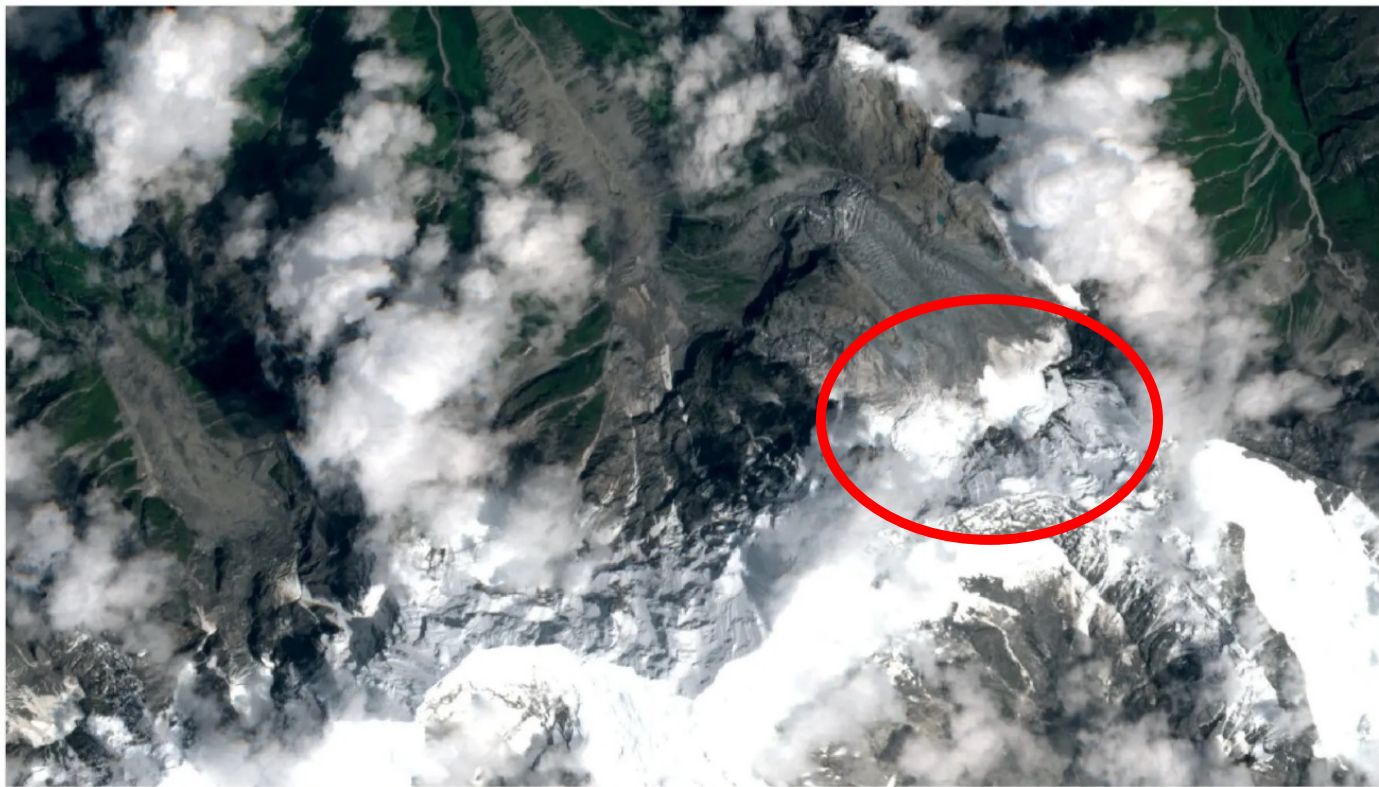


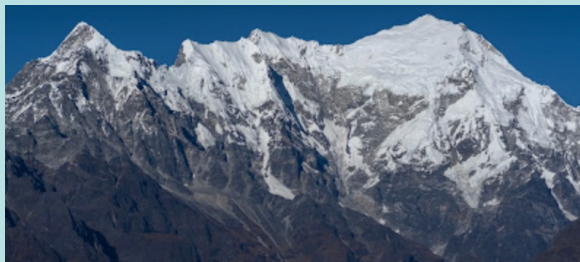
Satellite image by Copernicus and Landsat via Google.



Scientists say an avalanche likely began high up a mountain, causing a cascade of ice, water and earth to tumble into the river below.







藍塘里壤峰

लाङटाङ लिखुङ

4.6 ★★★★★ (62)

山峰

總覽

評論



規劃路線



儲存



附近



傳送到手機



分享



Langtang 45000 尼泊爾



7G48+8X Langtang, 尼泊爾



你的 Google 地圖記錄



新增標籤

相片和影片

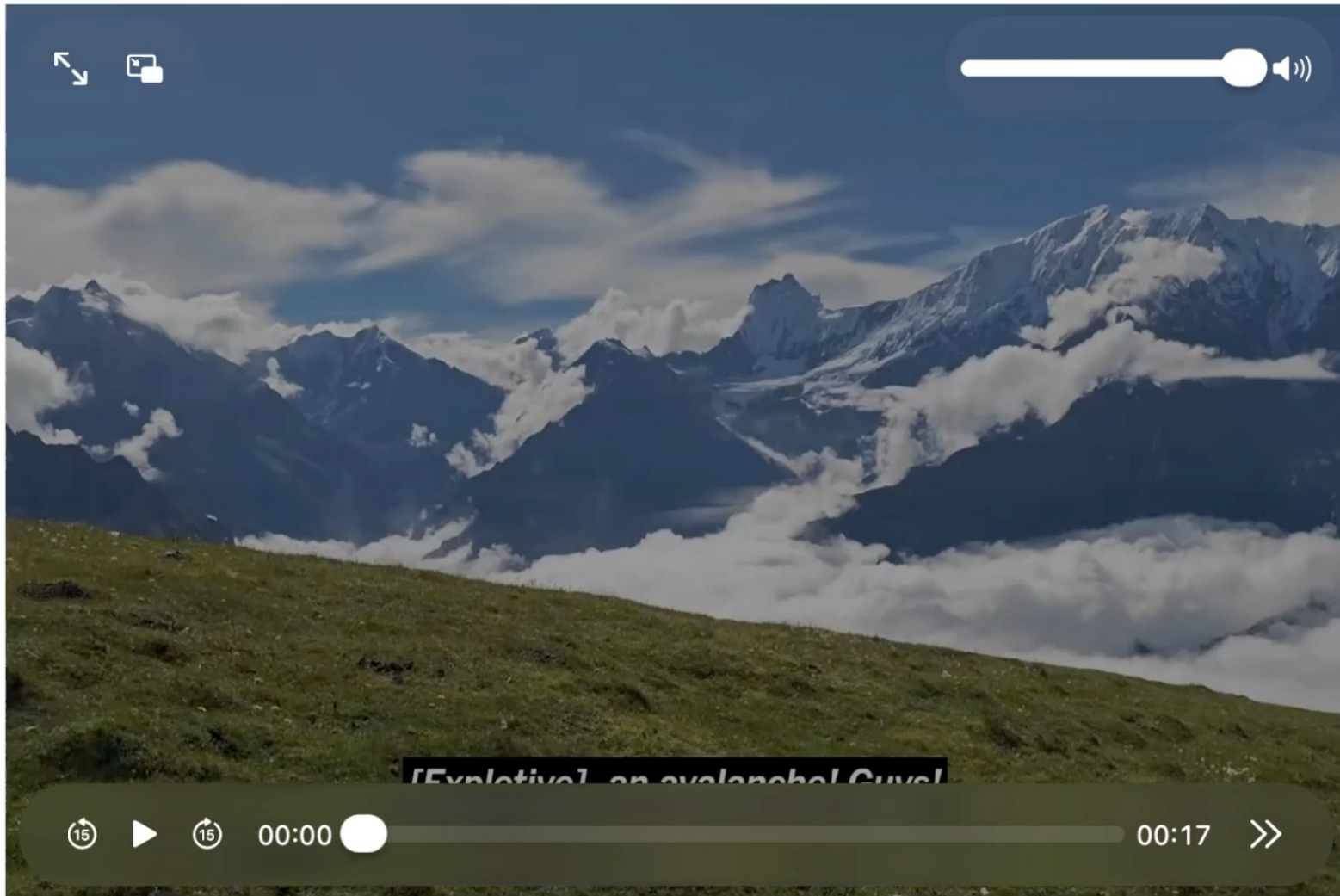
Screenshot



The landslide and glacial collapse took place on the north face of Langtang Lirung, a Nepalese mountain near the border with Tibet, at an elevation of around 17,000 feet, according to the scientists.



Langtang Lirung peak, part of the Langtang Himal mountain in Nepal, in 2022. Nicolas

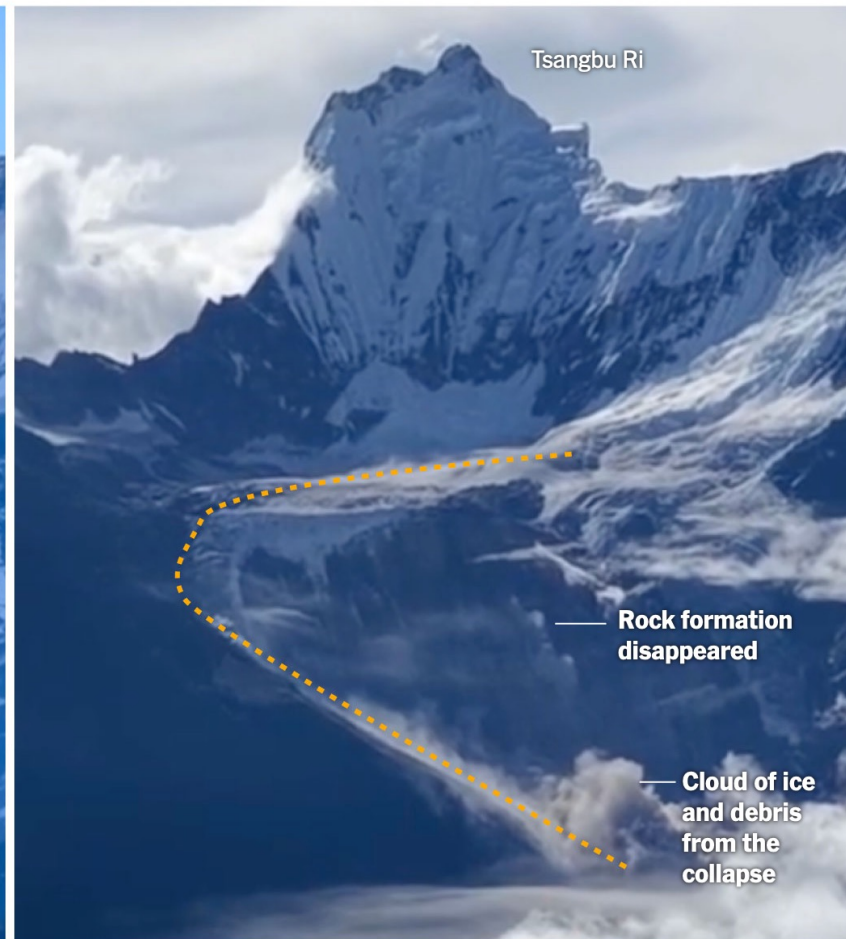


Wang Yijian

BEFORE



AFTER



The first image is a still from footage before the collapse posted on Xiaohongshu, a Chinese social media app, and verified by The New York Times. The image after the collapse was taken by Zihua Yitie on Wednesday. Weiji Screenshot

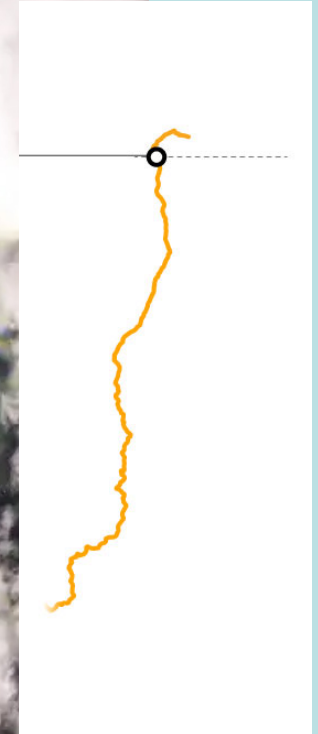




Atul Loke for The New York Times







Agence France-Presse via Getty Images

CCTV footage shows a wave of mud and water destroying buildings in Gyirong Port.

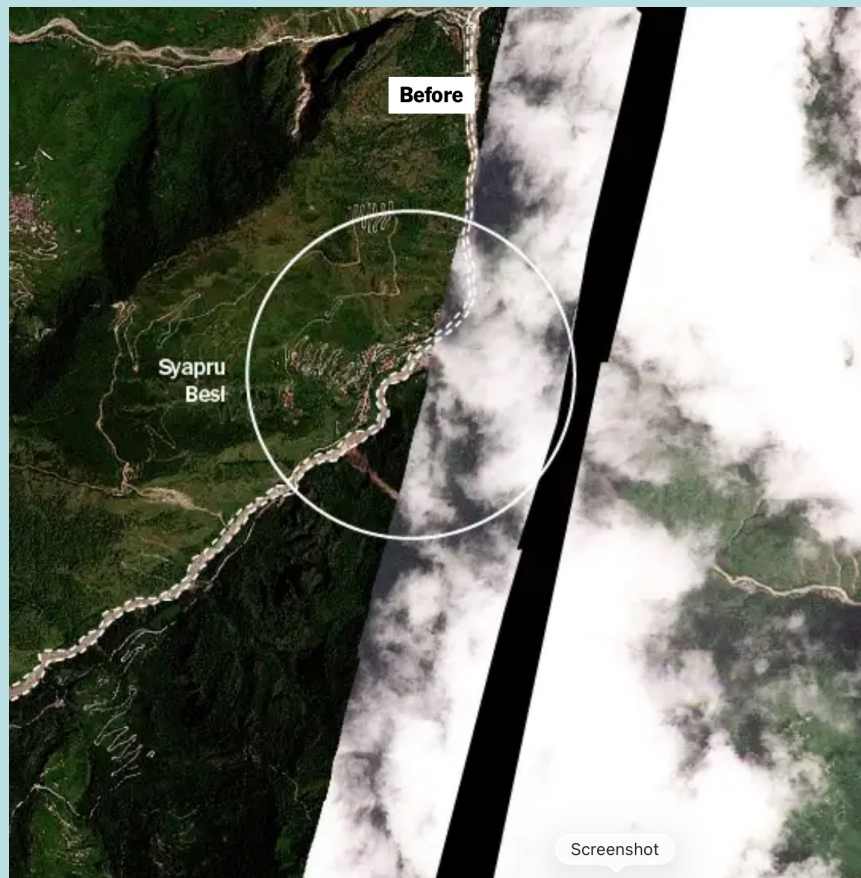


**Tragic: Massive Flash Floods Devastated Nepal's Rasuwa,
384 Missing Including 93 Nepalese and 291 Foreigners
Trekking & Tourists including 109 Indians**

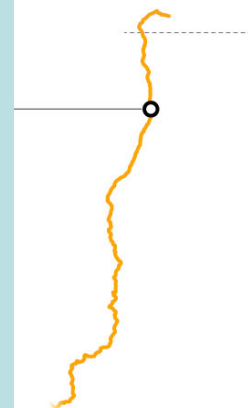


SIVASAGAR Buzz





A mud-deluged area in Trishuli, Nepal, on Thursday. Chunks of glacial ice, mud and rock surged down a river Wednesday, overwhelming the area. Navesh Chitrakar/Reuters



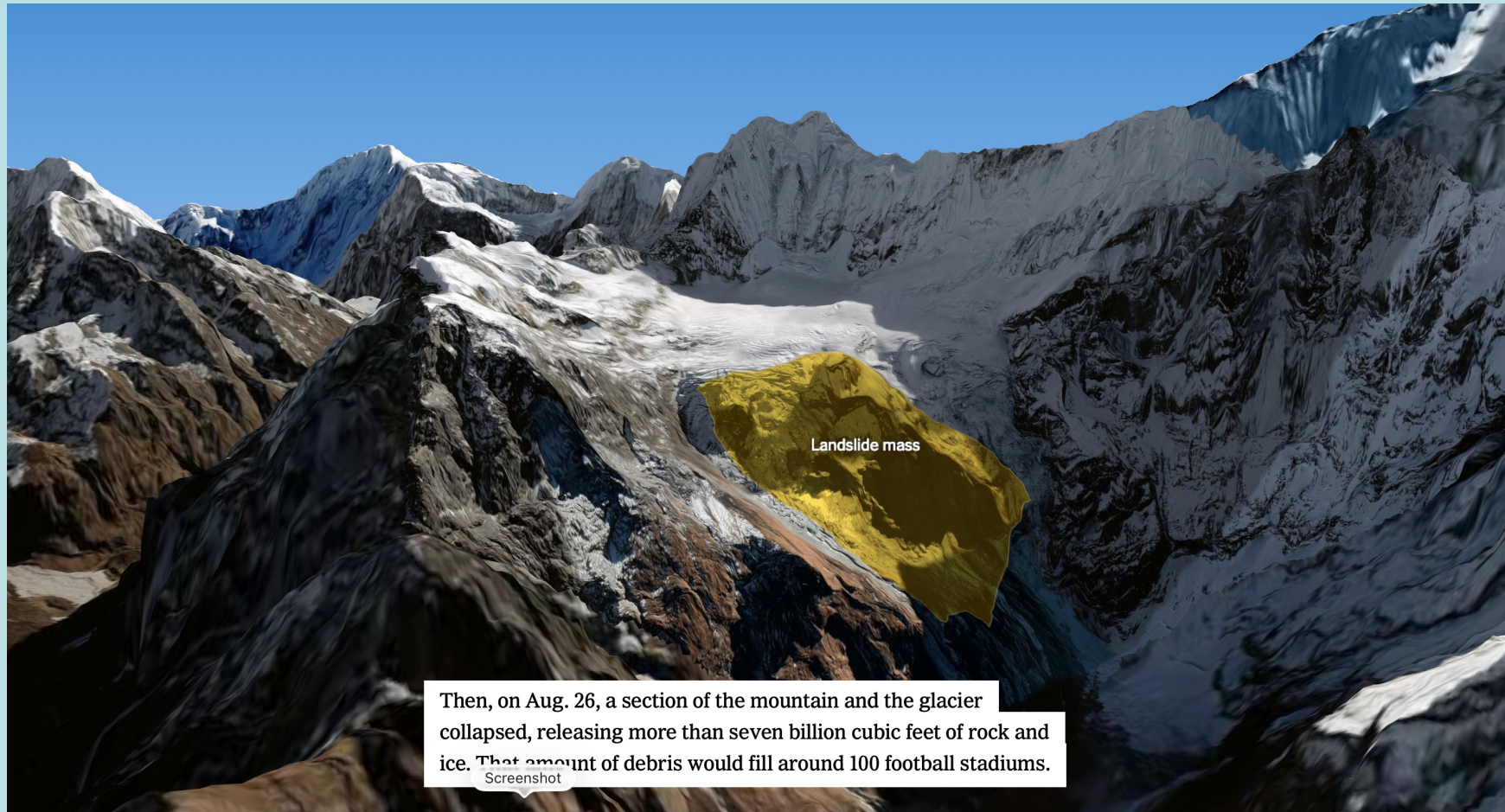






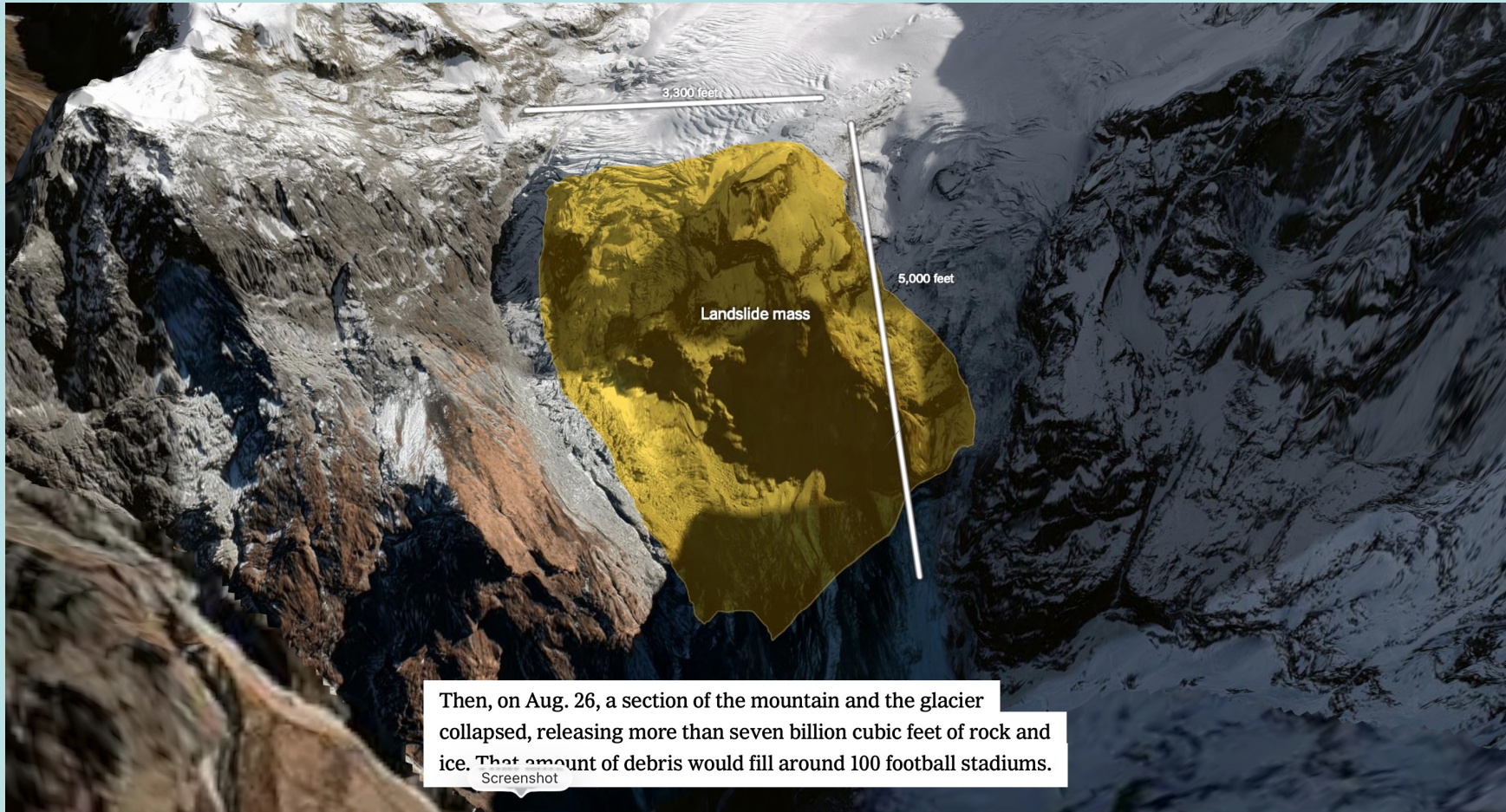
The glacier on the north face of Langtang Lirung, a mountain in Nepal near its border with Tibet, once sat nearly a mile above the valley floor below.

Screenshot



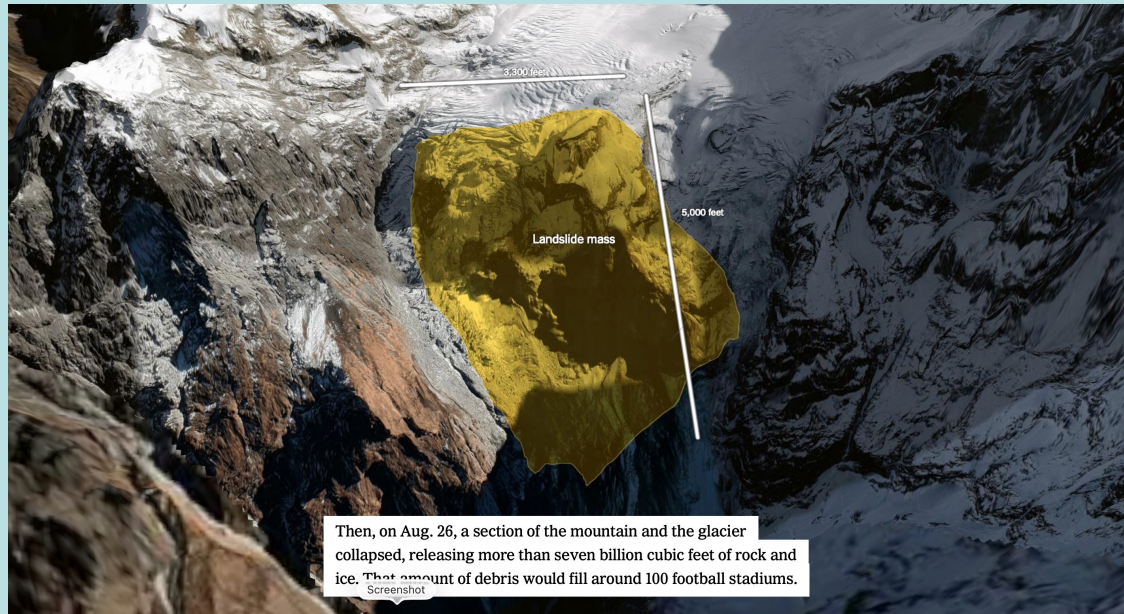
Then, on Aug. 26, a section of the mountain and the glacier collapsed, releasing more than seven billion cubic feet of rock and ice. That amount of debris would fill around 100 football stadiums.

Screenshot

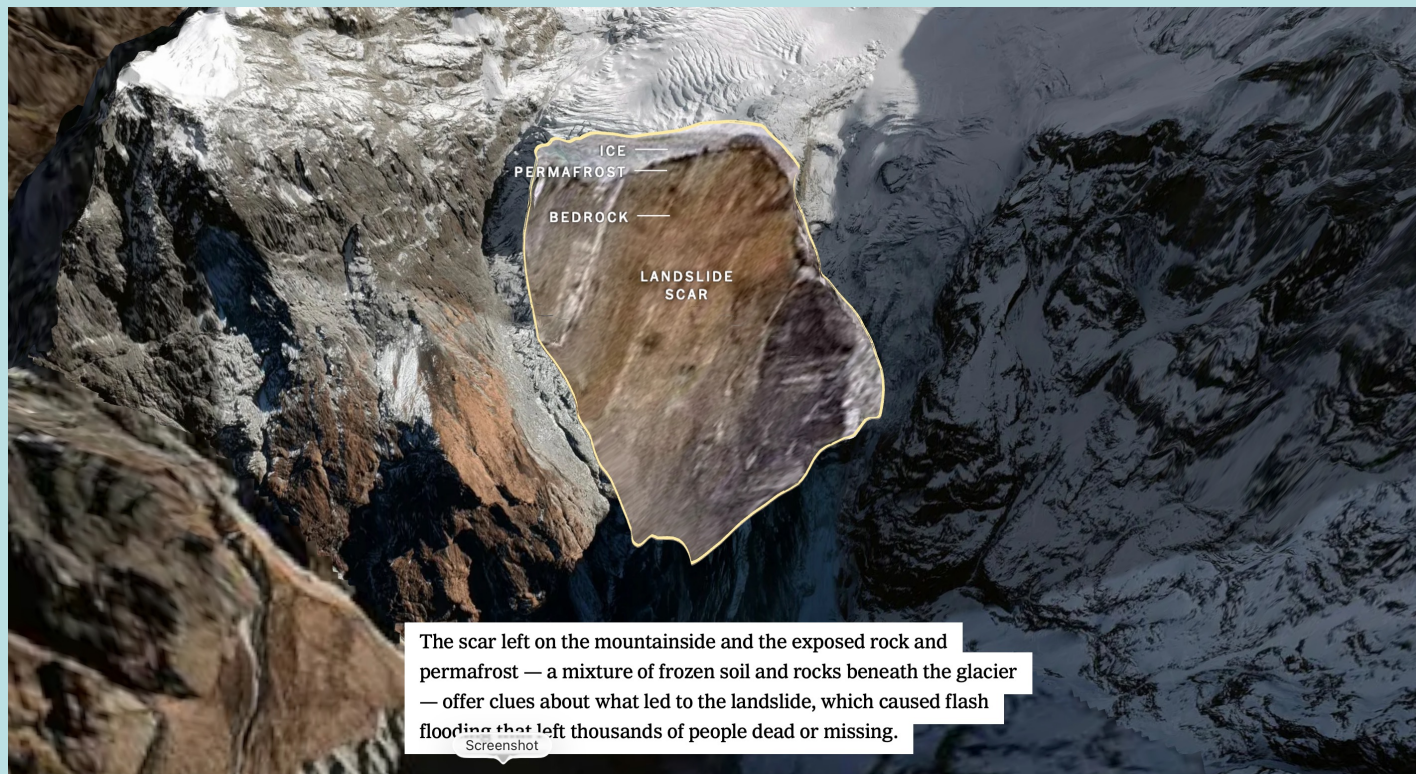


Then, on Aug. 26, a section of the mountain and the glacier collapsed, releasing more than seven billion cubic feet of rock and ice. That amount of debris would fill around 100 football stadiums.

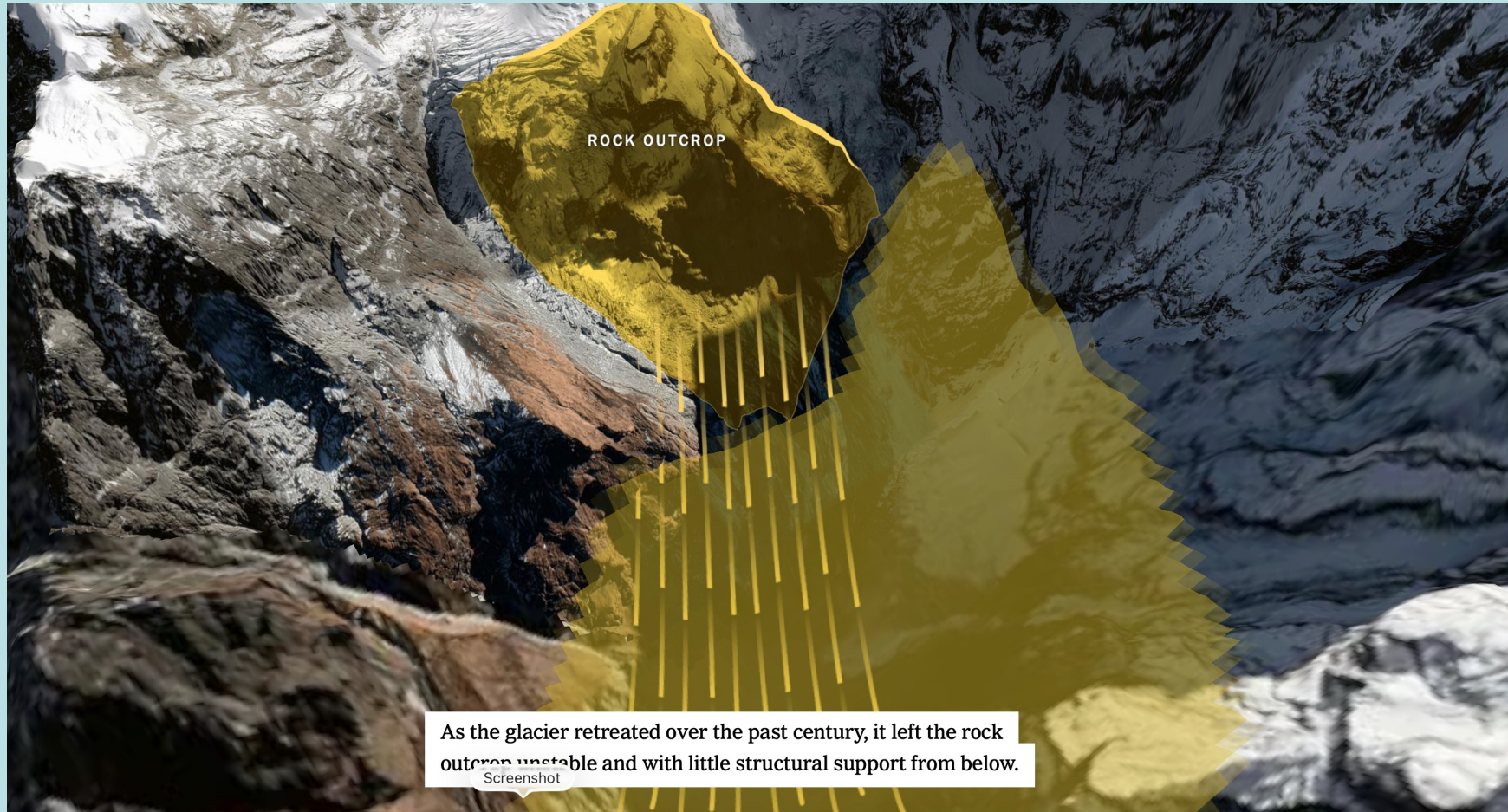
Screenshot



前



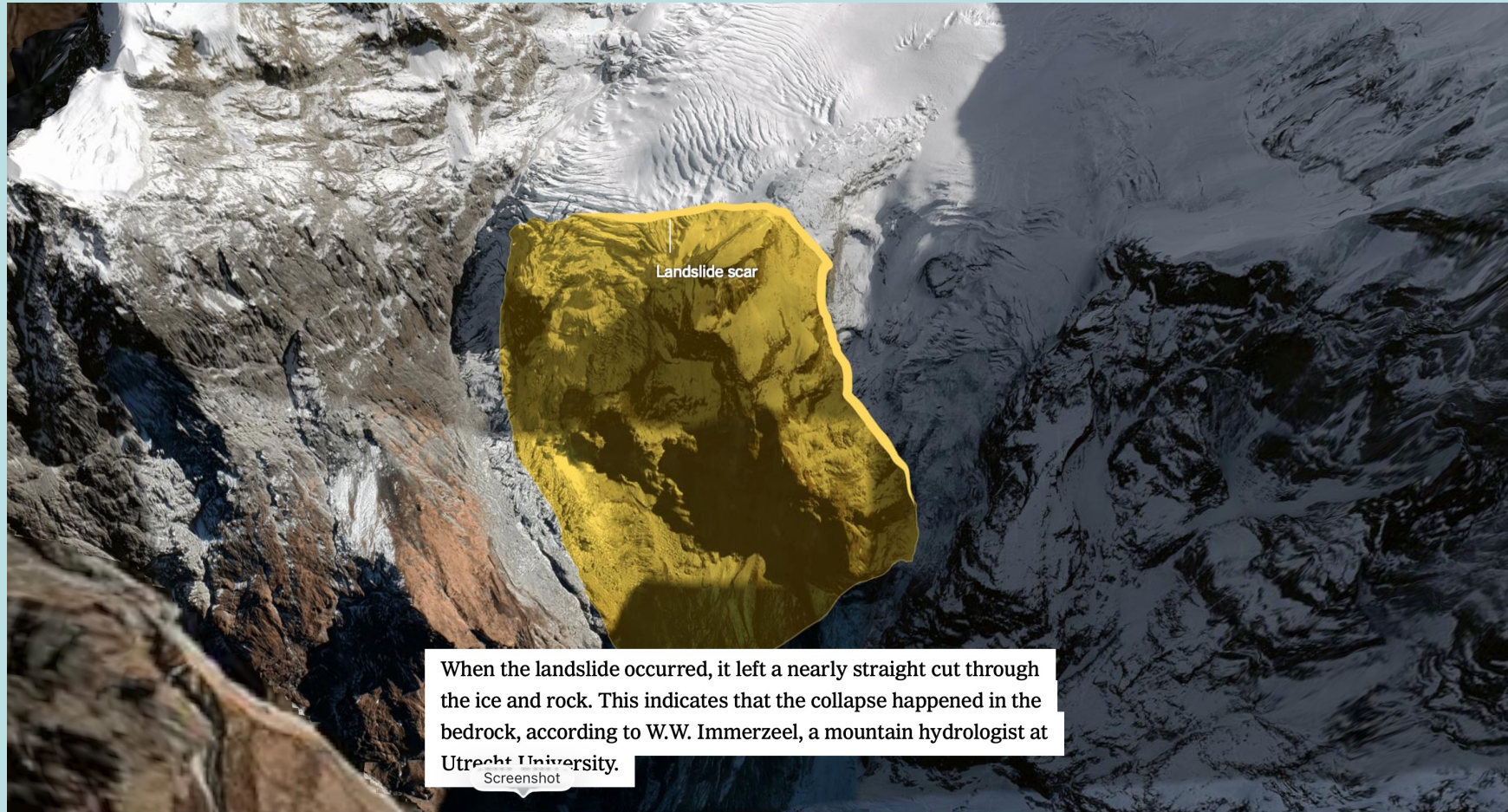
後



As the glacier retreated over the past century, it left the rock outcrop unstable and with little structural support from below.

Screenshot





When the landslide occurred, it left a nearly straight cut through the ice and rock. This indicates that the collapse happened in the bedrock, according to W.W. Immerzeel, a mountain hydrologist at Utrecht University.

Screenshot



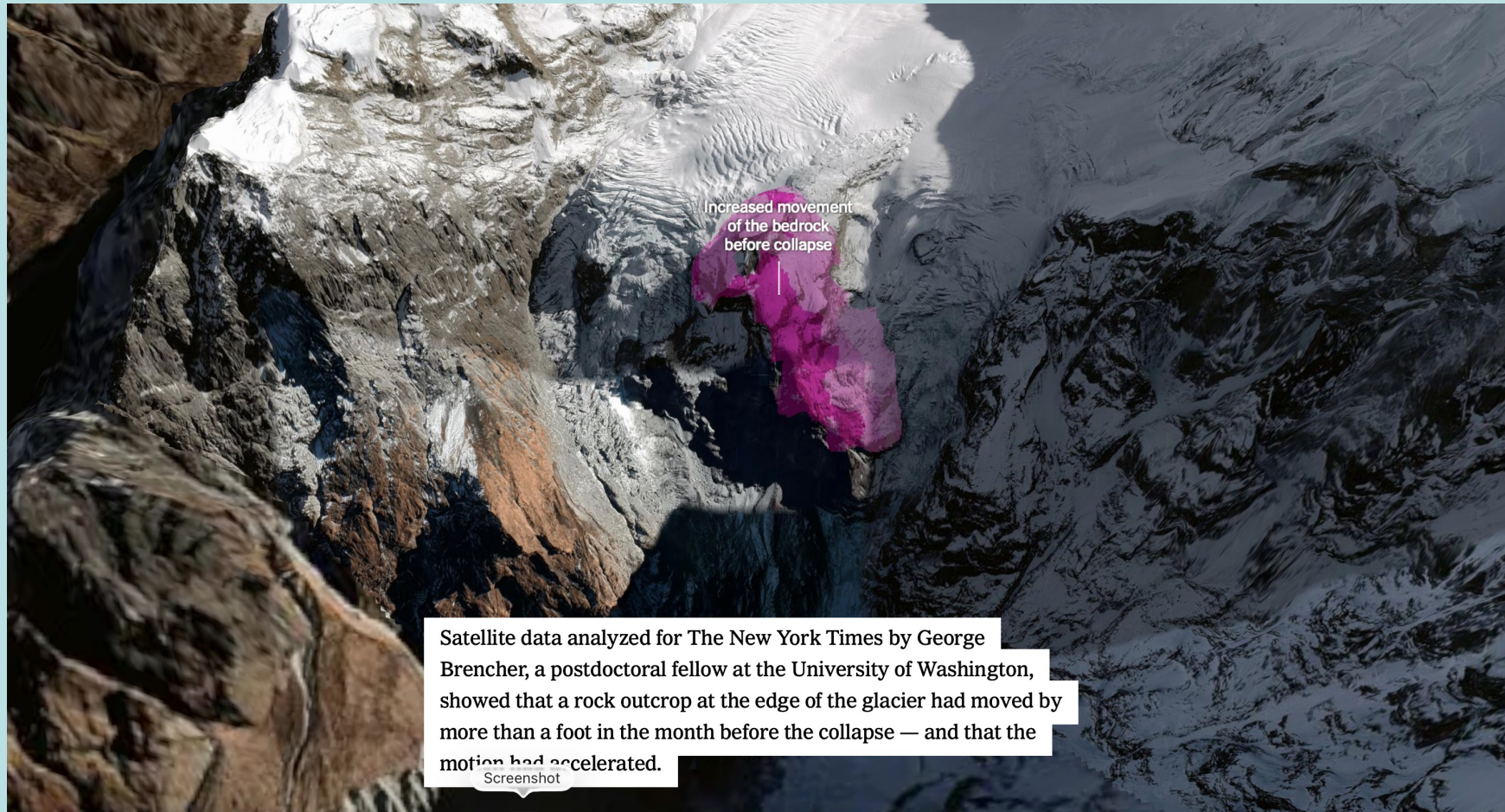
An aerial photograph showing a massive glacier in the Himalayas. A large section of the glacier has collapsed, creating a deep, dark crevasse. The surrounding ice is heavily crevassed and textured. The scene is set in a high-altitude, mountainous region.

Shigatse County, Tibet Region, China

Aug. 26

**New video shows the moment
after a glacier collapses
the Himalay
d**

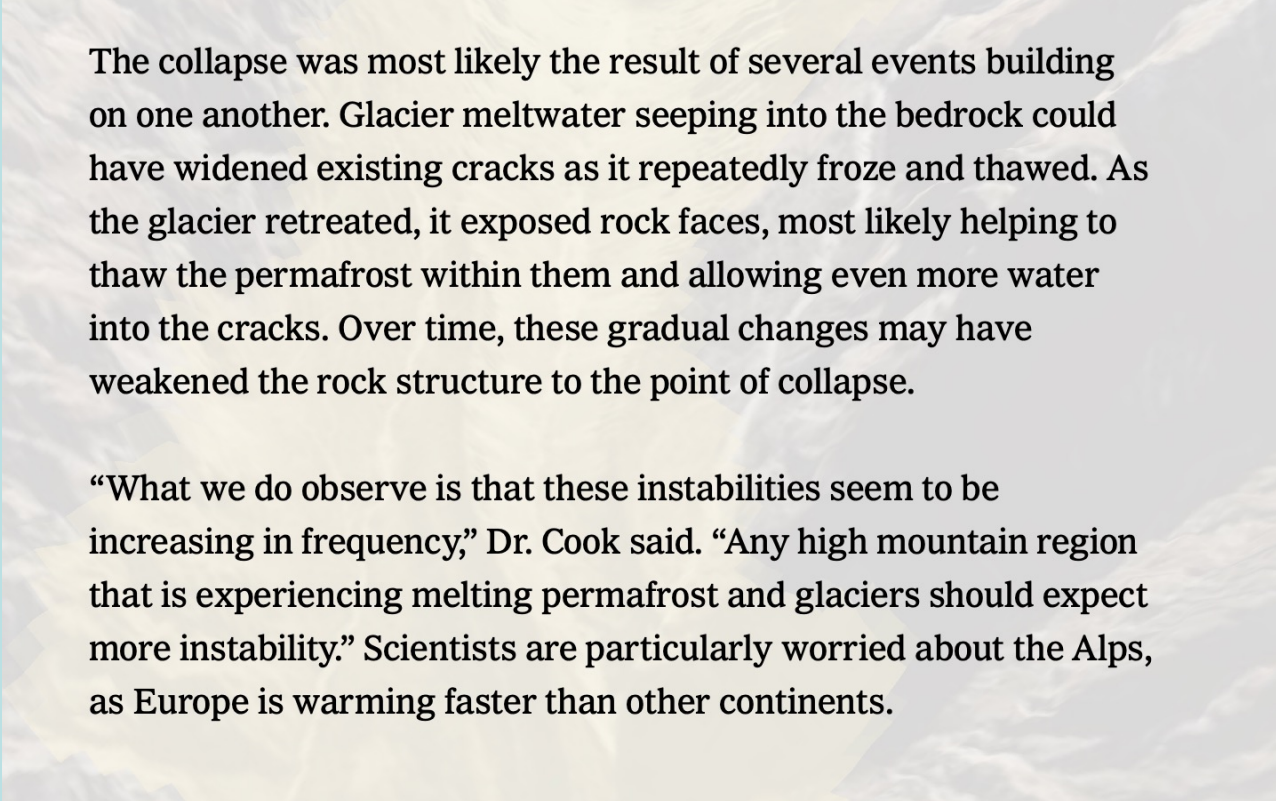
Ziha Yitie



Increased movement
of the bedrock
before collapse

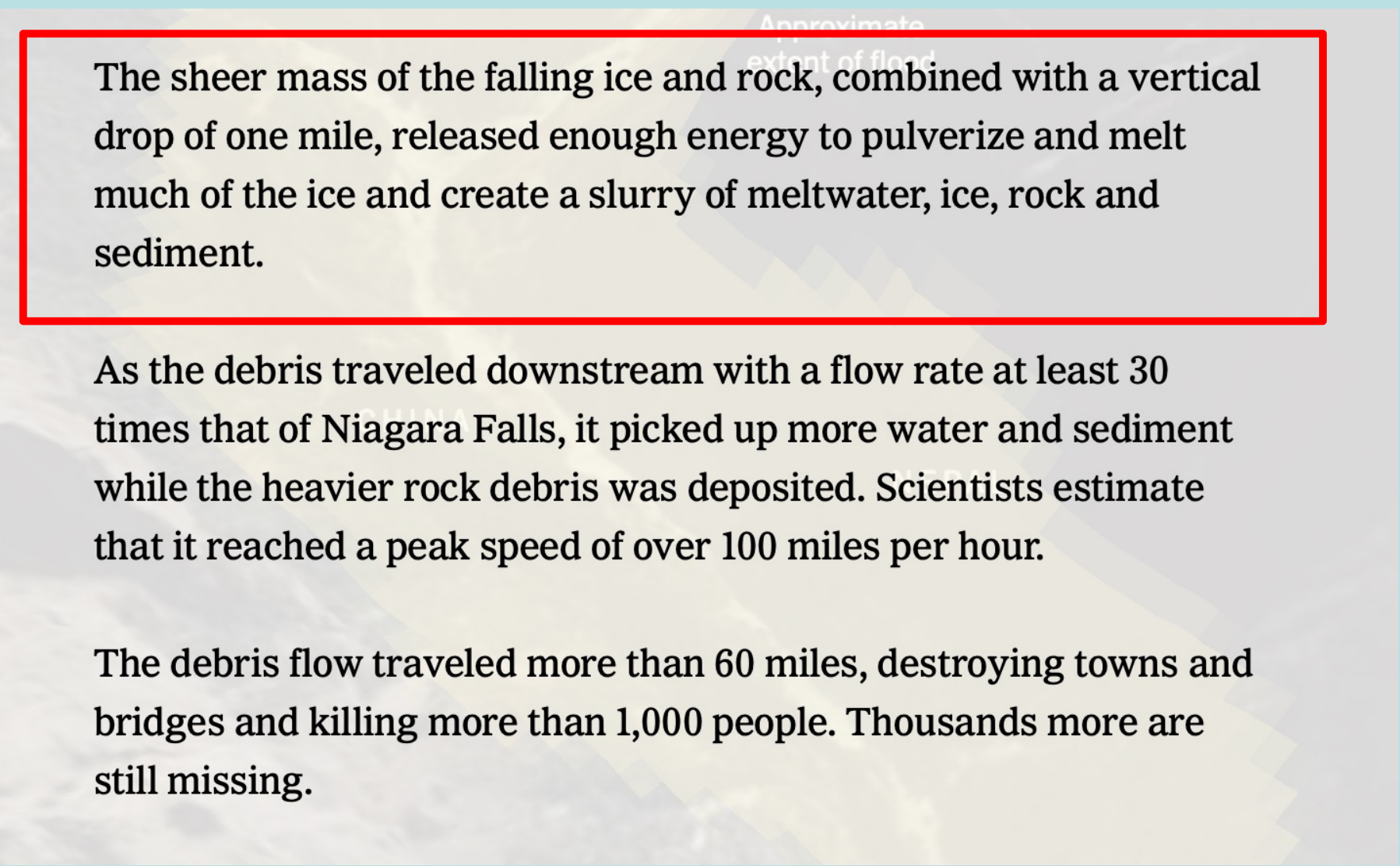
Satellite data analyzed for The New York Times by George Brencher, a postdoctoral fellow at the University of Washington, showed that a rock outcrop at the edge of the glacier had moved by more than a foot in the month before the collapse — and that the motion had accelerated.

Screenshot



The collapse was most likely the result of several events building on one another. Glacier meltwater seeping into the bedrock could have widened existing cracks as it repeatedly froze and thawed. As the glacier retreated, it exposed rock faces, most likely helping to thaw the permafrost within them and allowing even more water into the cracks. Over time, these gradual changes may have weakened the rock structure to the point of collapse.

“What we do observe is that these instabilities seem to be increasing in frequency,” Dr. Cook said. “Any high mountain region that is experiencing melting permafrost and glaciers should expect more instability.” Scientists are particularly worried about the Alps, as Europe is warming faster than other continents.

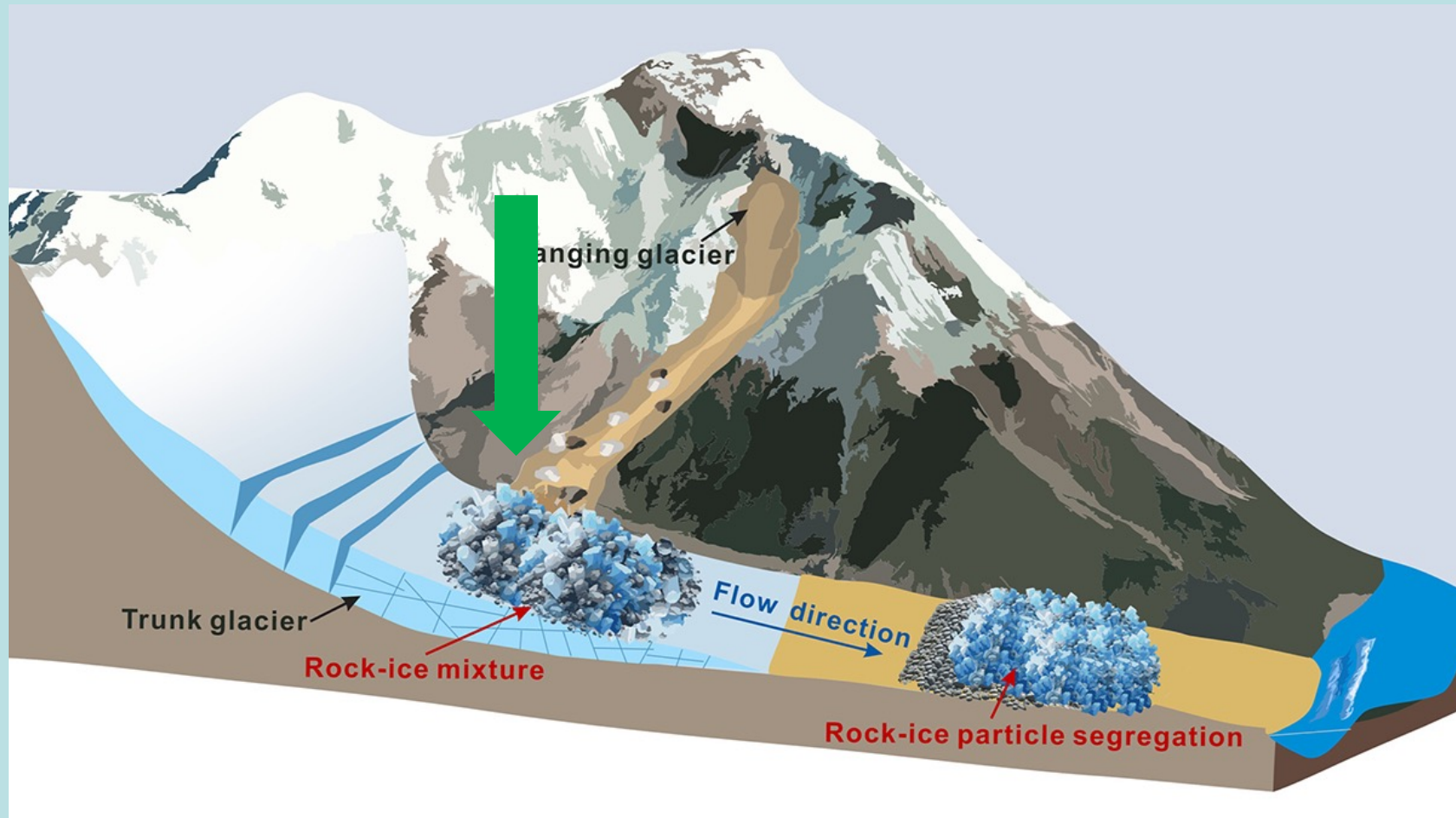


The sheer mass of the falling ice and rock, combined with a vertical drop of one mile, released enough energy to pulverize and melt much of the ice and create a slurry of meltwater, ice, rock and sediment.

As the debris traveled downstream with a flow rate at least 30 times that of Niagara Falls, it picked up more water and sediment while the heavier rock debris was deposited. Scientists estimate that it reached a peak speed of over 100 miles per hour.

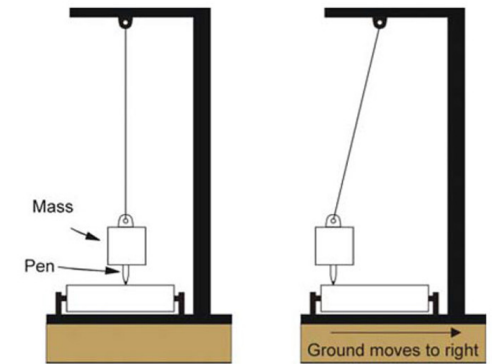
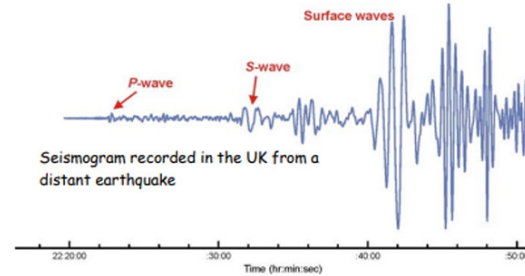
The debris flow traveled more than 60 miles, destroying towns and bridges and killing more than 1,000 people. Thousands more are still missing.

The sheer mass of the falling ice and rock, combined with a vertical drop of one mile, released enough energy to pulverize and melt much of the ice and create a slurry of meltwater, ice, rock and sediment.



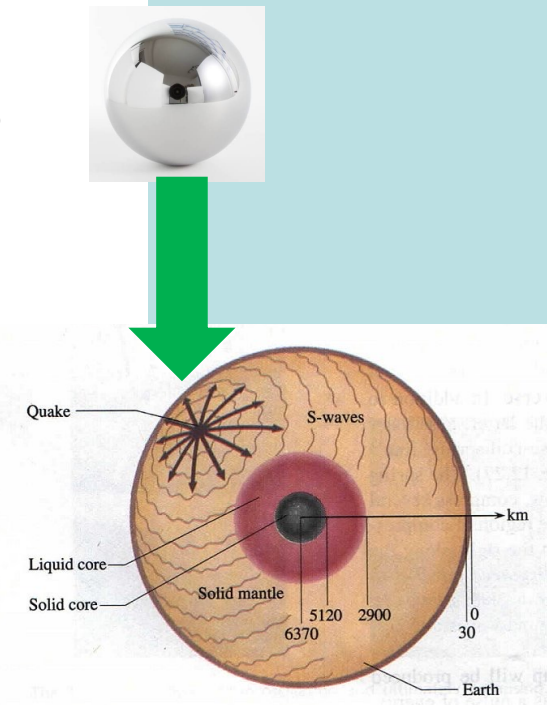
冰河及岩石墜落1000公尺，釋放出驚人的重力位能。

The deluge of rock and ice, which pulverized it surged down the mountainside, was so Geological Survey registered the landslide as a magnitude 5.2 seismic event. $E = Mgh = 4.0 \times 10^{12} \text{ J}$



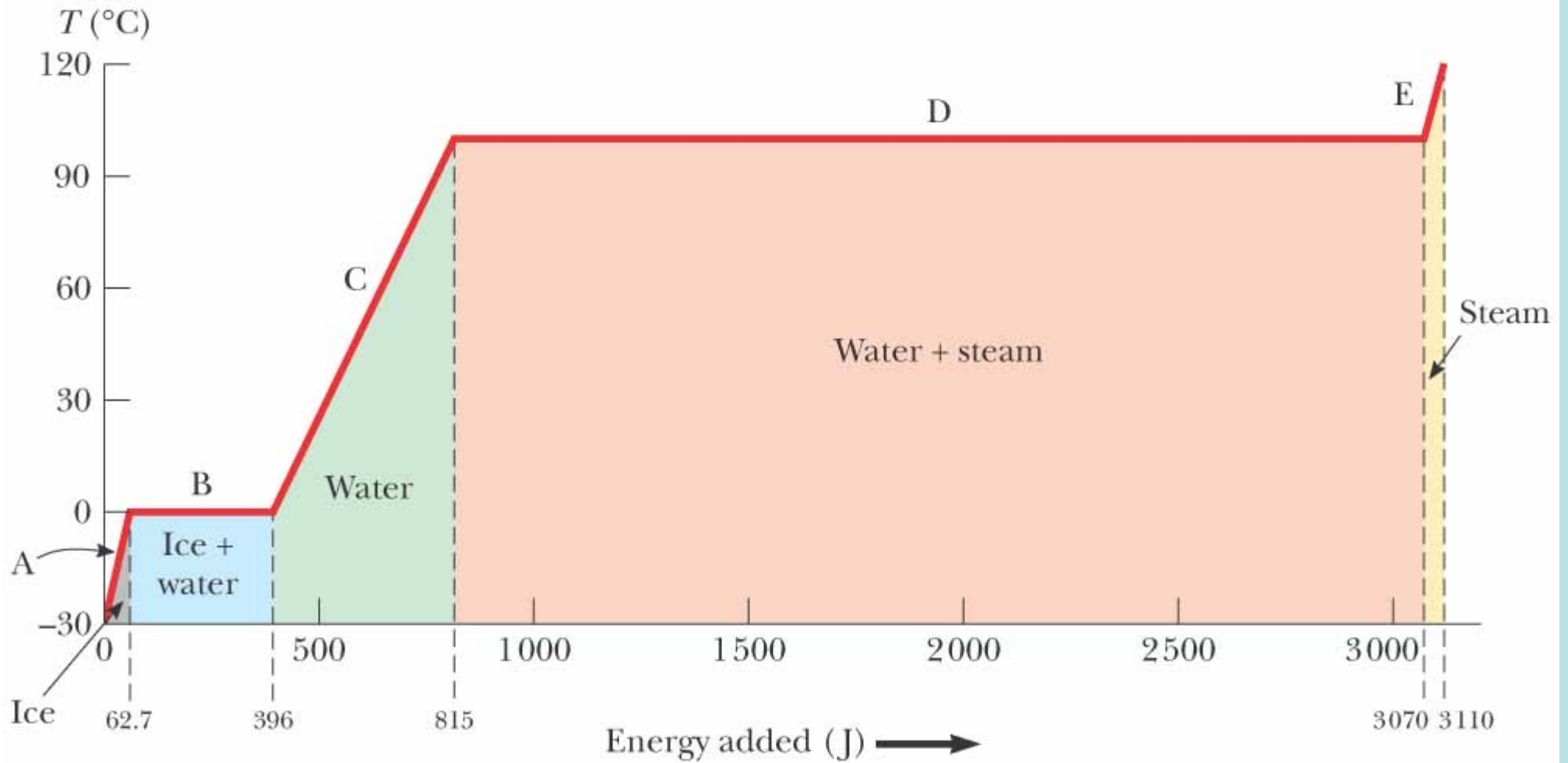
That this event registered as an earthquake is not unusual. Whenever a huge amount of energy is transferred to the Earth's crust — from an earthquake, an asteroid strike, or even a crowd of people jumping up and down at a concert — seismic waves are produced, which are detected by seismometers all over the planet.

This debris flow would have released the same amount of energy as 1,000 tons of TNT. “Perhaps more importantly than energy, we can directly compute the mass from our force estimate. This comes out as nearly 400 million metric tons,” said Stephen Hicks, a seismologist at University College London.



冰河及岩石墜落1000公尺、敲擊地殼，如同地震、釋出驚人能量。

釋放的重力位能將冰溶化為水：相變



單位質量物體發生相變時的熱量交換固定。

TABLE 17.3 Melting/boiling temperatures and heats of transform

Substance	T_m (°C)	L_f (J/kg)
Nitrogen (N ₂)	-210	0.26×10^5
Ethyl alcohol	-114	1.09×10^5
Mercury	-39	0.11×10^5
Water	0	3.33×10^5
Lead	328	0.25×10^5

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融化質量 m 的水需要的熱量：

$$Q = mL \sim m \times 3 \times 10^5 \text{ J}$$

$$E = Mgh = M \times 10 \times 2000 \text{ J}$$

如果崩塌全是冰 $M = m$ ，只有約十分之一的冰會溶解。

崩塌的除了冰川，還有岩層 $M > m$ ，位能幾乎接近融化熱

大量冰會溶解為水，與岩石混成泥，順流而下，造成災情





U.S. INTERNATIONAL CANADA ESPAÑOL 中文

LOG IN

Monday, September 7, 2026

Today's Paper

The New York Times

S&P 500 -0.38% ↓

U.S. ▾ World ▾ Business ▾ Arts ▾ Lifestyle ▾ Opinion ▾ Video ▾ Shows ▾ Games ▾ Cooking ▾ Wirecutter ▾ The Athletic ▾

These top stories are **free to read**.

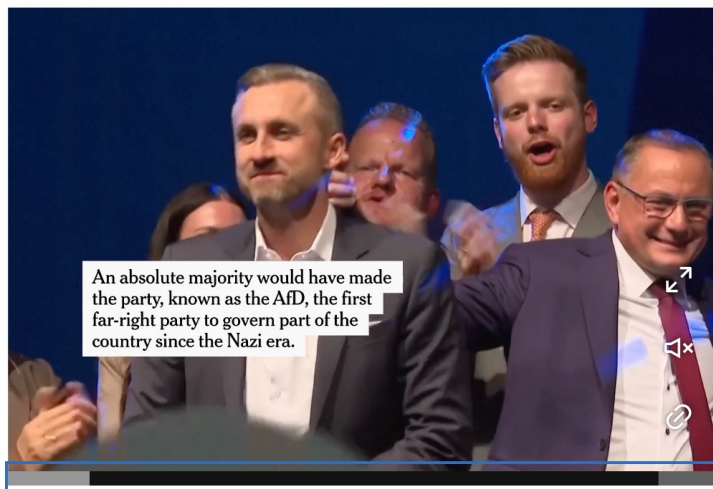
Germany's Far Right Just Misses Majority in Crucial State Election

The Alternative for Germany party is projected to finish first in Saxony-Anhalt. But without a coalition, it cannot become the first far-right party to govern a state since 1945.

4 MIN READ

Far-Right Victory in German State Sends a Signal to Europe

5 MIN READ



Vincent Alban for The New York Times

13 Hours, 5 Boroughs, Lots of Boats: Cruising New York City by Ferry

We spent a day bouncing around the city on the expanded NYC Ferry system — making stops at beaches, festivals, beloved bars and more — for just \$15.



對付棘手的自然現象，物理可以幫忙

天文觀測也是如此：





Gran Telescopio Canarias



Hubble Telescope 太空中觀測



ALMA, the Atacama Large Millimeter Array
以可見光以外的電磁波（微波）觀測

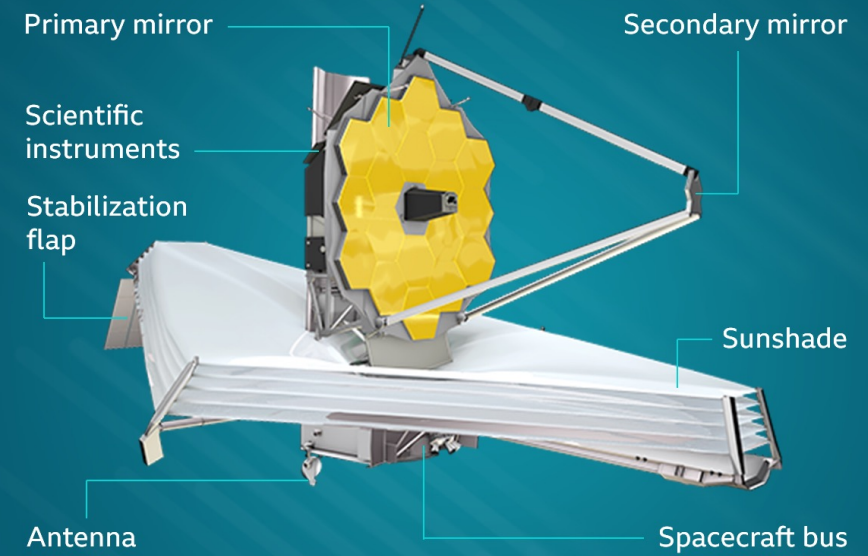
Webb Space Telescope 韋伯太空望遠鏡



一百億美金，費時三十年籌備



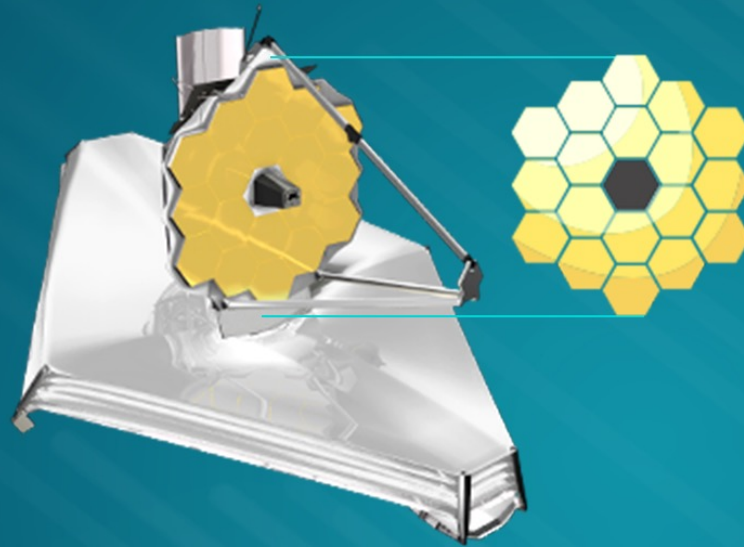
James Webb Space Telescope



Source: Nasa



James Webb and Hubble compared



JAMES WEBB

Launch 2021

Lifetime 10 years

Mirror size 6.5m

Mass 6,200 kg

Operating
temperature . . . -230C



HUBBLE

Launch 1990

Lifetime 31 years

Mirror size 2.4m

Mass 12,200kg

Operating
temperature . . . 20C

Source: Nasa

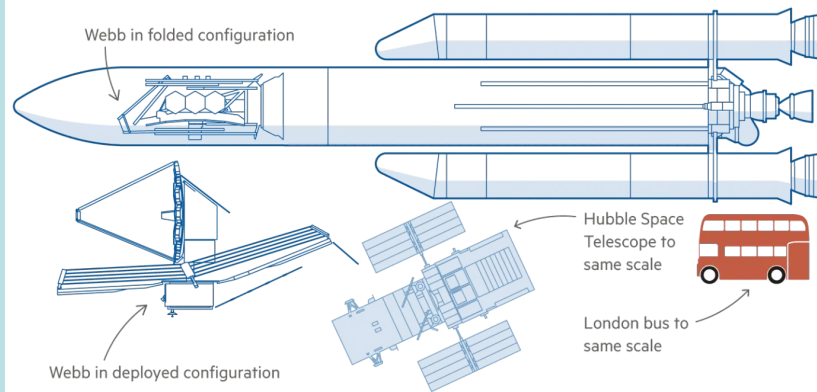
B B C

The James Webb Space Telescope

An international collaboration between US, European and Canadian space agencies. It will observe extremely distant objects at infrared wavelengths

Size

To achieve its goals, it has to be large but must fit in the fairing of an Ariane 5 rocket. So it is designed to fold, deploying over the month-long journey to orbit



The telescope

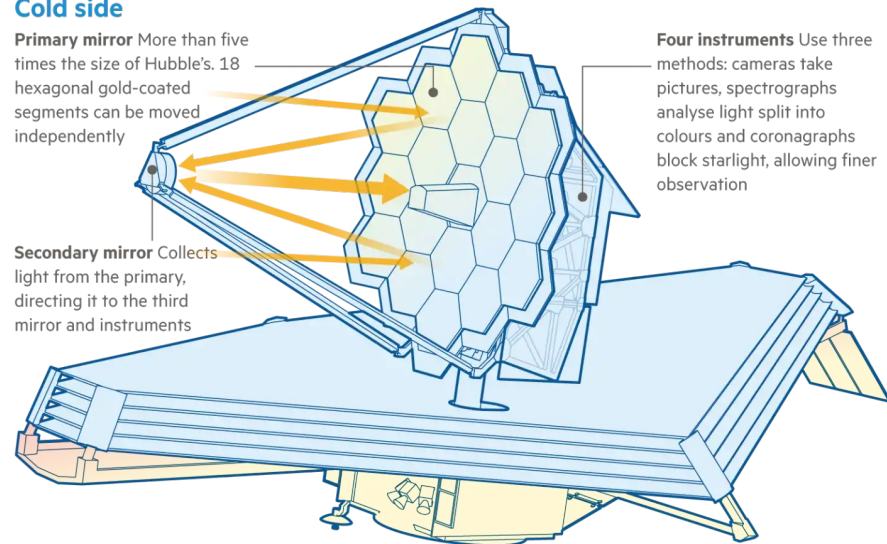
Webb has a hot (85C) and a cold (minus 233C) side

Cold side

Primary mirror More than five times the size of Hubble's. 18 hexagonal gold-coated segments can be moved independently

Secondary mirror Collects light from the primary, directing it to the third mirror and instruments

Four instruments Use three methods: cameras take pictures, spectrographs analyse light split into colours and coronagraphs block starlight, allowing finer observation

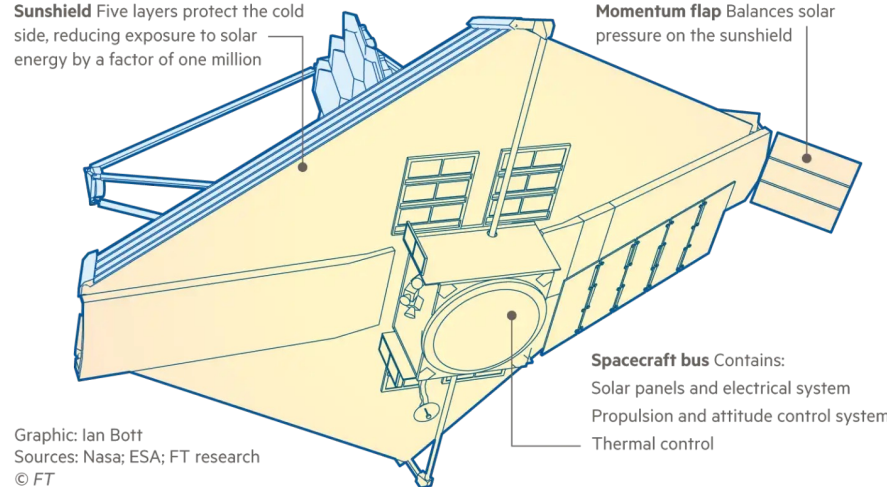


Hot side

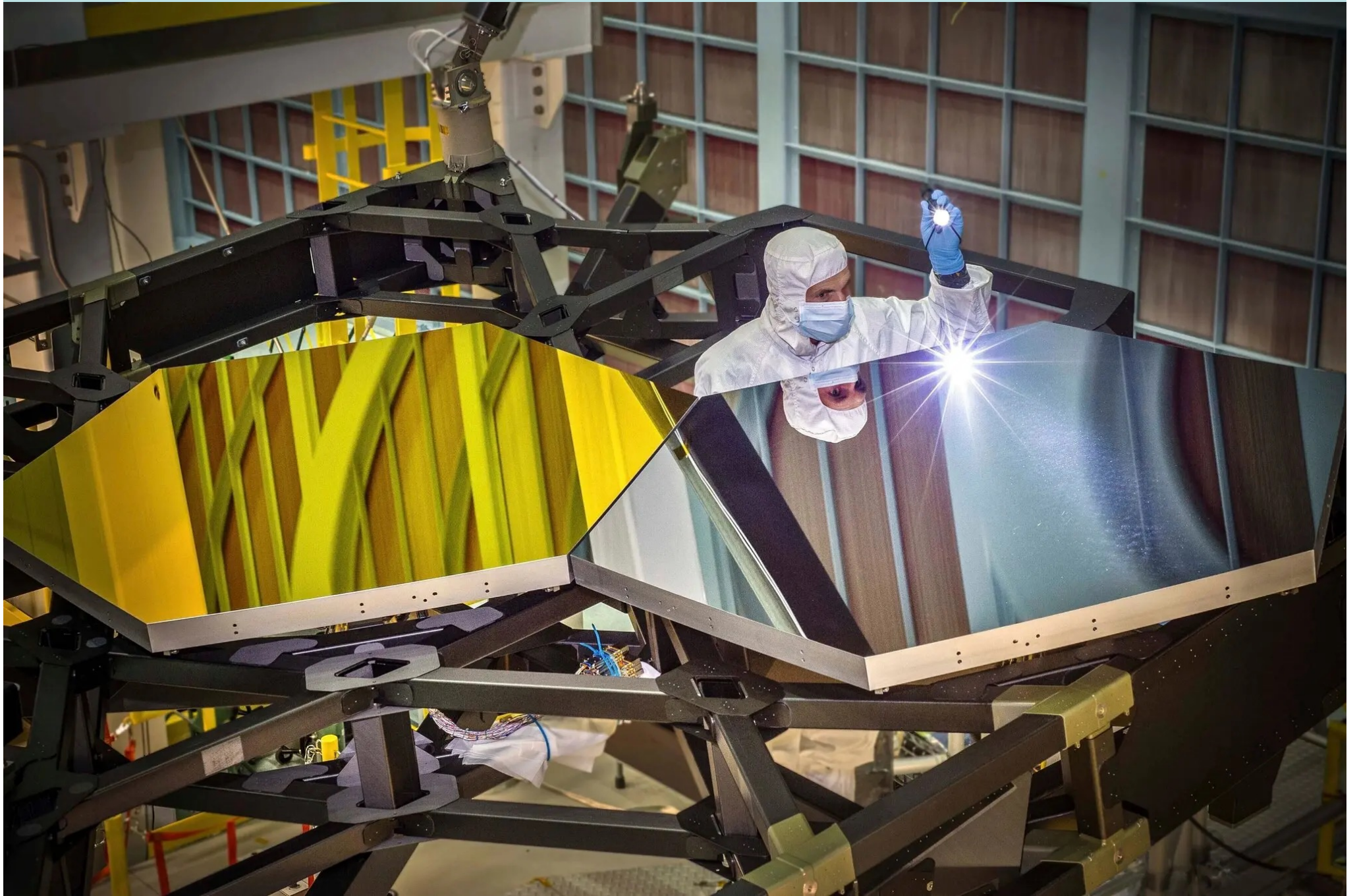
Sunshield Five layers protect the cold side, reducing exposure to solar energy by a factor of one million

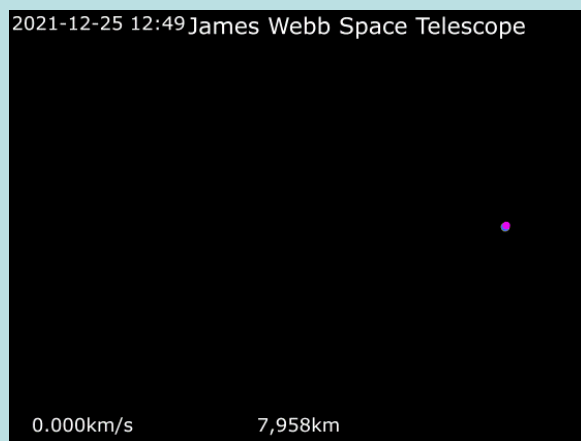
Momentum flap Balances solar pressure on the sunshield

Spacecraft bus Contains:
Solar panels and electrical system
Propulsion and attitude control system
Thermal control

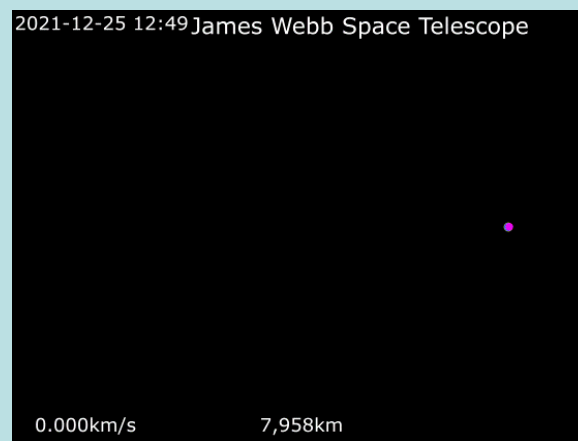


Graphic: Ian Boff
Sources: Nasa; ESA; FT research
© FT

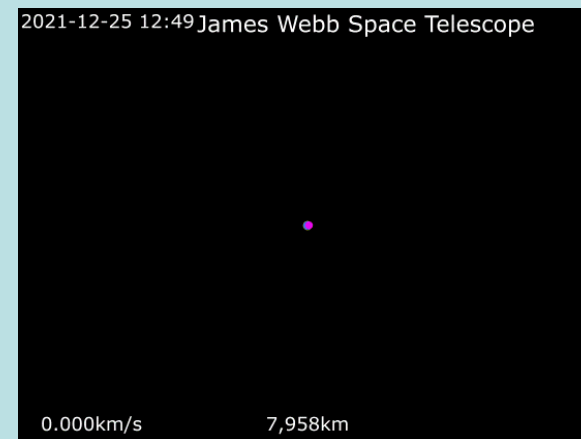




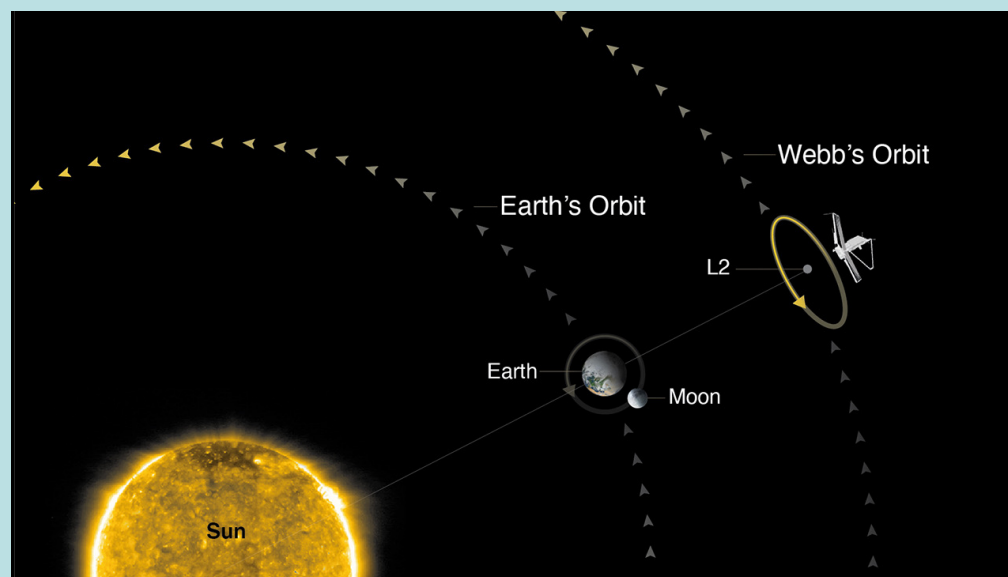
Top view



Side view



Side view from the Sun

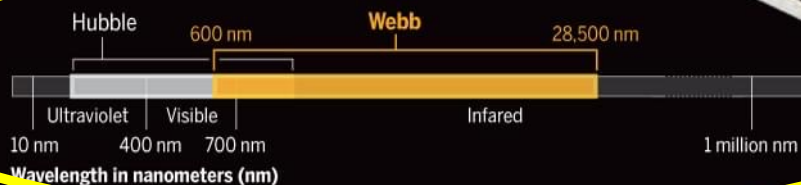


韋伯望遠鏡繞L2點旋轉：地球與太陽重力合力恰等於向心力，同時隨著地球一起繞日。

A golden opportunity

On 25 December, NASA will launch the \$10 billion James Webb Space Telescope, a successor to the Hubble Space Telescope. The segmented mirror—coated with a thin layer of gold—will work in the infrared, looking back across the universe to gather the light of the first stars and galaxies. It will also bring into view the atmospheres of Earth-size exoplanets.

Graphic by Chris Bickel



Honeycomb eye

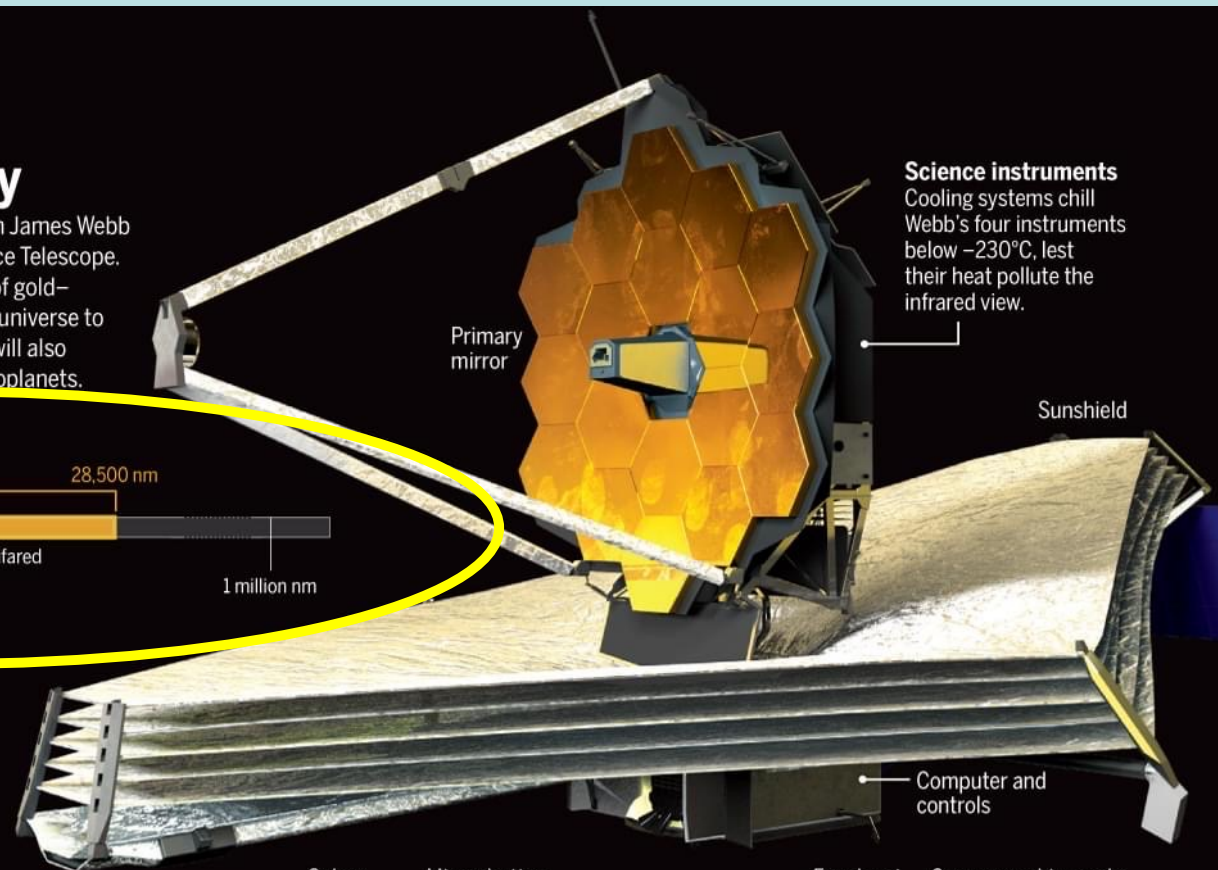
Webb has more than five times the light-gathering power of Hubble.



Hubble (2.4 m)

Human (1.7 m)

Webb (6.5 m)

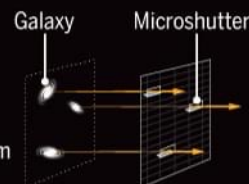


Science instruments

Cooling systems chill Webb's four instruments below -230°C , lest their heat pollute the infrared view.

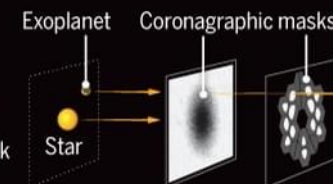
Multitasking

An array of nearly 250,000 microshutters allows one instrument to analyze light from hundreds of galaxies at once.

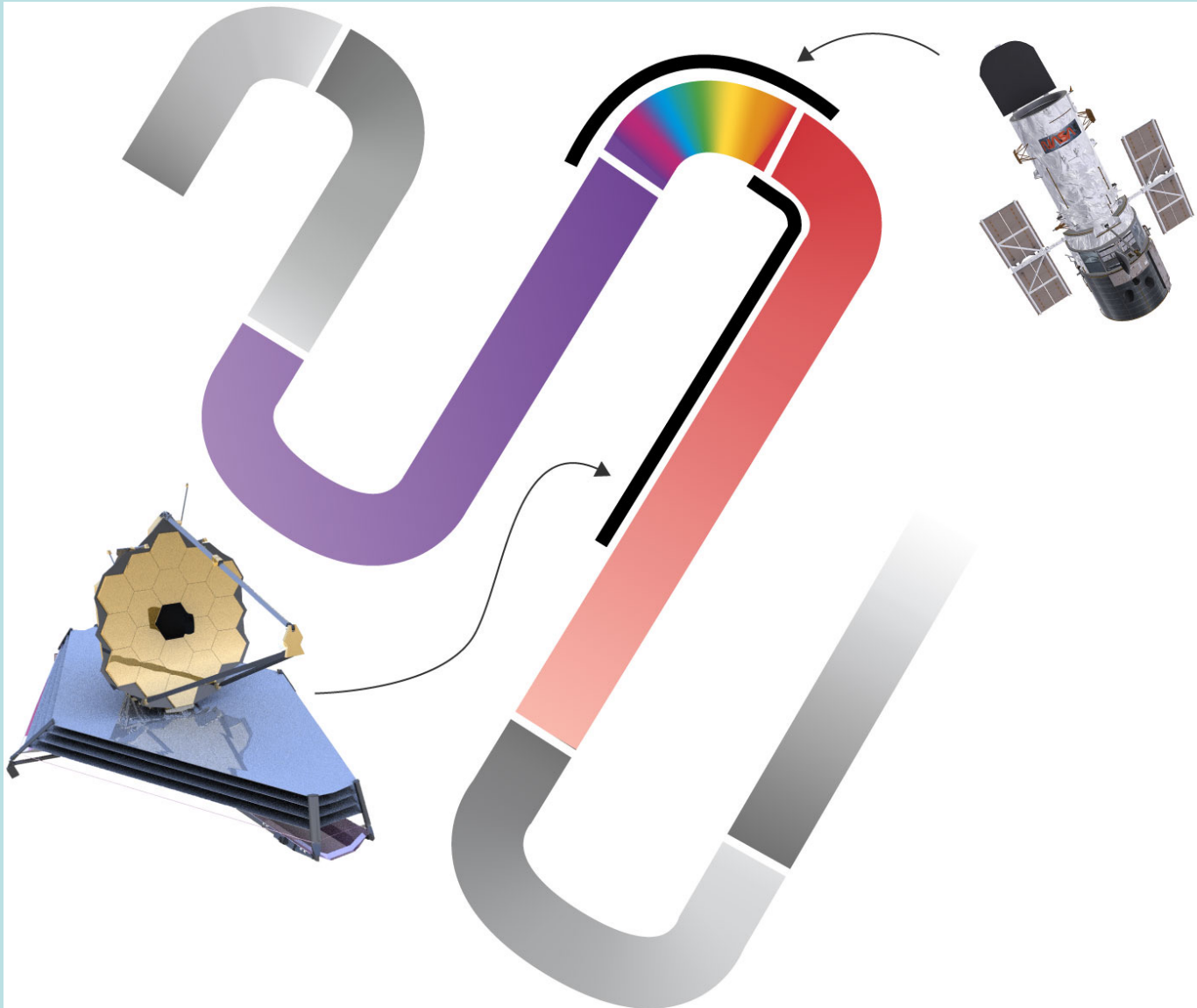


Mask mandate

To gather the light of a planet and image it directly, Webb will mask the glare of the star.



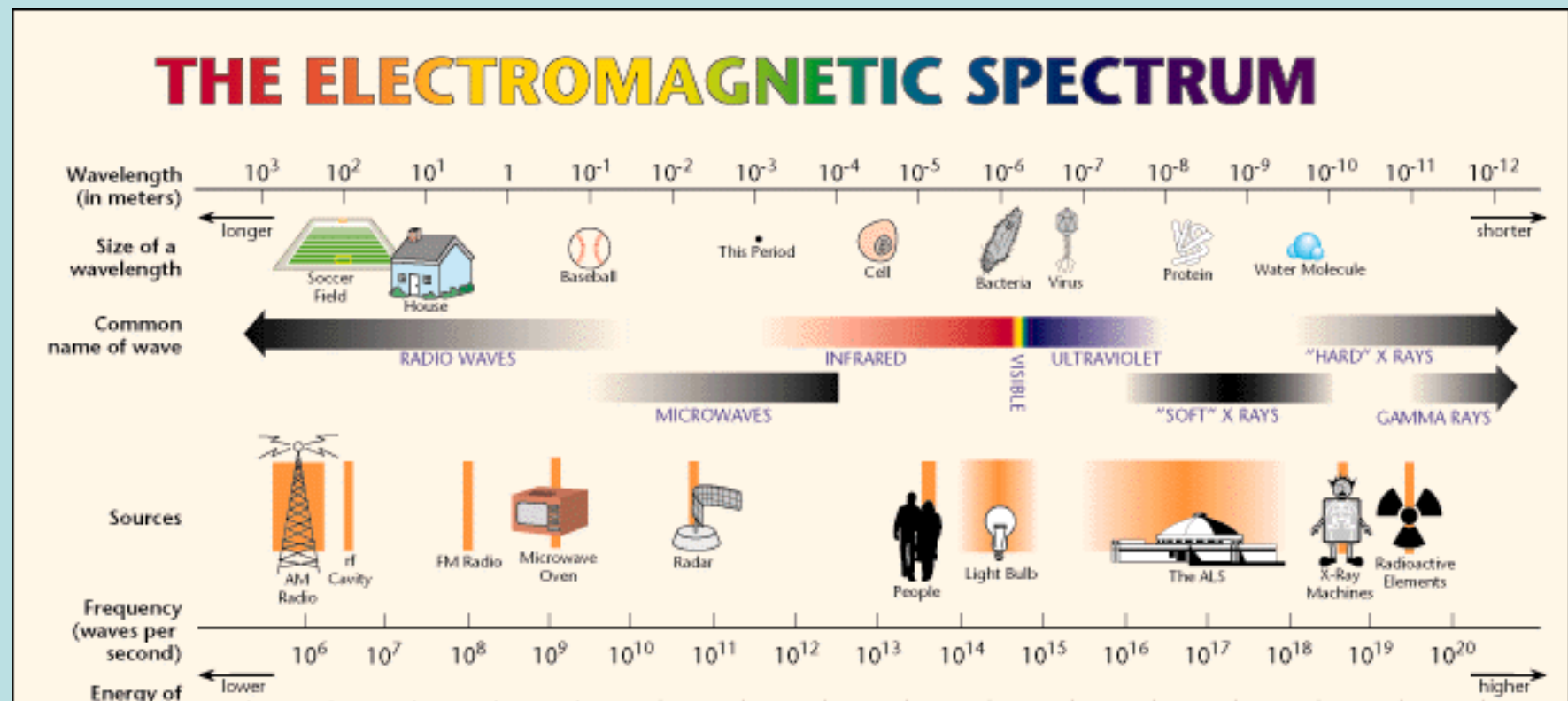
韋伯是一個紅外線望遠鏡！不像哈伯是可見光望遠鏡。
與其說是望遠鏡，不如說是接收電磁波的天線！



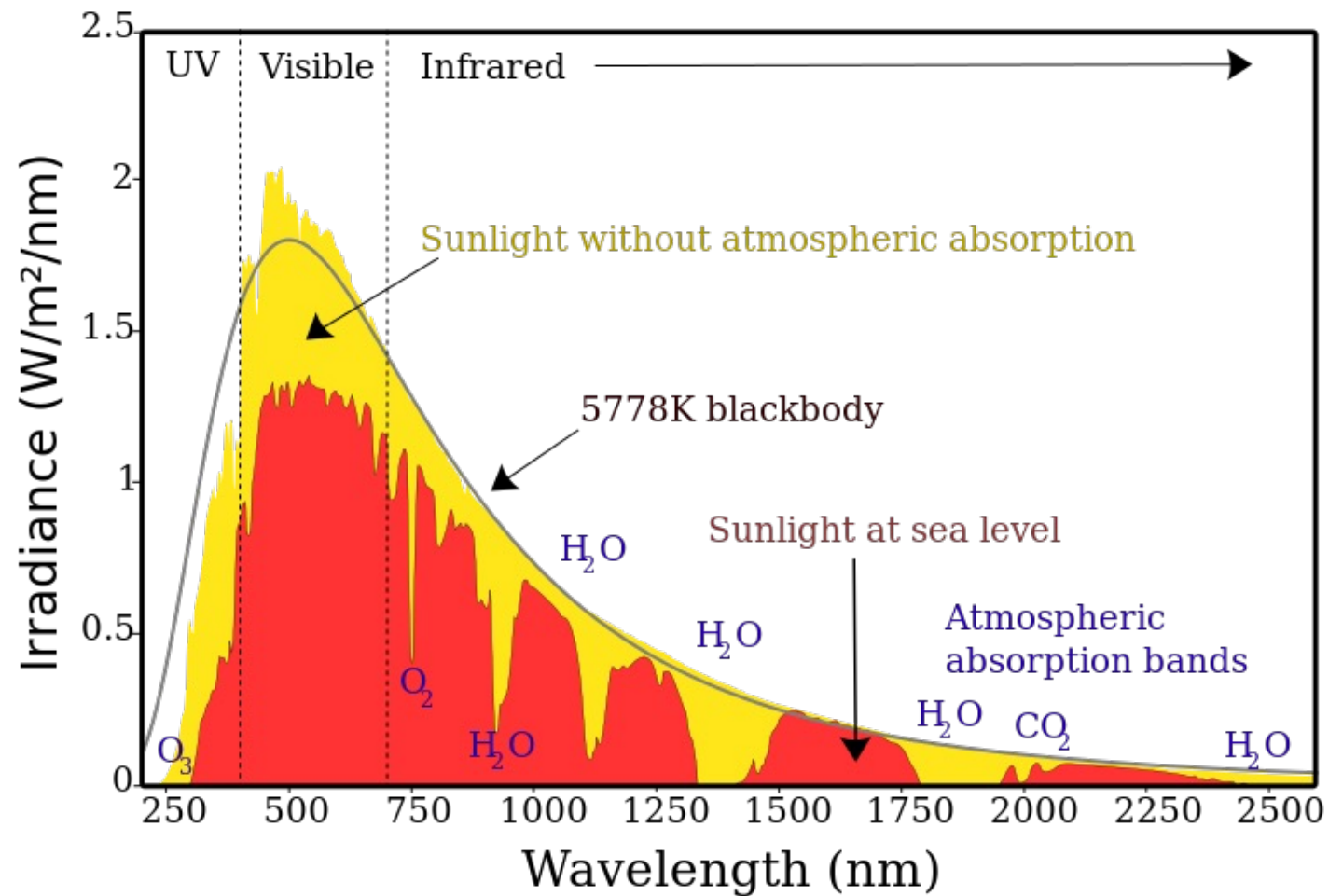


ALMA, the Atacama Large Millimeter Array
電磁波（微波）偵測天線陣列

馬克斯威爾的彩虹：依照頻率即波長排列的電磁波。



Spectrum of Solar Radiation (Earth)

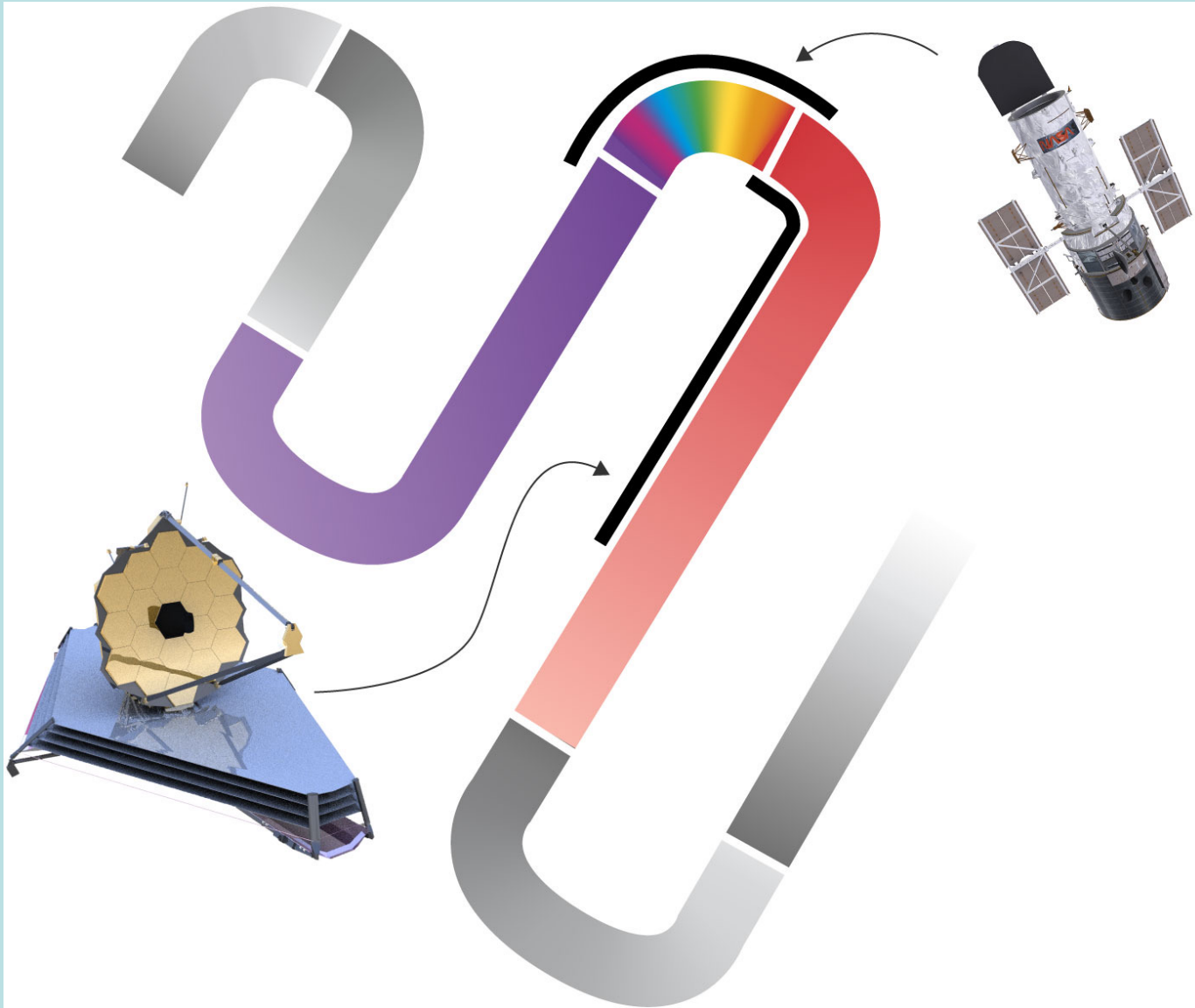


太陽或一般恆星會放出波長連續分布的電磁波，以上就稱為放射光譜。

天文觀測可以在任意波長，會看到不同的細節。



韋伯是一個紅外線望遠鏡！不像哈伯是可見光望遠鏡。
與其說是望遠鏡，不如說是接收電磁波的天線！



紅外線望遠鏡最大的好處是：



Pillars of creation Eagle Nebula

可見光會被塵埃遮蔽

紅外線可以透過塵埃

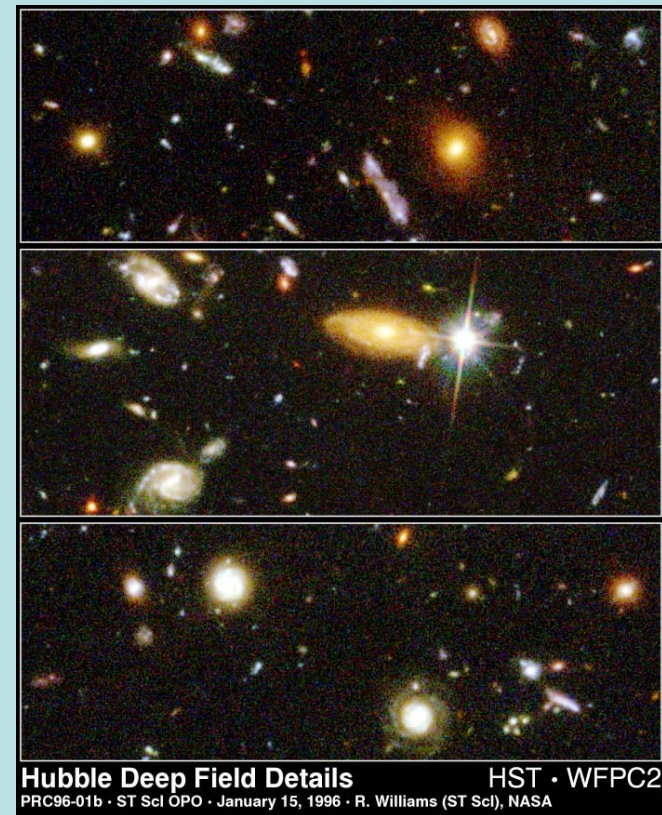
恆星Star發光被星際氣體Gas反射，形成星雲Nebula！



The Eagle Nebula is a young open cluster of stars in the constellation of Serpens. Alternatively, it is catalogued as Messier 16, M16, or NGC 6611, and sometimes referred to as the Star Queen Nebula. This cluster discovered by Jean-Philippe de Cheseaux in 1745–46. Both the "Eagle" and the "Star Queen" refer to visual impressions of the dark silhouette near the center of the nebula,[4][5] an area made famous as the "Pillars of Creation" imaged by the Hubble Space Telescope. The nebula contains several active star-forming gas and dust regions, including the aforementioned Pillars of Creation. The Eagle Nebula lies in the Sagittarius Arm of the Milky Way.



第一張韋伯深空區照片，包含上千個星系Galaxy，每個星系又有上億顆恆星Star。

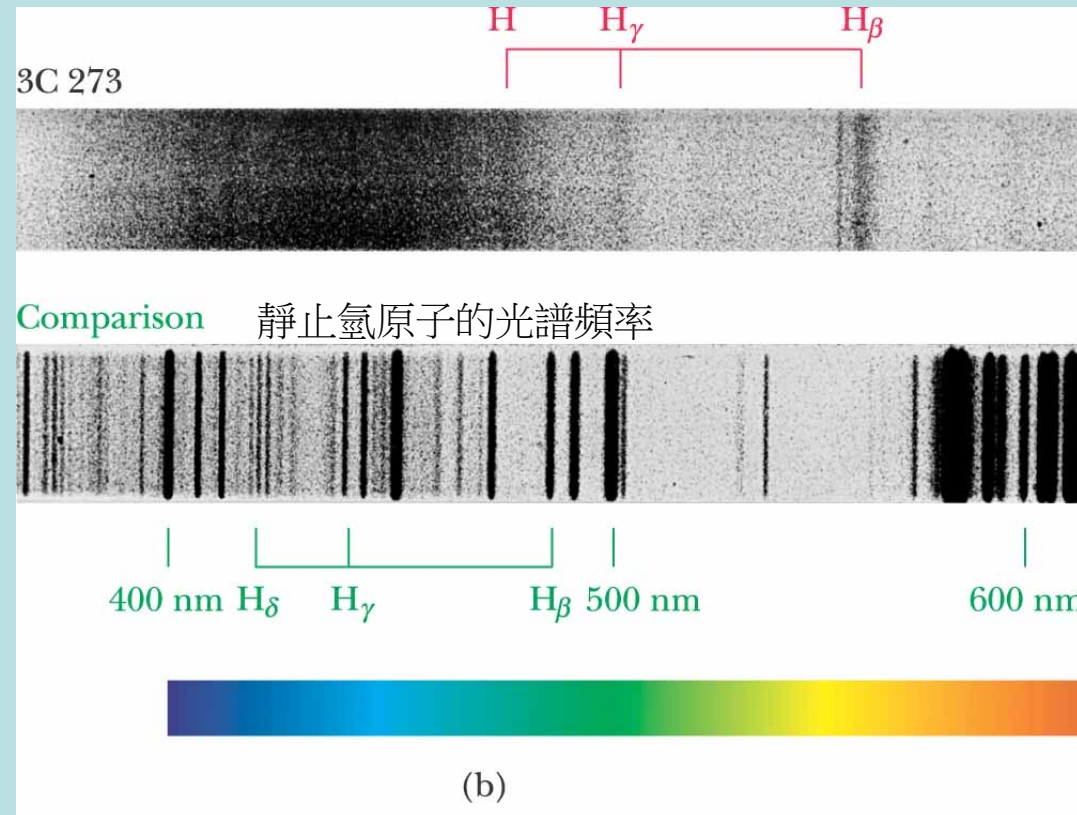
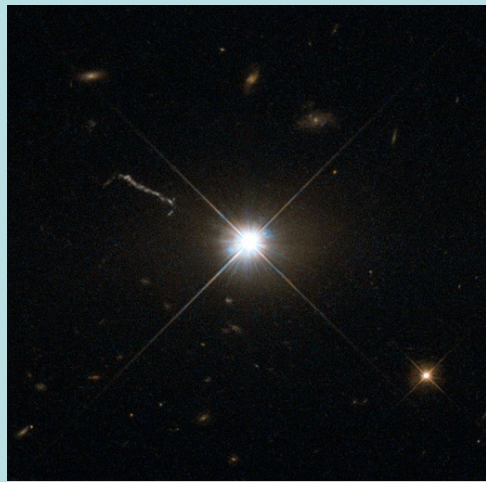


Hubble Deep Field

紅外線望遠鏡更大的好處是：可以看到非常古老的星系：
越遠的星系，觀察到的光出發的時間越古老，當然光也越弱，
而且越遠的星系，觀察到的光，紅移Red Shift越厲害。

星光是由原子發出，主要是氫原子！

Hubble發現遠處星光的紅移現象redshift：星光的光譜頻率低於靜止原子的光譜頻率！

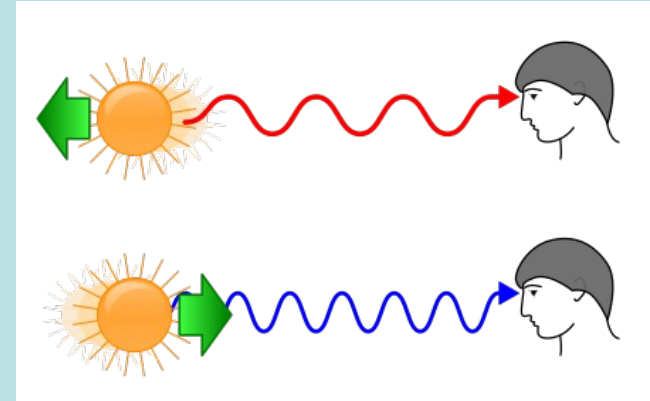
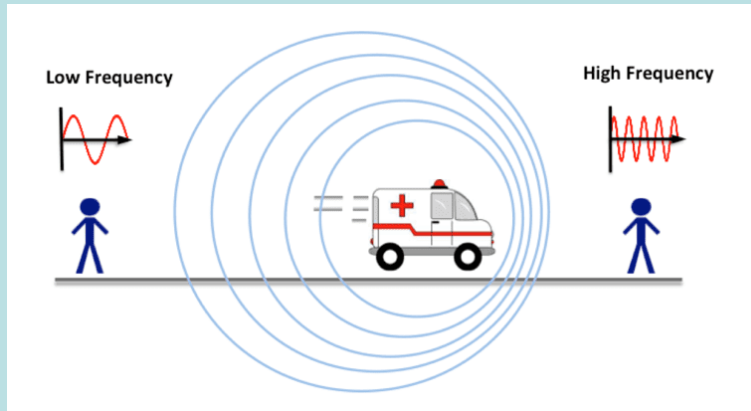


Vesto Slipher
1875-1969



3C 273 is a quasar located in the constellation Virgo. It was the first quasar ever to be identified. It is the optically brightest quasar in our sky and one of the closest with a redshift, z , of 0.158.

這是單一星體，第一個發現的Quasar，一顆星抵一個星系。



$$1 + z = \frac{\lambda_{\text{observed}}}{\lambda_{\text{emitted}}}$$

根據都卜勒效應： $z \sim \frac{v}{c}$ 速度遠小於光速時。

測量 z 就等於測量發光物體遠離的速度 v 。

z 相當方便，就用來表示星體離開我們的速度。

3C 273 is a quasar with a redshift, z , of 0.158. 遠離速度接近光速的五分之一。

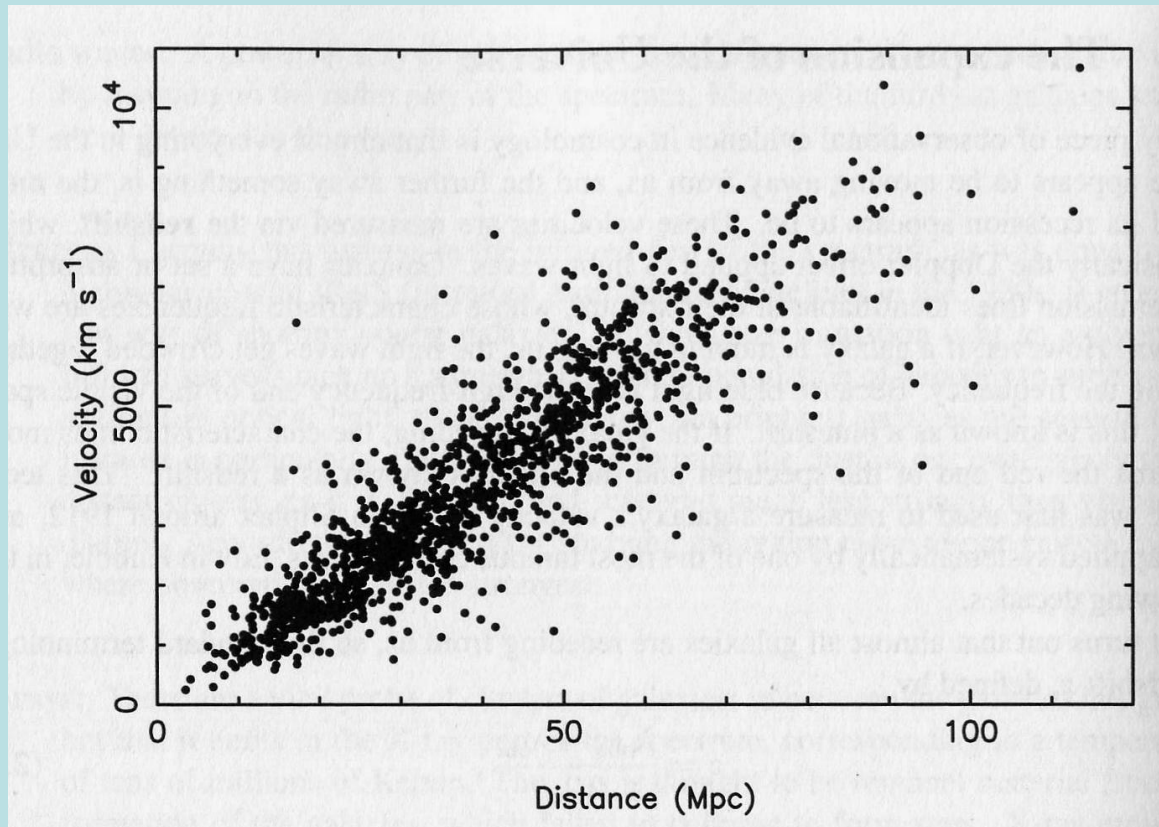
3C 273 is a quasar located at the center of a giant elliptical galaxy in the constellation of Virgo. It was the first quasar ever to be identified and is the visually brightest quasar in the sky as seen from the Earth, with an apparent visual magnitude of 12.9, outshining by more than 16 times the entire galaxy that hosts it.[2] The derived distance to this object is 749 megaparsecs (2.4 billion light-years). The mass of its central **supermassive black hole** is approximately 900 million times the mass of the Sun.

這是單一星體，第一個發現的Quasar，一顆星抵一個星系，是一個黑洞。



3C 273 as imaged by the Hubble Space Telescope's Advanced Camera for Surveys. Light from the bright quasar nucleus is blocked by a coronagraph so that the surrounding host galaxy can more easily be seen.

Edwin Hubble 1889-1953

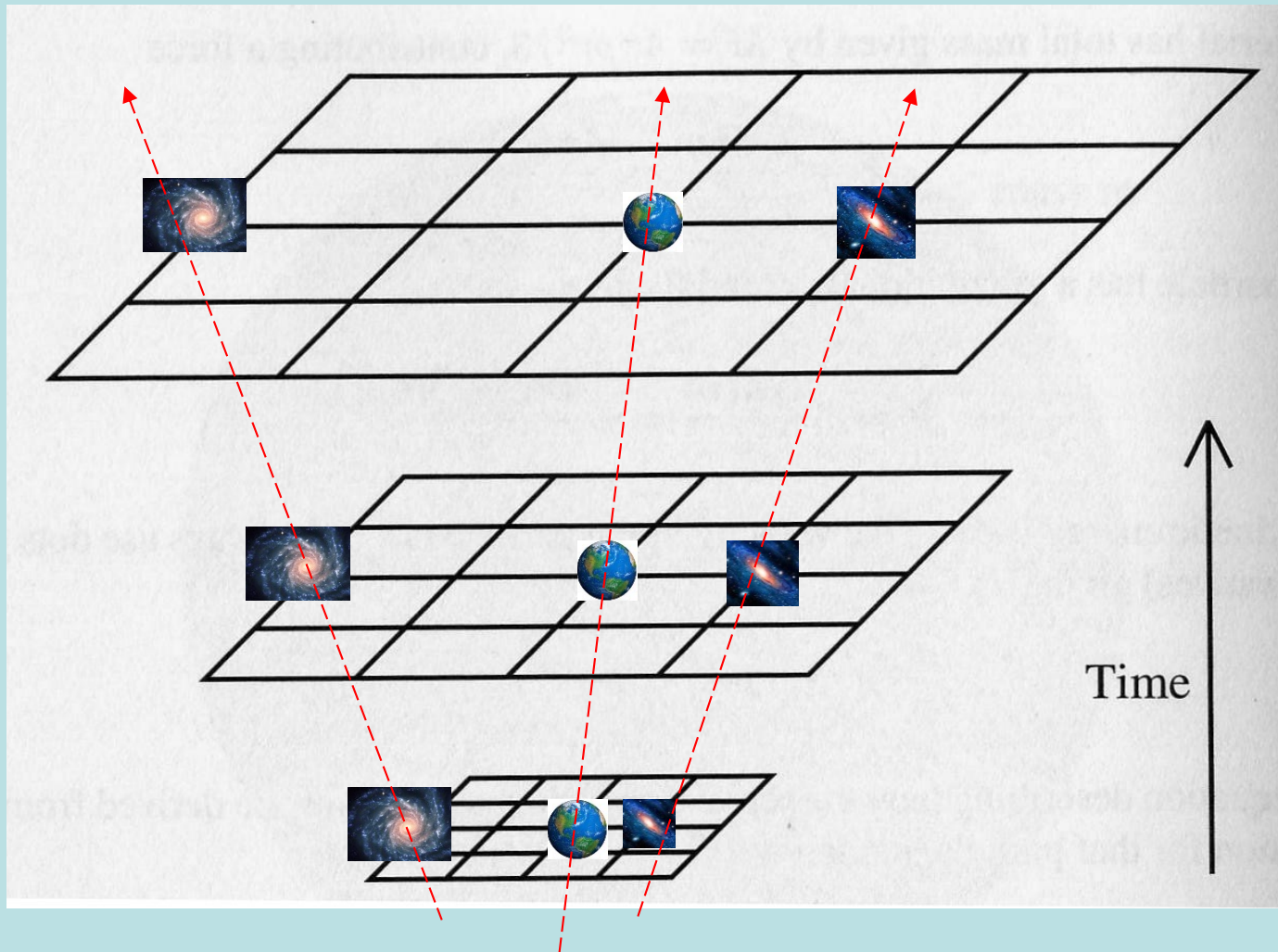


最近的數據，距離已經延伸至億光年。

Hubble發現銀河離開我們的速率，與該銀河與地球的距離成正比！

$$v = Hd \quad \text{Hubble's Law}$$

而且越遠的星系，紅移越厲害



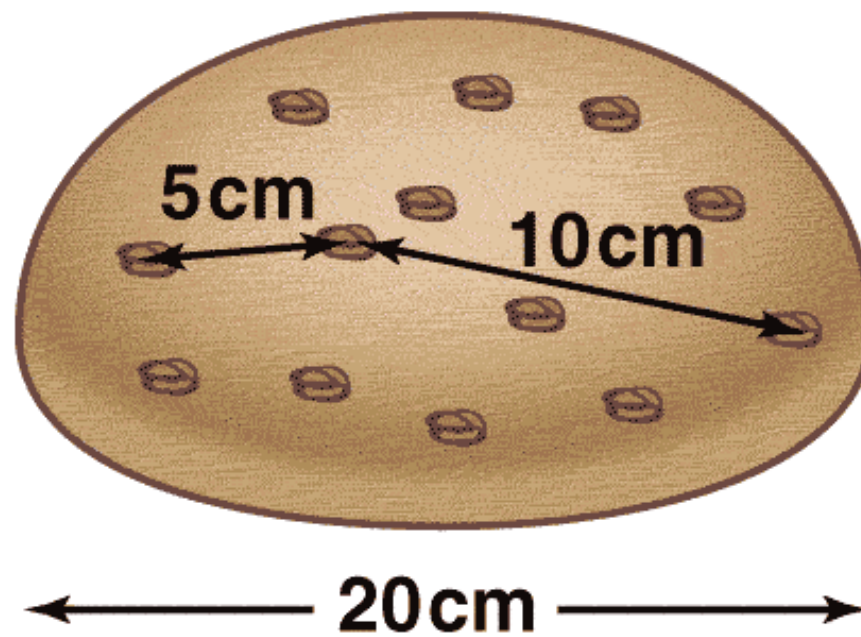
另一個可能是，宇宙是均勻在擴張之中！

想像宇宙的空間中有一測量距離的方格！銀河相對於方格是靜止的。

但宇宙的方格整個在擴張！方格間距隨著時間而越來越大！

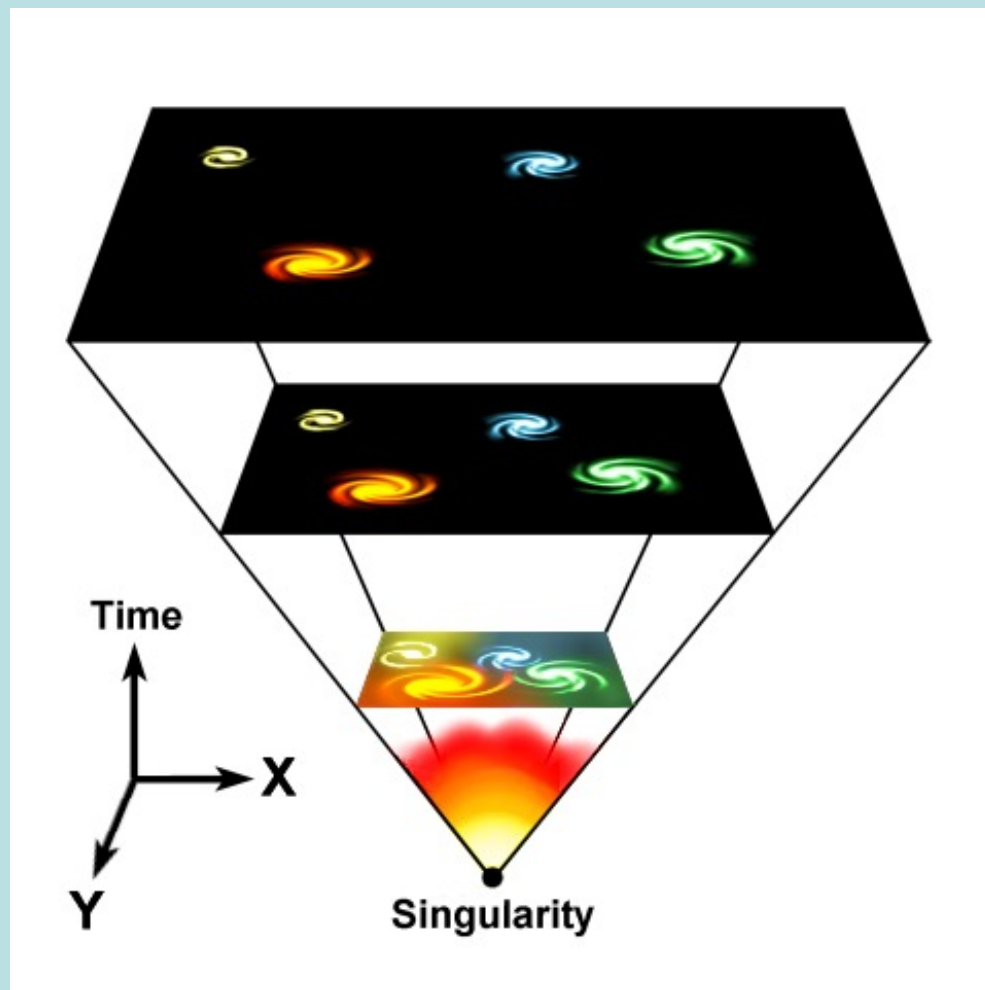
那麼越遠的銀河，自然遠離我們的速率越快！

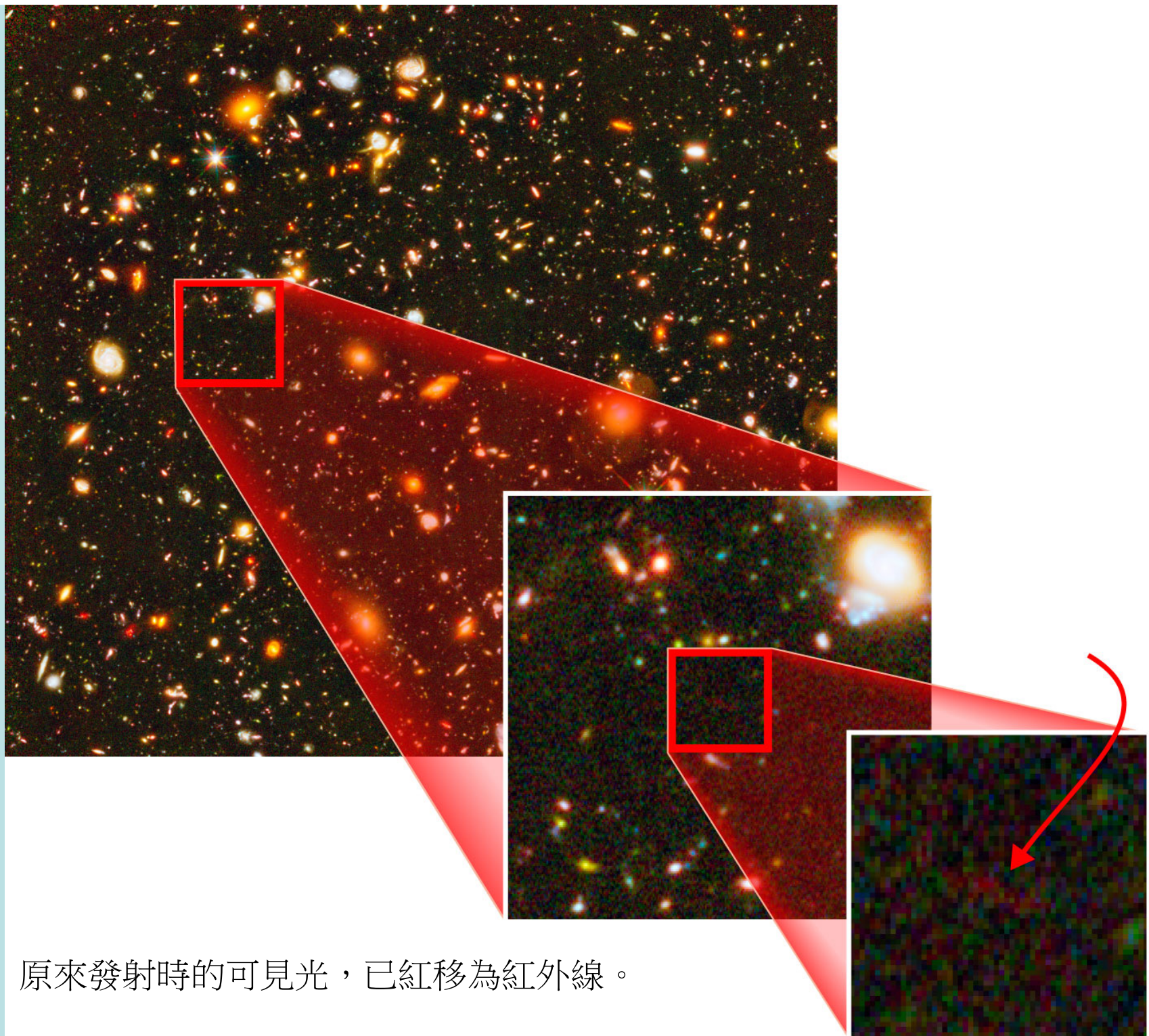
$$v = H \cdot d$$



宇宙真得像果凍.....或氣球

宇宙正在擴張之中，遠處的星系離我們遠去：

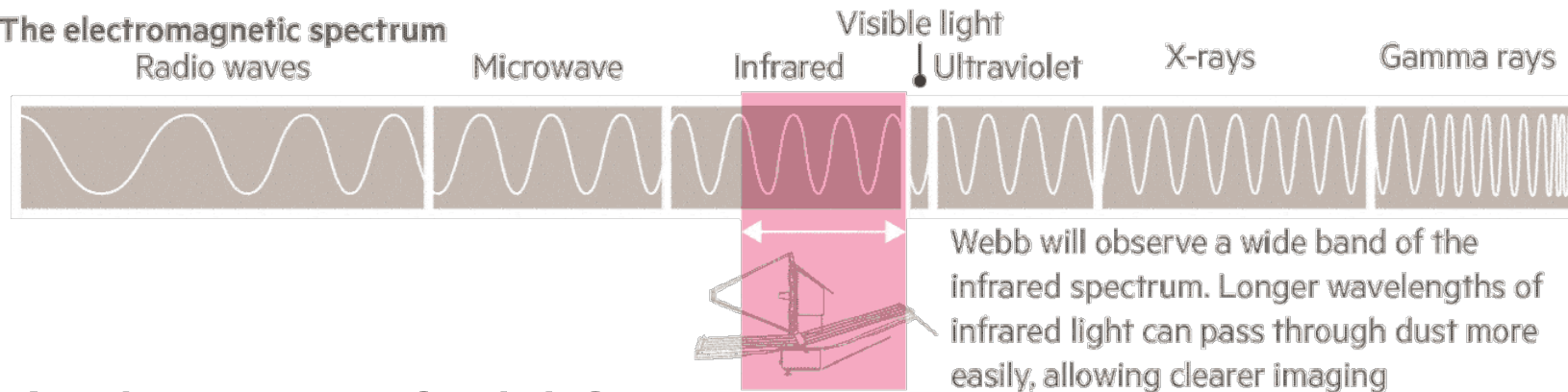




原來發射時的可見光，已紅移為紅外線。

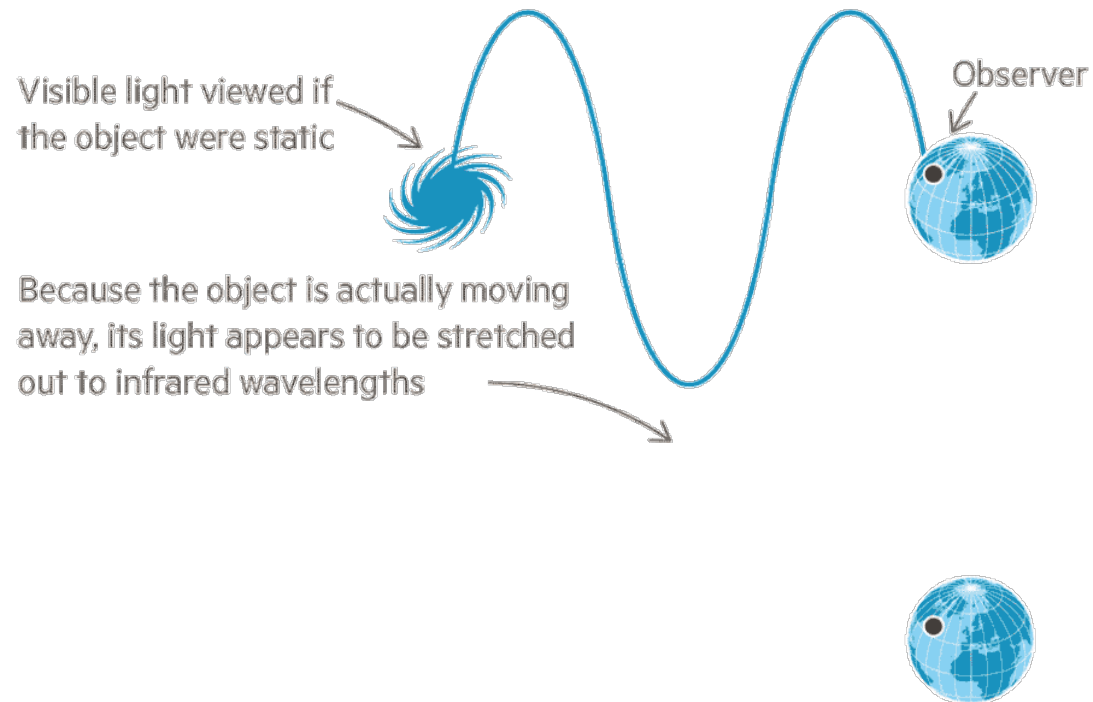
Why will Webb study infrared?

The electromagnetic spectrum



The phenomenon of red shift

Because the universe is expanding, distant stars and galaxies are moving away. To an observer, light waves from them appear to stretch out, making them more visible to infrared detectors

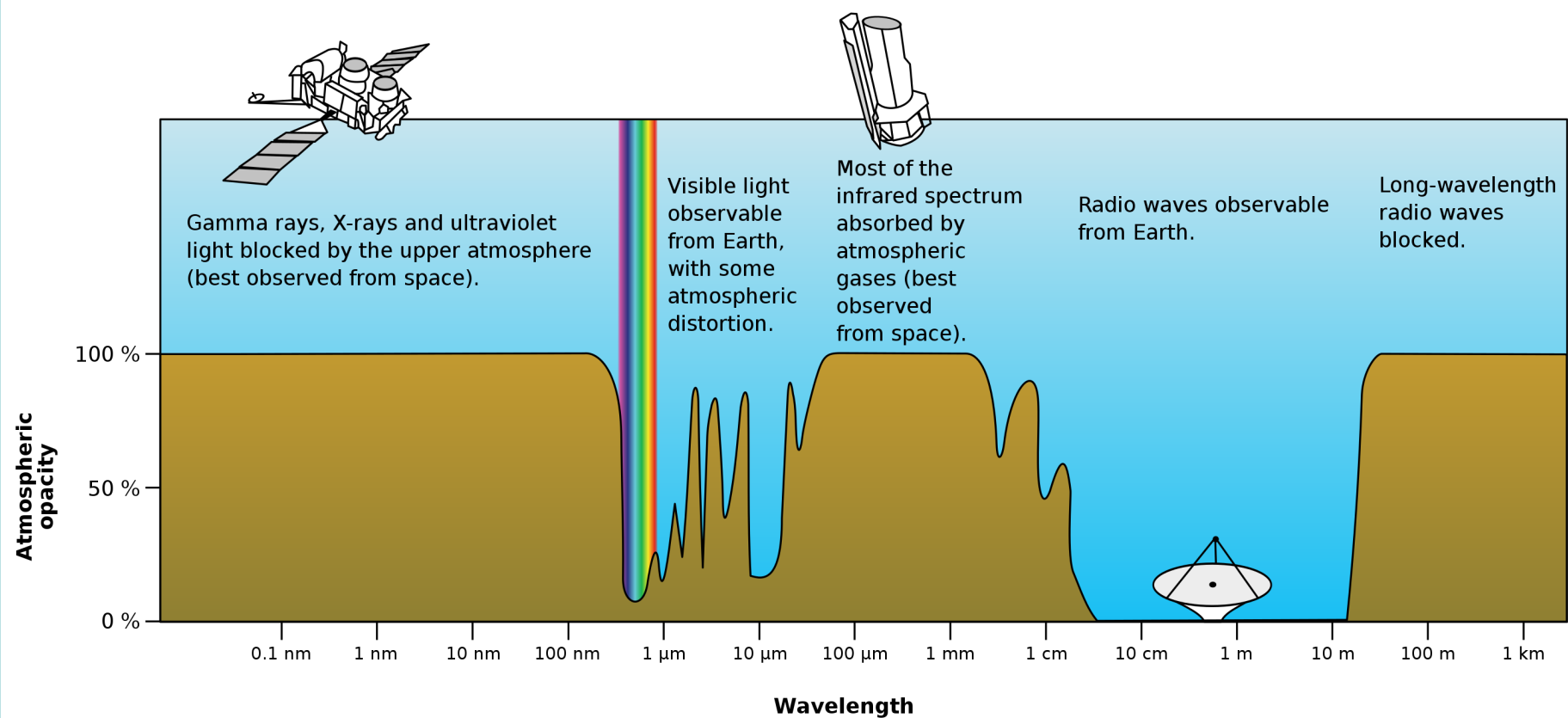


Graphic: Ian Bott

Sources: Nasa; ESA; FT research

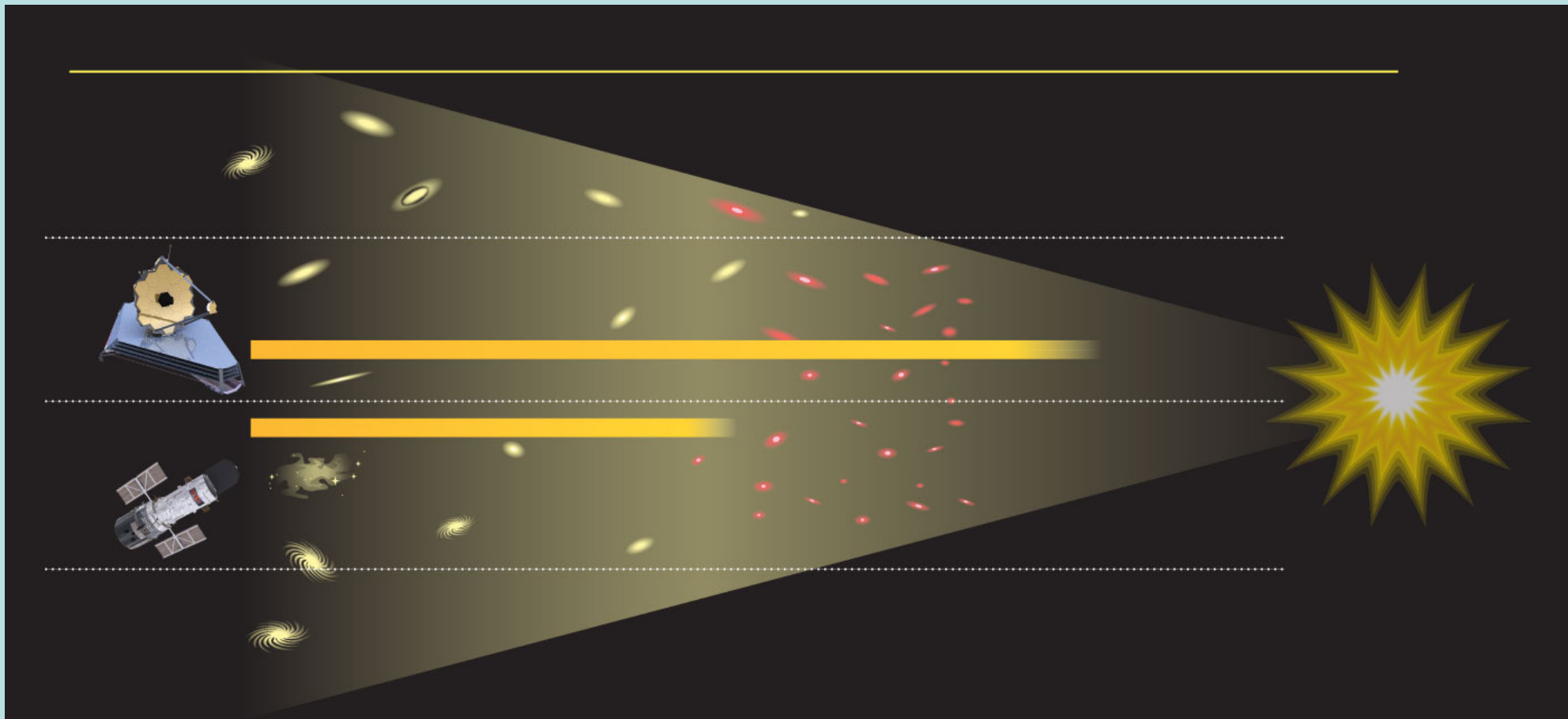
© FT

越遠的星系，紅移越大，紅外線看更清楚。

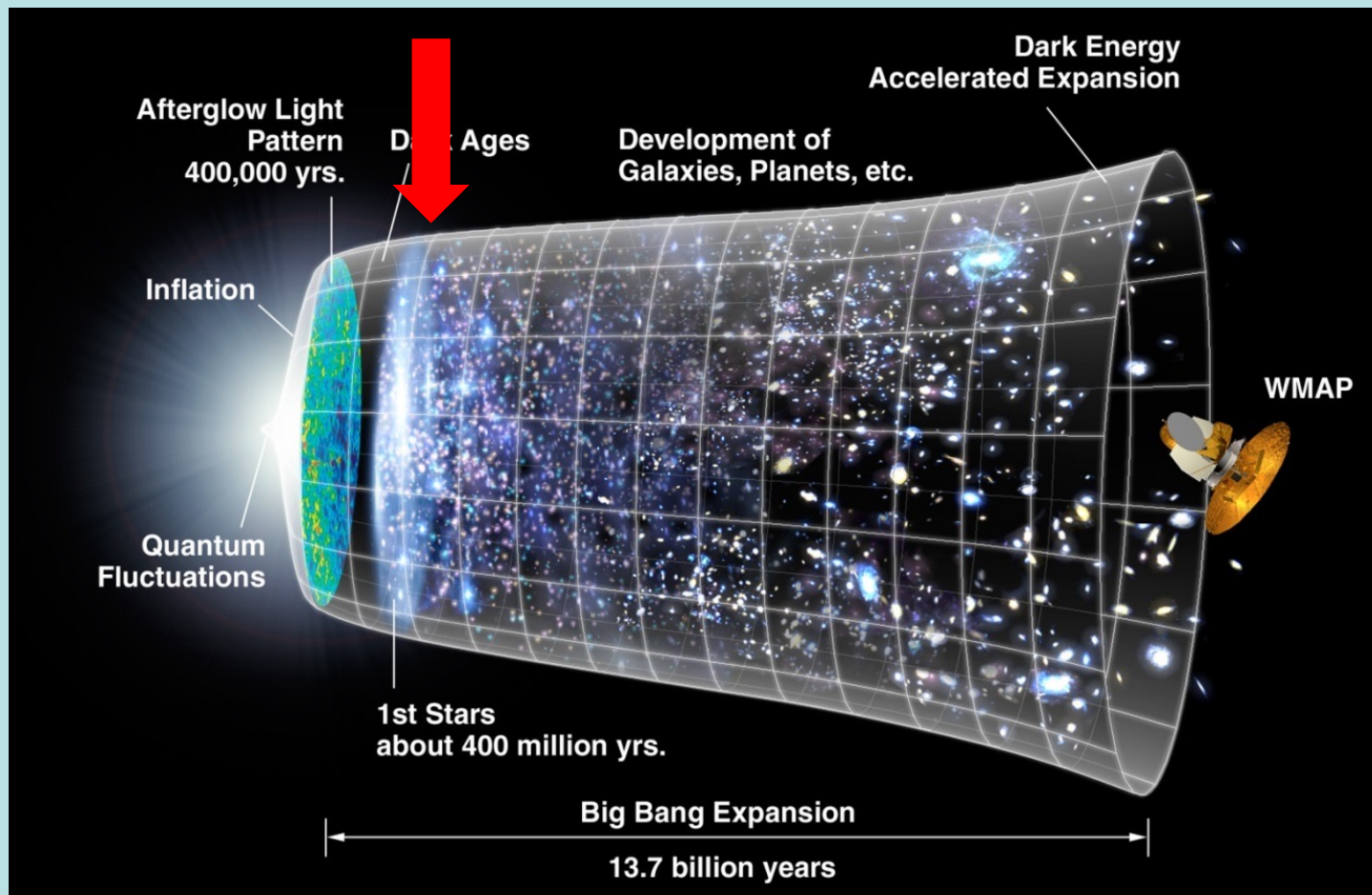


但紅外線會被地球大氣層吸收。

因此得到更高的太空觀察。



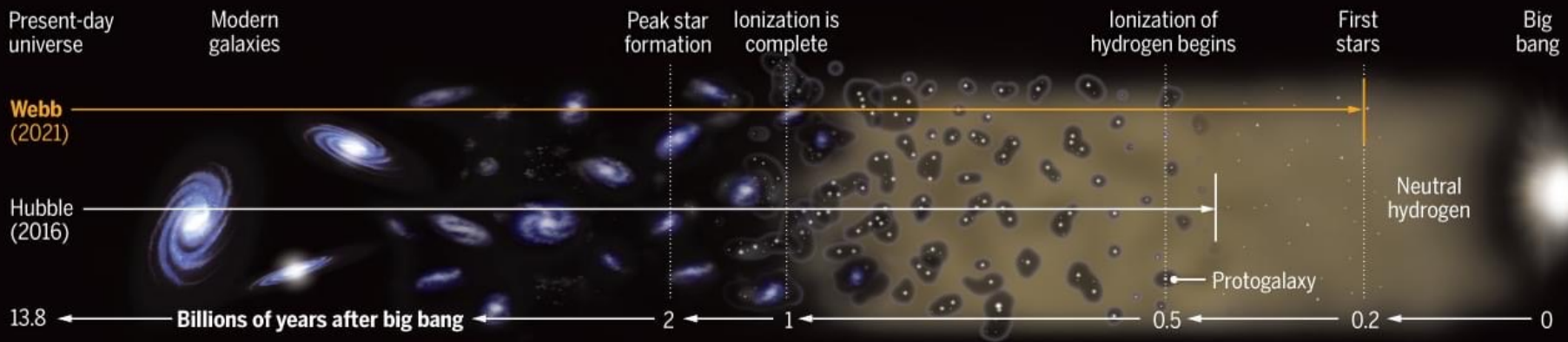
韋伯望遠鏡是一個紅外線望遠鏡，可以看得更遠，也就是更早。



Peering into the past

Webb will reach farther out in space and further back in time than Hubble or ground-based telescopes. It could show how galaxies evolved from ungainly clumps to the elegant spirals and ellipses seen today. It should also reveal whether starlight was sufficient to ionize the hydrogen gas that filled the universe, or whether black holes assisted.

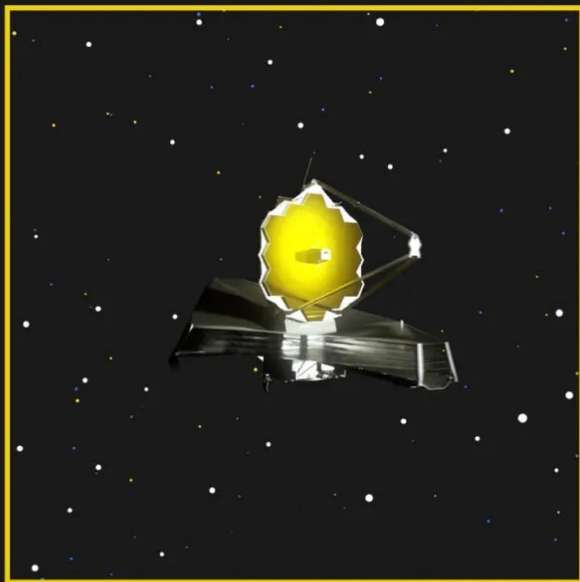
DATA: RYAN MACDONALD/CORNELL UNIVERSITY; NASA



大約是星球生成的時代

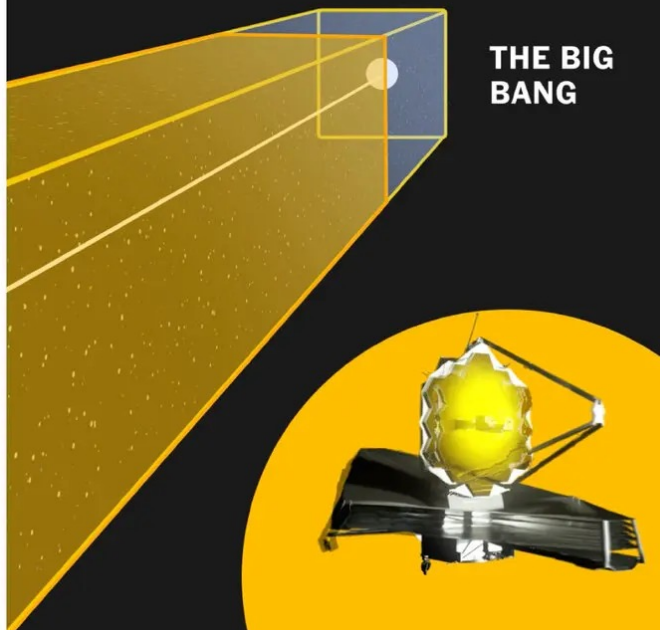
What Will the James Webb Space Telescope See?

After 30 years in development, the largest space telescope in history is scheduled to launch on Dec. 24. It will peer 13 billion years into the past to observe the universe in its infancy.



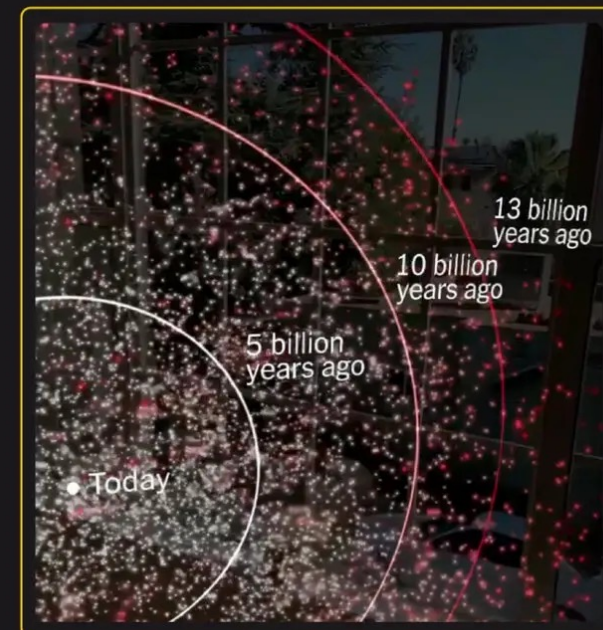
Webb takes us even closer to the beginning.

With a 22-foot mirror and the ability to see invisible infrared light, Webb will reveal the universe when it was just 250 million years old.



We created a 3-D map of the observable universe to show you where Webb will be looking for some of its first missions.

Tap the link to see it in your space with AR.



因為距離極遠，這些光多半來自宇宙誕生初期，所以韋伯不只是一個望遠鏡，還是一個時間機器呢，對這些光仔細研究，將讓我們可以看透整個宇宙的歷史。

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節目 知識好好玩

【物理好好玩S2EP08】馬克思威爾的彩虹與韋伯望遠鏡的深空照片

主持人 | 張嘉泓

單曲長度 | 00:25:22 發布時間 | 2022-08-09

#張嘉泓 #物理好好玩 #黑洞 #彩虹 #韋伯望遠鏡 #紅外線 #電磁波 #馬克思威爾 #深空照片 #伽馬射線

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 張嘉泓
Screenshot

專長是理論粒子物理，畢業於台大物理系，在美國哈佛大學取得博士學位後，曾在清華大學進行研究，現在...

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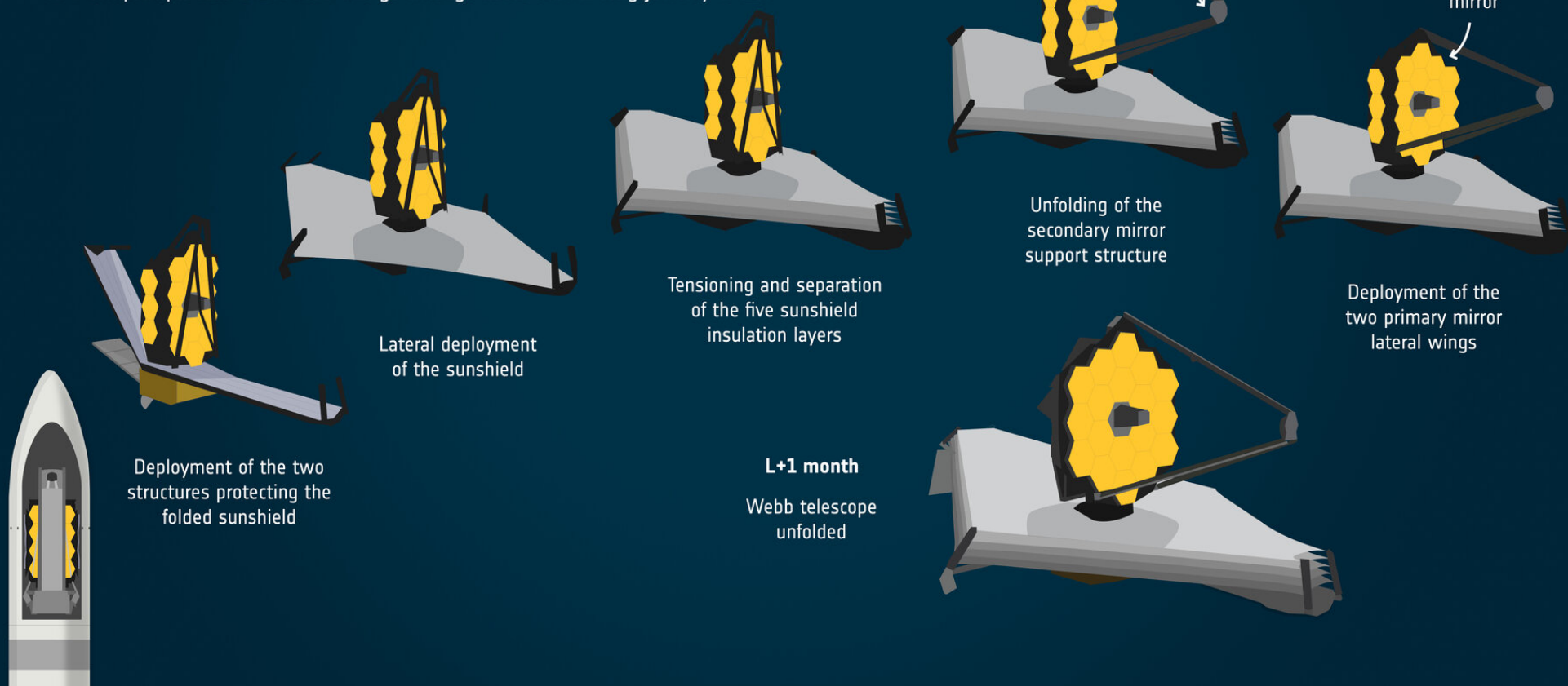


2021耶誕節



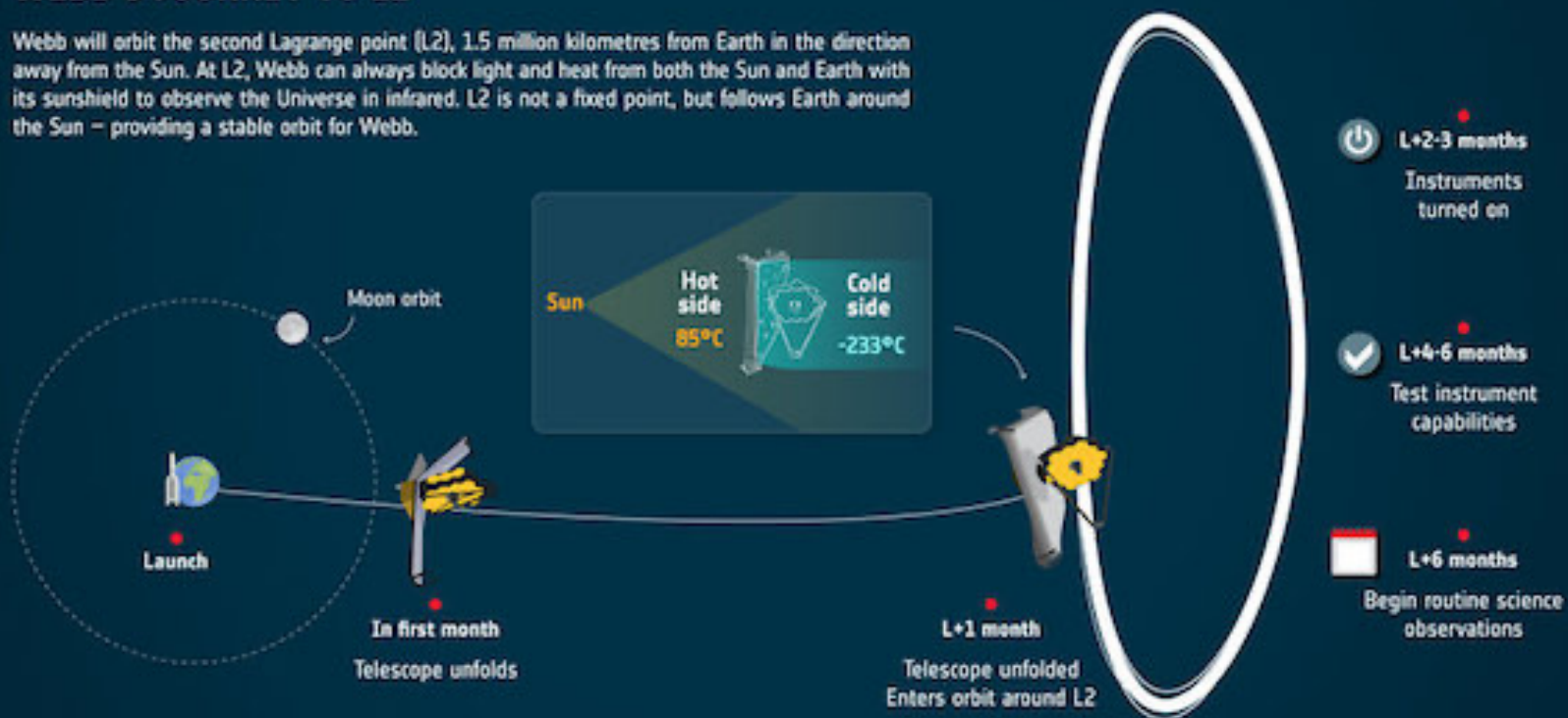
WEBB UNFOLDING SEQUENCE

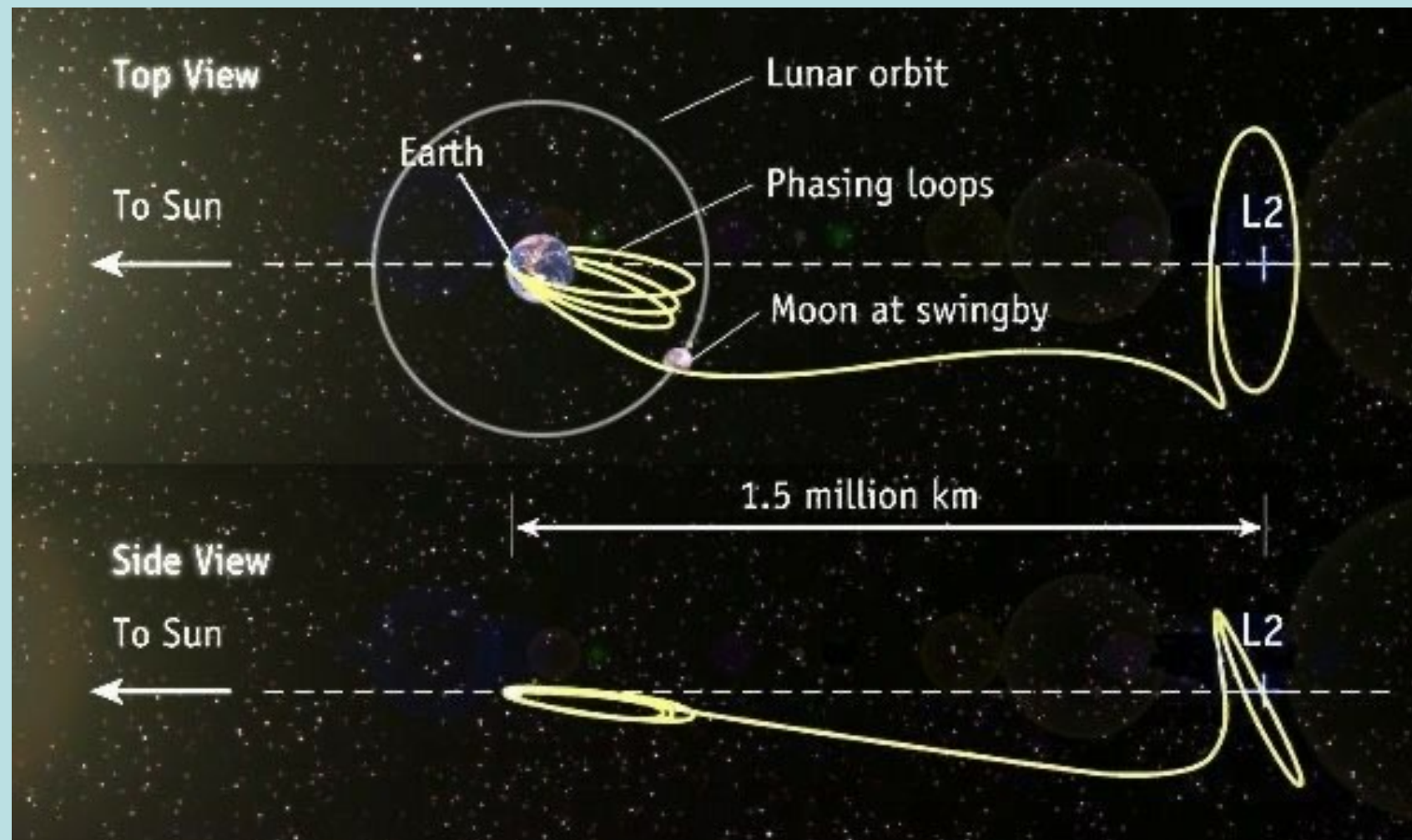
Webb is so big that it has to fold origami-style to fit in the Ariane 5 rocket and it will unfold like a 'transformer' in space. This graphic shows a few key steps of the unfolding sequence, which is a complex process that Webb will go through in its month-long journey to L2.



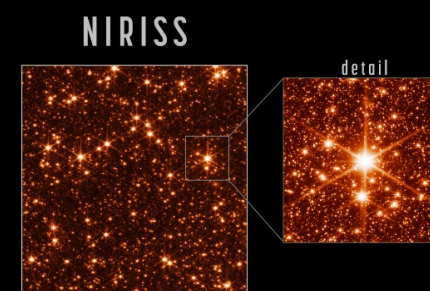
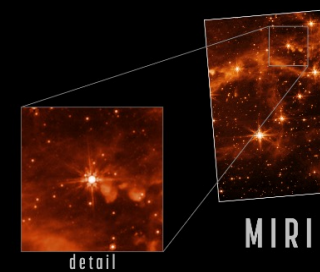
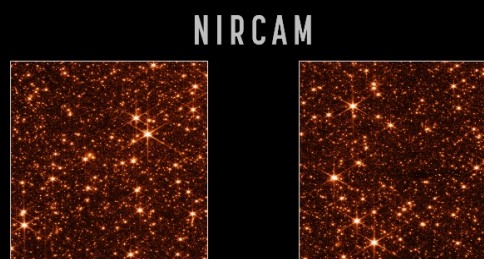
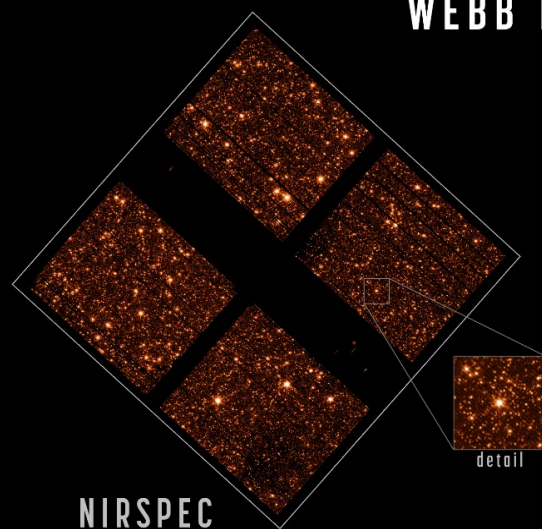
WEBB'S JOURNEY TO L2

Webb will orbit the second Lagrange point (L2), 1.5 million kilometres from Earth in the direction away from the Sun. At L2, Webb can always block light and heat from both the Sun and Earth with its sunshield to observe the Universe in infrared. L2 is not a fixed point, but follows Earth around the Sun – providing a stable orbit for Webb.





WEBB TELESCOPE IMAGE SHARPNESS CHECK





人類探索宇宙新突破！韋伯望遠鏡「首高解析彩色圖」曝

2022-07-12 08:19 聯合報／編譯張君堯／即時報導

+ 太空



眾所期盼的詹姆斯韋伯太空望遠鏡(Screenshot)第一張全彩色照片已經發布，而它「並沒有讓人們失望」，詹姆斯韋伯拍攝的更多照片將於12日由美國NASA向全球發布。





第三張照片南環星雲NGC 3132，距離2,500光年，星雲的中央有一頻死的恆星，正釋放出大量的塵埃與氣體，韋伯望遠鏡將能更細緻的解析氣體的成分與分佈。



第四張照片史蒂芬五重奏，五個相互吸引的星系，顯示在早期宇宙，星系彼此的作用、碰撞引發星系的演化。韋伯望遠鏡可以解析在星系交會處，出現激烈的恆星生成，以及大量氣體噴發。這張照片是由將近一千張影像拼接而成，是韋伯至今最大的照片。範圍達到滿月半徑的五分之一。



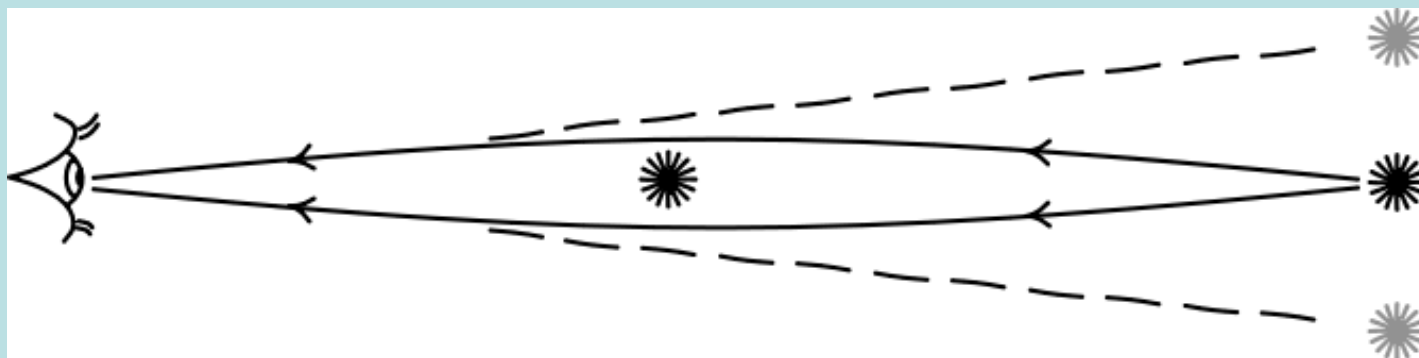


第五張照片：NGC 3324內的船底座星雲，這是大量年輕恆星的
誕生地。星雲的邊緣看來如同懸崖，這是由上方圖片外，極重極
熱的新生成恆星，所發出的強烈紫外線與星際風，所推擠造成。

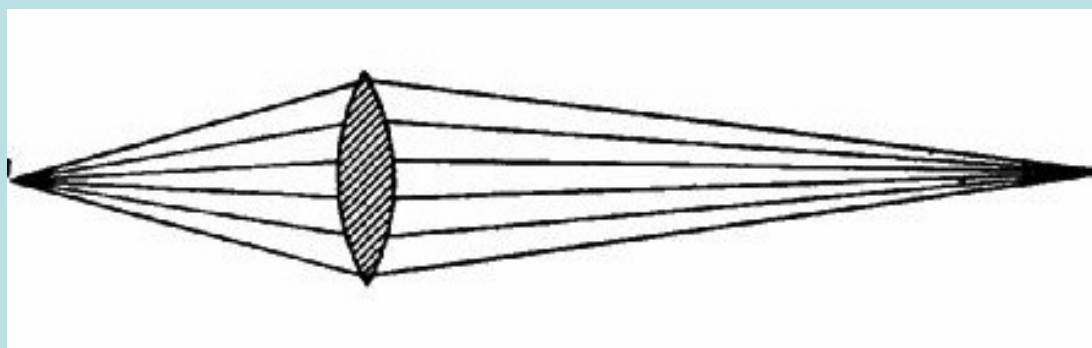




第一張韋伯深空區照片，包含上千個星系，每個星系又有上億顆恆星，是宇宙至今最深、最清晰的紅外線影像。照片前景中，大部分星系是屬於星系團 **SMACS 0723**，距離我們大約50億光年。而更顯眼、正要緊的是許多後方更加極度遙遠的星系，它們發出的光先經過**SMACS 0723**才到地球。被**SMACS 0723**極大的重力影響，光是彎著走的，所以它們影像好像經過了透鏡，被扭曲、放大成奇怪的形狀，有的看似毛筆隨意的一筆，有的像一段圓弧，有的甚至像是被壓扁了的麵疙瘩。這是典型的重力透鏡效應，



被近處星團遮蔽的遠方星團，所發出的光，其路徑會被近處星團彎曲。
在地球被看到時，看來會是位於偏離原來的星團的位置。
這樣的影像在近處星團周圍都會發生，因此遠處星團看來成了一個環！



這個現象就稱為重力透鏡：Gravitational Lenses

這是典型的重力透鏡效應，韋伯望遠鏡使他們細微結構清晰可見。因為距離極遠，這些光多半來自宇宙誕生初期，所以韋伯不只是一個望遠鏡，還是一個時間機器呢，對這些光仔細研究，將讓我們可以看透整個宇宙的歷史。

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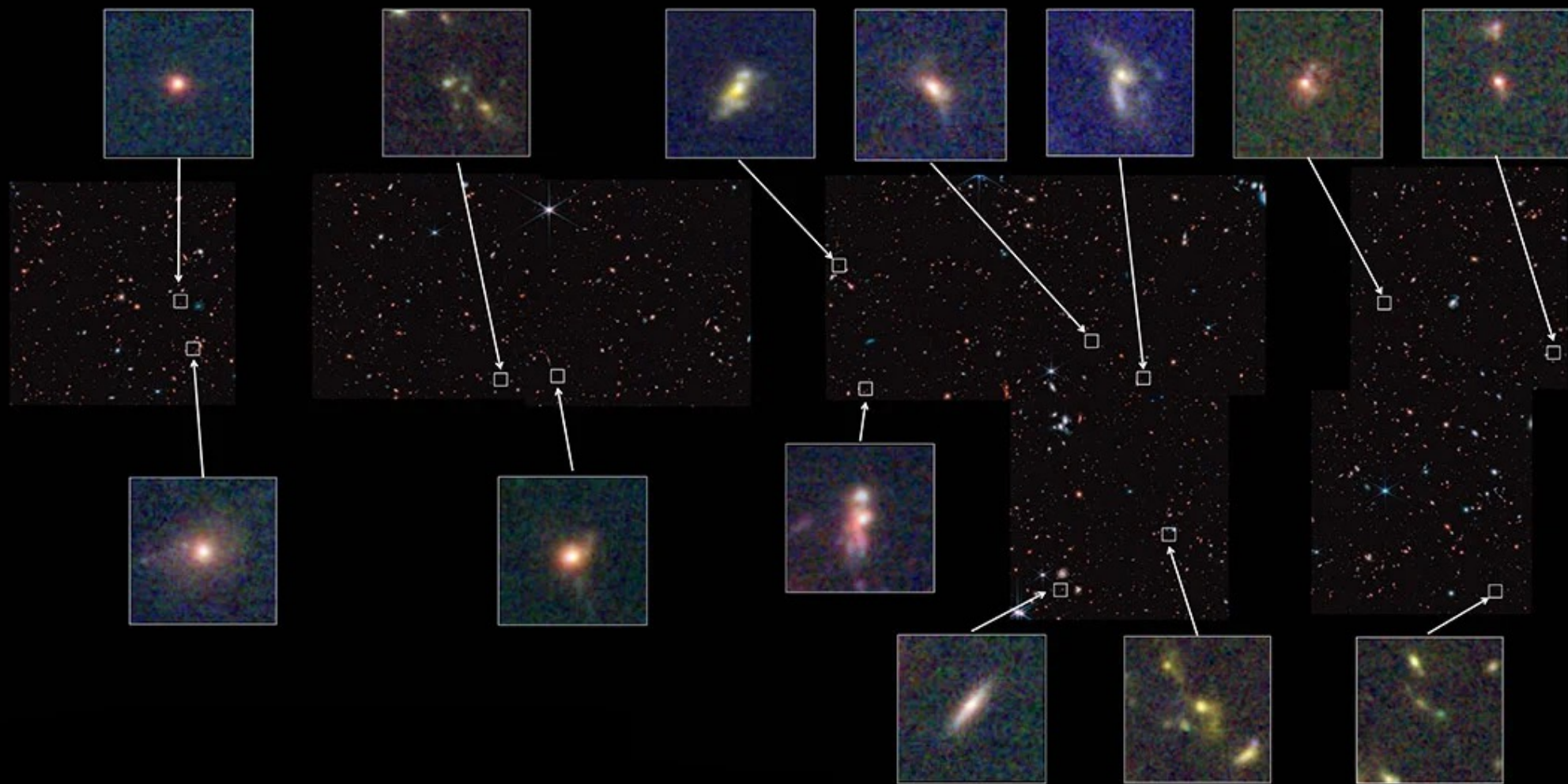
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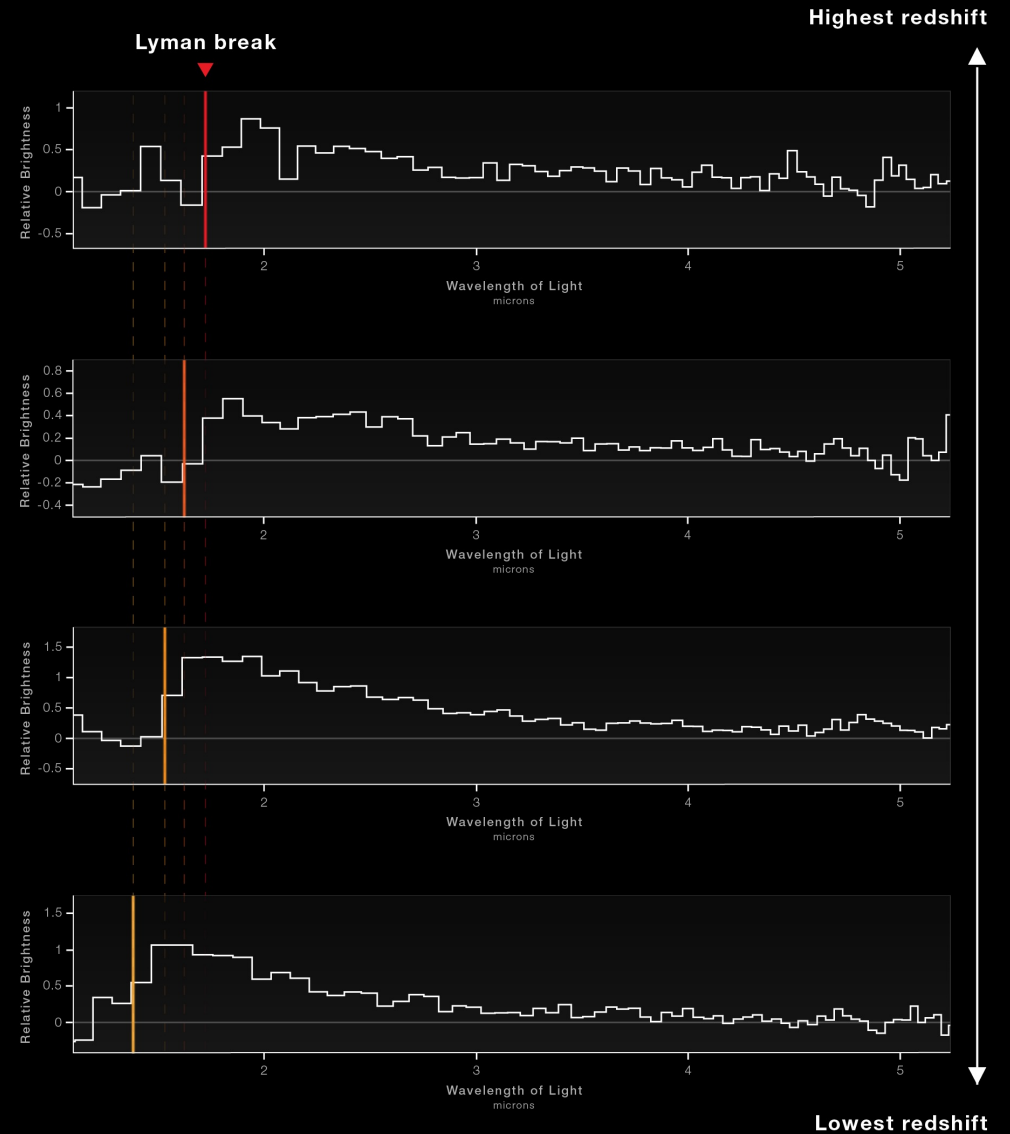
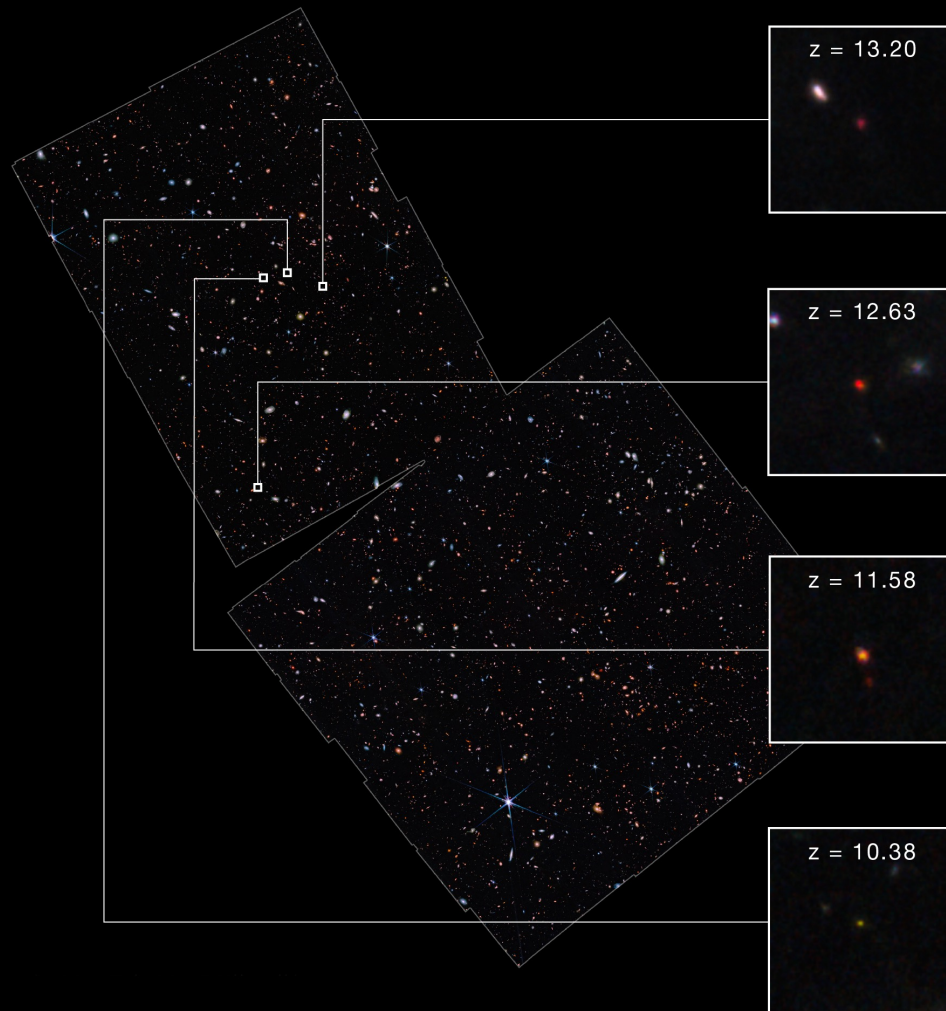


JWST ADVANCED DEEP EXTRAGALACTIC SURVEY (JADES)

WEBB SPECTRA REACH NEW MILESTONE IN REDSHIFT FRONTIER

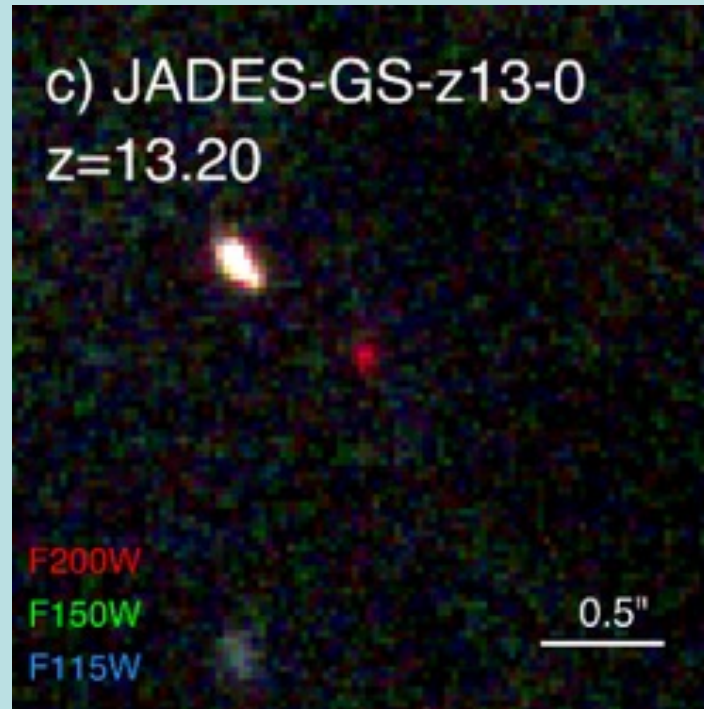
NIRCam Imaging

NIRSpec Microshutter Array Spectroscopy



WEBB
SPACE TELESCOPE





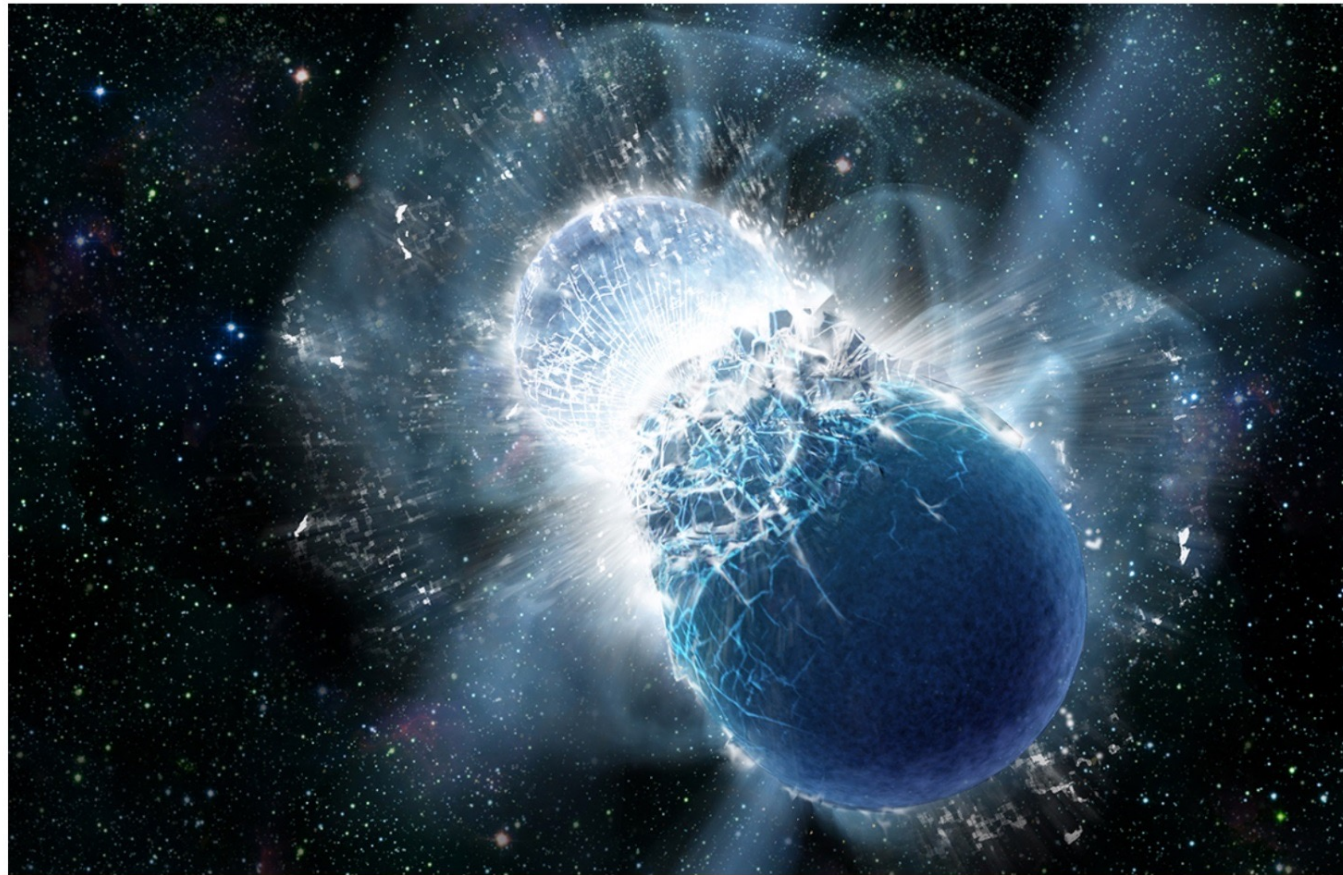
Of the four, the most distant is one with the somewhat unwieldy name JADES-GS-z13-0. It has a redshift value of 13.2, meaning we are seeing the galaxy as it appeared just **320 million** years after the big bang. That high redshift makes JADES-GS-z13-0 the most distant currently known in the universe

It is an exciting time to be a scientist!

做科學很令人興奮!

DAILY NEWS 23 August 2017, updated 23 August 2017

Exclusive: We may have detected a new kind of gravitational wave



Anthropic launches AI tool that can conduct scientific experiments

Claude chatbot maker unveils a system that autonomously operates a wide range of devices in laboratories

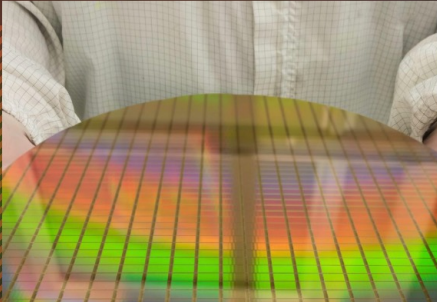


Anthropic says its new tool enables AI agents to autonomously operate devices ranging from complex microscopes to liquid handlers, lasers and robotic arms © Anthropic

科學家還有其他職涯的可能：加強數理與英文能力

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節目 知識好好玩

EP08 | 台灣這美麗的矽島——聊一聊半導體物理

主持人 | 張嘉泓

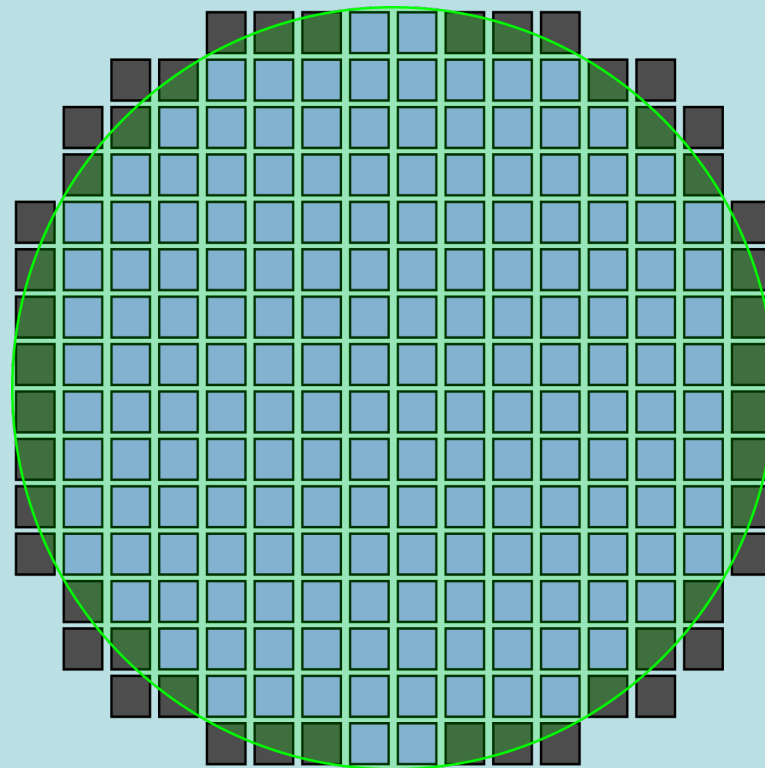
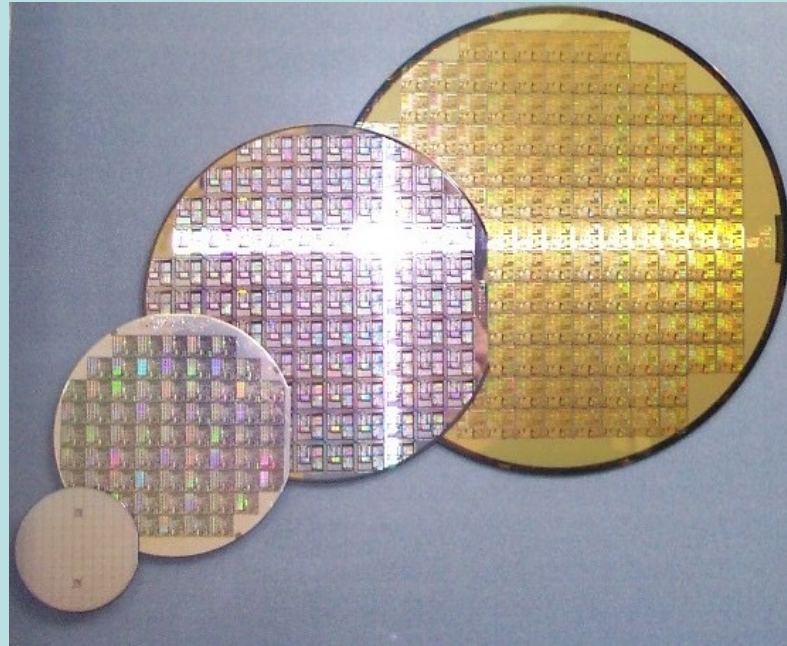
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以上所描述的電晶體配置有一個很長的名字：金屬氧化物半導體、場效型電晶體 MOSFET，比起傳統的雙極型電晶體，場效電晶體更適合於平面的半導體大量製造，而且體積可以極度縮小。如上所述，場效電晶體的主體是由p型與n型半導體分布組成，這個分布可以規劃在二維平面上，於是由電晶體所組成的電路就可以在一片平板上展開。製作時會以矽為晶片基板，第一步先全部摻雜為p型半導體。接著先設計好藍圖，在平面上安排出n型半導體的位置。第三步，在基板上塗一層感光的光阻劑，然後將設計畫在一片光罩上，當光罩放置於基板上時，光罩的圖案會遮蓋規劃為p型半導體的區域。接著以紫外線曝照，消除掉光罩圖案未遮蓋處的光阻劑，於是規劃為n型半導體區域的基板就曝露在外。最後，將此曝露的部分滲進適當雜質，就得到所設計的n型半導體分布，而光阻劑覆蓋的部分則維持原來的p型。利用這樣的製程就可以在晶片上建構出你所設計的分布，其他如絕緣層、導電線路與電極也可以用類似的方式往上堆疊建構。

上一段描述是不是讓你感覺很枯燥、很機械化？那就對了，一個接著一個的步驟，有條不紊，如此，就可以大量機械化生產。而且平面化的設計，可以將電路非常節省空間地集中在一塊小晶片上，這就稱為積體電路。它的最大好處在於，只要你的藍圖光罩夠精細，電晶體的大小幾乎可以無限地縮小。如此我們才能把驚人的計算能力，置於一個日常生活能夠輕鬆攜帶的裝置。積體電路在1960年代出現，大概從

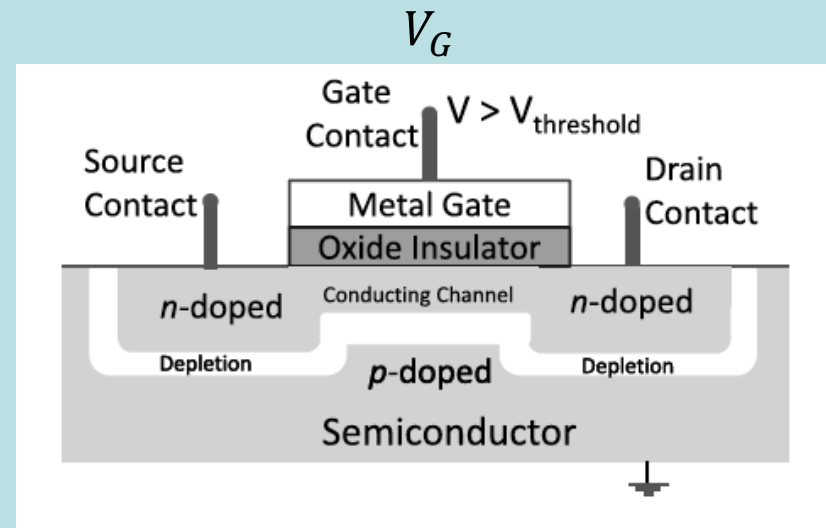
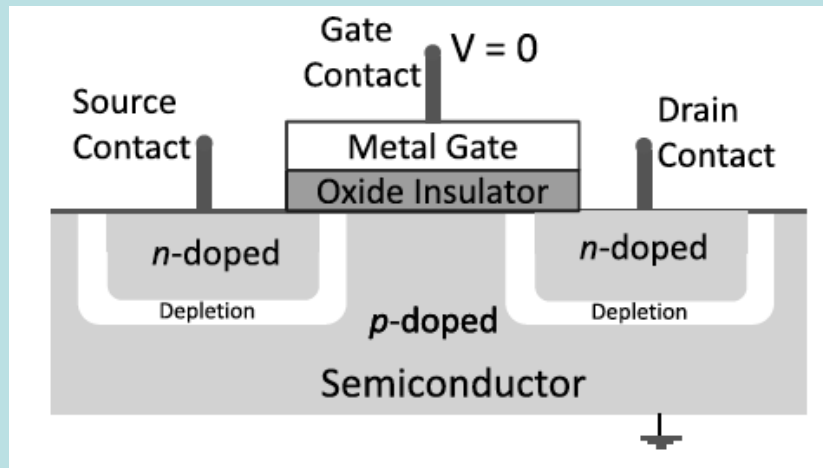








EUV stands for extreme ultraviolet light, which produces the circuitry.



如此以閘電壓 V_G 做為條件，來控制電壓 V_S 是否能產生 I_S 。

如果電壓 V_G 很小而且有訊號，電壓 V_S 很大，所產生的大 I_S 就會攜帶訊號。

