Imperial College London

Space; Enabler for Science

David Southwood
Blackett Laboratory, Imperial College London
and
Chair, Institute for Space Policy and Law

1. Answering the question how Space enables Science is straightforward. With the space age the capacity arrived to do things in space led to two immediate uses: military and scientific. Indeed, the space emerged under the aegis of science : the International Geophysical Year.

2. The science revealed by planetary missions like Venus Express, Mars Express and Cassini at Saturn often overturned theory (or maybe, led to strong revision). At the same time, the results often can be brought back to help understanding of Earth.

3. Space astronomy doesn't provide in situ information about the bodies studied but space had an enormous impact by allowing telescopes above the atmosphere to function at all em wavelengths without light being absorbed or scattered. Whole areas of new astronomy emerged. An example is the Herschel infra red observatory. The name subtly indicating the utility of astronomy. He discovered from astronomical observation that infrared light existed.

4. Space science can be an enabler for other space activity. The first satellite navigation system emerged directly from the purely scientific challenge of establishing the orbit of Sputnik. Two US military scientists cracked the problem in their spare time. Their boss realised inverting the problem could be used for location determination by the Polaris submarine deterrent system.

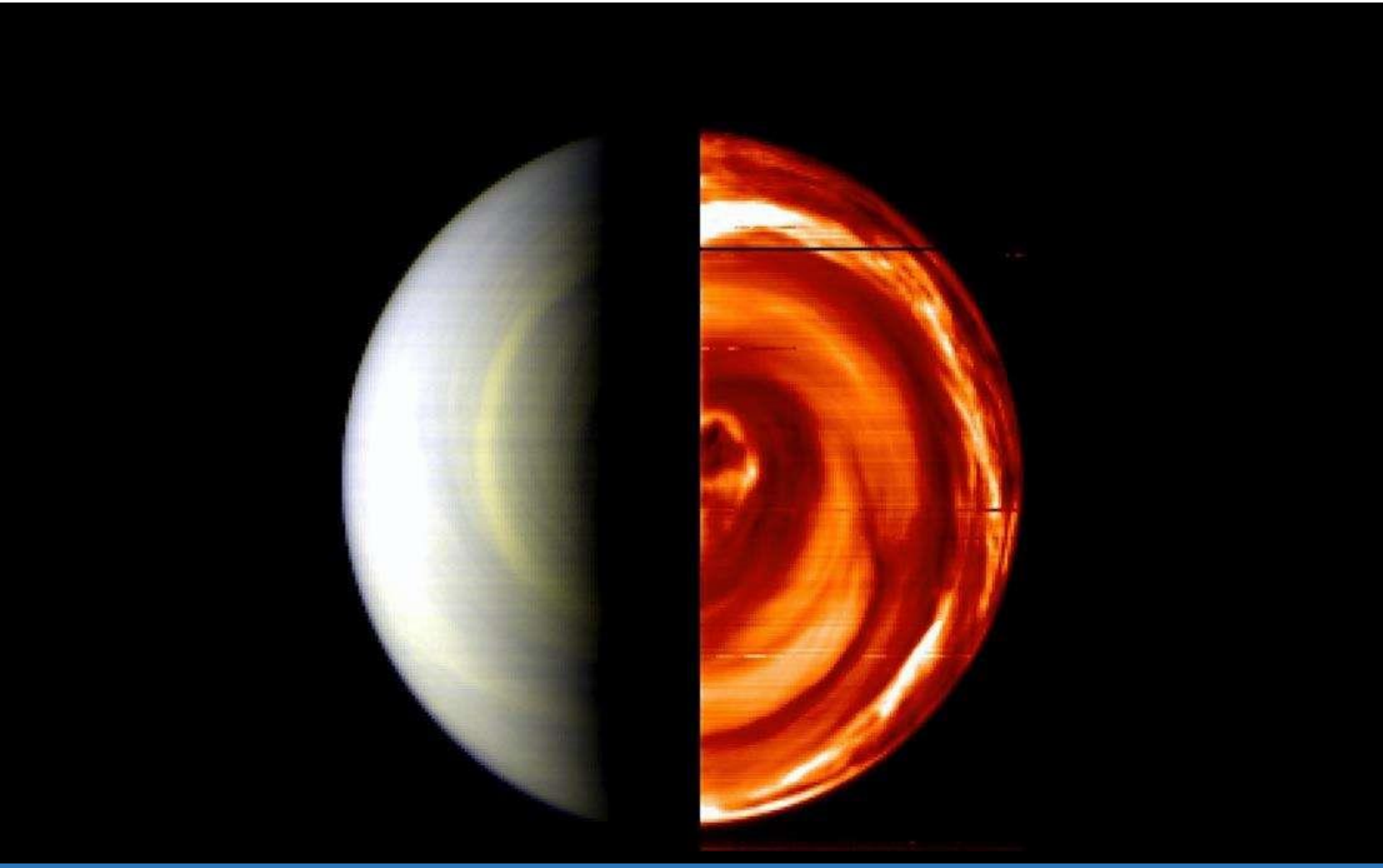
5. However, historically space science has also lead in directions perhaps unexpected today. Lloyd Berkner one of the architects of the IGY wrote as president of the US National Academy of sciences in 1961 to James Webb, head of NASA, to endorse human exploration of Moon (and planets) as the primary goal for NASA. A year later President Kennedy declared that the US would land a human on the Moon within a decade.

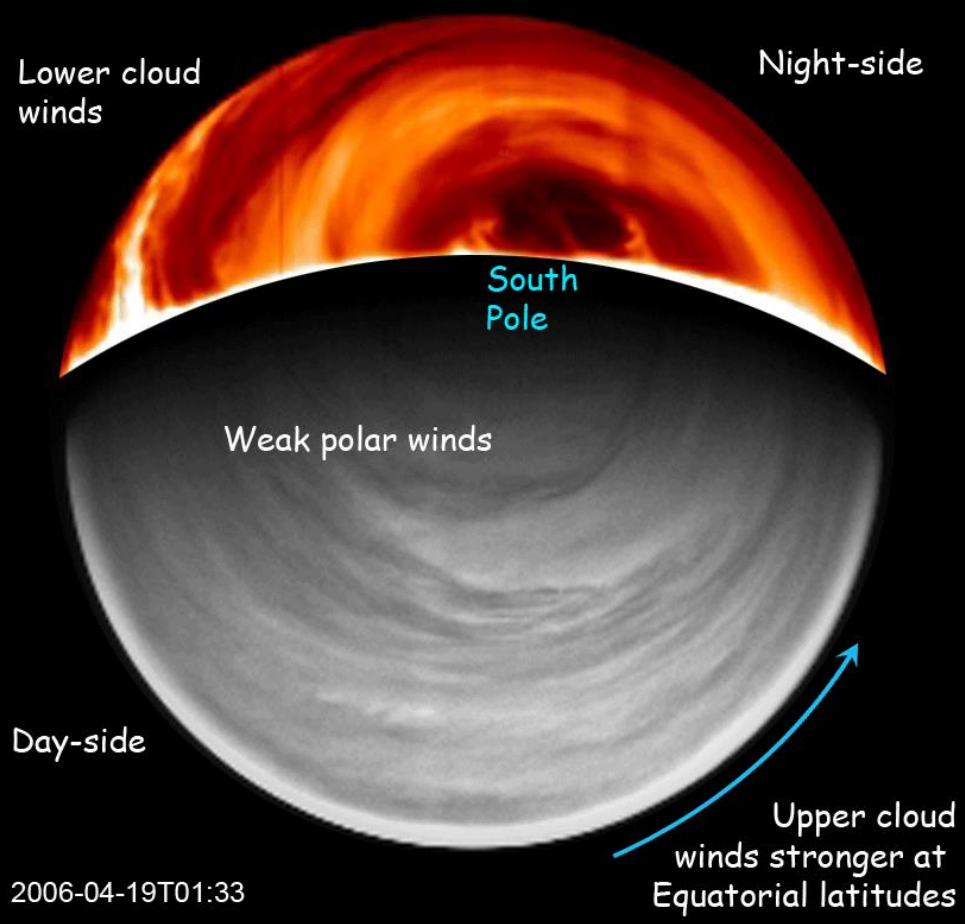
6. Space may well be the enabler of science but nowadays, scientists need heed what constraints are imposed by the mode oaf access. If there had not been a European rocket available to launch the Herschel 4m diameter mirror, the scientific harvest of Herschel would not have occurred.

7. If space changes, so must science. NewSpace is potentially going to radically change how space is done. Cheaper access to space may come but it means what science can demand may need to move with the changing environment.

8. The innovative business model of the Twinkle astronomy mission needs to be examined carefully as a potentially distinct new way to do space astronomy.

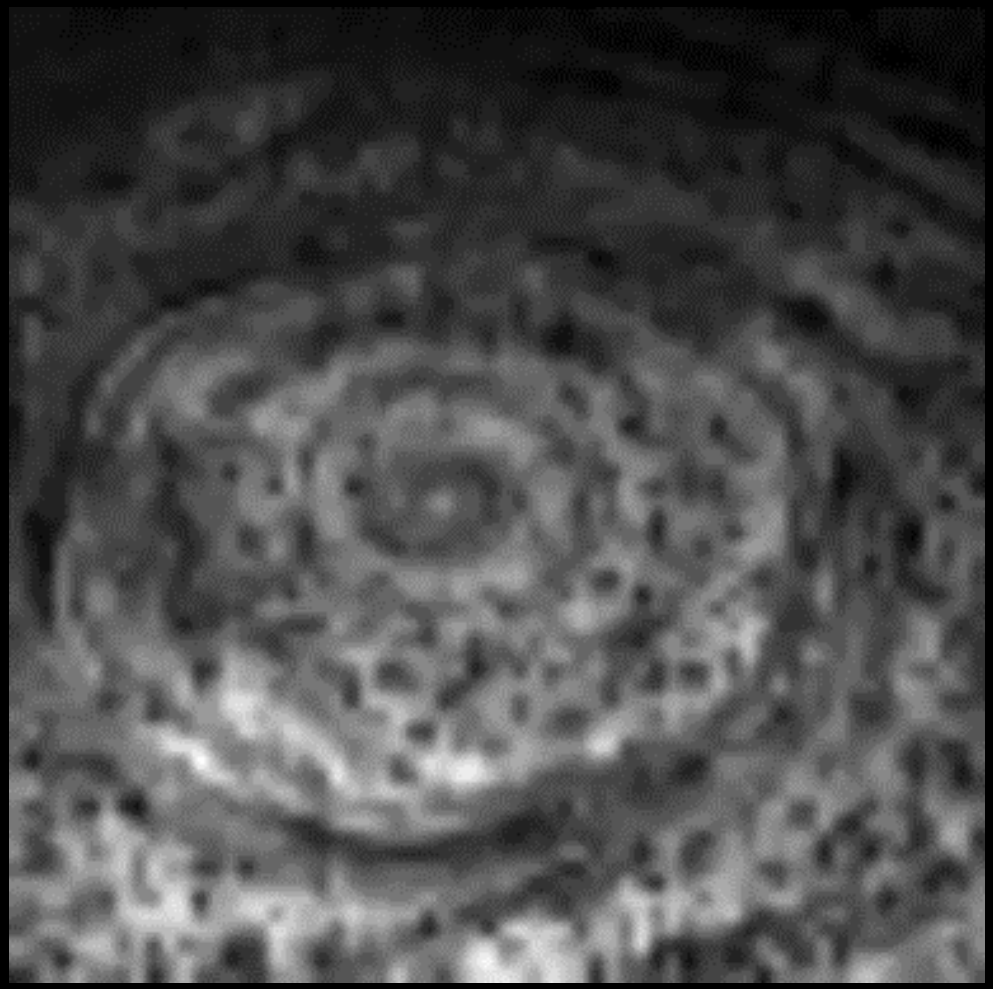
9. Similarly, creative ideas are emerging for lunar and planetary exploration.





Atmospheric winds in the clouds of Venus

Image credit ESA: Venus Express

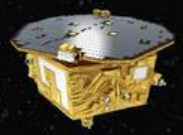


Saturn North Polar Vortex

Image credit NASA

→ ESA'S FLEET ACROSS THE SPECTRUM

Thanks to cutting edge technology, astronomy is unveiling a new world around us. With ESA's fleet of spacecraft, we can explore the full spectrum of light and probe the fundamental physics that underly our entire Universe. From cool and dusty star formation revealed only at infrared wavelengths, to hot and violent high-energy phenomena, ESA missions are charting our cosmos and even looking back to the dawn of time to discover more about our place in space.

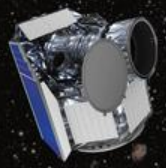


lisa pathfinder
Testing the technology for gravitational wave detection

jwst
Observing the first light

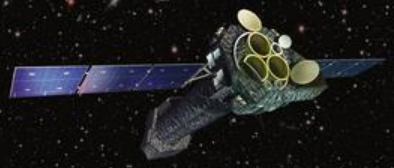
herschel
Unveiling the cool and dusty Universe

cheops
Characterising exoplanets

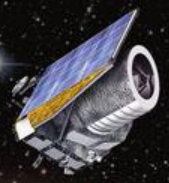


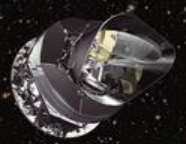
gaia
Surveying a billion stars

xmm-newton
Seeing deeply into the hot and violent Universe



euclid
Exploring the dark Universe

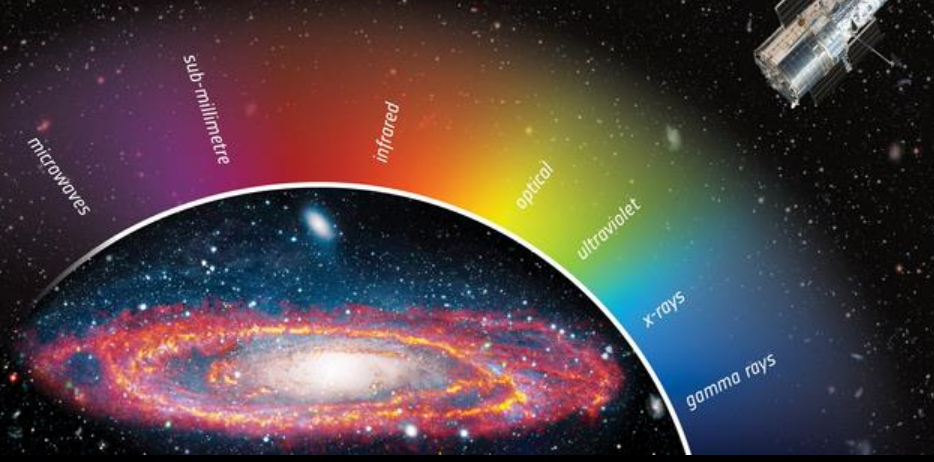


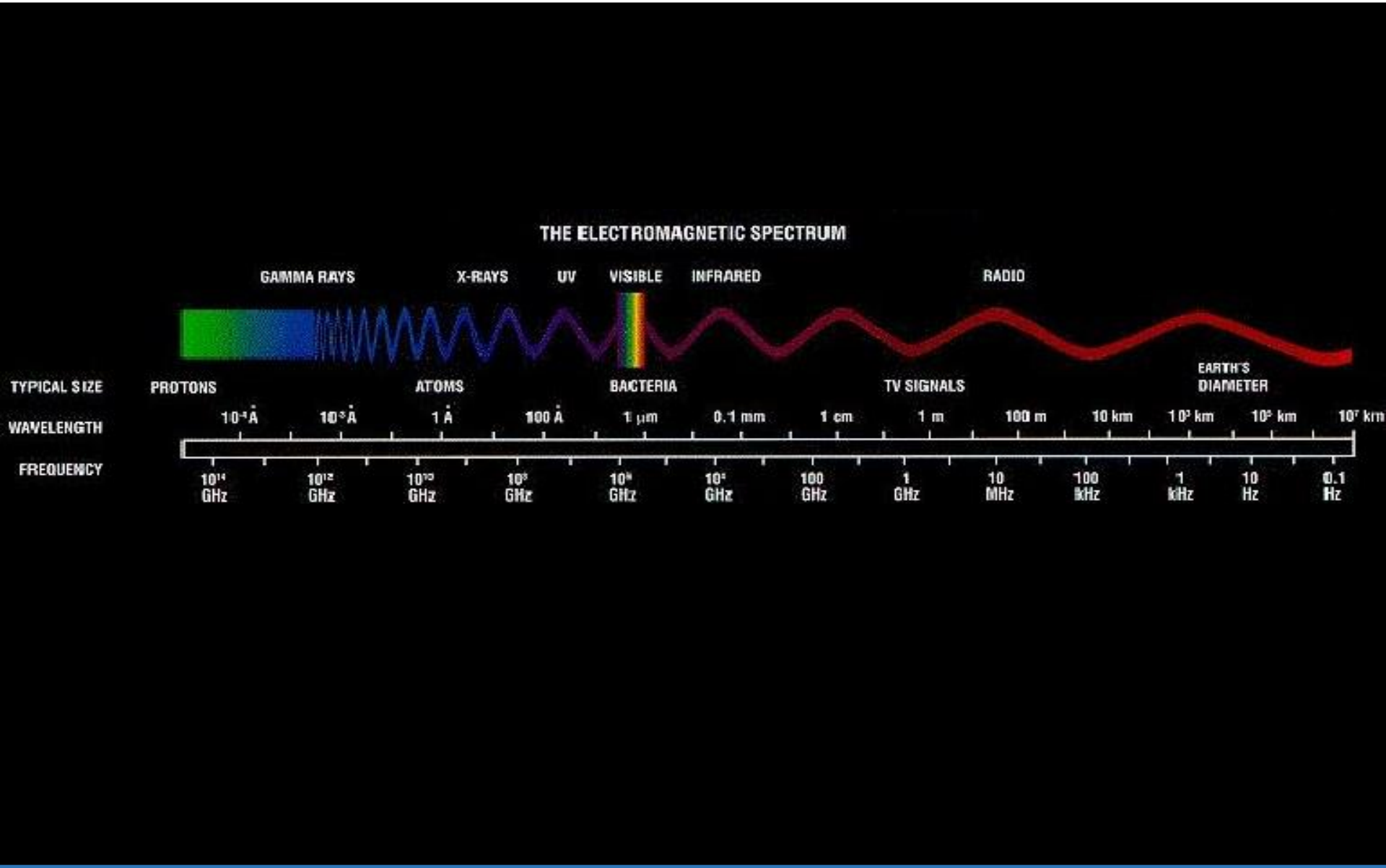


planck
Looking back at the dawn of time

hst
Expanding the frontiers of the visible Universe

integral
Seeking out the extremes of the Universe




THE ELECTROMAGNETIC SPECTRUM
GAMMA RAYS
X-RAYS
UV
VISIBLE
INFRARED
RADIO
TYPICAL SIZE
PROTONS
ATOMS
BACTERIA
TV SIGNALS
EARTH'S DIAMETER
WAVELENGTH
1 Å
100 Å
1 μm
0.1 mm
1 cm
1 m
100 m
10 km
FREQUENCY
100 GHz
1 GHz
10 MHz
100 kHz
1 kHz
10 Hz
0.1 Hz

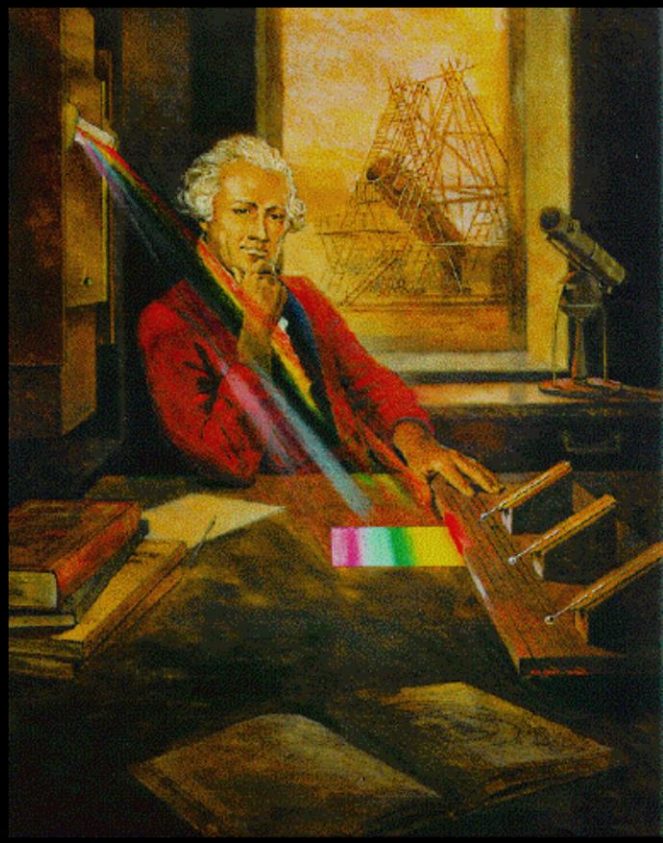
Herschel Space Observatory

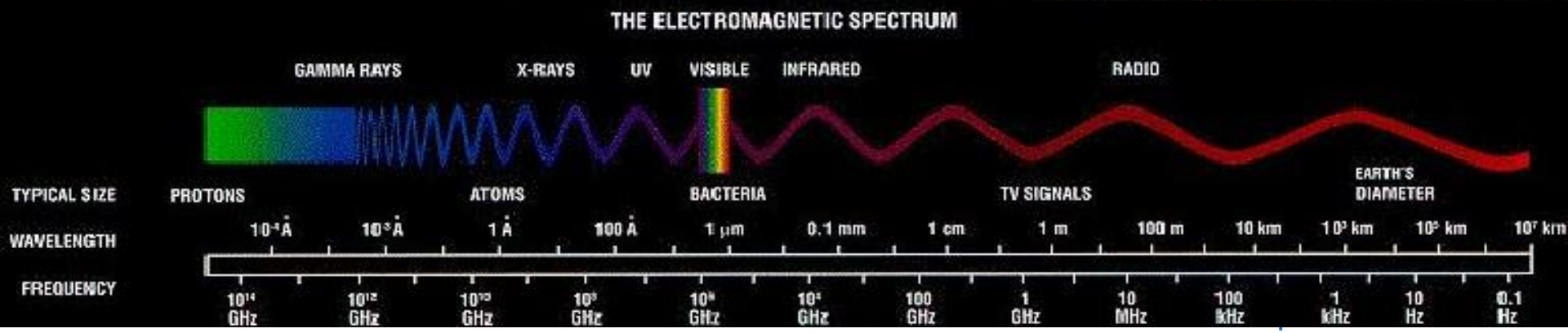
Who was "Herschel "?

Sir William Herschel (1738 – 1822),

Both he and his sister, Caroline, and son, John,
were successful astronomers.

Herschel discovered the existence of infrared light in 1800.





Methane – discovered by Mars Express 2004 confirmed by NASA 2009

THE Sun

Thursday, January 15, 2009 30p thesun.co.uk

FA CUP
SOUTHEND.....1
CHELSEA.....4

PREMIER LEAGUE
MAN UTD.....1
WIGAN.....0
SEE SUNSPORT

SAVE £5.20 OFF SHOPPING WITH CAPTAIN CRUNCH
VOUCHERS: PAGES 36 & 37

Plunge ... Rachel Ward, 20

Ski girl dies in icy river

By NEIL EVSON

A DIET student froze to death looking for her ski chalet in the dark – after falling into a river following a bar crawl.

Rachel Ward, 20, of Halifax, West Yorks, battled to drag herself from the icy water in the French resort of Val d'Isere.

Last night cops quizzing university pals over the horror said she died within minutes.

Full Story – Page Nine

30p WHY PAY MORE FOR LESS?

'Green shoots' uproar

By GRAEME WILSON

GORDON Brown's economic guru sparked fury last night by saying she could see "green shoots" of UK economic recovery – as thousands lost jobs.

Baroness Vadera was accused of crass insensitivity for her remark on a grim day for workers.

Tories said it showed the Business minister was "out of touch" with the

Continued on Page Six

NASA'S HISTORIC DISCOVERY OF METHANE ON THE RED PLANET

LIFE ON MARS

(Well, SOMETHING up there has wind)

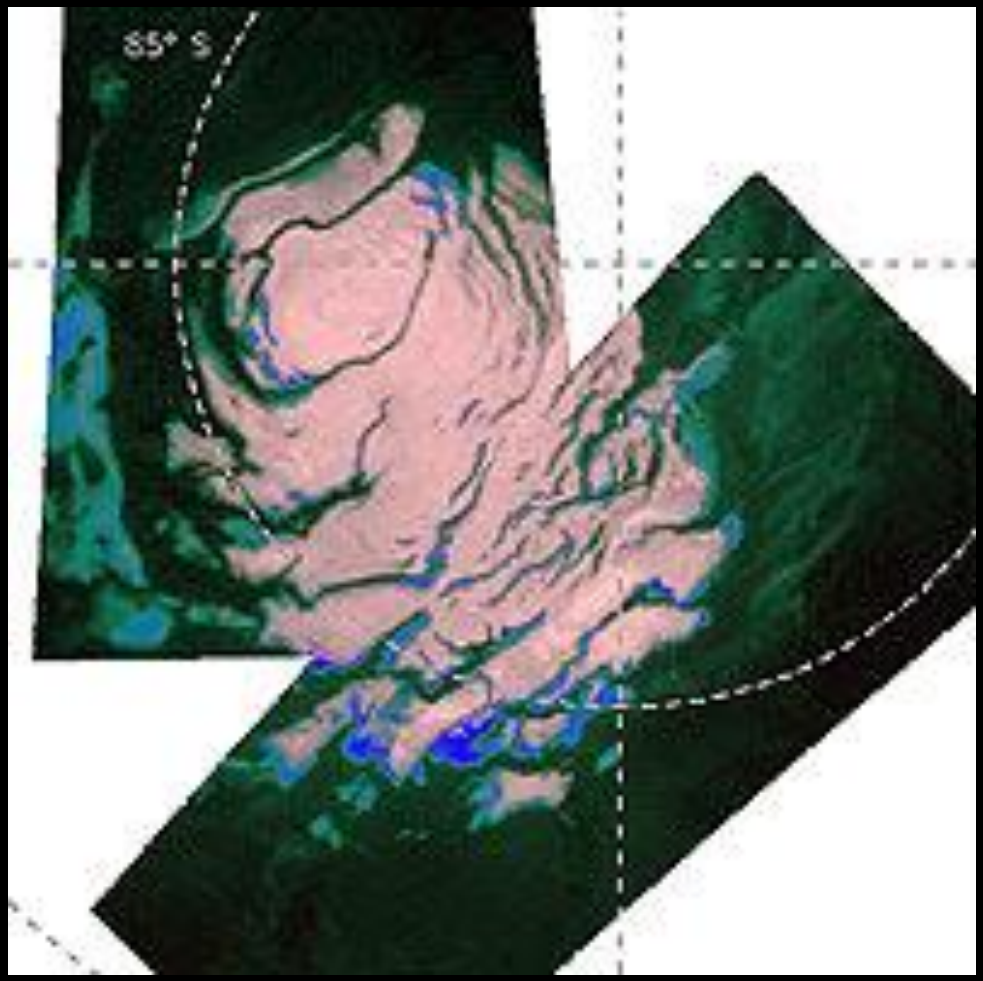
Mission . . . probe on the surface of Mars

EXCLUSIVE by PAUL SUTHERLAND
Sun Scientist

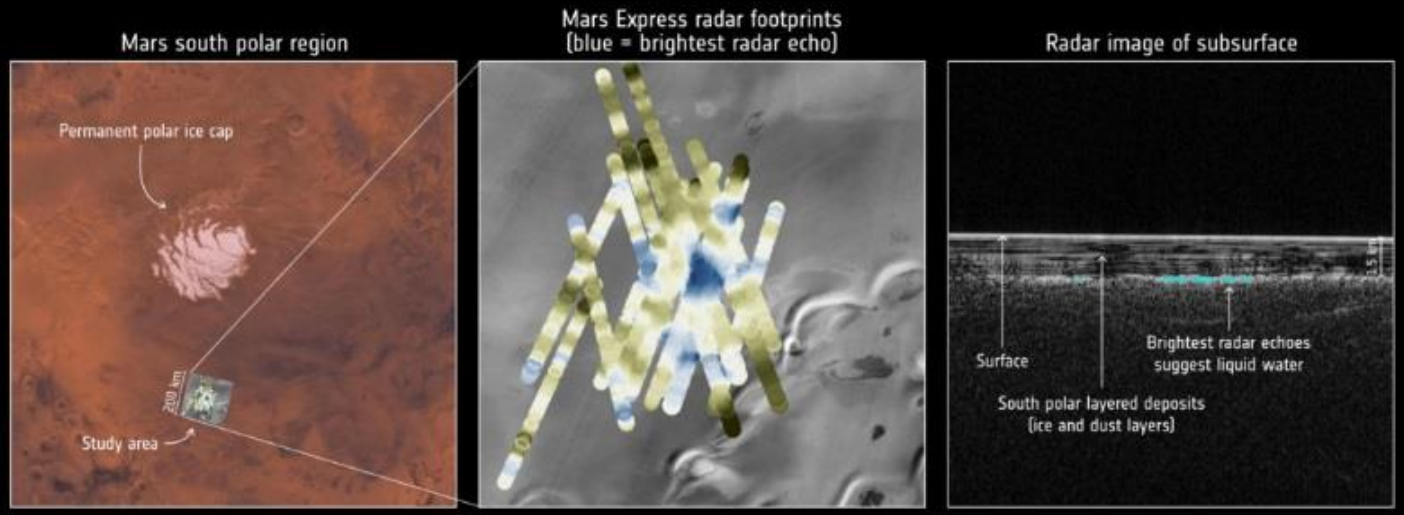
NASA experts will today reveal compelling new evidence that there really IS life on Mars.

Studies of the Red Planet are said to have detected methane gas. Scientists believe it is seeping from organisms living just below the surface.

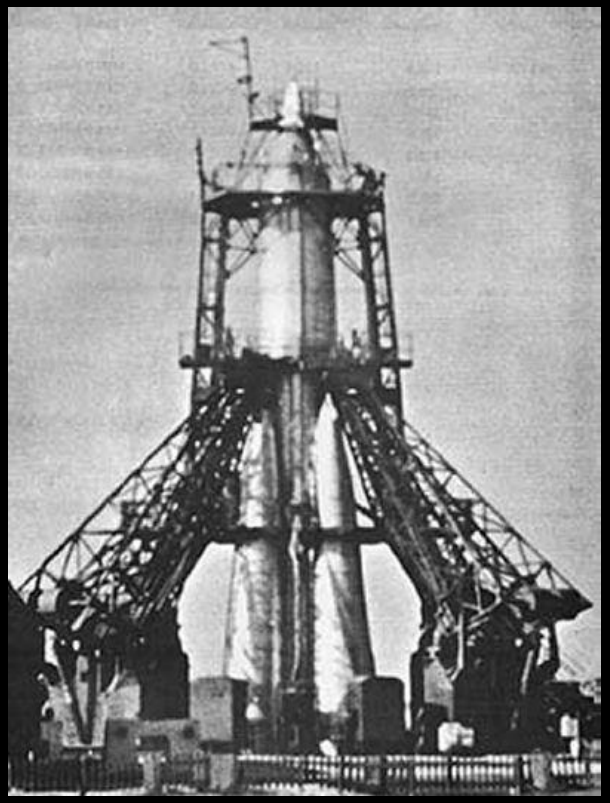
Full Story – Pages Four and Five



Map of the Mars south pole seen in IR light by OMEGA
Area rich in carbon dioxide (light pink),
Water-rich ice, free of carbon dioxide (green to blue).


Mars south polar region
Permanent polar ice cap
200 km
Study area
Mars Express radar footprints
(blue = brightest radar echo)
Radar image of subsurface
Surface
Brightest radar echoes
suggest liquid water
South polar layered deposits
(ice and dust layers)

Science as an enabler for Space?



What connects Sputnik to the car you drive today?

Satellite Navigation – its origins….

International Geophysical Year

→ Launch of Sputnik, October 1957

→ worldwide effort to determine orbit

→ race is won by two US scientists

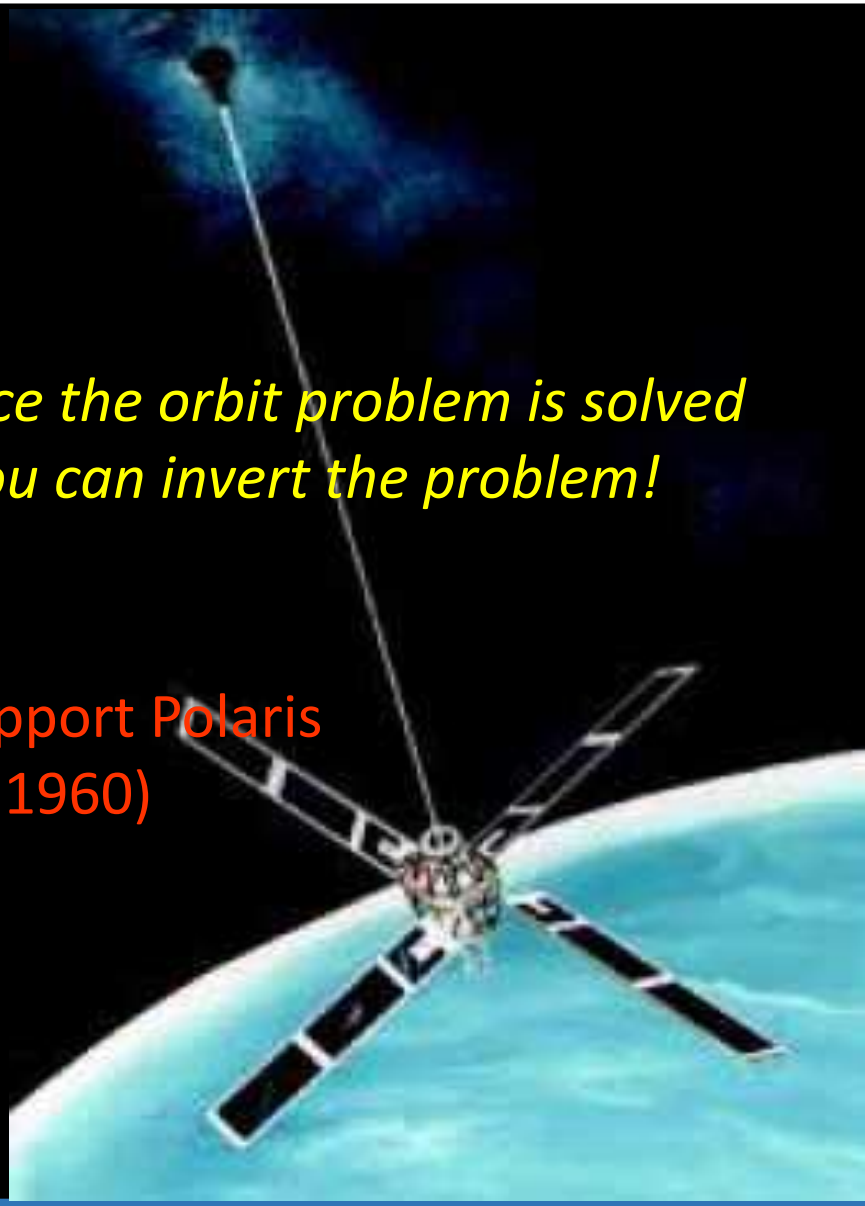
→ who happen to work for US navy

Their boss realises that……

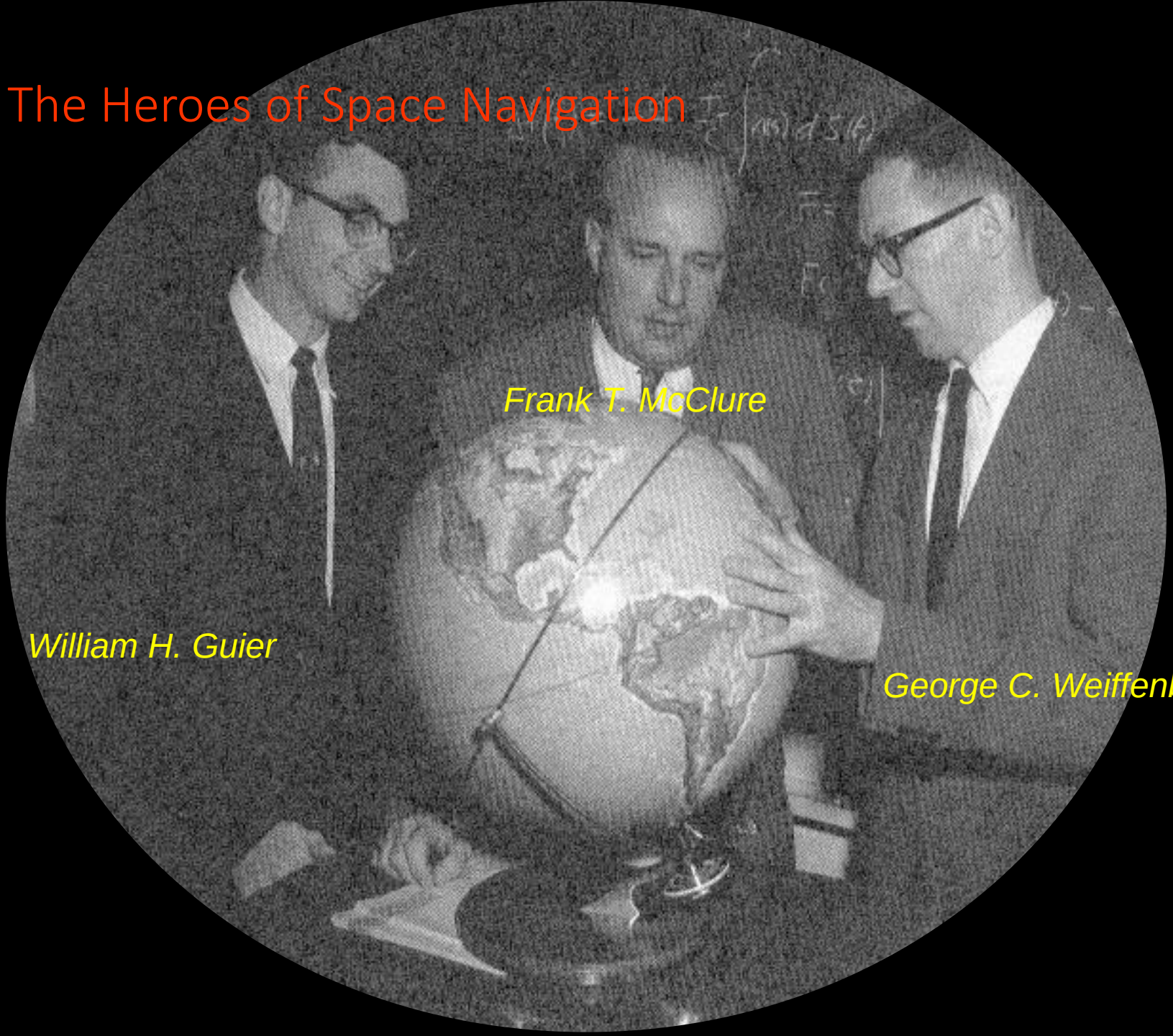
…..once the orbit problem is solved you can invert the problem!

Transit system of satellites built to support Polaris submarine deployment (from 1960)

Civilian use from 1967 !



The Heroes of Space Navigation



Space as an enabler for Science II

SPACE SCIENCE BOARD
National Academy of Sciences
2101 Constitution Avenue
Washington 25, D. C.

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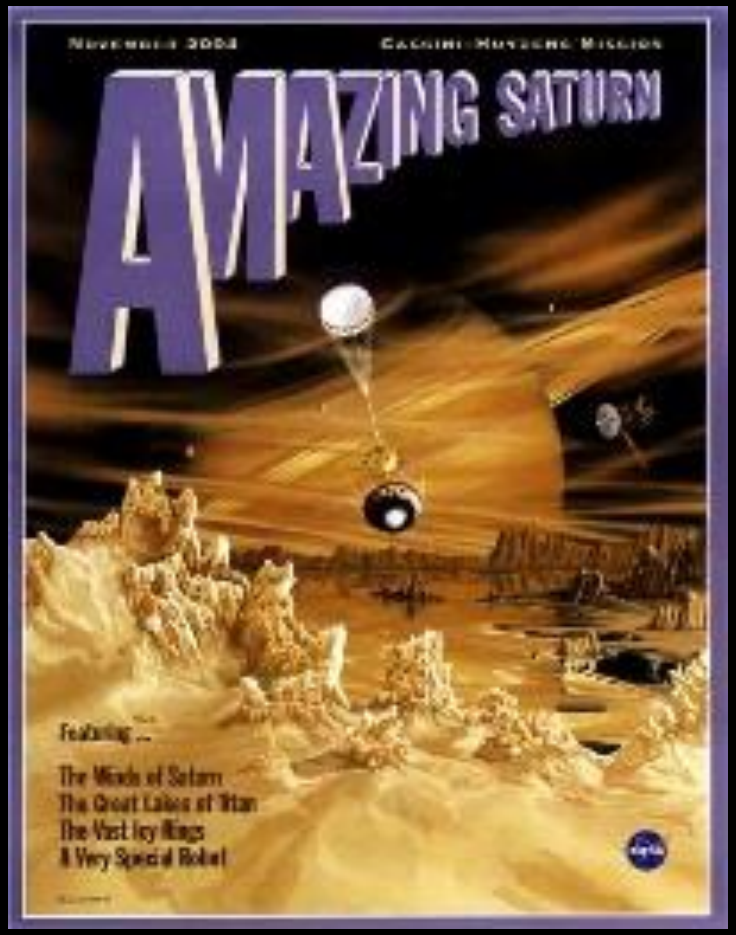
Man's Role in The National Space Program

At [illegible] on February 10 and 11, 1961, the [illegible] Science Board gave particular consideration to the role of man in space in the national space science program. As a result of these deliberations the Board concluded that scientific exploration of the Moon and planets should be clearly stated as the ultimate objective of the U.S. space program for the foreseeable future. This objective should be promptly adopted as the official goal of the United States space program and clearly announced, discussed and supported. In addition, it should be stressed that the United States will continue to press toward a thorough scientific understanding of space, of solving problems of manned space exploration, and of development of applications of space science for man's welfare.

The Board concluded that it is not now possible to decide whether man will be able to accompany early expeditions to the Moon and planets. Many intermediate problems remain to be solved. However, the Board strongly emphasized that planning for scientific exploration of the Moon and planets must at once be developed on the premise that man will be included. Failure to adopt and develop our national program upon this premise will inevitably prevent man's inclusion, and every effort should be made to establish the feasibility of manned space flight at the earliest opportunity.

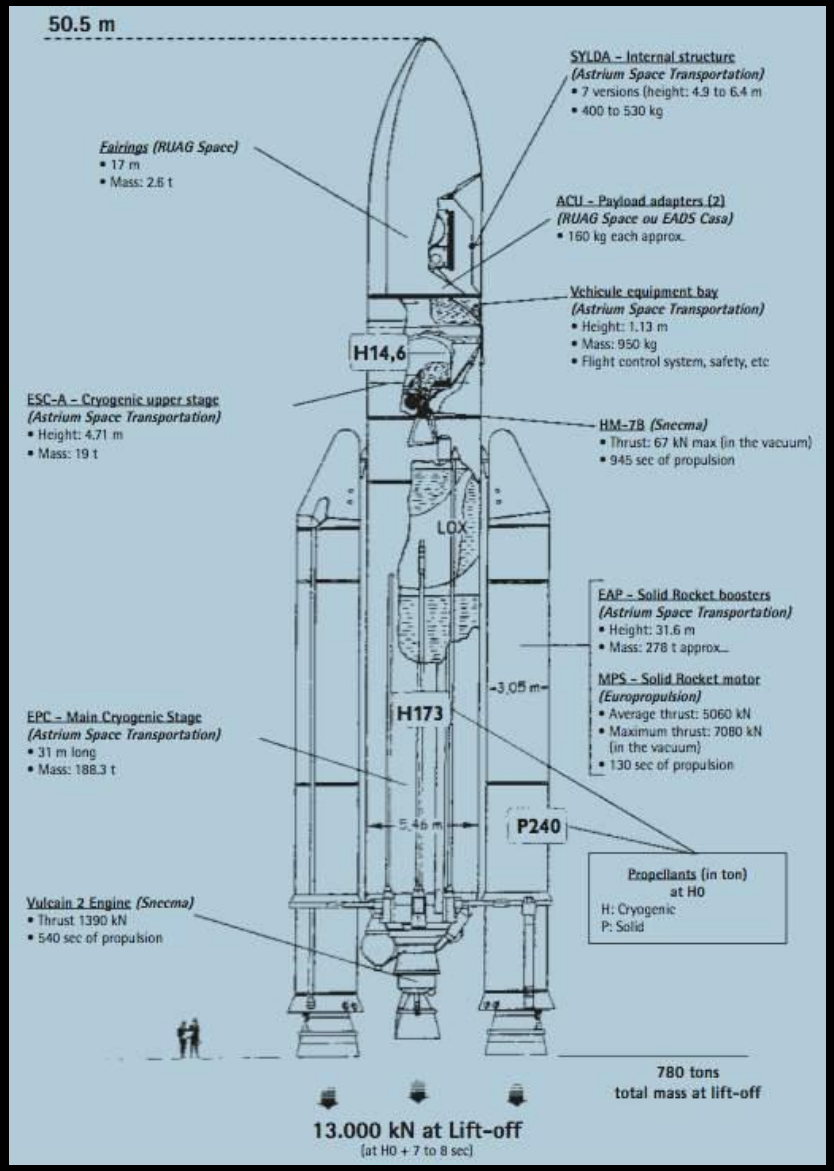
From a scientific standpoint, there seems little room for dissent that man's participation in the exploration of the Moon and planets will be essential, if and when it becomes technologically feasible to include him. Man can contribute critical elements of scientific judgment and discrimination in conducting the scientific exploration of these bodies which can never be fully supplied by his instruments, however complex and sophisticated they may become. Thus, carefully planned and executed manned scientific [illegible] will inevitably [illegible] fruitful. Moreover, the very technical problems of control at very great distances, involving substantial time delays in command signal reception, may make perfection of planetary experiments impossible without manned controls on the vehicles.

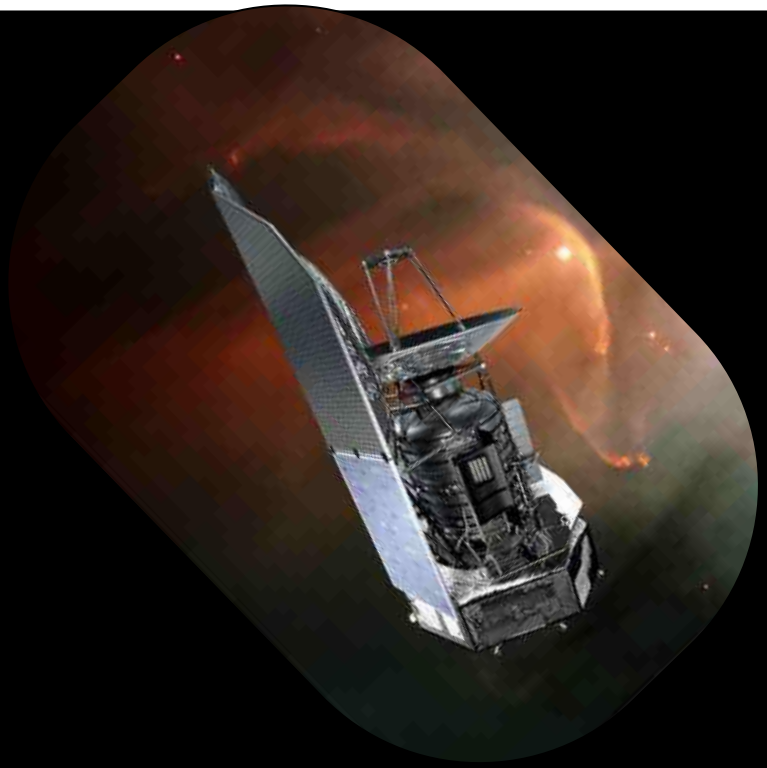
Lloyd Berkner
US National Academy of Sciences


AMAZING SATURN
The Winds of Saturn
The Great Lakes of Titan
The Vast Icy Rings
A Very Special Robot


DAN DARE
PILOT OF THE FUTURE
OPERATION SATURN
TAKE OFF CHECKS, FELLOWS! AND MAKE IT SNAPPY!

Access to space as an enabler for Science





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0.716-0.822 t	2.00 t	2.13 t	2.5 t

European access to space

Where we are now?

The decision to start development of Ariane 6 was taken at the ESA Council at Ministerial level meeting in December 2014, the main motivation being to maintain Europe's leadership in the fast-changing commercial launch service market while also responding to the needs of European independence in accessing and using space

Imperial College London

British access to space: A'Mhoine, Sutherland

New Space?

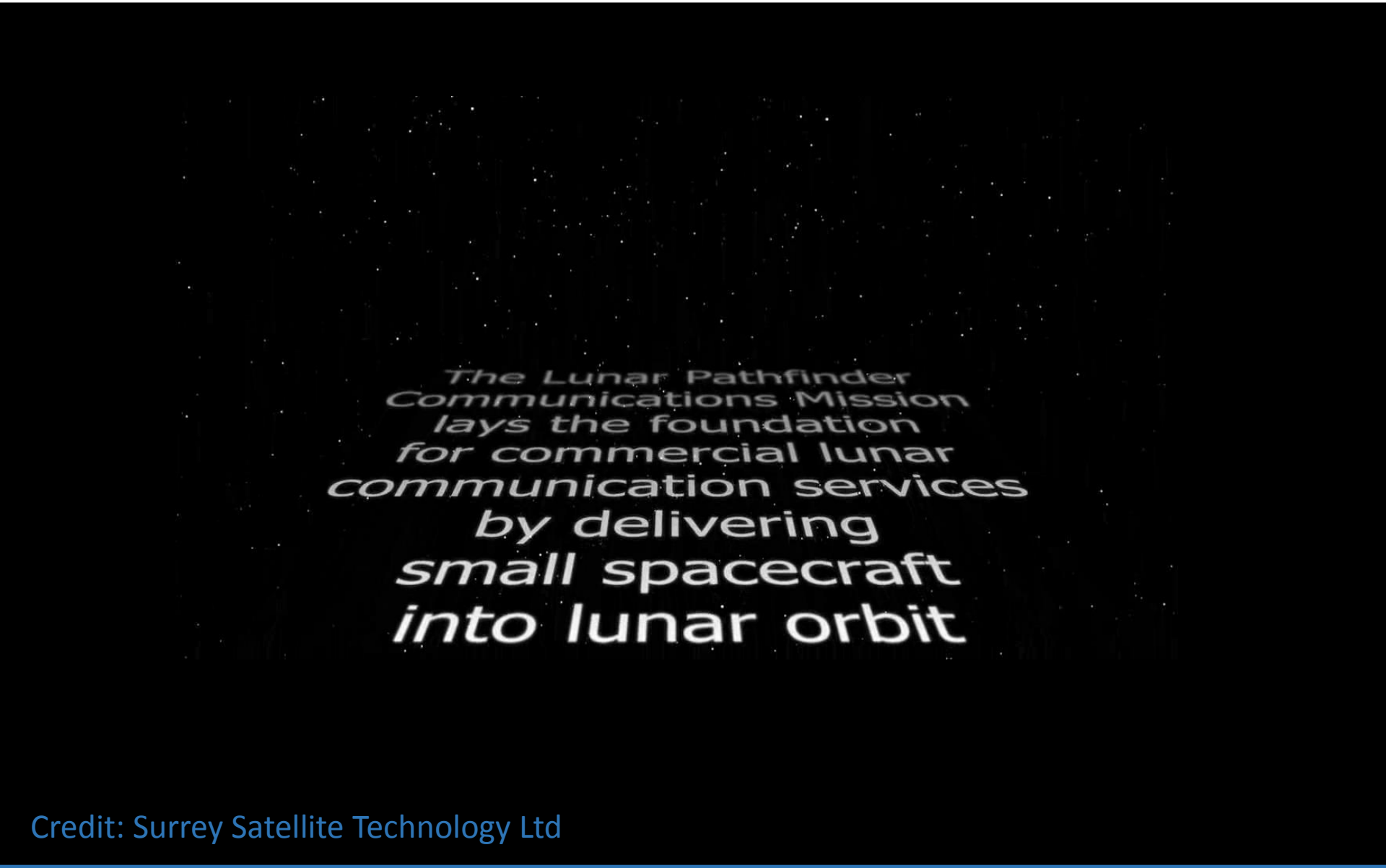
From Wikipedia:

"NewSpace, alt.space, and entrepreneurial space are umbrella terms for a movement and philosophy often affiliated with, but not synonymous with, an emergent private spaceflight industry. Specifically, the terms are used to refer to a community of relatively new aerospace companies working to develop low-cost access to space or spaceflight technologies and advocates of low-cost spaceflight technology and policy."

RE-THINKING SPACE SCIENCE

The growing demand for astronomy data far outstrips the supply from existing and upcoming space observatories. The Twinkle Space Mission will deliver broader access to high-quality infrared spectroscopy for the characterisation of exoplanet atmospheres and solar system objects. Scientists worldwide can secure rapid access to telescope time through Twinkle's unique service-based model.

a new business model for space science missions based upon commercial mission delivery.



Credit: Surrey Satellite Technology Ltd

Credit: Surrey Satellite Technology Ltd