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 electromagnetic 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 of 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 underlie 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.

- **Gaia**
  - Surveying a billion stars

- **Cheops**
  - Characterising exoplanets

- **Lisa Pathfinder**
  - Testing the technology for gravitational wave detection

- **Herschel**
  - Unveiling the cool and dusty Universe

- **JWST**
  - Observing the first light

- **Euclid**
  - Exploring the dark Universe

- **XMM-Newton**
  - Seeing deeply into the hot and violent Universe

- **HST**
  - Expanding the frontiers of the visible Universe

- **Planck**
  - Looking back at the dawn of time

- **Integral**
  - Seeking out the extremes of the Universe

www.esa.int

European Space Agency
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
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).
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

William H. Guier

Frank T. McClure

George C. Weiffenbach
Space as an enabler for Science II
US National Academy of Sciences
Lloyd Berkner

On the planets, peripheries, or outer edges of our solar system, the study of planets and their moons can provide insights into the formation and evolution of our solar system. The study of planets and their moons can help us understand the processes that have shaped our solar system. The study of planets and their moons can also help us understand the potential for life on other planets. The study of planets and their moons can also help us understand the potential for resource extraction on other planets. The study of planets and their moons can also help us understand the potential for space tourism. The study of planets and their moons can also help us understand the potential for space exploration. The study of planets and their moons can also help us understand the potential for space colonization. The study of planets and their moons can also help us understand the potential for space defense. The study of planets and their moons can also help us understand the potential for space weather. The study of planets and their moons can also help us understand the potential for space communication. The study of planets and their moons can also help us understand the potential for space transportation. The study of planets and their moons can also help us understand the potential for space mining. The study of planets and their moons can also help us understand the potential for space manufacturing. The study of planets and their moons can also help us understand the potential for space energy. The study of planets and their moons can also help us understand the potential for space agriculture. The study of planets and their moons can also help us understand the potential for space tourism. The study of planets and their moons can also help us understand the potential for space exploration. The study of planets and their moons can also help us understand the potential for space colonization. The study of planets and their moons can also help us understand the potential for space defense. The study of planets and their moons can also help us understand the potential for space weather. The study of planets and their moons can also help us understand the potential for space communication. The study of planets and their moons can also help us understand the potential for space transportation. The study of planets and their moons can also help us understand the potential for space mining. The study of planets and their moons can also help us understand the potential for space manufacturing. The study of planets and their moons can also help us understand the potential for space energy. The study of planets and their moons can also help us understand the potential for space agriculture.

The study of planets and their moons can also help us understand the potential for space weather. The study of planets and their moons can also help us understand the potential for space communication. The study of planets and their moons can also help us understand the potential for space transportation. The study of planets and their moons can also help us understand the potential for space mining. The study of planets and their moons can also help us understand the potential for space manufacturing. The study of planets and their moons can also help us understand the potential for space energy. The study of planets and their moons can also help us understand the potential for space agriculture. The study of planets and their moons can also help us understand the potential for space tourism. The study of planets and their moons can also help us understand the potential for space exploration. The study of planets and their moons can also help us understand the potential for space colonization. The study of planets and their moons can also help us understand the potential for space defense. The study of planets and their moons can also help us understand the potential for space weather. The study of planets and their moons can also help us understand the potential for space communication. The study of planets and their moons can also help us understand the potential for space transportation. The study of planets and their moons can also help us understand the potential for space mining. The study of planets and their moons can also help us understand the potential for space manufacturing. The study of planets and their moons can also help us understand the potential for space energy. The study of planets and their moons can also help us understand the potential for space agriculture.
Access to space as an enabler for Science
**Speltra**

- **Fairing**
  - Short: 5.4 m, 2.00 t
  - Medium: 5.4 m, 2.13 t
  - Long: 5.4 m, 2.5 t
  - Propellant:
    - O₂: Liquid
    - H₂: Liquid
  - Thrust: 5.000 kN at 40 sec
  - Maximum推:$3030\text{ kN}$

---

**Vehicle equipment box**

- Height: 14.3 m
- Mass: 950 kg
- Flight control system, etc.

---

**VLD/ — Internal Lettering**

- Payload adapters [12]
  - 100 kg each approx.
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.
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.”
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.

**TWINKLE**
ADVANCED SCIENCE
GUARANTEED TELESCOPE TIME

**RE-THINKING SPACE SCIENCE**

a new business model for space science missions based upon commercial mission delivery.
The Lunar Pathfinder Communications Mission lays the foundation for commercial lunar communication services by delivering small spacecraft into lunar orbit.

Credit: Surrey Satellite Technology Ltd
Lowering of orbital altitude to customer missions deployment orbit

Credit: Surrey Satellite Technology Ltd