Astronomy from the Moon

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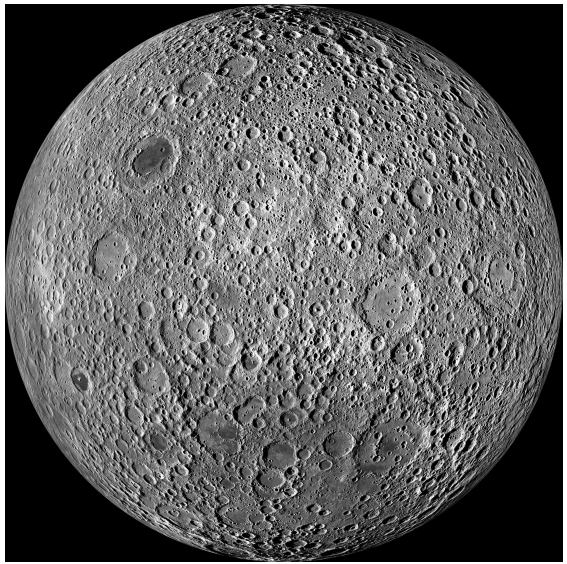
Sites of Extraordinary Scientific Importance (SESIs)

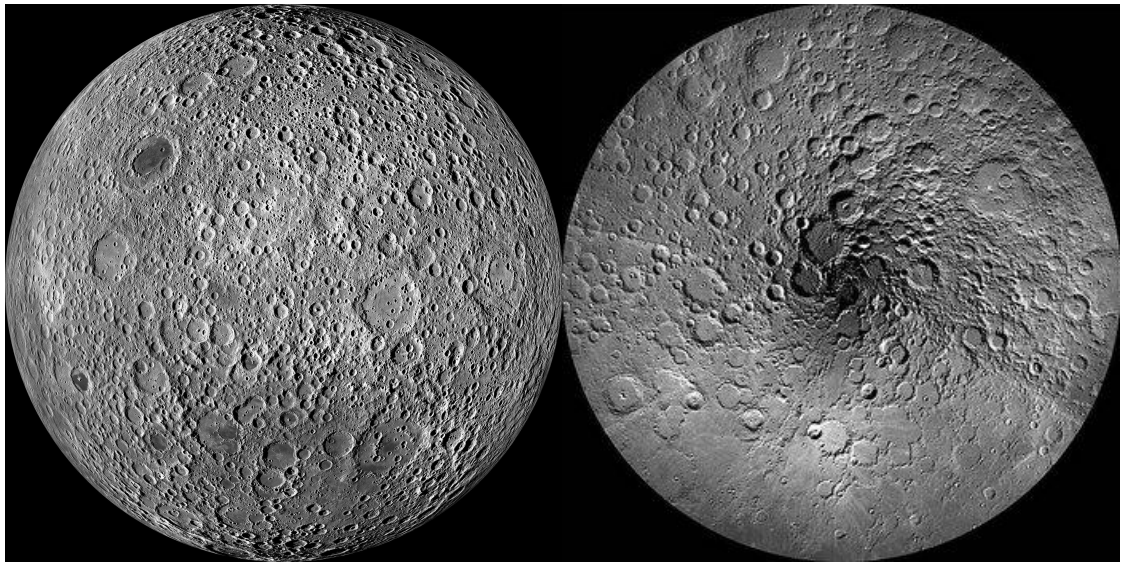
★ Farside of the Moon



Left: Farside of the Moon. Image Credit: NASA/Goddard/Arizona State University.

Sites of Extraordinary Scientific Importance (SESIs)

- ★ Farside of the Moon
- ★ Craters at the lunar poles

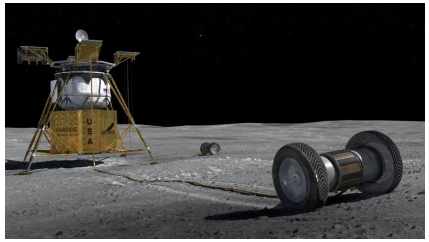


Left: Farside of the Moon. Image Credit: NASA/Goddard/Arizona State University.
Right: Lunar South Pole. Image Credit: United States Geological Survey, 2015.

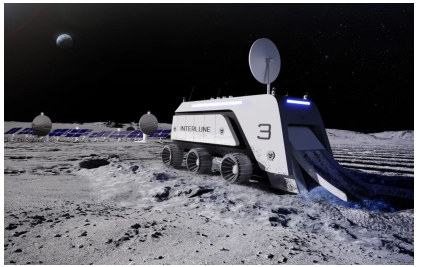
Sites of Extraordinary Scientific Importance (SESIs)

★ Farside of the Moon
★ Craters at the lunar poles

- Concentrated in valuable raw materials
  - Water, Helium-3, rare-Earth elements, heavy elements, radioactive elements



Scientific experiments vs. Commercial missions



Moon farside

- ★ Shielded by human made radio interference (RFI) by 80 dB
- ★ Sensitive low frequency radio observations

  (50 – 100 MHz)

  - ○ Breakthrough discoveries in cosmology & fundamental physics
  - ○ 21-cm hydrogen signal of the **Dark Ages**, before stars and galaxies

Farside large areas of smooth terrain

- > 200 km diameter
- need large smooth areas
- with slopes < 15° for rovers
- BUT farside is mountainous

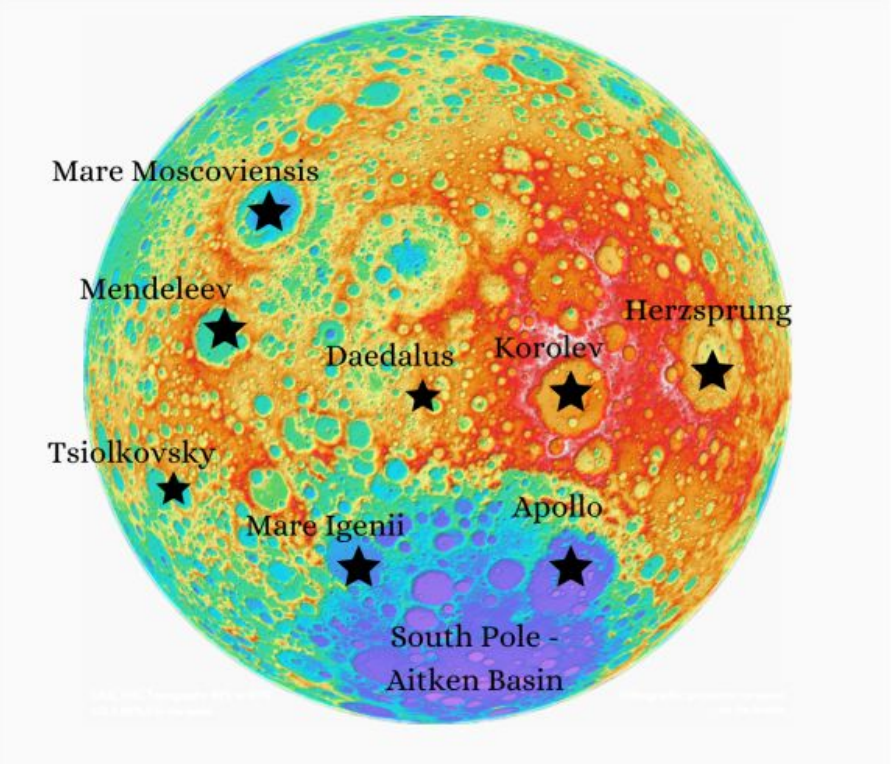


Image credit: Le Conte, Elvis & Gläser, 2023

Lunar cold traps

- Permanently shadowed craters at the lunar poles
- Diameter: 50 km
- T < 50 Kelvin in the coldest traps

Shoemaker Crater, lunar south pole. Image credit: ESA

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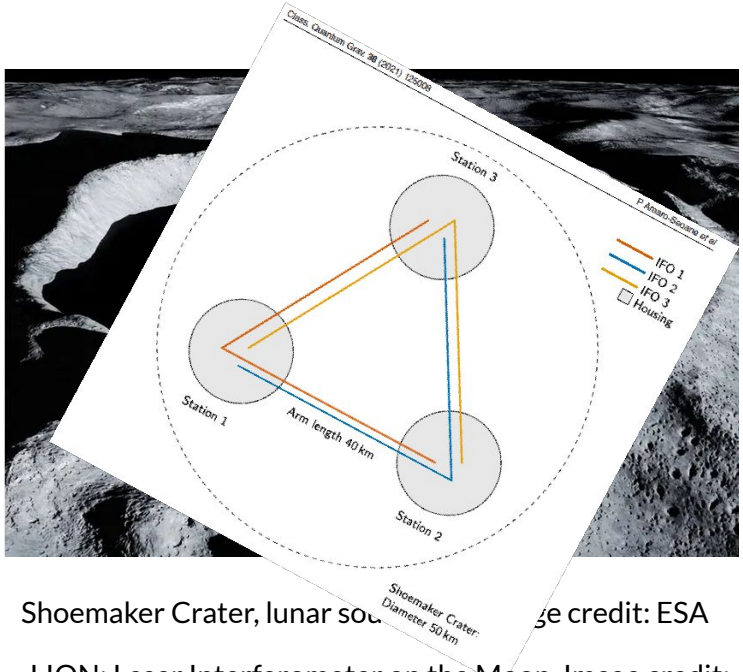

Shoemaker Crater, lunar so… …ge credit: ESA

LION: Laser Interferometer on the Moon. Image credit: Amaro-Seoane+2021

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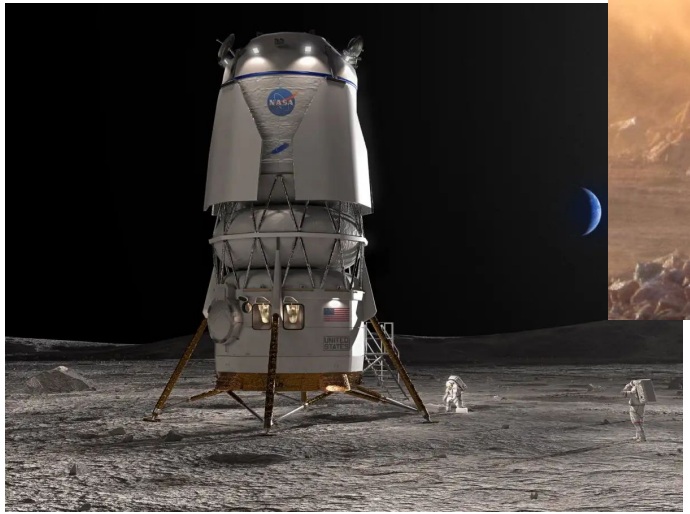
● Water ice signatures, volatiles

Shoemaker Crater, lunar south pole. Image credit: ESA

Threats to science objectives

- Mining
- Landing Rockets

dirty (dust lofting), noisy



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- Artificial electromagnetic noise
    - Satellite networks
    - Instrumentation on the surface

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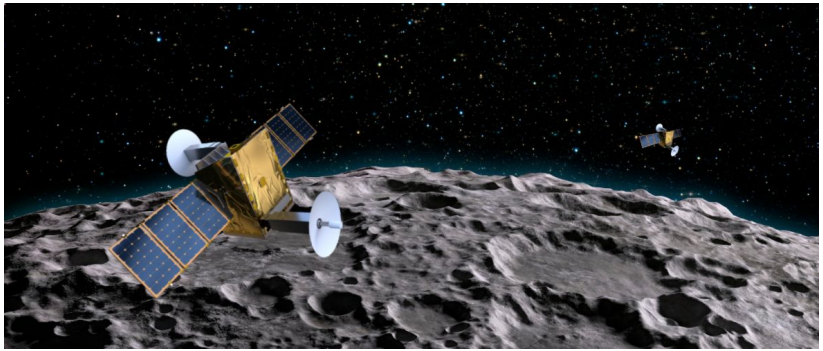

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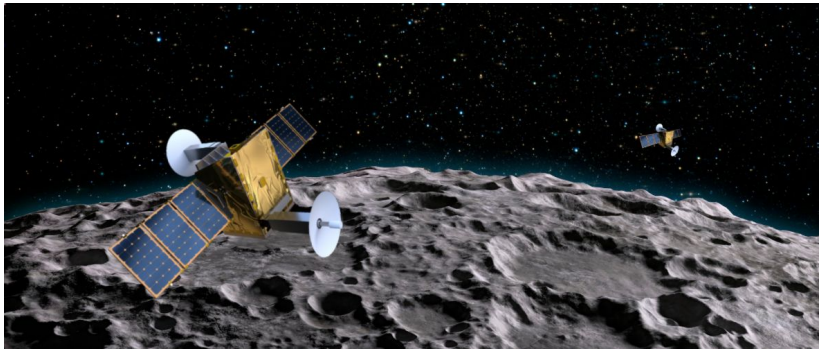
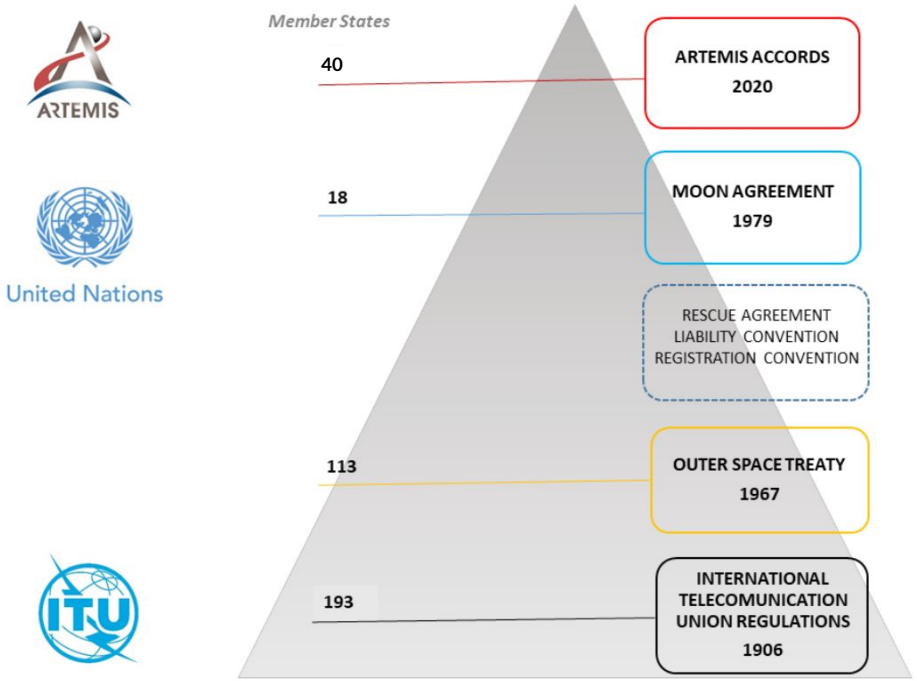
need Faraday screen!



Policy framework



Need for a new governance structure!

- No explicit protection/prioritization of lunar science by the existing law of outer space
- The mechanisms of all missions to break the radio silence of the farside
- There should be **zones exclusively dedicated to science in global agreement!**
  - ★ The most valuable SESIs
- **Technical requirements to keep the lunar farside radio quiet!**

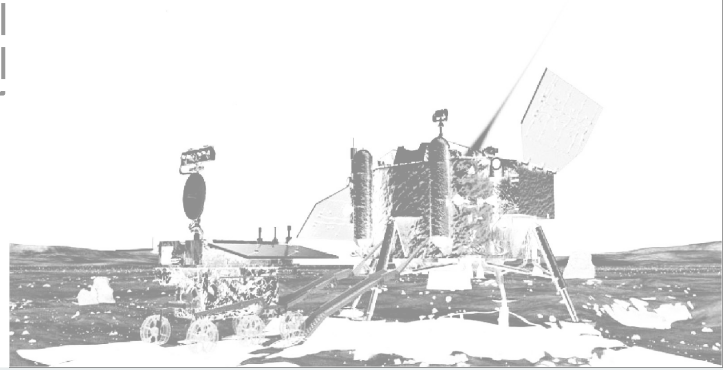
Image credit: NASA

What actions should the IAU pursue?

I. Collect scientific consensus on the lunar sites with priority for protection in the near and long term

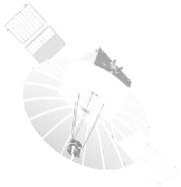
II. Create technical requirements for all operational instruments, as an aggregate, not to interfere with the target signal of the sensitive experiments

Inside the scientific community



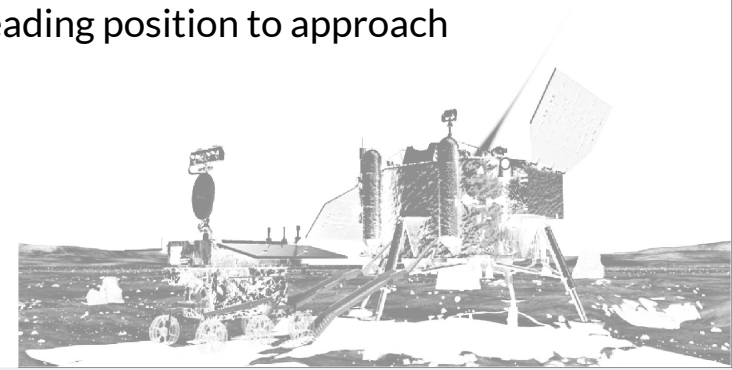
What actions should the IAU pursue?

Science to private sector & government



III. Communicate with commercial industry and space agencies to make sure their plans are aware of the scientific issues

IV. Align with other professional scientific societies and take a leading position to approach the UN COPUOS to get consideration of the protection of astronomy from the Moon by the Committee



IAU Working Group on Astronomy on the Moon

- ★ Established in 2023
- ★ Chaired by Dr. Richard Green, Dr. Martin Elvis and Christopher Johnson
- ★ Part of Commission C.B7 for Protection of Existing and Potential Observatory Sites

Image credit: NOIRLab

IAU Working Group on Astronomy on the Moon

1. Protect the ability to perform radio astronomical observations in the Shielded Zone of the Moon (SZM)
2. Preserve lunar SESIs for other astronomical objectives (e.g., IR observations, gravitational wave detection)
3. Communicate cis-lunar astronomy needs and immediate threats to policy makers and agencies
4. Support the IAU to get consideration of lunar science protection by the UN COPUOS and other bodies

university of groningen

Consistent plan of actions, collaboration with other organizations (e.g. IAA), connections with different sectors, influence…. Impact on lunar research & new policy achievement!

References

- Nicotera Lorena, MSc Thesis “Astronomy from the Moon”, https://fse.studenttheses.ub.rug.nl/30221/
- Elvis, M., Krolikowski, A., & Milligan, T. (2021). Concentrated lunar resources: imminent implications for governance and justice. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 379(2188), 20190563. https://doi.org/10.1098/rsta.2019.0563
- Le Conte, Z. A., Elvis, M., & Gläser, P. A. (2023). Lunar far-side radio arrays: a preliminary site survey. RAS Techniques and Instruments, 2(1), 360–377. https://doi.org/10.1093/rasti/rzad022

Thank you!