

Dark and Quiet Skies for Science and Society



Credit: South African Astronomical Observatory

Willy Benz
International Astronomical Union

International Astronomical Union (IAU)

To promote and safeguard the science of astronomy in all its aspects including research, communication, education and development through international cooperation

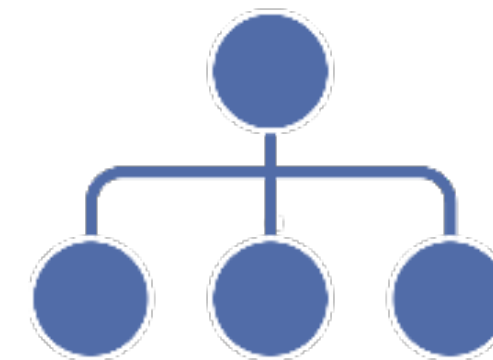
- Worldwide union of professional astronomers
- Officially approves the names for astronomical objects or features
- Founded in 1919, headquarters in Paris, France



12,550
Individual and
Junior Members



92 countries worldwide
85 national members

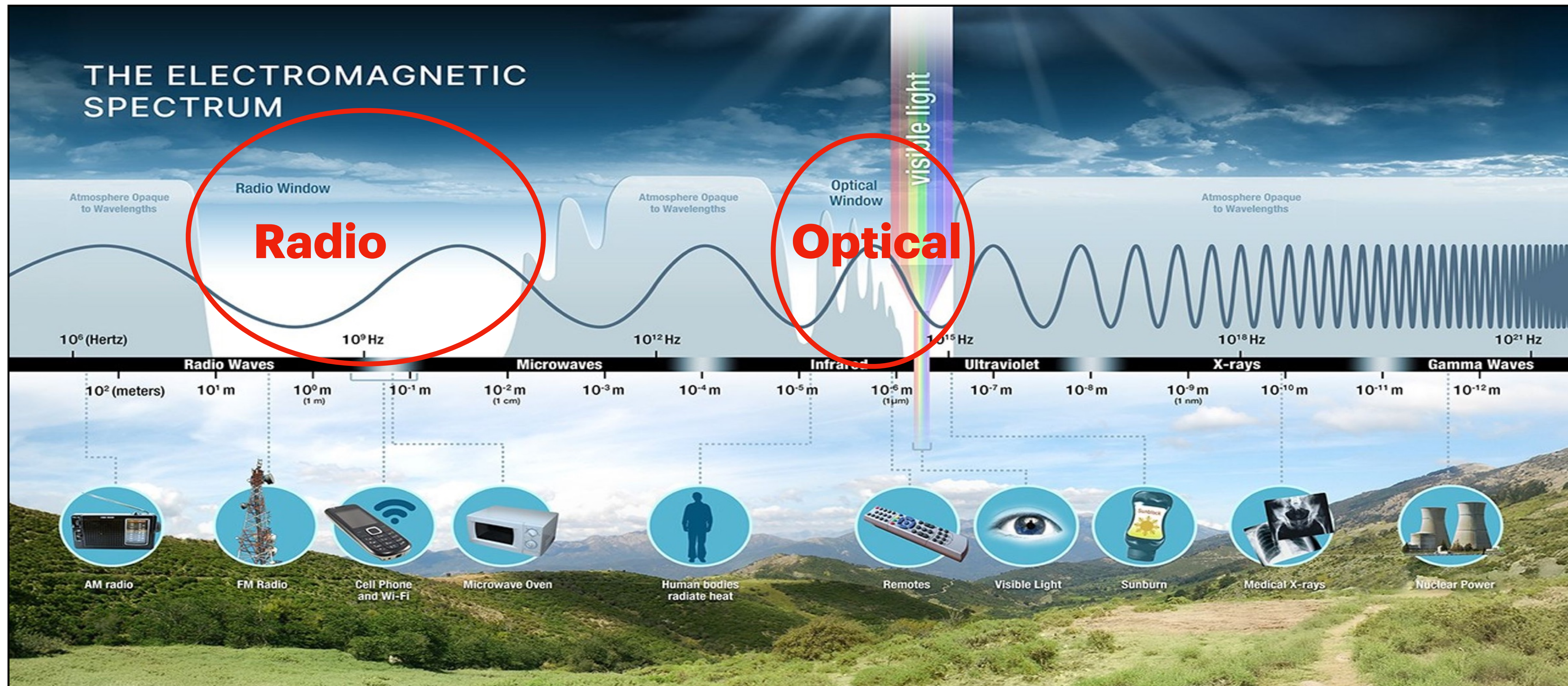


9 Divisions
39 Commissions
4 Working Groups



4 Offices
1 Center

The Earth's atmosphere is transparent to electromagnetic waves in only two regions: the optical and radio domains. These are our unique windows on the universe!



The largest astronomical facilities are built to detect the faintest possible signals coming for the universe with the highest possible resolution

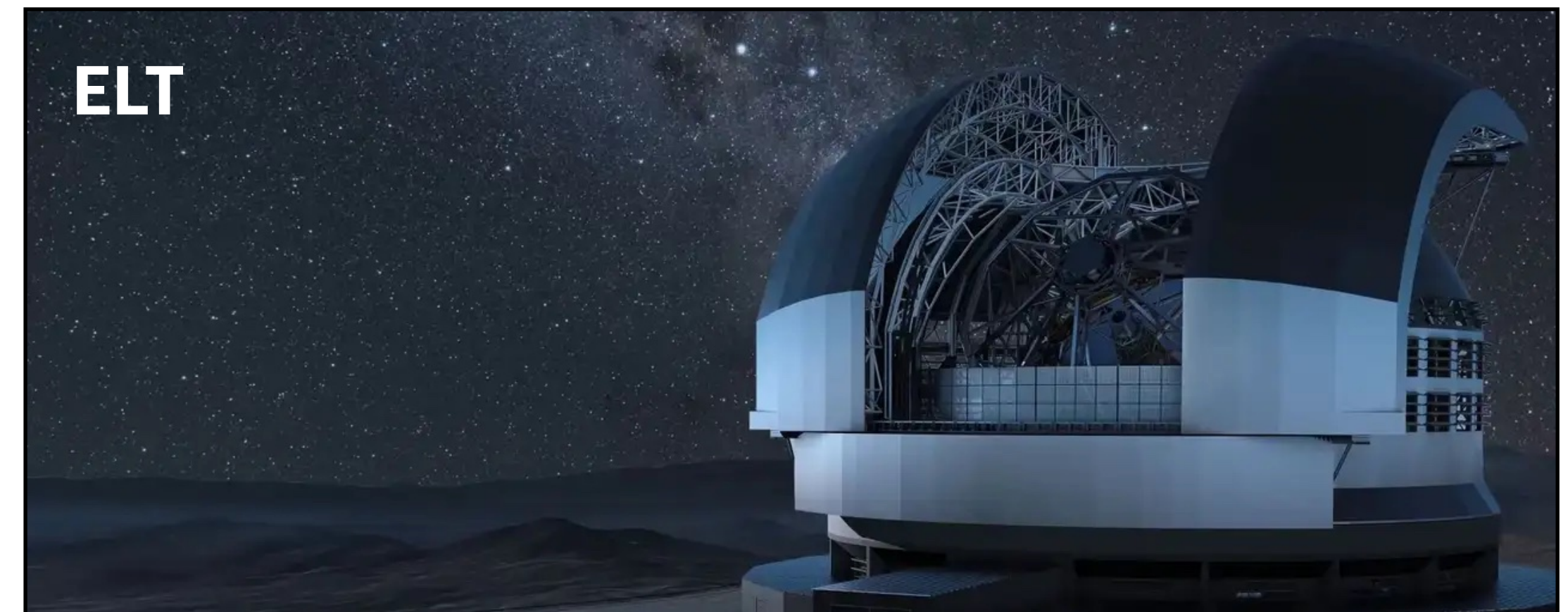
Optical domain:

- Detection limit ~ apparent magnitude 30
- Analogy: Detecting the light from a single candle on the surface of the Moon from the Earth

Radio domain:

- Detection limit ~ a few μJy
- Analogy: Hearing someone whispering on the Moon from the Earth

Credit: ESO



Credit: SKAO

The universe offers us a unique laboratory in which we can test the laws of physics in ways that are impossible on Earth. Telescopes are our key to exploring it.

- **Gravity, temperature, energies, etc.**

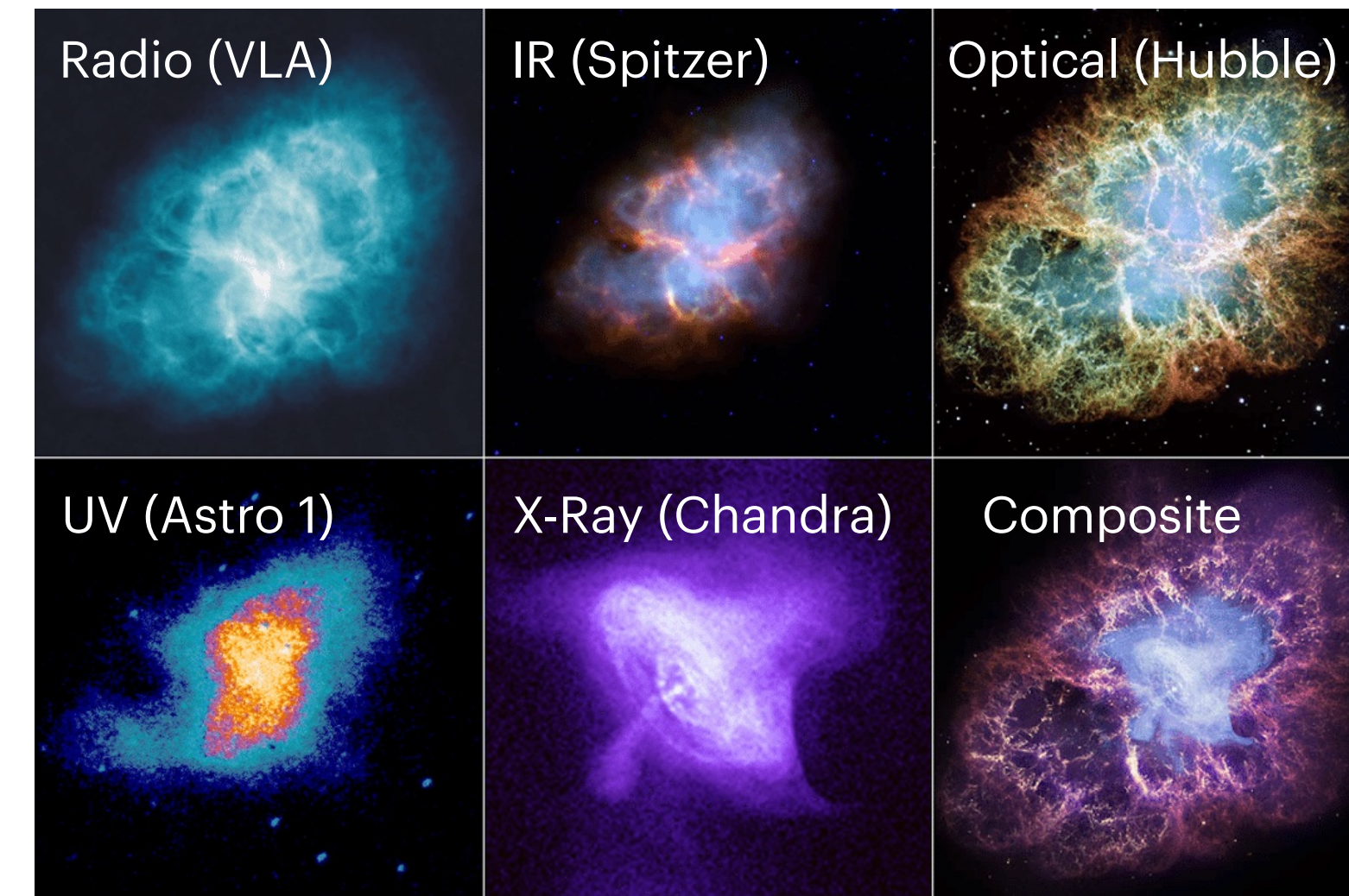
- Black holes: Test of general relativity
- Origin of elements: Carbon, gold, etc.
- Supernovae: Particle accelerators

- **Looking back in time**

- Watch the past in real time!

- **Earth and the prevalence of life in the universe**

- The discovery of thousands of exoplanets enables us to contextualise Earth and, eventually, to determine whether life exists elsewhere.



Crab nebula
in different
wavelengths

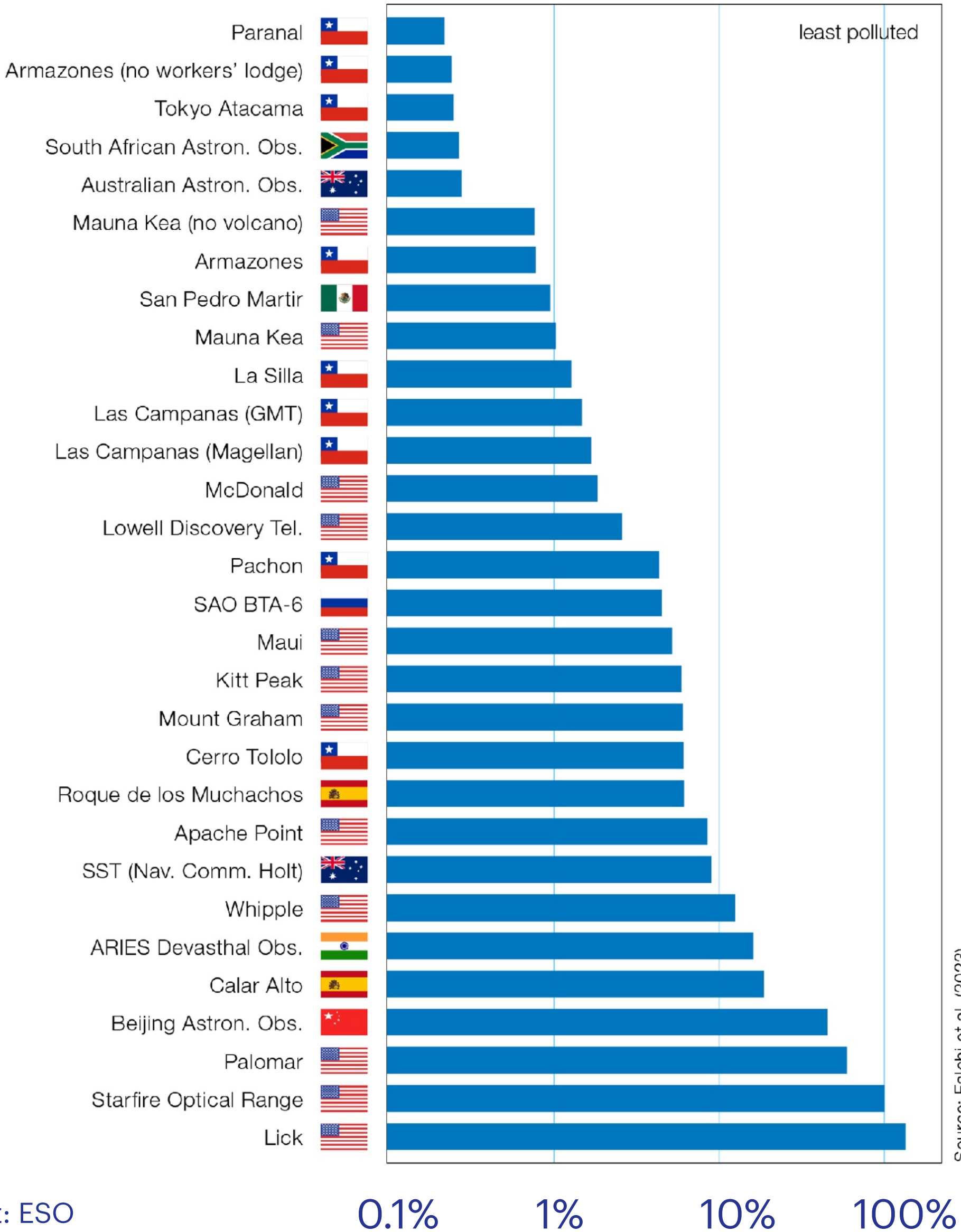
The Earth photographed by Voyager 1 on February 14 1990 from a distance of ~40 AU



The nearest star is at a distance of 268'770 AU!
It is known to host at least one planet

Credit: NASA

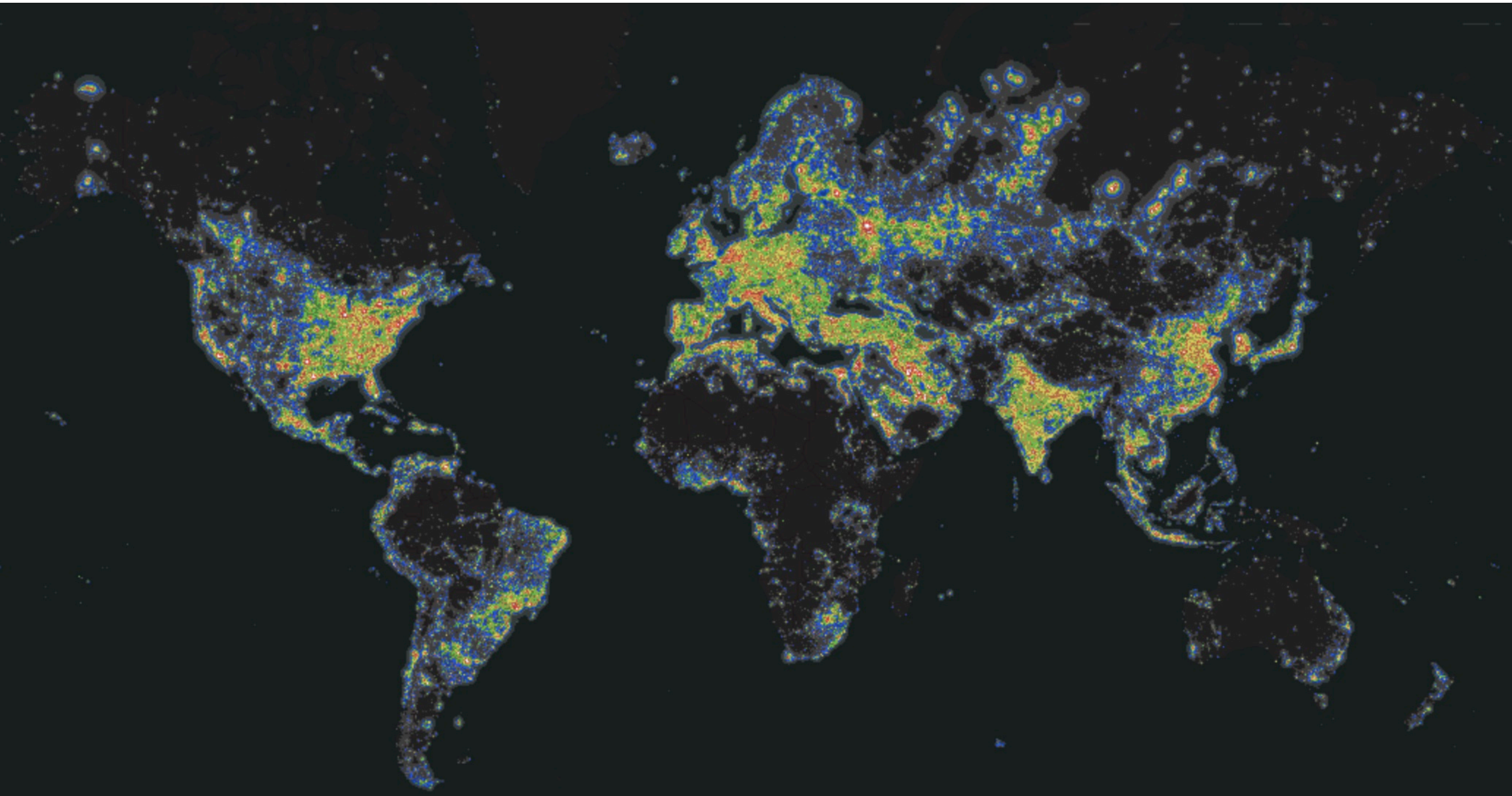
Light pollution over major observatories



Credit: ESO

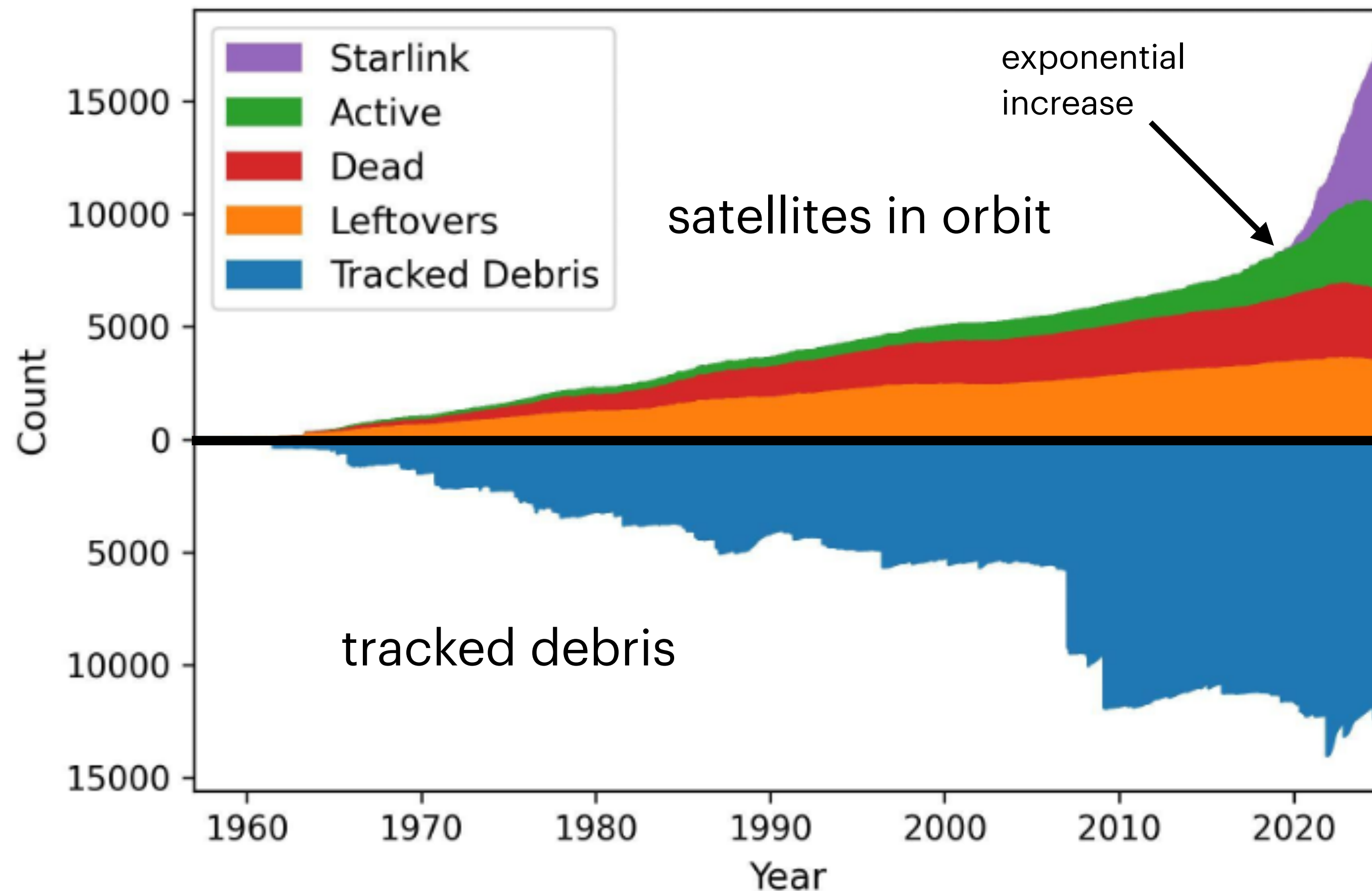
Source: Falchi et al. (2023)

2024



Credit: D. Lorenz, Light pollution atlas

Regions with pristine dark sky are becoming increasingly rare. Major astronomical observatories are under threat.



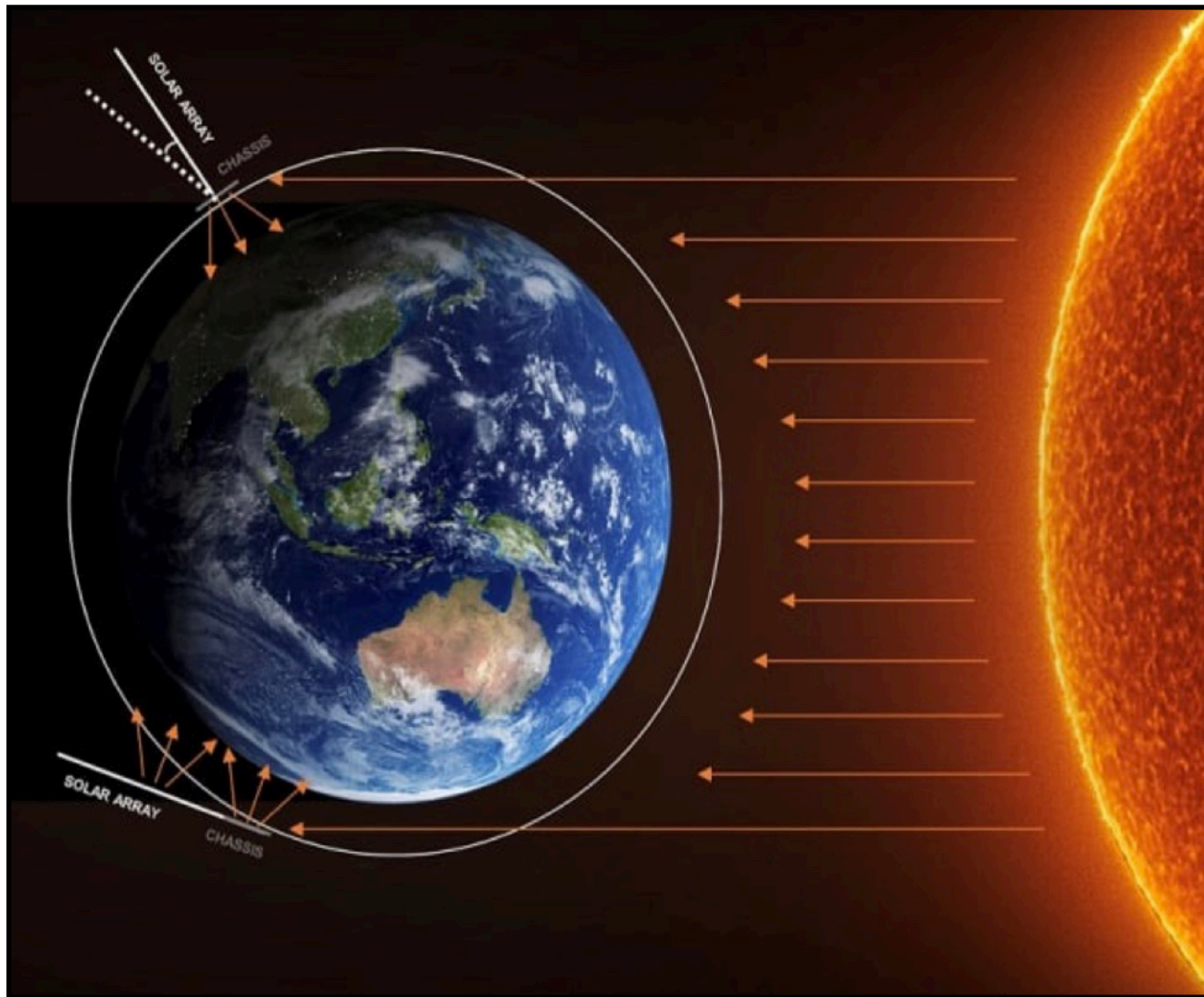
Credit: IAU/CPS

“Commercial space” represents a paradigm shift in space activity development.

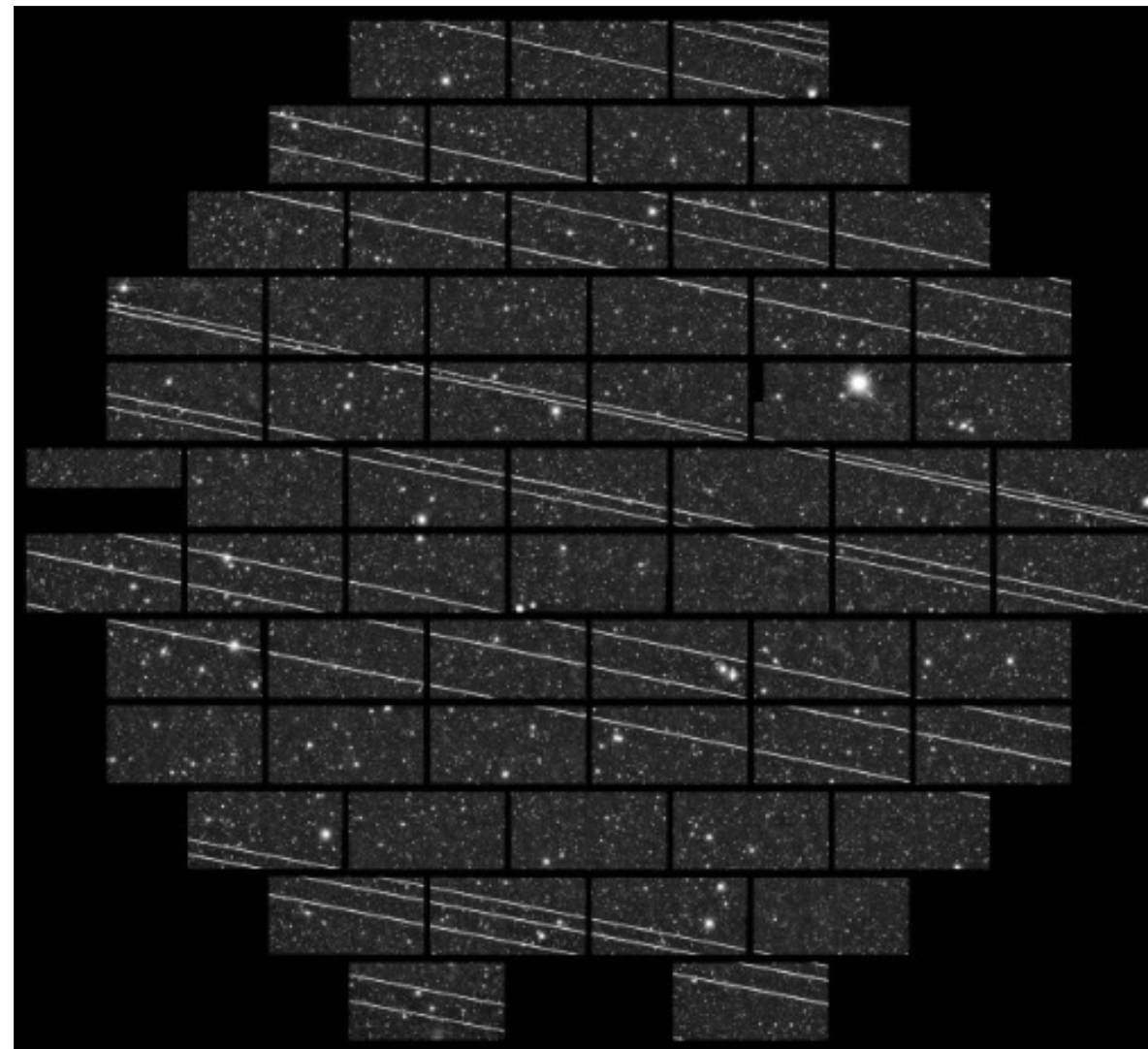
Active Satellites in low Earth orbit
2019 May : ~ 2,200
2023 Nov. : ~ 6,800 (3x in 4 years)
2025 May : ~ 12,000 (2x in 18 months)
2030 (forecast): ~ 40,000

The International Telecommunication Union (ITU) has received requests for ~ 2 million (!!) satellites in the next 5-10 years.

Sunlight is reflected by the satellites



Credit: SpaceX



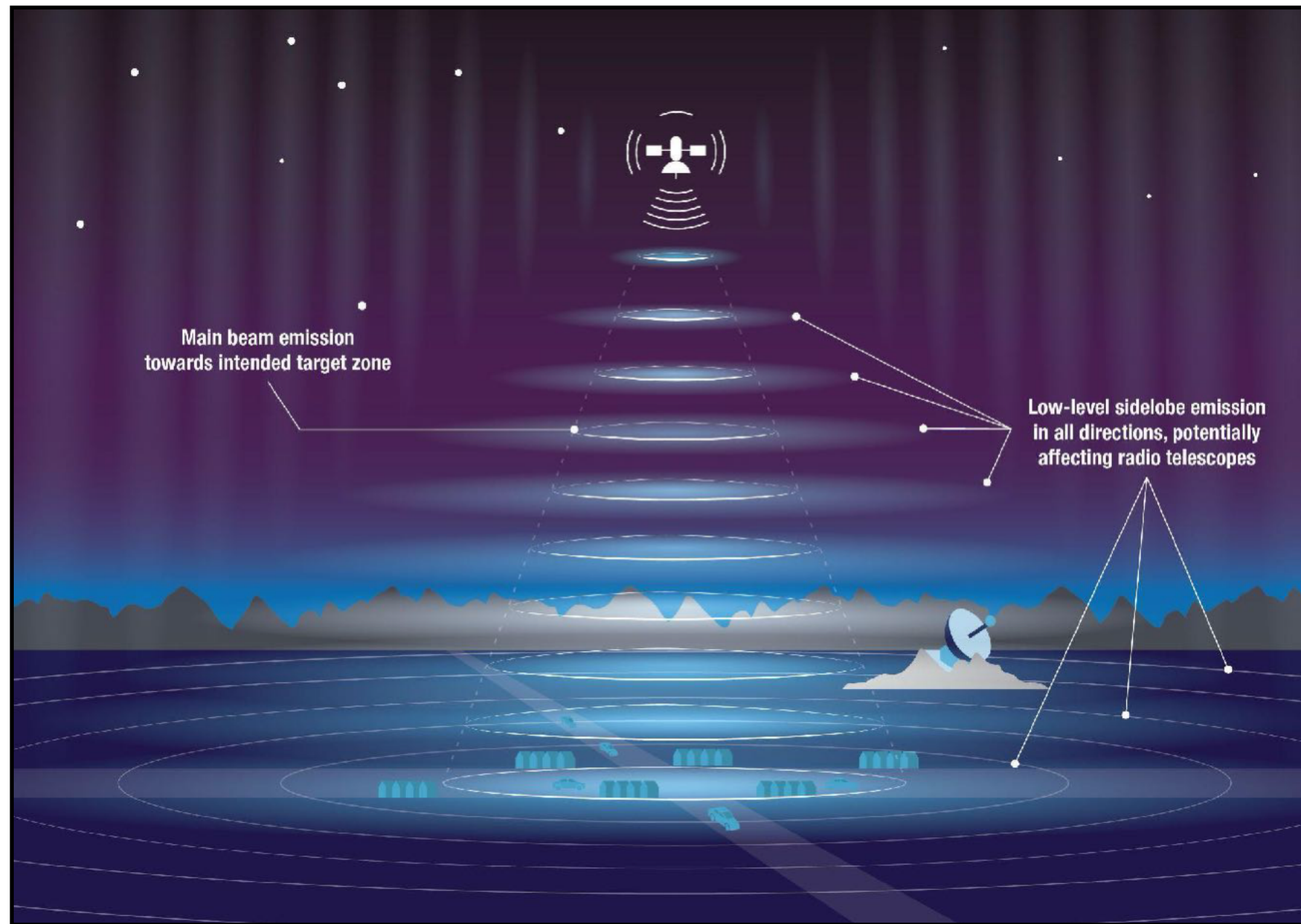
Credit: CTIO/NOIRLab/NSF/AURA/Decam DELVE Survey

- Telescopes are built to detect faint objects -> see many of them
- Reflection depends upon geometry, material, etc.
- Brightest during early evening or early morning

Largest impact: large-scale, wide-field, time sensitive programs

Examples

- Detection of objects potentially colliding with the Earth (NEOs)
- Detection of transient and variable phenomena (supernovae, gamma-ray burst, etc.)
- Increased difficulty in the detection of faint and distant objects will threaten the study of cosmology, galaxy evolution, and dark matter



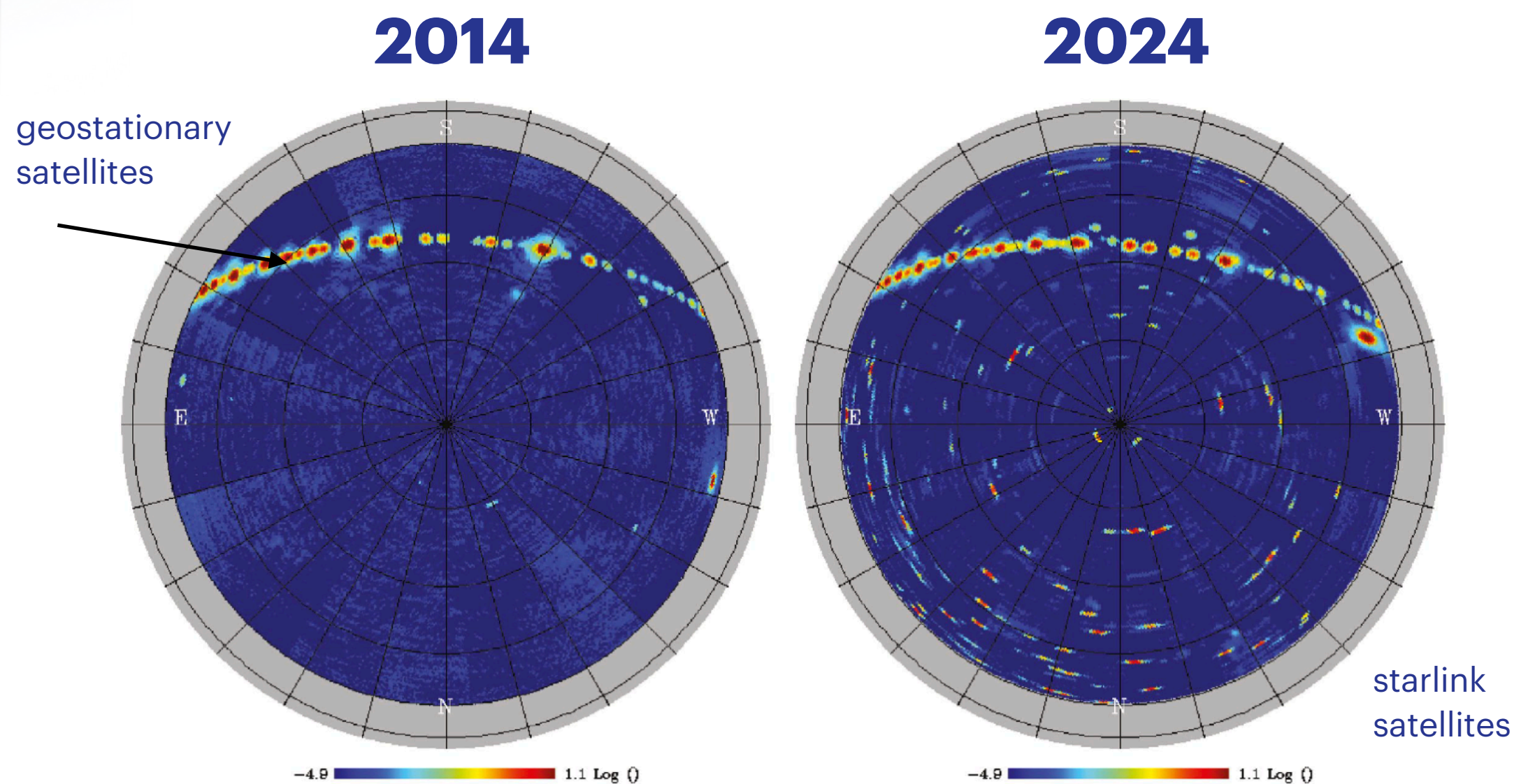
Credit: SKAO

- Low-level sideline emission spread much beyond the target zone
- Electronics used in the satellite generates very low-level unintended electromagnetic radiation (UEMR) including in protected frequencies
- Radio telescopes are designed to detect extremely faint radio signals
 - 10 million times fainter than UEMR of latest Starlink

Largest impact: Wide-field and highly sensitive observations drowned by satellite interferences

Examples

- Study of pulsars, fast radio-bursts, galactic centers etc.
- Time-domain astronomy made more difficult
- Molecular clouds and star formation



Credit: Quijote 10-14 GHz

Protecting the dark, quiet sky for the benefit of science and society lies at the heart of the IAU's mission, since without it, astronomy would no longer be possible from Earth.

Two line of actions:

- Provide scientific facts to facilitate national and international discussions to reach a consensus on actions.
- Centre of own competences for pragmatic rapid responses



These actions are not intended to prevent technological development or the creation of new services. Instead, they aim to find ways for technological developments and astronomy to coexist.

Thank you for your attention!

more information at

<https://iau.org>

