Preservation of the dark and quiet sky

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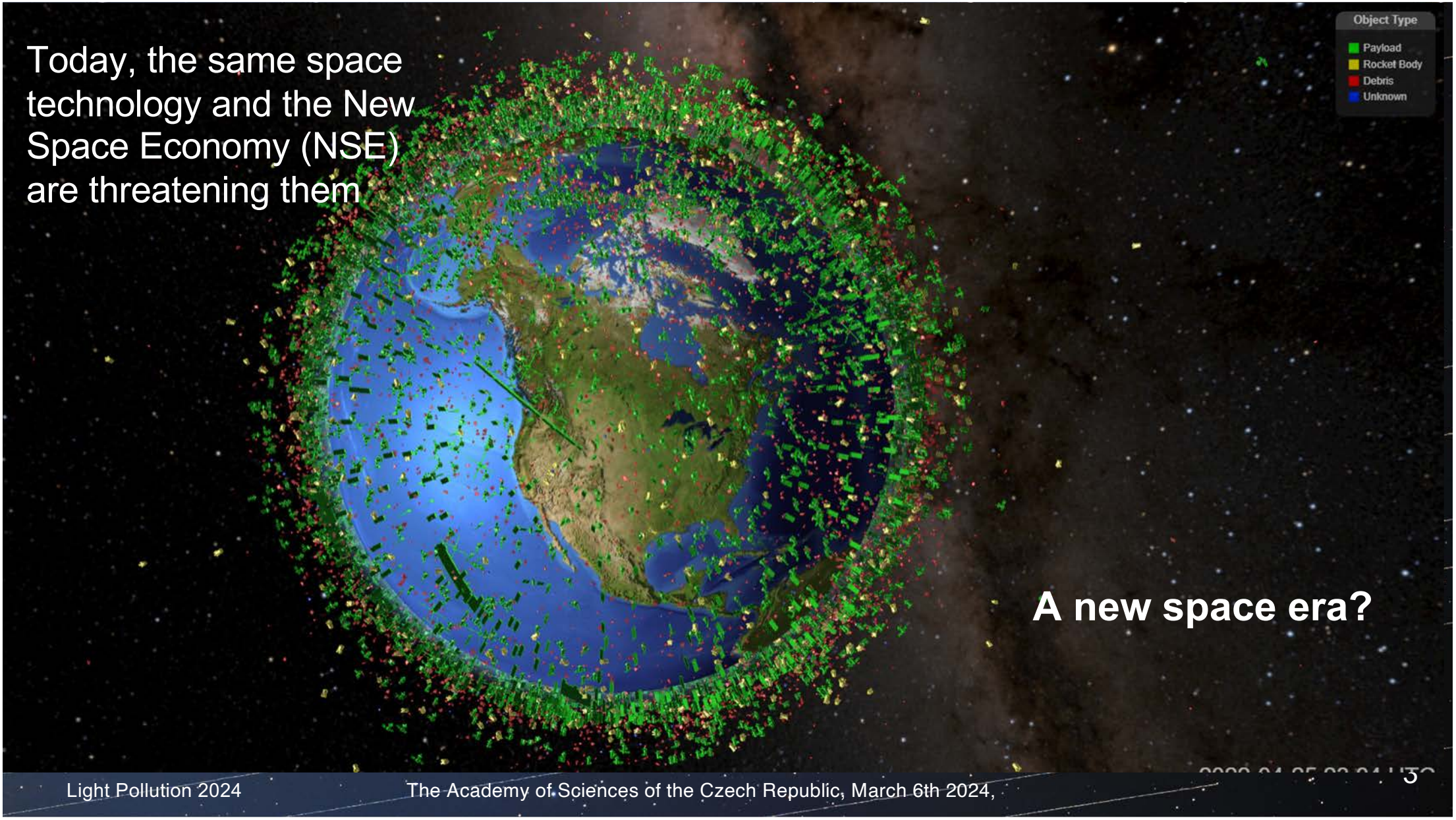
Interim IAU General Secretary

Astronomy and Space technology

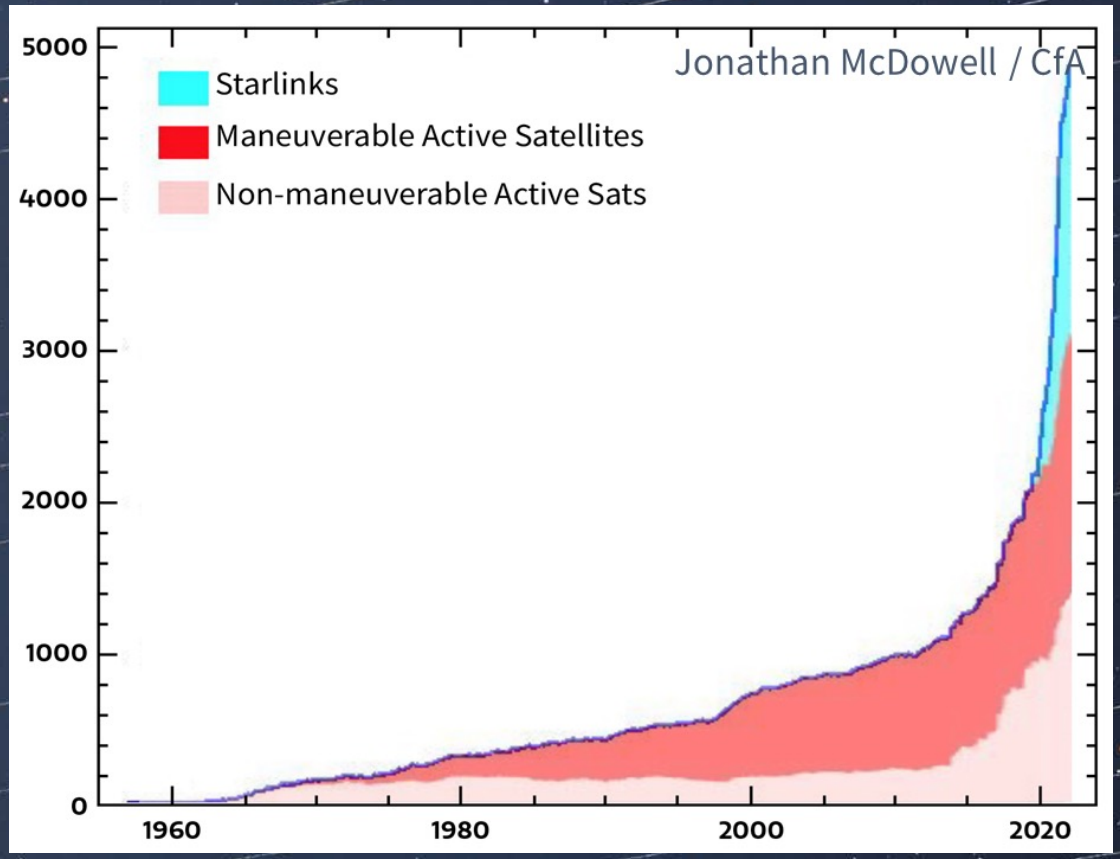
- Astronomy and Cosmology are very much indebted to space technology…however…


Today, the same space technology and the New Space Economy (NSE) are threatening them
Object Type
Payload
Rocket Body
Debris
Unknown
A new space era?

What has changed and why?

- Until recently, space was the domain of National and International Space Agencies
- Using taxpayers' resources, they had as goals scientific/technological advancements and space exploration
- Today space is becoming the domain of private companies that have profit as their unique objective
- The very nature of the threats calls for innovative mitigating measures
- The large satellite constellations are just a first example of the possible threats of the New Space Economy…

The root of the problem: an exponential increase in space activity

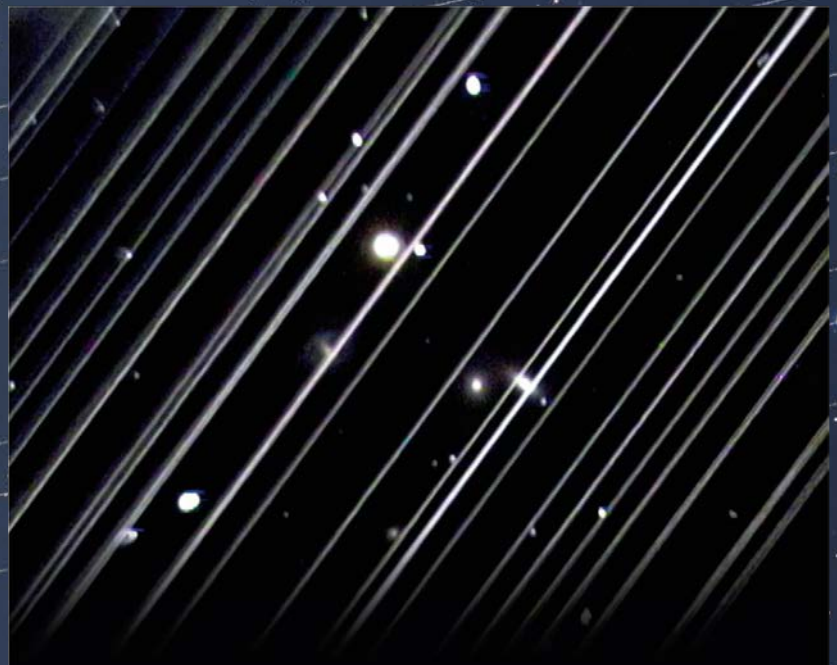


Active Satellites
2019 May 1: ~2,200
2023 Nov 1: ~6,800 (3x in 4 years)

Active+Inactive Satellites ~10,000
Trackable space junks ~30,000

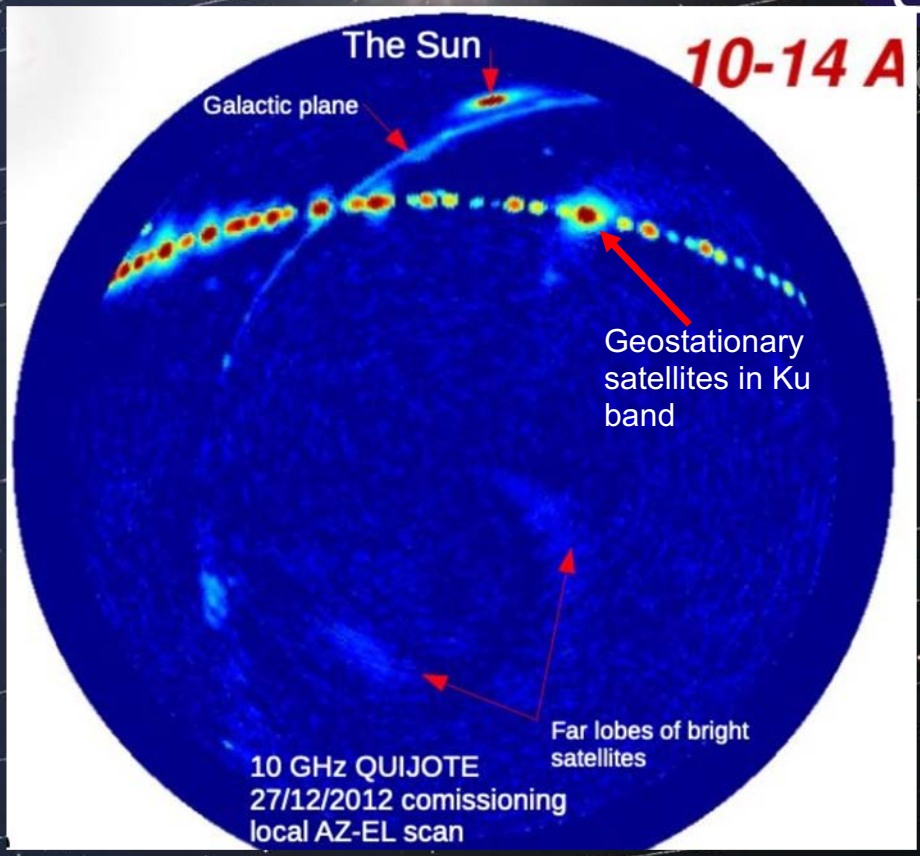
Disturbing Reality: ~ 420,000 constellation satellites are planned (according to FCC+ITU application)

Why do satellites interfere with astronomy?



- They reflect sunlight
- They emit microwave radiation

Source: Victoria Girgis/Lowell Observatory

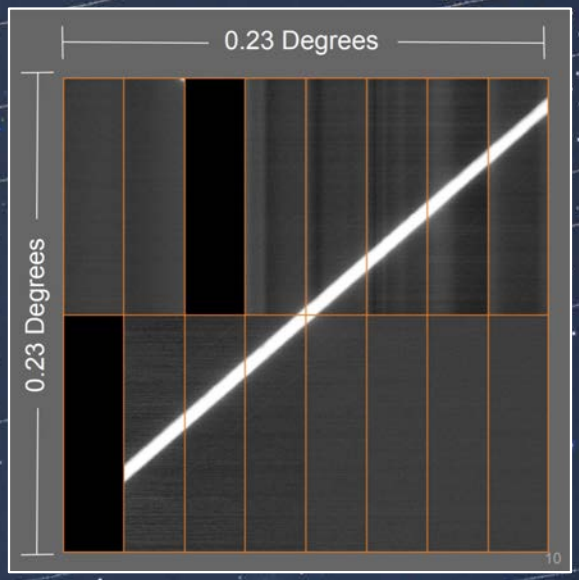


Source: Robert Watson / JBCA - Mike Peel / IAC

nces of the Czech Republic, March 6th 2024,

Post processing is not the solution

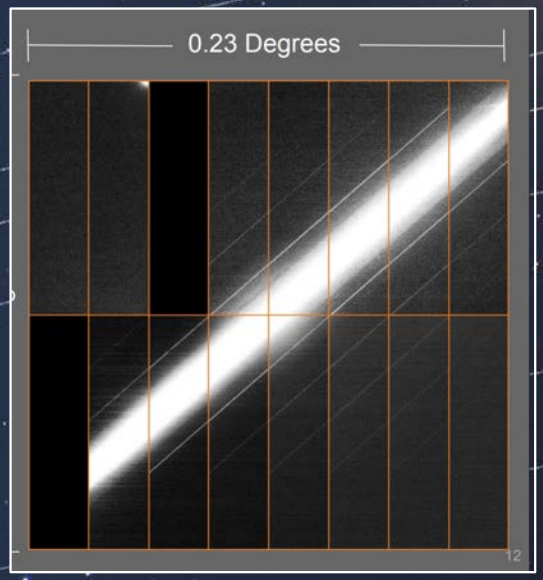
IAU CPS recommendation



Crosstalk Correctable with <10%
Error = 5,000 peak electron count
= 7-8th magnitude*

Faint brightness science affected

Current Starlinks



Saturation/ "Correctible" with large
Error = 100,000 electrons =
4th mag

Most science programs affected

BlueWalker 3

Blooming/ Not Correctable =
1 Million electrons = 0-1 Mag

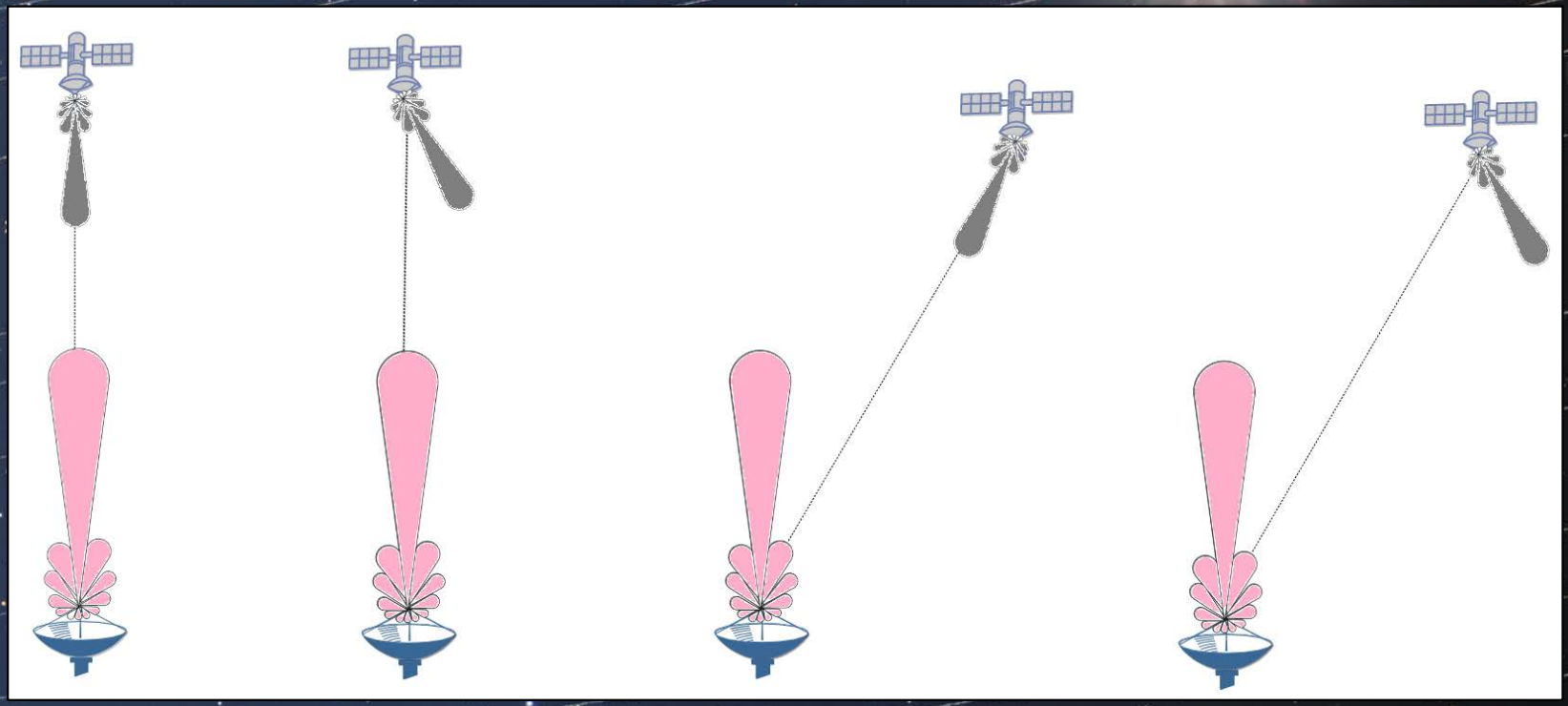
Radio interference

- ***Ultra-bright beams*** from satellite downlinks
- Unintended ElectroMagnetic Radiation (***UEMR***)
- LOFAR detected UEMR radiation between 110 and 188 MHz

Unintended Starlink Emissions at SKA - Low (D. Grigg)

How do we see satellites in radio domain?

High power RFI **Low power RFI**



Beam to beam Beam to sidelobe Sidelobe to beam Sidelobe to sidelobe

The IAU Mission and actions

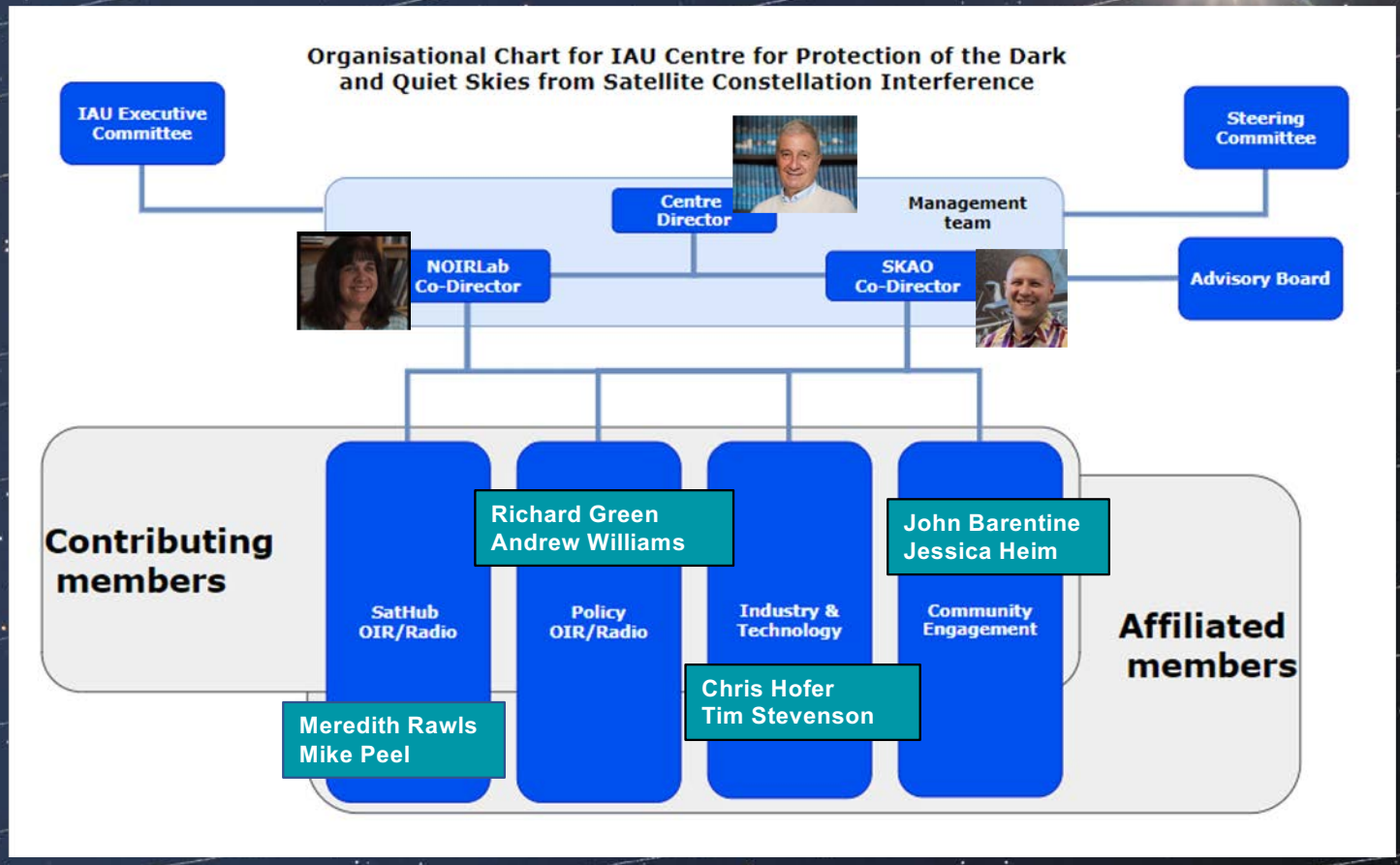
- The International Astronomical Union, founded in 1919, has today more than 13,000 individual Members from about 80 Countries.
- Its main mission: to promote and safeguard the science of astronomy in all its aspects. The IAU could not have remained inert in front of the threats.
- The two lines of attack:
  - International (voluntary) regulations (COPUOS)
  - A dedicated pragmatic action (CPS)
- A line which was explicitly not endorsed: legal actions (albeit still pursued by some astronomical minorities)

UNITED NATIONS
Committee on the Peaceful Uses of Outer Space

Internet connectivity for all

- Access to internet is one of the targets of the UN SDGs
- Satellite connectivity has proven to be an effective tool to provide internet to underserved areas
- The IAU do not intend to hinder the operation of the communication satellite constellations
- However, the interference of the constellations on astronomy and on the visibility of the sky has to be mitigated

The IAU CPS (2022)



Is mitigation possible?

- Satellites can be made less reflective:
  - The pristine vision of the night sky is preserved
  - The astronomical detectors are not saturated or damaged and the satellites' trails can be partially removed by post processing
- The apparent position of the satellites can be accurately predicted:
  - The astronomical observation can be interrupted during the passage of the satellites within the field of view of the telescopes
- The radio emission of the satellites can be interrupted or deviated when passing over major radio-astronomical observatories
- The wavelengths bands of radio-astronomical interest should continued to be protected (an ITU-R matter – more later)

Yes, but…

- A strong collaboration with the satellites industries and private companies is needed.
  - ➢ Best practices have to be identified and voluntarily implemented.
  - ➢ Experience shows that companies are more amenable to implement them if they become knowledgeable in the early phase of the constellation design
- The IAU CPS is working along these lines with, until now, satisfactory results.
- However, the situation is in fast evolution, involving more Countries and possibly larger and more impacting satellites.
- In order to remain effective, the best practices need to be acknowledged and supported by the Governments from which the companies depend.

COPUOS and STSC 2020-2024

- COPUOS: COmmittee for the Peaceful Use of Outer Space
  - STSC: Scientific and Technical SubCommittee
  - LSC: Legal SubCommittee
- 57th STSC (2020) – Technical Presentation
  - Raising attention
- 58th STSC (2021) – CPR (Chile, Ethiopia, Jordan, Slovakia, Spain, IAU, ESO, SKAO) and Technical Presentation (C. Walker)
  - Positive support by 18 Delegations, dedicated Item in the Agenda of STSC 59th
- 59th STSC (2022) – WP (Austria, Chile, Dominican Republic, Slovakia, Spain, IAU, ESO, SKAO)
  - 25 intervention under the dedicated Agenda Item
  - Astronomy is instrumental to space activities, its protection is within the COPUOS remit
  - The constellations' impact is serious and requires the cooperation of all stakeholders
  - The dedicated Item shall be maintained in the Agenda of STSC 60th
- 65th COPUOS (2022) – The CPS presented
  - Very positive comments by about 15 Delegations (including China for the first time)

- 60th STSC (2023): CRP on the Protection of Dark and Quiet Skies for science and society (Presented by Chile, Spain, Slovakia, Bulgaria, Dominican Republic, Peru, South Africa, IAU, ESO and SKAO)
  - Keeping the D&Q_S Agenda Item for a minimum of 3 more years
  - Creation of a COPUOS Expert Group on D&Q_S
  - The CRP got the support of ~ 50 Delegations
  - No consensus on the scope of the Agenda item (opposition by Russian Fed. and Iran)
  - Group of Friends created by an initiative of Chile and Spain

- 61th STSC (2024): Agenda Item approved for 5 years.
  - “Dark and Quiet Sky, astronomy and large constellations: discussion on emerging issues and challenges”

Group of Friends of D&Q_S

Aims of the Group of Friends:

- Promote awareness
- Review best practices and mitigation suggestions
- Discuss the overall implications of the adoption of mitigating measures
- Discuss approaches for coordination between the various stakeholders
- Support the development of best practices

- Currently adering Delegations and Observers:
  - Belgium, Bulgaria, Chile, Colombia, Germany, Italy, Luxembourg, Mexico, New Zealand, Rumania, Slovakia, South Africa, Spain, Switzerland, UK, USA
  - COSPAR, EAS, ESO, IAA, IAU, SKAO

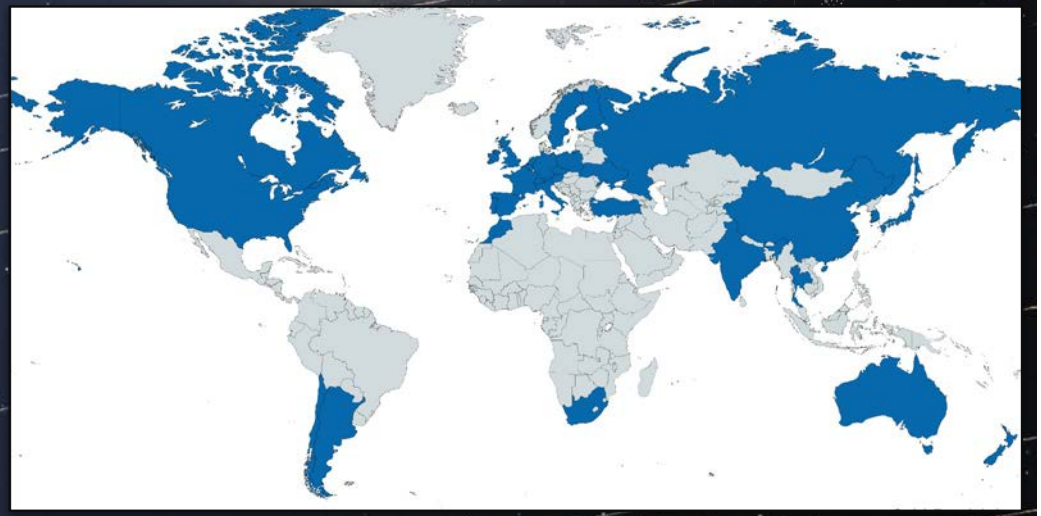
- GoF webpage: https://cps.iau.org/group-of-friends/

Conclusions

- Let's turn a problem into an advantage
- Astronomy has never enjoyed the current visibility at UN level
- We should use the favourable situation to convince policy makers and the society at large that:
  - Astronomy is absolutely instrumental for progressing in the understanding of reality
  - Cosmology and *Cosmologia* can help promoting peace and tolerance: not only we all live under the same sky, but we **are** the sky and its consciousness
- In order to achieve that we should:
  - Critically review our outreach goals...
  - Foster the dialogue between science, philosophy, theology and arts

CPS Welcomes Your Participation

- The Center will coordinate the involvement of **two groups of members**:
  - **Contributing Members**
    - Opportunity to actively work on mitigation strategies
    - Access to hubs and their resources
    - Expected to commit resources and develop a work plan
  - **Affiliated Members**
    - Interested in the work of the Centre
    - Contributing on a best effort basis



Nations with contributors or affiliated members (53 institutions, 31 with resources to offer) + 260 affiliated members

If interested, contact **info@cps.iau.org** for a membership form or visit cps home page (cps.iau.org)

Thank you for your kind attention!

QUESTIONS?

Contact: info@cps.iau.org