IAU Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference

Mike Peel on behalf of the IAU CPS

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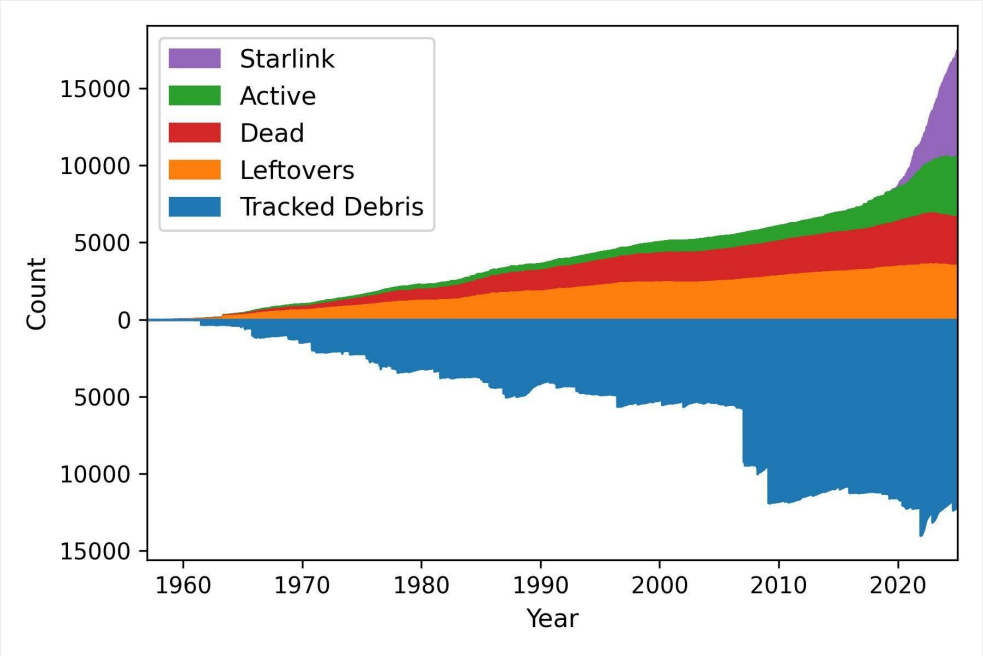
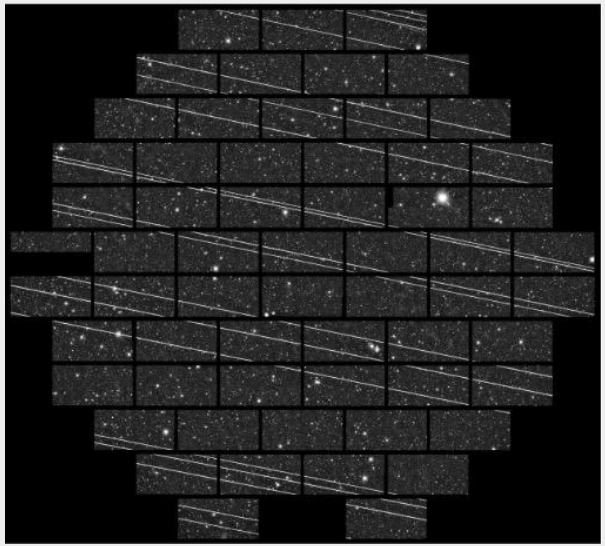
Space is changing rapidly

- 8500+ satellites in Low Earth Orbit
- ITU filings for >1,000,000 satellites
- Major concerns:
  - Effects on optical astronomy
  - Effects on radio astronomy
  - Effects on the night sky
  - Space traffic management
  - Space debris



Effects on astronomy

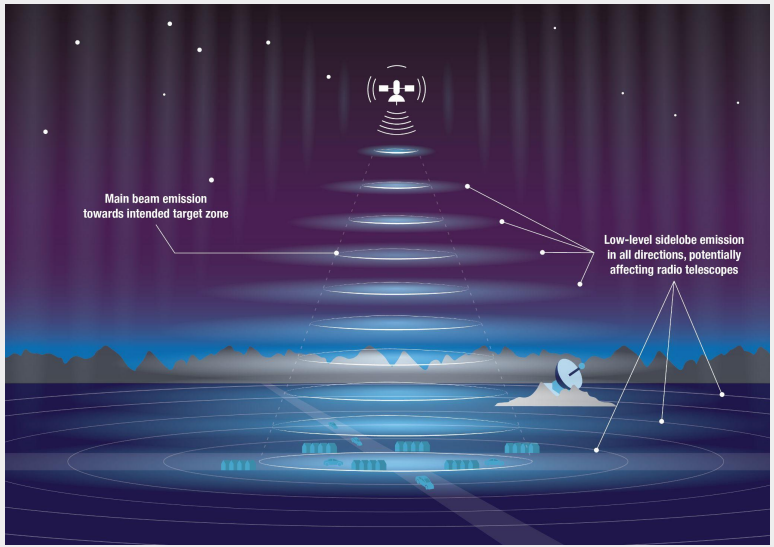
Optical astronomy: Satellite streaks can cause unusable data



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

Radio astronomy:

- Intentional emissions (i.e. strong downlinks)
- UEMR (unintentional electromagnetic radiation)



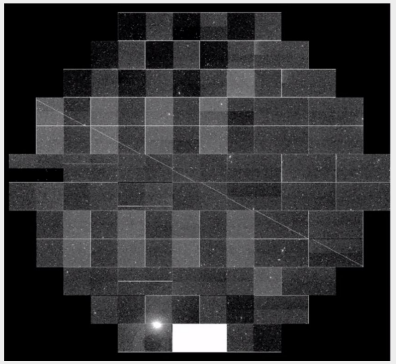
Credit: SKAO

Four hubs

- **SatHub**
  - Satellite observation and data analysis to understand problem + find mitigations during data processing
- **Industry & Technology Hub**
  - Foster collaboration between the astronomy and satellite operator communities
- **Policy Hub**
  - Studies national and international policies and regulations related to the use of space
- **Community & Engagement Hub**
  - Bridge between all involved stakeholders and affected communities

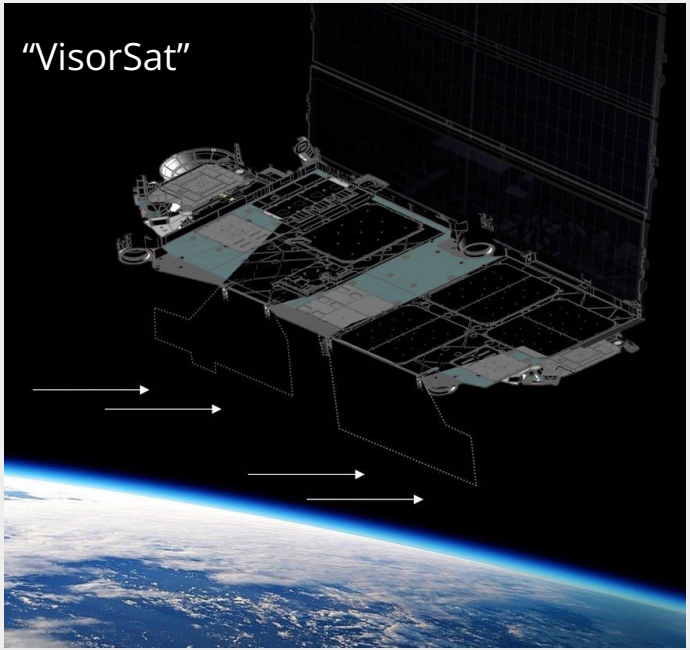
IAU CPS SatHub Aims (see Connie's talk)

- **Assess constellation impact on optical and radio astronomy** via independent observation campaigns and peer reviewed publications
- **Strengthen relations** with key players:
  Privateer, The Exclosure, Slingshot Aerospace, European Centre for Space Safety, The Aerospace Corporation, AST SpaceMobile, SpaceX, Amazon Kuiper, Planet Labs, and more
- **Develop mitigation tools for astronomers**/observatories
  - SatChecker satellite position prediction service (also connections with Satellite Orbit Prediction Processor/SOPP under development)
  - Satellite Constellation Observation REpository (SCORE)
  - NSF SWIFT-Sat: Field-Of-View / active satellite avoidance service
  - Radio astronomy impact modeling (SCEPTER)
- **Coordinate mitigation efforts** with all stakeholders



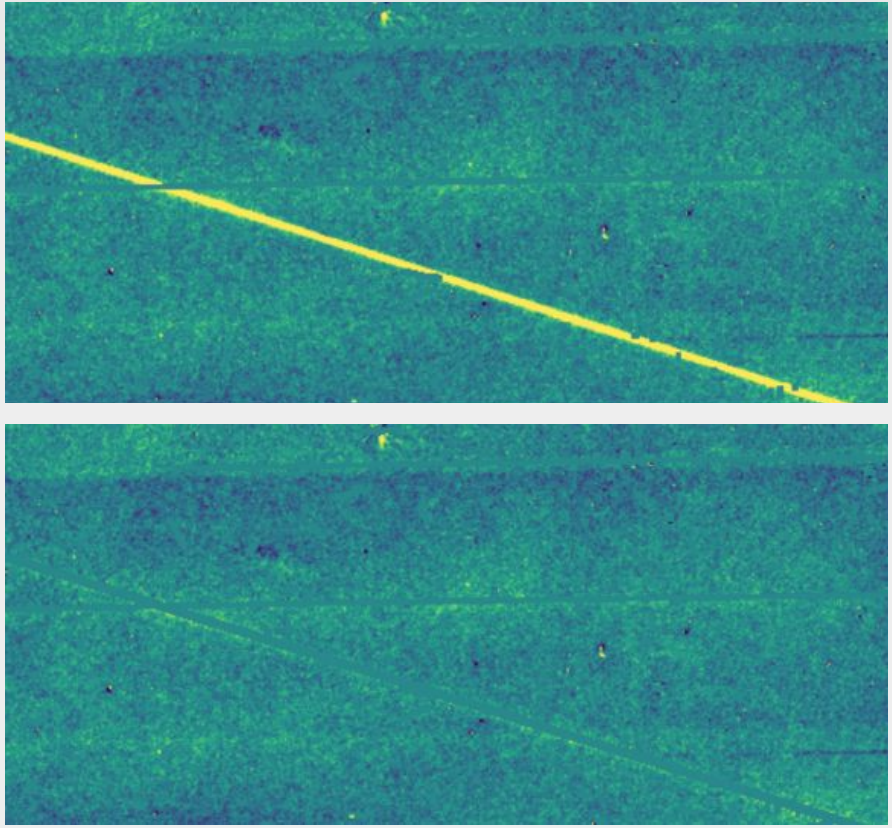
Mitigations: Satellites

- Fewer satellites
- Materials engineering: coatings (specular reflectivity)
- Attitude control (minimise reflections)
- Reflectivity simulation and testing labs (growing need)
- Steerable radio beams (enable direct illumination avoidance)
- Minimise sidelobe emission
- Control of unintended electromagnetic radiation



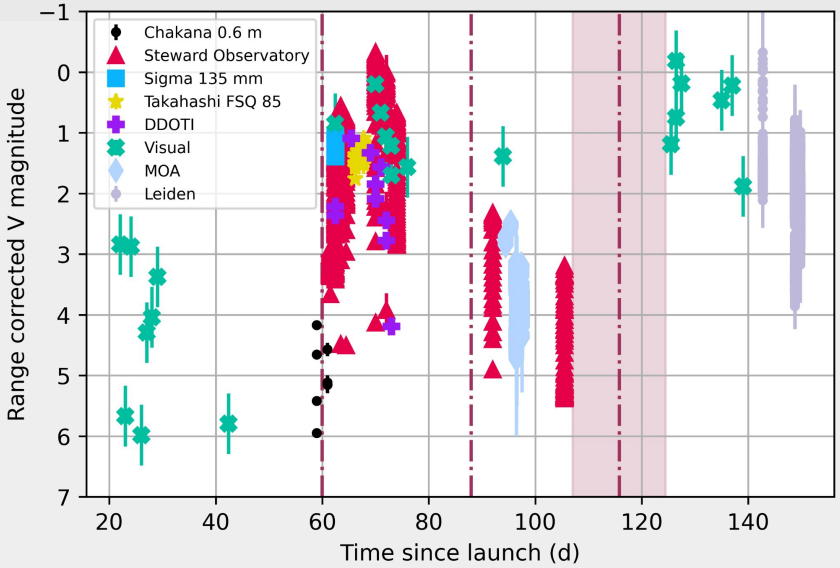
Telescopes

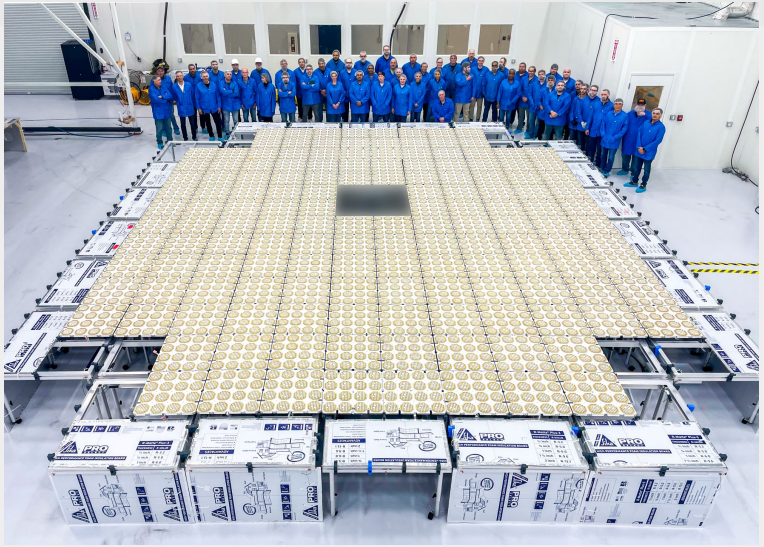
- Observations planning
- Software to avoid satellites
- Closing telescope shutter when satellite overhead
- More resilient receivers
- Observations to verify mitigations
- Redoing observations
- Modelling / Simulations
- Post processing of data (masking)



Hasan et al. (2022)

AST SpaceMobile Bluewalker 3 observations





- 64m² phased array, prototype for mobile phone connections using standard phones + satellite
- Observing campaign to observe with multiple telescopes + visual observers
- Optical measurements show it to be brighter than all except top 10 stars (Nandakumar et al., Nature, 2023)
- + launch vehicle adapter bright & untracked for first few days
- + position predictions degrade over time
- 5 BlueBirds since, more (and larger) expected soon...

UN Committee on the Peaceful Uses of Outer Space

- UN Committee on the Peaceful Uses of Outer Space
  - Dark and Quiet Skies agenda item in the Scientific and Technical Subcommittee (STSC)
  - Group of Friends for the Dark and Quiet Skies for Science and Society
- International Telecommunication Union (ITU) (See Federico's talk!)
  - WRC-27: AI 1.16: to address impacts on RAS bands and Radio Quiet Zones from satellite systems; AI 1.18: EESS and RAS above 76 GHz; AI 1.15: use of radiocommunications in the cislunar space
  - Report on UEMR (ongoing at WP7D)
  - Resolution 219 (Bucharest 2022) and Resolution ITU-R 74: Sustainable use of spectrum and space orbits
- Efforts in Space Sustainability include Dark and Quiet Skies:
  - ESA Zero Debris charter
  - UK Earth Space Sustainability Initiative

Thanks for listening!

Questions?

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