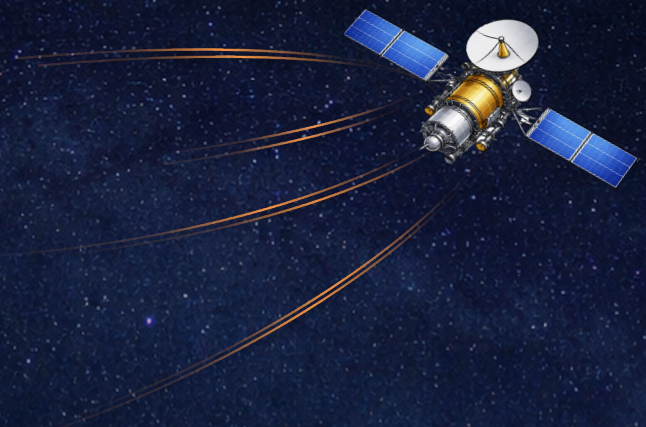
Dark & Quiet Skies

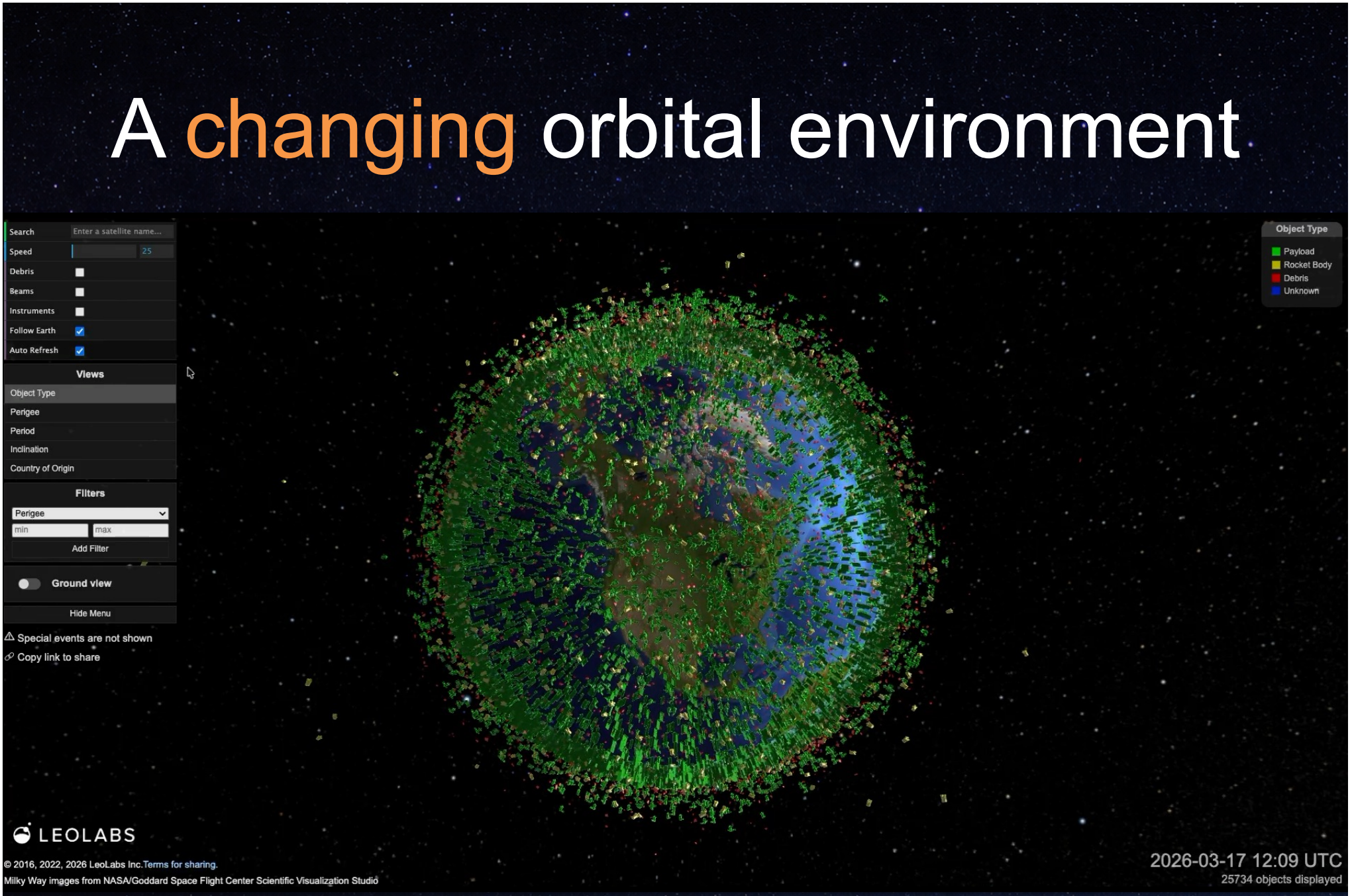
2026 *update*



Federico Di Vruno
Spectrum Manager, SKAO
Associate Director, IAU CPS

Cosmology in the Alps 2026
Les Diablerets, Switzerland

A changing orbital environment



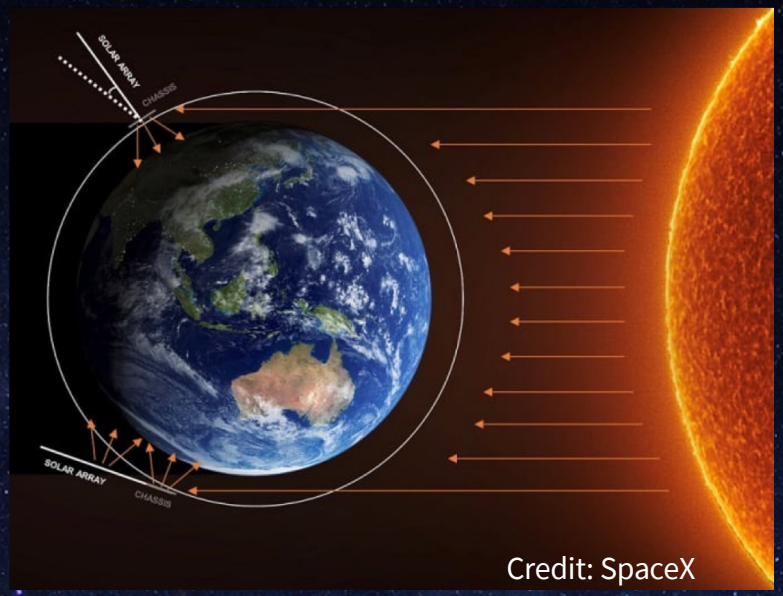
Source: https://leolabs.space

Satellite constellations affect Astronomy in different ways

1. Downlink radio emissions
2. Unintended radio emissions (UEMR)
3. Optical reflection of sunlight

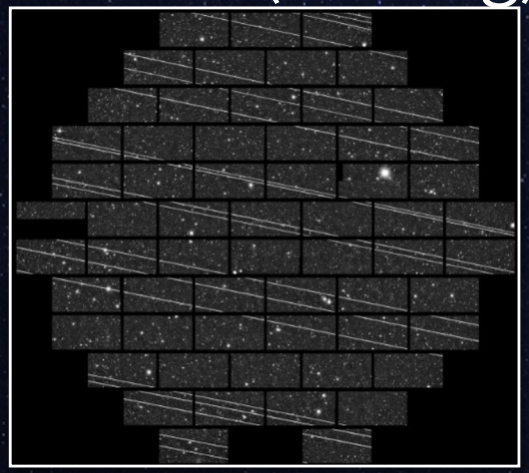
Optical impact: sunlight reflection

Bright satellite reflections contaminate ground- and space-based observations



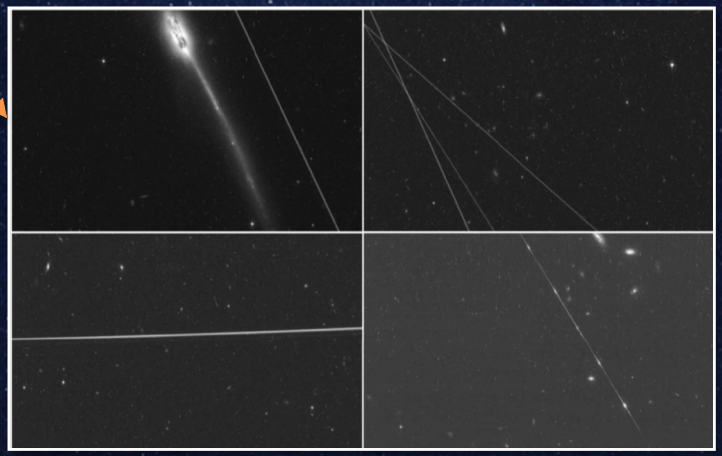
Credit: SpaceX

DECAM (2.2 deg)



Credit:
CTIO
NOIRLab
NSF/AURA
Decam DELVE Survey

Hubble



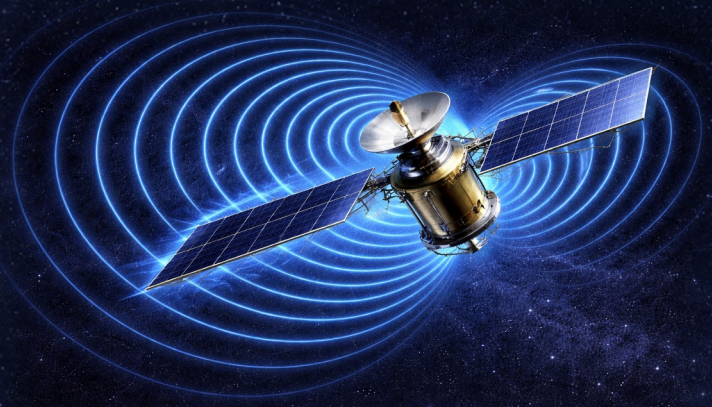
Credit: Kruk et al. 2023, NatAs, 7, 262

Radio impacts: two mechanisms

Downlink signals

Unintended emissions (UEMR)

from onboard electronics



Downlinks → controlled and directional

UEMR → low-level, uncontrolled, ubiquitous

From novelty to steady state

Impacts are now routinely observed

Numbers continue to **grow exponentially**

Mitigation must be designed in – not an afterthought

Policy responses are **urgent**, but slow

Beyond communications
new space uses

Credit: Reflect Orbital

Direct to Device (mobile phones)

Inter-satellite lasers

Space-based data centres

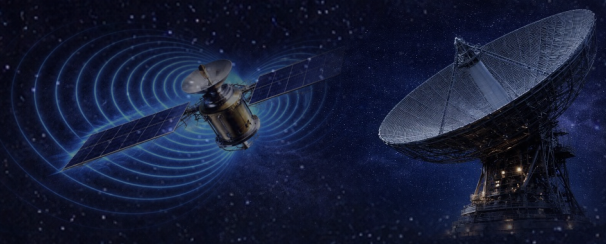
Power/sunlight services

Debris-induced sky brightness

Where action is taking place

across multiple domains

Technical mitigation



International frameworks

COPUOS

National/Regional level

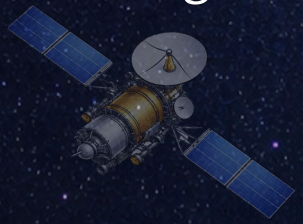
Community coordination

Technical mitigation approaches
satellites and telescopes

Satellites

Optical

- Reduced reflectivity
- Light redirection
- Attitude /orbit control
- Ephemerides sharing



Radio

- Steerable beams
- Reduced unwanted emission
- Low-noise electronics
- Boresight avoidance

Telescopes

- Scheduling
- Streak detection
- Post-processing
- RFI detection/subtraction
- Operational Data Sharing

Technical mitigation approaches

Limitations

Satellites

Largely voluntary

Operator-dependent

Limited incentives

Perceived as constraints

Lack of enforcement

Telescopes

Instrument heterogeneity

Limited resources

Mitigation → Data loss
Reduced efficiency

International policy: COPUOS

Committee on the Peaceful Uses of Outer Space

D&QS is now a core topic:

- Agenda Item at *STSC
- Group of Friends (33 members)
- LTS Working Group now includes D&QS considerations
- UN/SKAO workshop on D&QS 2025
- Towards guidelines on D&QS?

*Scientific and Technical Sub Committee

International policy: ITU-R

International Telecommunication Union

Agenda items related to:

- UEMR report (in WP7D)
- Radio Quiet Zones and Satellites
- Radio Astronomy on the Moon
- Direct to Device communications

Much work in preparation to WRC-27

WP7D: Working Party 7D: Radio Astronomy
WRC : World Radiocommunication Conference

National/regional policy

National

- Licensing conditions (some)
- Coordination with astronomy
- Investment on studies
- National laws

Regional

- EU Space Act
- ESA Zero Debris Charter & booklet

Standardisation bodies

Space standards

- Earth-Space sustainability (ISO)
- Generic Standard for space (IEC-CISPR)
- Possible UEMR standard in ESA (to be confirmed)
- Specific emissions standard in ISO
- CRAF is leading the efforts with CISPR/ISO

International Standards can be adopted nationally or referenced by ITU and COPUOS

ISO: International Organization for Standardization
IEC: International Electrotechnical Commission
CISPR: International Special Committee on Radio Interference

CRAF: Committee on Radio Astronomy Frequencies

Community Coordination

IAU Centre for the Protection of Dark and Quiet Skies

Partners: ESO, NSF NOIRLab, SKAO

Renewed until 2030

+500 members

+14 satellite companies

Four Hubs:

- SatHub
- Policy Hub
- Industry Hub
- Community Engagement Hub
- Small project teams within each hub

Industry engagement

Awareness increasing

SpaceX testing components for UEMR

Others planning design mitigation

Progress but still low incentives

SKAO operates at all levels to protect the D&QS

UNITED NATIONS
Committee on the Peaceful Uses of Outer Space

SKAO

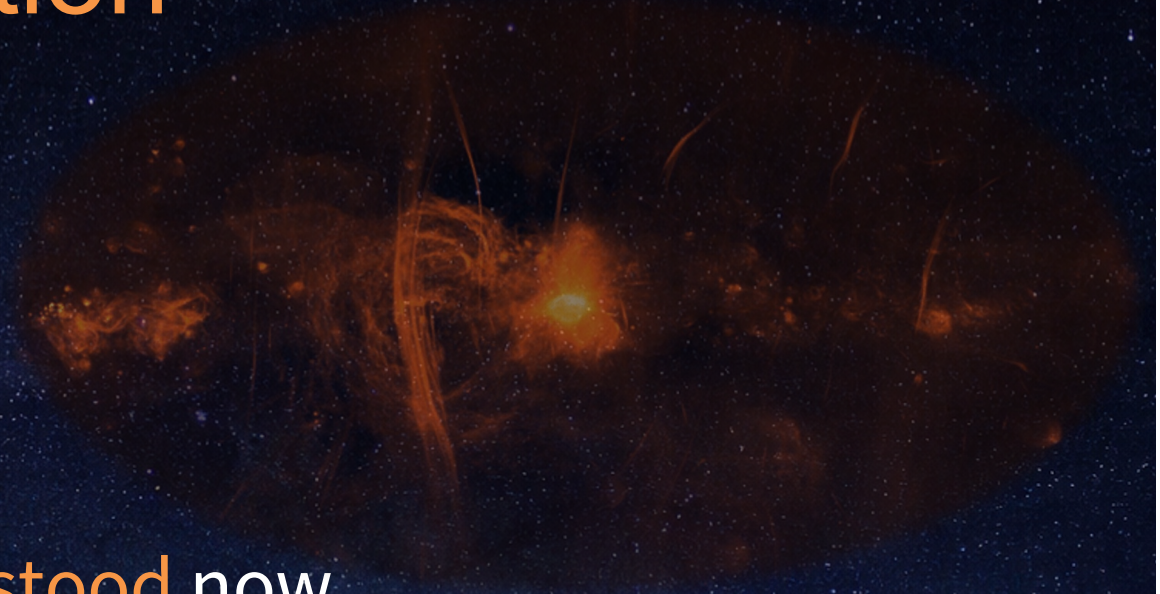
ISO IEC

bsi.

ITU

CENTRE FOR THE PROTECTION OF THE DARK AND QUIET SKY
CPS

Moving from awareness to coordinated action



New space era is here

Problem mostly understood now

Technical mitigations are a must

Policy gaining momentum (ITU/COPUOS)

National laws and standards are emerging