

constellations, sustainability,
and
the impact on the night sky

Andy Lawrence
GNOSIS Annual Conference
“Birmingham” Sept 9th 2021

Impact
Mitigation
Awareness
Regulation
Environment

Impact



reality
on the sky

reality
on the ground



key reports



On-line Workshop

Dark and Quiet Skies for Science and Society

Report and recommendations



UNITED NATIONS
Office for Outer Space Affairs



The Impacts of Large Constellations of Satellites

Contact: Gordon Long — glong@mitre.org

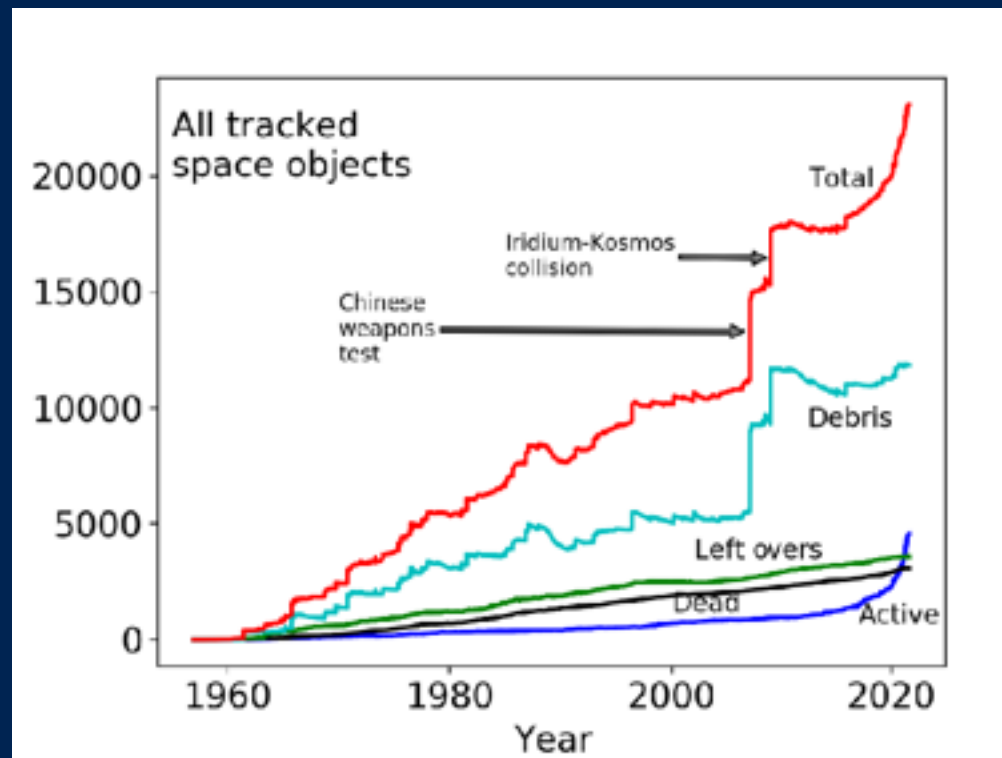
JSR-20-2H

November 2020
(Updated: January 21, 2021)

DISTRIBUTION A. Approved for public release. Distribution unlimited.

JASON
The MITRE Corporation
7515 Colshire Drive
McLean, Virginia 22102-7508
(703) 583-6997

impact modest today
but could get MUCH worse



grow to much larger constellations, as explained in §2.7.3. The most concrete conclusion we can draw from this table is that a lot of companies with deep pockets think that constellations of communication satellites are a profitable endeavor, and we could very quickly wake up on a world with over 100,000 communications satellites in LEO.

impact scorecard for 100K

Casual stargazing	On the edge	$m < 6$?
Amateur Astronomy	Bad	streaks in every image
Pro optical Astronomy	Bad	
Radio Astronomy	Very Bad	10-20% longer
Debris	Potentially catastrophic	tens of disabling collisions/yr

Mitigation

ideas from engagement with companies

- Changing albedo
- Predicting glints
- Orbit height recommendations
- Planned lifetimes
- Publishing orbits
- Radio beam re-direction
- Software correction

All takes TIME

All costs MONEY



IAU Launches Call for Proposals for New Centre for the Protection of the Dark Sky from Satellite Constellation Interference

[Click to Enlarge](#)

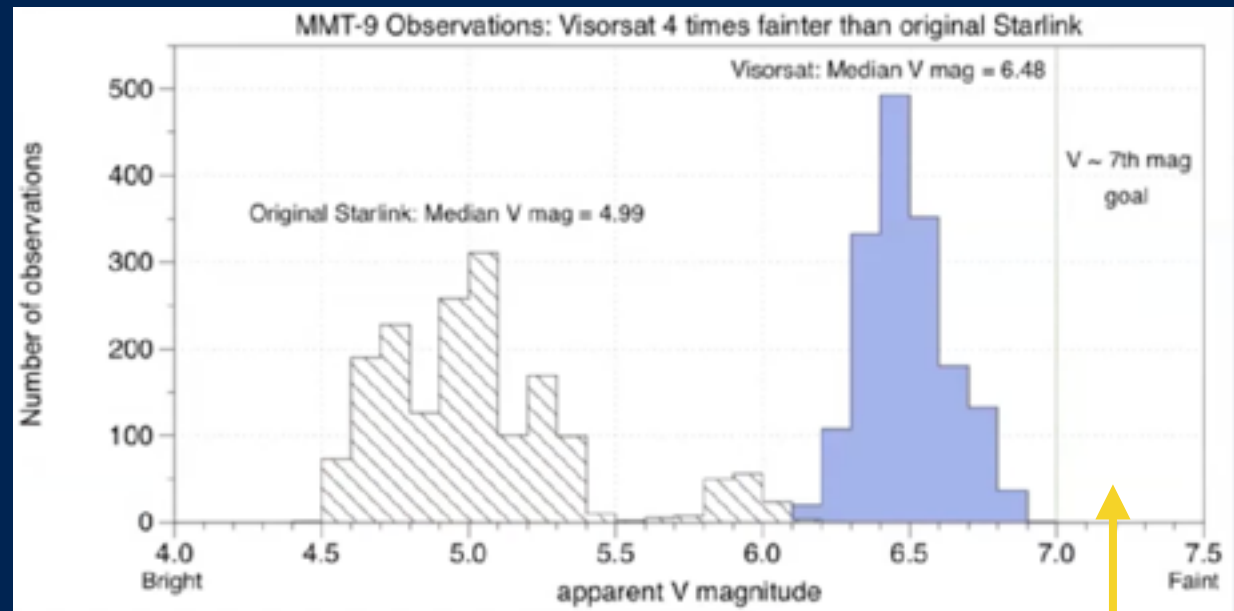
[Note: this call was updated 23 June 2021]

The International Astronomical Union (IAU) invites proposals for the establishment of an IAU Centre for the Protection of the Dark Sky from Satellite Constellation Interference that will focus on mitigation of optical (i.e., visible and infrared) light interference by satellite constellations. The centre will foster the development of tools and procedures that can mitigate the impact of satellite constellations on optical astronomy, and work with the space companies and industries to discuss and converge on mitigations. Interested institutes or organisations are invited, individually or in partnerships, to submit proposals to host the centre.

Brightness (magnitude)

m=6 naked eye limit

m=7 Rubin crosstalk limit



Flares

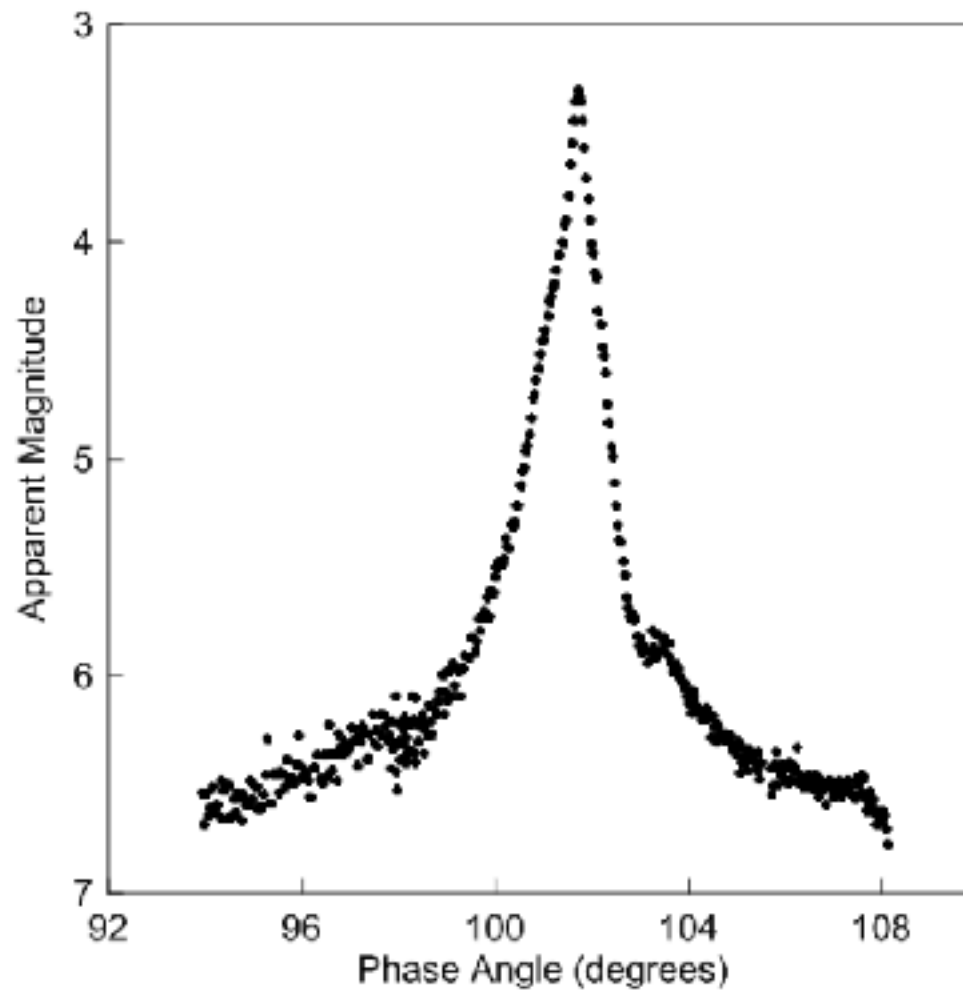
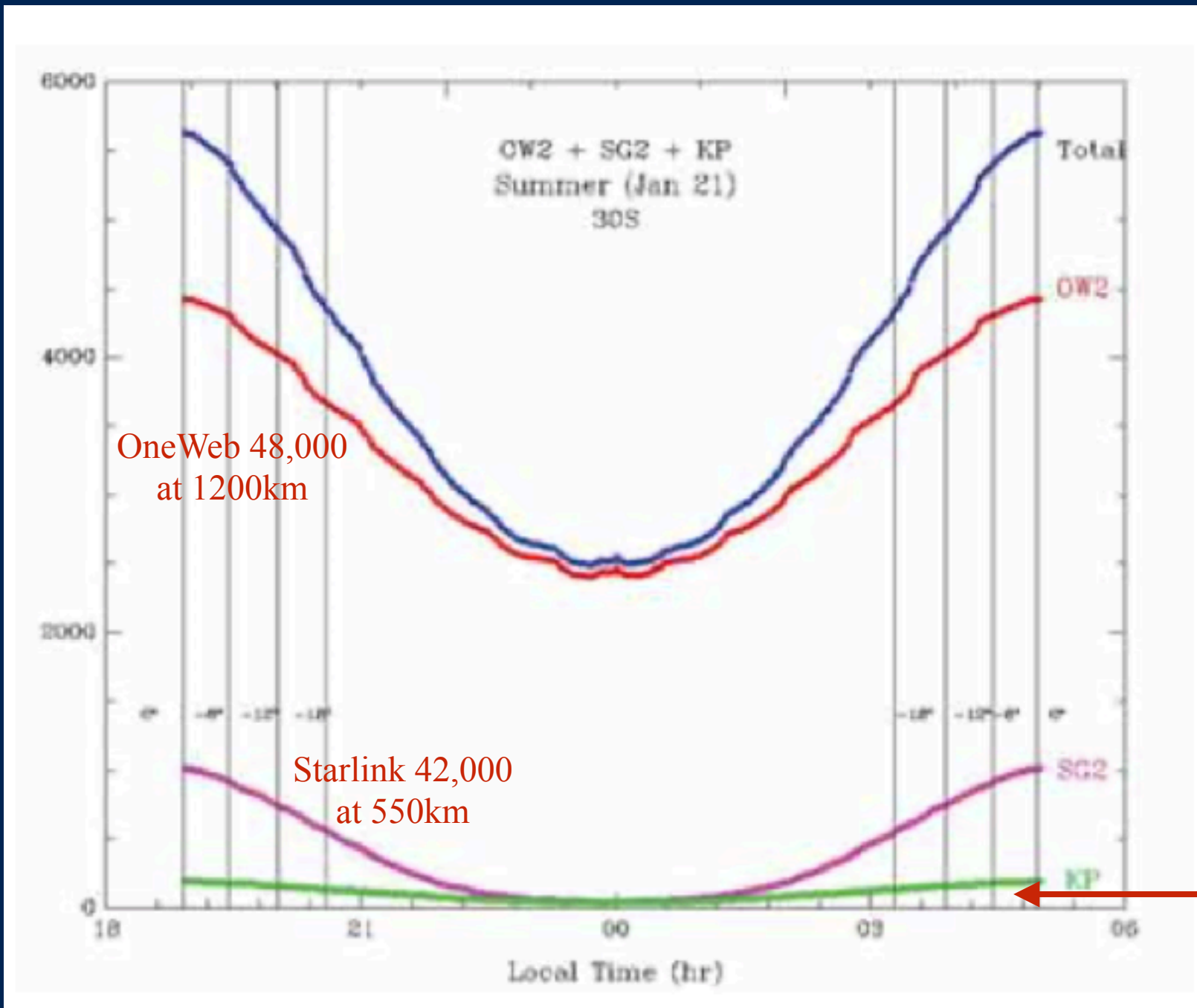


Figure 3. MMT light curve of Starlink-1549 recorded on 2020 November 27. The large brightness surge is not explained by the phase angles of the observations.

Visibility and orbit height



Awareness

LOSING THE SKY

Andy Lawrence

Foreword
by Dr Brian May

Andy Lawrence

Astronomy and other stuff



HOME RESEARCH OUTPUT TEACHING OUTREACH LOSING THE SKY

Losing The Sky: Event

A live public discussion took place on June 15th 19:30 BST, bringing together forty international experts including Andy Lawrence, Brian Eno, Catherine Heymans and many others. What are the real issues, and what should we do? For information on the associated book, click [here](#). For what you can do to help, click [here](#). A recording of the event is on the [YouTube channel of the Astronomical Society of Edinburgh](#). Here is a [transcript of the Zoom chat](#) between the participants. The video is also embedded below



Recording of the event

Connecting the world sounds great: very few people would argue with that, and what new space companies have been doing is visionary and exciting. However, experts around the world are becoming increasingly anxious about where the New Space Race is

Sun THE SUN, A MERRILL LYNCH COMPANY

SPORT NEWS MONEY DEAR DEBBIE MOTOR TRAVEL TECH

FAIR PLAY BUSINESS TRAVEL & ACCOMMODATION



Tech & Science

SAVE OUR SKIES Astronomers fear growing number of satellites will spoil space as Elon Musk to send thousands into orbit

Sam Kerton
11:20, 5 Jun 2021 • Updated 11:35, 5 Jun 2021

Share

STARLINKERS have launched a bid to clean up the first frontier.

Astronomers fear the explosion of satellites being blasted into orbit to super-charge the internet will spoil space.

bbc NEWS Top stories Your area Topics Weather

We could see as many satellites as stars in our sky by 2030 thanks to space junk, astronomers warn

SCIENCE | ENVIRONMENT | SPACE | Tuesday 15 June 2021 5:14pm




Within a decade, we could be seeing as many satellites as stars in our night sky.
Credit: Sam Barak/istock

Within a decade, we could be seeing as many satellites as stars in our night sky, thanks to all the "space junk" that is being launched into the Earth's orbit, astronomers have warned.

The 2019, there were about 2,000 satellites orbiting the Earth. The number today is double that, and in 10 years, that number could shoot up to 100,000, according to Andy Lawrence, deputy professor for astronomy at the University of Edinburgh.

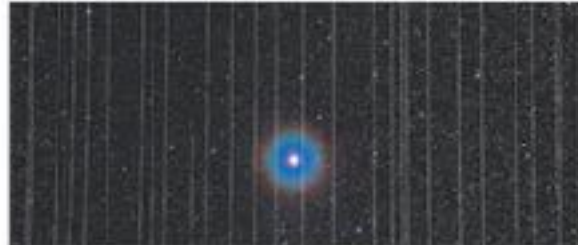
NEWS Politics Opinion Culture Money Lifestyle Features Sport

Science



Brian Eno calls for space to be better protected – like Antarctica is

He is concerned about plans to send 100,000 satellites into low-Earth orbit in less than a decade



BBC A Dachgach Naidheachdan Spòrs

Fàilte gu BBC ALBA



Seinneadair Yoik a' dìon rèin-fhiadh ann an Dùthaich nan Sàmi

BBC Home Sport Weather iPlayer More

TODAY
Weekdays 6-9am and Saturdays 7-9am



Home Episodes Highlights Podcasts Student Rewards



Listen now

15/06/2021

More and current affairs, including Sports Desk, Weather and Through it for the Day

15 cups left to listen
2 hours

See

SISSA PRESENTS

A STORY FROM THE FUTURE

LIBRA

8/9 September 2021 - MIRAMARE CASTLE [Trieste, Italy]

12 September 2021 - GRADISCA FORTRESS [Gradisca d'Isonzo, Italy]

Roberto Trotta
Trieste

Sept 8-12



Max Alexander

Waste In Space

exhibition 2022
National and
International venues



Regulation

JASON report quote:

A company who wanted to launch a dump truck full of sand into the same orbit as the International Space Station would have no formal barriers to doing so in many countries around the world.

Regulation scorecard

Broad Principles	✓	Outer Space Treaty
Competence to launch	✓	in most countries..
Use of radio spectrum	✓	ITU
GSO interference	✓	
Liability	—	“diplomatic channels”
Minimising Debris	—	non-binding guidelines
LEO advertising	— ✗	in some countries..
Atmospheric Pollution	✗	
Sky Pollution	✗	see Viasat court case
LEO interference	✗	



regulatory
shake-up
will come?



**WE CALL ON GOVERNMENTS TO
SUPPORT A GLOBAL MORATORIUM ON
DEEP SEABED MINING**

**BMW
GROUP**

SAMSUNG
SAMSUNG SDI

Google

VOLVO
VOLVO GROUP

Environment



Skyrora places education and sustainability at the heart of our core values.

Press release

G7 nations commit to the safe and sustainable use of space

eSpace
EPFL Space
Center

Space Sustainability Rating

United States Court of Appeals
For The District of Columbia Circuit

**VIASAT, INC.; DISH NETWORK CORPORATION;
THE BALANCE GROUP,**
Appellants,

v.

FEDERAL COMMUNICATIONS COMMISSION,
Appellee.

SPACE EXPLORATION HOLDINGS, LLC,
Intervenor for Respondent

**ON APPEAL FROM THE FEDERAL COMMUNICATIONS COMMISSION
IBFS FILE NO. SAT-MOD-20200417-00037**

**BRIEF OF PROFESSOR ANDY LAWRENCE AS *AMICUS CURIAE*
IN SUPPORT OF VACATUR**

key US
legal case

should NEPA
apply to major
satellite
projects?

assisted by Meredith Rawls, Moriba Jah,
and many community contributors

available at
<https://andyxlastro.me>

Key points

Orbital Space should be considered as part of the environment

We rely on that environment by looking through it as well as working within it

Environmental damage is significant and cumulative

Environmental damage externalises costs

FCC categorical exclusion dates from 1986 when there were only 389 active satellites



Max Alexander

Joanne Wheeler

Andy Lawrence

Howard Nye

Hugh Lewis

Stuart Clark

proposal being put to UK Govt
to take to UN GA

*probably
Nov 2022*

discussing organisational home

... and hopefully
many backers..

FIN