

## Unlocking commercial spaceflight for the UK: response from the Royal Astronomical Society

### Introduction

This is the official submission from the Royal Astronomical Society (RAS)<sup>1</sup> in response to the consultation on commercial spaceflight and orbital activities by the UK Space Agency, Department for Transport (DfT), the Civil Aviation Authority (CAA), and the Department for Business, Energy and Industrial Strategy (BEIS).

The RAS represents more than 4,400 astronomers and geophysicists, in the UK and around the world, in occupations in academia, industry, education and public engagement, and journalism, as well as others in the wider economy. Our members are described as 'Fellows'.

This response was shaped by input from our governing Council, and our satellite megaconstellation working groups consisting of RAS Fellows in industry, universities and research establishments.

Our central aim is to highlight a major omission in the consultation document, namely the impact of satellite deployments on ground-based astronomy. We have therefore confined this response to this area, answering only those questions pertaining to it.

Astronomers and planetary geophysicists remain beneficiaries of orbiting observatories and probes, including the Hubble Space Telescope, the Swift observatory and Earth observation satellites such as the Sentinel programme. Participation in these space missions helped the UK take a world-leading role in the sciences we represent, and is part of the reason for us being consistently ranked second or third in the world in terms of publication output<sup>2</sup>.

Our community is thus a major component of the 'space industry', but we are deeply concerned at the now well publicised impacts of planned satellite megaconstellations on astronomy. These constellations include Starlink, and OneWeb, where the UK government has made a significant investment.

Satellites reflect sunlight during twilight and later in the night, and appear as streaks crossing optical images of astronomical objects. Megaconstellations could make some areas of ground- and space-based<sup>3</sup> optical astronomy work such as detecting transient phenomena, monitoring meteors, or detecting potentially hazardous asteroids difficult if not impossible. Longer exposures will also be complicated, with the need to remove many trails from images compromising the scientific data.

At radio wavelengths, the signals transmitted from satellites to ground receivers could threaten the operation of existing and new facilities, hampering areas of work such as the evolution of the universe, the formation of stars and planets, and the search for biosignatures on planets orbiting other stars. In high density deployments, the increasing probability of direct illumination of a satellite could have an impact on radio astronomical observations even outside of the frequency range of the satellite transmissions.

A related concern is geodetic Very Long Baseline Interferometry, which is threatened by 10-12 GHz transmissions from satellites. This should be considered as a critical national/international infrastructure, in terms of its fundamental role in establishing and maintaining the international celestial and terrestrial reference frames at high precision, and one that requires protection in the

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<sup>1</sup> <https://ras.ac.uk/>

<sup>2</sup> See e.g. <https://www.scimagojr.com/countryrank.php?category=3103> and <https://www.scimagojr.com/countryrank.php?category=1901>

<sup>3</sup> Based on conversations with ESA staff

new licencing regime. (A new UK GNSS to replace access to Galileo will need to use data from a system of this type.)

The Agency, DfT, CAA and BEIS should note that these impacts are in no sense confined to the UK, as satellites in orbit will be visible across the whole inhabited world, and from virtually all astronomical facilities. These include some under construction where the UK has made a significant commitment, such as the European Extremely Large Telescope<sup>4</sup> under construction by the European Southern Observatory (the UK is a member), the Vera Rubin Observatory<sup>5</sup> and the Square Kilometre Array<sup>6</sup> (the UK is a member, and it has its HQ at Jodrell Bank in Cheshire). New and existing astronomical observatories will also complement the work of their counterparts in space, where the UK is in many cases again making an important scientific and financial contribution.

It would be deeply regrettable if new satellite systems, particularly the constellations planned and under construction, were to undermine the science of astronomy, the achievements of researchers around the world, government investment already made, and future opportunities for recruiting young people to science, given astronomy's role as a STEM attractor<sup>7</sup>.

We therefore ask for the responsible design and deployment of satellites to be built into UK launch regulations, to minimise their impact on a scientific discipline where we are world leading.

### **Questions in the consultation**

#### **1. Do you have any comments to our approach to assessment of environmental impacts?**

As in our introduction, we ask for the approach to include the impact on ground-based scientific facilities, including astronomical observatories, that result from the deployment of satellites in Low Earth Orbit. These include facilities operating at optical and radio wavelengths in different sites around the world, which are and will be affected by the light reflected and radio transmissions from satellites, with those effects scaling up in proportion to the number deployed.

These considerations should be specifically included in the environmental features 'landscape and visual impact' and 'material assets and cultural heritage' described in the 'Guidance for the Assessment of Environmental Effects'<sup>8</sup>.

#### **4. Do you have any comments on our approach to orbital activities? Please provide details**

The regulation of orbital activities needs to consider the impact after spacecraft are deployed, rather than being confined to the launch phase. The night sky should be considered for protection in the same way as the terrestrial environment, and operators should be obliged to factor this into the design and operation of spacecraft destined for orbit, with this added to the 'Guidance for Orbital Operator Licence Applicants and Orbital Operator Licensees'<sup>9</sup>.

For more than a year, members of the RAS, the American Astronomical Society, the European Astronomical Society, the International Astronomical Union, specialists in major astronomical

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<sup>4</sup> <https://www.elte-uk.org/>

<sup>5</sup> <https://www.lsst.org/>

<sup>6</sup> <https://www.skatelescope.org/>

<sup>7</sup> See e.g. "Teaching astronomy in UK schools", Roche P. et al., School Science Review, 2012, available from <https://www.stem.org.uk/elibrary/resource/31566>

<sup>8</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/904454/guidance-for-the-assessment-of-environmental-effects..pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904454/guidance-for-the-assessment-of-environmental-effects..pdf)

<sup>9</sup> [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/904448/guidance-for-orbital-operator-licence-applicants-and-licensees.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904448/guidance-for-orbital-operator-licence-applicants-and-licensees.pdf)

facilities, and engineers in the space industry have worked together on recommendations encompassing responsible satellite design and deployment. We have already submitted outline guidelines to the UK Space Agency, and the SATCON working group recently presented detailed proposals to the UN Office of Outer Space Affairs 'Dark and Quiet Skies' conference<sup>10</sup>. The new regulations should incorporate these findings, currently in draft form<sup>11</sup>, and which will be presented to the UN Committee on the Peaceful Uses of Outer Space early next year.

The UK should take an international lead too, working with the UN bodies and the International Organisation for Standardization to develop best practice guidelines and construction standards for satellites licenced by different nations.

51. Regulation 104 and Schedule 1 identify a number of requirements for parts of the launch vehicle that reach orbit or for any sub-orbital launches that interfere with the space environment. These seek to minimise the interference of the spaceflight activity with other space objects and ensure the operator considers aspects such as space debris mitigation in their mission. Do you have any comments about the requirements relating to the launch vehicle during operator's spaceflight activities? Please provide details.

We of course support every effort made to minimise space debris resulting from the launch of deployment of satellites. Regulation 104 also requires operators to 'avoid the launch vehicle interfering with the space activities of other persons in the peaceful exploration and use of outer space' and to 'prevent contamination of outer space arising from the launch vehicle in orbit or adverse changes in the environment of the Earth from that vehicle in orbit'.

It is not sufficient to consider the launch vehicle alone, as deployed payloads in the form of satellites are also a source of a significant impact.

We urge the UK Space Agency, the Department for Transport and the Department for Business, Energy and Industrial Strategy to explicitly include both ground- and space-based astronomical facilities in the remit of regulation 104. We further argue that (unmitigated) deployment of satellites threatens the view of the night sky, a part of the natural 'space environment' that requires protection.

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<sup>10</sup> Discussed on Thursday 8 October. See <http://research.iac.es/congreso/quietdarksky2020/pages/program.php>

<sup>11</sup> Draft recommendations available at <https://owncloud.iac.es/index.php/s/WcdR7Z8GeqfRWxG#pdfviewer>