UNIVERSITY OF LEICESTER

Department of Genetics & Genome Biology

University of Leicester
University Road
Leicester LE1 7RH
UK

Professor Charalambos Kyriacou, FMedSci

t: +44 (0)116 252 3430
f: +44 (0)116 252 3378
e: cpk@leicester.ac.uk
w: www.le.ac.uk/genetics

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Federal Communications Commission
45 L Street NE
Washington, DC 20554
United States of America

Re: Environmental and Public Health Considerations Regarding Proposed Satellite Deployments
SAT-LOA-20250701-00129 (Reflect Orbital)
SAT-LOA-20260108-00016 (SpaceX)

Dear Commissioners,

We write in our capacities as Presidents of the European Biological Rhythms Society (EBRS), the Society for Research on Biological Rhythms (SRBR), the Japanese Society for Chronobiology (JSC) and the Canadian Society for Chronobiology (CSVC). Furthermore, one of us (CPK) also serves as co-founder and Steering Group member of the UK Government–funded BioClocks UK research network. Together we represent ~2500 scientists from over 30 countries. On behalf of our members, we wish to express scientific and public health concerns regarding proposals SAT-LOA-20250701-00129 from Reflect Orbital and SAT-LOA-20260108-00016 from SpaceX which, together with related filings, could authorize the deployment of up to one million additional satellites in low Earth orbit in the coming decades.

Artificial light at night (ALAN) is now widely recognized as a form of environmental pollution with measurable biological and ecological effects [1,2]. The proposed scale of orbital deployment would represent a significant alteration of the natural night-time light environment at a planetary scale. The potential chronobiological and ecological implications of cumulative satellite brightness and moving orbital light sources therefore warrant formal environmental evaluation under a precautionary, evidence-based framework. The global light–dark cycle is a fundamental geophysical signal comparable in biological importance to temperature and seasonal photoperiod, and large-scale anthropogenic alteration of nocturnal illumination therefore represents a form of environmental change with potentially widespread biological consequences.

While satellite constellations have primarily been considered in terms of radio-frequency interference and impacts on astronomy, their consequences for nocturnal illumination of the Earth's surface and atmosphere have received comparatively little regulatory scrutiny. Yet the night-time light environment has been a fundamental environmental constant throughout evolutionary history and functions as a key signal regulating biological timing systems across species.

Circadian Regulation and Human Health

All humans possess an internal biological clock that regulates sleep, hormone production, metabolism, immune function and mood. This circadian system is synchronized primarily by the daily cycle of light and darkness [3]. Even relatively low levels of light at night comparable to ordinary indoor lighting suppress the hormone melatonin, delay the timing of the internal clock and disrupt sleep quality [4,5].

Experimental studies demonstrate that misalignment between internal biological time and the external environment produces adverse metabolic and cardiovascular changes [6]. Long-term epidemiological studies associate chronic circadian disruption, such as that experienced by shift workers, with increased risk of metabolic disease and certain cancers [7]. The International Agency for Research on Cancer (IARC) has therefore classified night shift work involving circadian disruption as a Group 2A probable carcinogen [8].

Because satellite-generated skyglow would be diffuse and cannot be locally shielded or mitigated through conventional urban lighting controls, even modest increases in background night-time brightness could have global environmental level relevance, particularly in regions that currently experience relatively dark skies [1].

Wildlife Navigation and Seasonal Physiology

Many animals depend on natural darkness and celestial cues for orientation and migration. Artificial night lighting has been shown to disrupt migratory behavior in birds and other species [9,10]. Nocturnally migrating birds in particular use stars and natural twilight illumination for navigation; artificial light sources can attract and disorient them.

In addition, many animals measure day length (photoperiod) with remarkable precision in order to regulate reproduction, hibernation, migration and other seasonal behaviors. Experimental exposure to even low-intensity night lighting alters reproductive physiology and hormone timing in mammals, birds and insects [11]. Photoperiodism, the biological measurement of day and night length, is a deeply conserved adaptive mechanism across plant and animal species [12]. Systematic alteration of perceived night length therefore represents a biologically meaningful environmental signal capable of altering seasonal timing.

Plant Rhythmicity, Oxygen Production, and Carbon Cycling

Terrestrial vegetation and marine phytoplankton together account for essentially all biological oxygen production on Earth. Oceanic primary producers contribute approximately half of global net primary production and are central to carbon sequestration and climate regulation [13,14].

Plants, including major food crops, possess internal circadian clocks that regulate photosynthesis, respiration, stomatal opening, stress resilience, flowering and seed production [15,16]. Artificial night-time illumination has been shown to alter flowering time, leaf phenology and physiological processes in wild plants [16]. Disruption of seasonal timing can desynchronize plant–pollinator interactions and alter plant–pathogen dynamics. Because agricultural productivity depends on precise seasonal coordination, such effects may have implications for global food security.

In marine ecosystems, artificial light at night is increasingly recognised as an emerging ecological stressor. Biological rhythms in primary producers, such as phytoplankton at the base of aquatic/marine food webs, are tightly regulated by periodic light–dark cycles and are highly sensitive to artificial light at night [17]. Likewise, many marine animals, including corals, rely on the natural light cycles of sunlight and moonlight to regulate various physiological, biological, and behavioral processes. Light pollution has already been shown to collapse and delay gametogenesis in coral species [17] and can disrupt the behavior and vertical distribution of Arctic fish and zooplankton at depths of up to 200 meters [18]. Given that marine ecosystems cover nearly 70% of the Earth's surface, the continued expansion of artificial lighting is likely to have far-reaching consequences for biodiversity, reproductive success, predator–prey interactions, and overall ecosystem functioning and the oceanic carbon pump.

Importantly, darkness initiates essential metabolic processes in photosynthetic organisms, including carbohydrate remobilisation, mitochondrial respiration, repair of photosynthetic machinery and regulation of reactive oxygen species [15]. The biological mechanisms by which altered nocturnal illumination influences plant and marine physiology are therefore well established.

Orbital Illumination Technologies

Reflect Orbital

Of particular concern is the Reflect Orbital proposal to provide illumination of terrestrial locations "on demand" using reflective mirrors mounted on satellites. According to publicly available descriptions, the concept involves redirecting sunlight from orbit in order to illuminate specific areas of the Earth during night-time hours [19].

While the proposal acknowledges potential concerns from astronomical observatories, available descriptions do not appear to address possible biological, ecological or public-health consequences of introducing controllable artificial illumination from orbit. For example, what happens if control is lost and sustained illumination of unintended locations occurs? Such technology represents a qualitatively new class of environmental light source capable of illuminating large geographic regions without the possibilities of local shielding or opt-out mechanisms.

Satellite Constellations and Cumulative Sky Brightness (SpaceX)

The proposal submitted by SpaceX would contribute to a rapidly expanding population of satellites in low Earth orbit. Current projections suggest that, if multiple constellation proposals are approved, the total number of operational satellites could increase by one to two orders of magnitude relative to the historical spaceflight era.

Recent modelling studies indicate that large satellite constellations can measurably increase the overall brightness of the night sky through sunlight reflected from satellite surfaces and subsequent scattering within the upper atmosphere [20,21]. These reflections contribute to diffuse skyglow visible across extremely large geographic regions.

While predicted increases in sky brightness may appear modest in astronomical terms, biological systems are known to respond to relatively small changes in nocturnal illumination, particularly within wavelengths influencing circadian photoreceptors [3–5].

Satellite reflections are also dynamic rather than stationary. Moving points of light traversing the sky may produce transient illumination events that differ qualitatively from the relatively constant skyglow generated by terrestrial lighting and may therefore have distinct biological and ecological consequences.

Environmental Review Considerations

Under the National Environmental Policy Act (NEPA), federal agencies are required to evaluate environmental consequences of major federal actions prior to authorization. The unprecedented scale of proposed satellite constellations and orbital illumination technologies raises the possibility of cumulative environmental effects that extend beyond traditional regulatory categories. Such cumulative impacts are specifically recognized within NEPA as requiring careful evaluation before technological deployment.

Given the scale of proposed deployment, we respectfully recommend:

1. Preparation of a comprehensive Environmental Impact Statement (EIS).
2. Explicit assessment of chronobiological, ecological and biogeochemical implications.
3. Inclusion of independent expertise in circadian biology, ecology, plant physiology, marine science and environmental health.
4. Establishment of measurable reflectivity standards and cumulative luminance thresholds prior to authorization.

Because satellite deployments are effectively irreversible once launched, precautionary environmental review prior to large-scale implementation is particularly important.

Orbital Light Pollution

The natural night-time light environment has remained remarkably stable throughout evolutionary history, shaped primarily by the Moon, stars and faint atmospheric airglow. The rapid expansion of reflective objects in low Earth orbit introduces the possibility of a new category of anthropogenic environmental disturbance that may be described as **orbital light pollution**.

Unlike terrestrial lighting, orbital light sources cannot be geographically confined, shielded or locally regulated. Their effects are inherently transboundary and planetary in scale. For this reason, cumulative illumination produced by large satellite constellations and orbital mirror technologies should be evaluated as part of the global night-time environment upon which biological timing systems depend.

Careful scientific evaluation is therefore essential before proceeding with technological developments capable of modifying the nocturnal light regime of the Earth.

The EBRS, SRBR, JSC, CSC and BioClocks UK research network stand ready to provide expert consultation should the Commission require additional scientific input.

Respectfully submitted,

Charalambos P. Kyriacou
President, European Biological Rhythms Society
Co-founder and Steering group member, BioClocks UK

John B Hogenesch
President, Society for Research in Biological Rhythms (SRBR)
Division of Human Genetics, Center for Circadian Medicine, Department of Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA.

Kazuhiro Kume
President, Japanese Society for Chronobiology
Department of Neuropharmacology, Graduate School of Pharmaceutical Sciences
Nagoya City University, Nagoya, Aichi, Japan.

Tami Martino
President, Canadian Society for Chronobiology (CSC)
Department of Biomedical Sciences
University of Guelph, Guelph, Ontario, Canada

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