U.K. Space Missions and Policy

The *Hawking Space Platform*: A U.K. flagship mission to pioneer the circular space ecosystem

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Abstract Missions and objects launched to Outer Space have traditionally been bespoke and single-use. Recently, the dramatic increase in cadence of launches and mass-to-orbit means that certain orbits, in particulate Low Earth Orbit (LEO; 200-2000km) are rapidly becoming not only congested but are also at high risk for sites of collisions resulting in non-use. As such, a new approach is needed in order to futher continue the utilization of space for all of humankinds goals. Here we present the *Hawking Space Platform*, a flagship mission for the UK space sector, that will engage leading research institutes, Primes, Start-up/SMEs, Scale-ups and Government into bold, concerted action for space sustainability and the future of the circular economy in space. *Hawking Space Platform* will be a modular spacecraft that will function as an observatory for astrophysics, a free-fall ("zero-g") laboratory for a range of sciences and be a technology demonstrator for on-orbit circular economy practices. We motivate the *Hawking Space Platform*, suggest key mission parameters and requirements and argue that bold action is taken now by those interested in the short-term and long-term benefits of outer space.

OVERVIEW Numerous authorities, including the UK Space Agency (UKSA) and the European Space Agency (ESA) have identified space debris as an existential threat to space operations, especially in Low Earth Orbit (LEO; 200-2000km). Indeed, even in case of no further launches into orbit, it is expected that collisions among the space debris objects already present will lead to catastrophic collisions in LEO in the near future.[1] Based on these findings there is a growing consensus that stricter space debris mitigation practices need to be implemented globally, and, eventually, remediation will need to take place.

As such, the UK has been building leadership in space debris removal and specifically Active Debris Removal (ADR) with the *Clearing the LEO Environment with Active Removal* (CLEAR) mission from ClearSpace UK and the *Cleaning Outer Space Mission through Innovative Capture* (COSMIC) mission from Astroscale Ltd. set to launch in 2026.[2]

While the ADR missions are a critical start to limiting the severe impact of large space debris, the space sector is looking towards a fully circular economy for space - a model of resource production and consumption that involves reusing, repairing, refurbishing, and recycling existing materials and products for as long as possible. Indeed there is deep energy and fierce urgency in both the academical and industrial spheres with a range of UK Space companies that are looking to implement e.g. In-Orbit Servicing and Manufacturing (IOSM)[3].

THE CIRCULAR ECONOMY IN ASTROPHYSICS Interestingly, repairing and refurbishing space assets has a long legacy and heritage in astrophysics. Indeed, one of, if not the most iconic space telescopes - the *Hubble Space Telescope* - was specifically designed to be repaired and refurbished over its mission lifetime. *Hubble* had regular servicing and equipment upgrades while in orbit as well as orbital boosts. Instruments and limited life items were designed as orbital replacement units with five servicing missions flown by the NASA Space Shuttles, the last in May 2009. Some components from older instruments were reused in later instrument generations.[4]

THIS PROPOSAL Here, we propose the *Hawking Space Platform*. The *Hawking Space Platform* will be a modular spacecraft that will function both as an observatory for astrophysics and also as a free-fall ("zero-g") laboratory for Energy, Health and Life Sciences, Quantum, Digital, and Defence and Security investigations. The *Hawking Space Platform* will be akin to the *Hubble Space Telescope* in that it will have instrument and laboratory bays where observations and experiments can be carried out. Also like *Hubble*, these instruments will be designed to be replaced at a regular cadence, making sure technology is continually bleeding-edge. The key mission parameters of the *Hawking Space Platform* are given in Table 1.

Unlike *Hubble*, however, the *Hawking Space Platform* will have the instruments and laboratories upgraded via robotic interactions (and not human intervention and Space Shuttle infrastructure). Designing this ability will enable a range of technology demonstrators including, but not limited to: Rendezvous and Proximity Operations (RPO); Advanced Guidance & Targeting, and Interface standardisation. Obsolete *Hawking Space Platform* equipment would be recycled on orbit or,

[1] ESA, Annual Space Environment Report, 2004, GEN-DB-LOG-00288-OPS-SD; Figure 7.

[2] https://www.adsadvance.co.uk/astroscale-to-continue-uk-national-debris-removal-mission.html

[3] https://www.ukspace.org/event/in-orbit-servicing-and-manufacturing-iosm-conference-2024; https://www.gov.uk/government/news/space-sustainability-conference-kicks-off-with-18-million-for-tech-innovation

[4] The first WFPC was dismantled, and some components were then re-used in WFC3.

Table 1: Key Mission parameters of the *Hawking Space Platform*

Mass Launch/Payload	2,000/800 kg	ESA *Euclid* as baseline
Initital Launcher	Ariane 6	>2000 kg payload
Subsequent Launches	various	from e.g. UK spaceports
Orbit	LEO	200-2000km (Perigee and Apogee)
Payload Bays	several	for Observatory instruments and laboratories
Mass equivalent reused	>95%	Primary Mission Requirement

indeed one (or more) of the instrument bays in the *Hawking* could be a recycling centre. Technological risks can be explored and retired for a range of innovative technologies, while regulations can be stress-tested in a scientific environment.

HAWKING SPACE PLATFORM IN ASTROPHYSICS CONTEXT NASA WISE, NASA NEO Surveyor and NASA SPHEREx all have relatively modest primary mirror size (20-50cm) and operate in the near-to-mid infrared (0.75-20μm).[5] A baseline for the observatory part of *Hawking* could be close to the ESA Infrared Space Observatory (ISO). ISO was a space telescope with a 60cm primary mirror designed for wavelengths of 2.5 to 240μm and operated from 1995 to 1998. The more precise design and optimization for wavelength would be the focus of a Concept Study, though initially wavelengths longer than ∼25μm (the longest JWST MIRI wavelength) which are often cryogenics-limited (see Table 2) and close to 100% absorbed by the Earth's atmosphere would be a natural waveband to initially explore.

HAWKING SPACE PLATFORM IN BUDGETARY AND POLITICAL CONTEXT We envisage the *Hawking Space Telescope* to have a budget envelop of greater than a NASA MIDEX mission and less than an ESA medium-class ("M-class") mission, putting this in the £400-500 million range. This would be, by some considerable distance, the most ambitious UK-led civil space mission ever considered. However, this is directly comparable to the investment from the UK Government in OneWeb[6] and significantly less than the Skynet family of military communications satellites, so the UK does have precedent for this ambition. More importantly, the potential ROI could be truly significant and generational, immediately supercharging numerous scientific fields, sector innovation, giving the UK launch sector a long-lived destination and be an industry-led, Government-backed space mission. Universities, research institutes, public sector research establishments, Primes, UKRI (including of course STFC), the UKSA and ESA would all be involved.

In conclusion, the Hawking Space Platform will be the flagship mission for the UK space sector, that engages leading research institutes, Primes, Start-up/SMEs, Scale-ups and Government into bold, concerted action for space sustainability and the future of the circular economy in space.

[5] Noting the NASA WISE mission became the NASA NEOWISE mission with only the 3.4, 4.6μm bands
[6] https://www.gov.uk/government/news/uk-government-to-acquire-cutting-edge-satellite-network

Table 2: List of selected astrophysics missions and reason for End of Mission

Astrophysics Mission	Lifetime	End of Mission cause
ESA/NASA *Hubble Space Telescope*	1990-ongoing	Likely re-entry into Earth's atmosphere
ESA ISO	1995-1998	Liquid helium depletion
ESA *Herschel* Space Observatory	2009-2013	Liquid helium depletion
ESA *Planck*	2009-2013	Liquid helium depletion
NASA *Compton* GRO	1991-2000	Gyroscope failure and de-orbit
NASA *Kepler*	2009-2018	Reaction Control System fuel depleted
NASA *Spitzer Space Telescope*	2003-2009	Liquid helium depletion
NASA WISE	2009-2012	Hydrogen coolant depletion