

John I Davies & Gill Norman report on recent developments in interstellar studies

IAU Focus Meetings at the 2027 IAU General Assembly

Many congratulations to T Marshall Eubanks and W Paul Blase (Space Initiatives Inc, USA) who proposed '*Interstellar Objects in the Time of the Rubin LSST*' [1] to the International Astronomical Union (IAU) [2]. The IAU Executive Committee has approved this as one of twelve IAU Focus Meetings to be held during the 2027 IAU General Assembly in Rome, Italy [3]. IAU Symposia and Focus Meetings are "at the very core of the IAU's scientific activities" and they have described the proposal "excellent and exciting". See the list of Scientific Meetings here: <https://www.iau.org/iau/News/Ann2026/IAU-Scientific-Meetings-2027.aspx>.

Propulsion Options for the Solar Gravitational Lens Mission

A recent post by Paul Gilster caught our eye and can be viewed here on his excellent Centauri Dreams site:

<https://www.centauri-dreams.org/2026/02/17/propulsion-options-for-the-solar-gravitational-lens-mission/>.

"A mission to the Sun's gravity focus - or more precisely, the focal 'line' we might begin to use at around 650 AU - is never far from my mind. Any interstellar mission we might launch within the next thirty years or so (think Breakthrough Starshot, about which more next week) will essentially be shooting blind. We have little idea what to expect at Proxima Centauri b, if that is our (logical) target. But a mission to the solar gravity focus (SGL) would give us a chance to examine any prospective target at close hand. Indeed, so powerful are the effects if we can exploit this opportunity that we should be able to see continents, weather patterns, oceans and more if we can disentangle the Einstein Ring that the planet's image forms as shaped by general relativity. We've discussed the phenomenon many a time: the Sun's gravitational well so shapes the image of what is directly behind it as seen from the SGL so as to produce stupendous magnification, the image served up as a 'ring' around the Sun in the same way that astronomers now see some distant galaxies as rings around closer galaxies."

[1] The Rubin LSST: The Vera C Rubin Observatory's Legacy Survey of Space and Time, <https://rubinobservatory.org/news/visitors-from-distant-stars>

[2] <https://www.iau.org/>

[3] <https://iaurome2027.org/>

Broadband SETI: a New Strategy To Find Nearby Alien Civilizations

Ben Zuckerman (University of California, USA) has published "*Broadband Searches for Extraterrestrial Technological Intelligence: a New Strategy To Find Nearby Alien Civilizations*" (see <https://arxiv.org/abs/2603.07333>). One of the most interesting questions that astronomy can hope to answer is: are we alone in our Milky Way galaxy? A detection of an electromagnetic (EM) signal generated by an extraterrestrial technological intelligence (ETI), or the presence in our Solar System of an alien probe, would answer this question in the negative. Purposeful interstellar communication is a 2-way street - the transmitting and receiving technological intelligence (TI) both need to do its part. As the receiving TI, our EM search programmes should incorporate a model of what a transmitting TI is likely to be doing. Published searches for extraterrestrial technological intelligence (SETI) have generally not done so and, thus, have often been sub-optimally designed. They propose an improved search technique that more closely corresponds to astronomical surveys that have been undertaken for reasons that have nothing to do with SETI. Published non-SETI radio and optical surveys are sufficiently extensive that they already supply meaningful constraints on the prevalence of nearby purposely communicative alien civilizations. Purposeful communication can also include the sending of spaceships (probes). The absence of evidence for alien probes in the Solar System suggests that no alien civilization has passed within 100 light-years of Earth during the past few billion years.

2nd European Interstellar Symposium: Call for Papers

The Interstellar Research Group (<https://irg.space/>) have announced that the [Call for Papers](#) is now open for the 2nd European Interstellar Symposium, taking place in December 2026, in Venice, Italy. Hosted by the Venetian Institute of Sciences, Letters and Arts in association with the Interstellar Research Group and the International Academy of Astronautics, [1] this symposium will bring together an interdisciplinary community focused on the future of interstellar exploration.

Abstract Submission Deadline: 31 July 2026

Notification of Abstract Acceptance: 15 September 2026

Symposium Dates: 2 to 4 December 2026

To learn more, please visit the symposium page:

<https://irg.space/second-european-interstellar-symposium/>

Abstracts should be submitted to Registrar@irg.space.

[1] <https://iaaspace.org/>



What Is Space Bioethics?

Maurizio Balistreri (University of Tuscia, Italy) has published this paper:

<https://onlinelibrary.wiley.com/doi/10.1111/bioe.70082>. Classical bioethics examines moral issues in terrestrial medicine and the life sciences. According to Konrad Szocik [1], space bioethics merely relocates those questions to harsher environments. They argue that this view is incomplete: space bioethics is a genuinely original domain. Unprecedented conditions – chronic radiation exposure, partial gravity, closed ecologies, long communication delays, and severe resource constraints – reconfigure risk and responsibility. Survival-oriented interventions – human bio-enhancement, human-machine integration, germline editing for adaptation and off-world reproduction (potentially via ectogenesis) – pose dilemmas with no close terrestrial analogue. Moreover, some technologies may be developed and adopted in space before diffusion to Earth, generating ethical challenges in advance. These scenarios strain the portability of standard moral norms and cannot be addressed by simply importing frameworks from military or extreme-environment medicine.

Toward extraterrestrial librarianship: Designing knowledge systems for human settlements in space

Dattatraya Kalbande has published a paper in the Journal of Space Safety Engineering. As humanity moves closer to establishing settlements beyond Earth, libraries must be reconceptualized as autonomous, adaptive, and ethically grounded systems that support human survival, learning, and cultural continuity in extraterrestrial environments. This paper presents a conceptual framework for “extraterrestrial librarianship,” integrating insights from space science, digital preservation, human-computer interaction, and Library and Information Science (LIS). The proposed three-layered model - Sensing, Processing, and Interaction - guides the design of space libraries capable of functioning under extreme conditions such as microgravity, radiation, communication latency, and social isolation. Comparative and functional analysis tables distinguish traditional Earth-based libraries from their space counterparts and map practical use-cases ranging from mental health support to conflict mediation. The paper expands the librarian’s role into that of a knowledge architect, ethical curator, cultural diplomat, and emotional support agent. Through speculative yet grounded scenarios - including Martian knowledge pods, bio-encoded interstellar archives, and zero-gravity VR story lounges - the study demonstrates the transformative potential of libraries in future space civilizations. It affirms that wherever humans venture, libraries will remain critical infrastructure for preserving memory, fostering identity, and sustaining civilization beyond planetary boundaries. The full paper is behind a paywall, however extracts from the paper can be read here:

<https://www.sciencedirect.com/science/article/abs/pii/S246889672600039X>.

[1] Konrad Szocik, University of Information Technology and Management, Poland
<https://www.researchgate.net/profile/Konrad-Szocik>

The Jevons Filter: Why Civilizations May Fail Before Reaching Type I Status

Giray Fidan (Ankara HBV University, Turkey) presents this interesting proposition:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=6090866.

Humanity's accelerating energy use poses profound questions about the long-term viability of technological civilization. This paper introduces the "Jevons Filter" hypothesis: a self-reinforcing feedback loop between efficiency improvements and rising aggregate consumption, rooted in the classical Jevons Paradox that systematically drives civilizations toward resource depletion and environmental thresholds. Drawing on economic history, thermodynamic modelling, and astrobiology, they argue that this feedback constitutes a critical developmental barrier, hindering sustainable progression toward Kardashev Type I [1] energy mastery. By amplifying the risks of overshoot, the Jevons Filter may form part of the Great Filter proposed to account for the Fermi Paradox. They develop a simplified thermodynamic model linking energy efficiency, economic expansion, and civilizational dynamics, and critically engage with counterarguments regarding absolute decoupling and transformative technological innovations. Their analysis suggests that, without fundamental structural transformations to break the growth consumption cycle, civilizations are likely to face collapse or stagnation before reaching stable, planetary-scale energy management. Grasping this embedded dynamic is essential for futures thinking: overcoming the Jevons Filter may represent an exceptionally rare and difficult pathway, requiring sweeping reorientations in socioeconomic priorities, governance frameworks, and cultural values. This paper emphasizes the implications for sustainability transitions and reframes planetary stewardship as a central determinant of civilizational longevity.

Dami Lee on Project Hyperion

We were really happy to see that our [Project Hyperion](#) competition captured the imagination of the architect and Youtuber Dami Lee, who posted a detailed and thoughtful video commentary 'Can Humans REALLY Leave Earth?' Over one million views! Check it out:

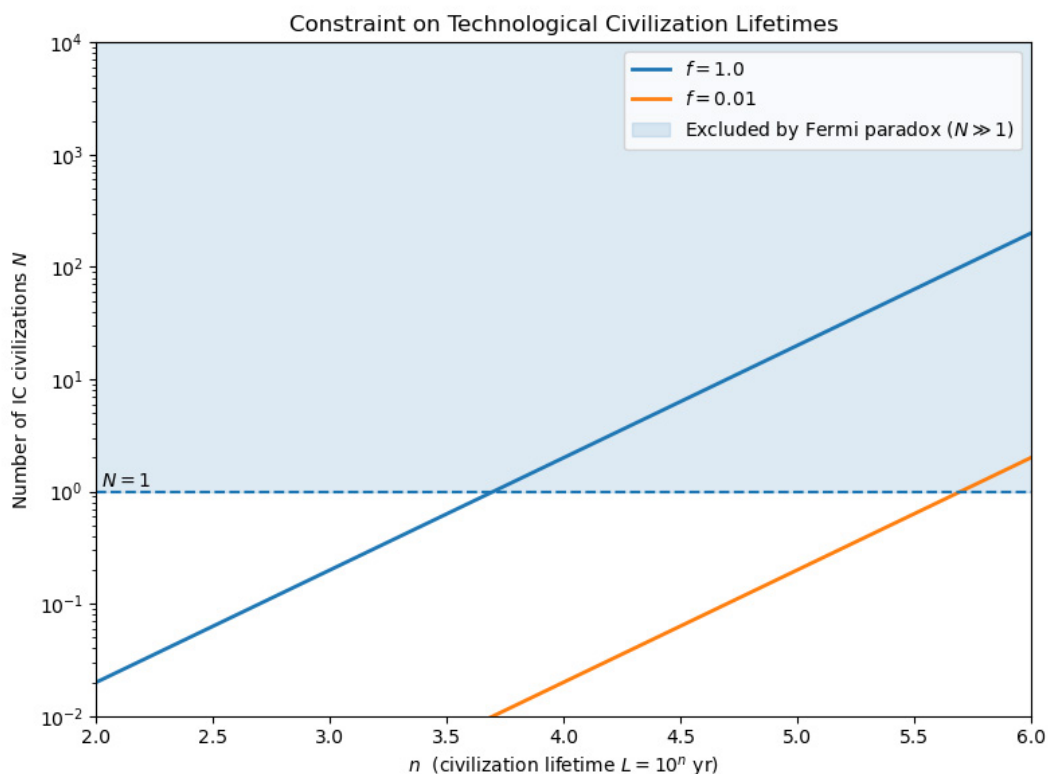
<https://m.youtube.com/watch?v=BBb2gCOIByk&pp=0gcJCVACo7VqN5tD>.

(You may want to skip the ads that are part of the video from 13:00 to 14:30).

[1] Kardashev Type I civilisation, see, eg, https://en.wikipedia.org/wiki/Kardashev_scale

Constraining the Lifespan of Intelligent Technological Civilization in the Galaxy

Sohrab Rahvar and Shahin Rouhani (Sharif University of Technology, Iran) have released this paper exploring constraints on the emergence and longevity of technologically intelligent civilizations in our Galaxy, considering the Fermi paradox: <https://arxiv.org/abs/2602.22252> (also published in the Monthly Notices of the Royal Astronomical Society). They argue that under optimistic assumptions about the probability of life and intelligence emerging on Earth-like planets, the absence of contact with extraterrestrial civilizations imposes limits on their lifespan. Their analysis suggests that if intelligent life is common, technological civilizations must be relatively short-lived, with lifetimes constrained to years under their most optimistic scenario. Considering electromagnetic communication, they note that our current light cone encompasses the entire Galactic history over the past years, making the lack of detected signals particularly puzzling for long-lived civilizations. They emphasize that these results should be interpreted as upper bounds derived from the Fermi paradox, not as predictions of actual lifespans.

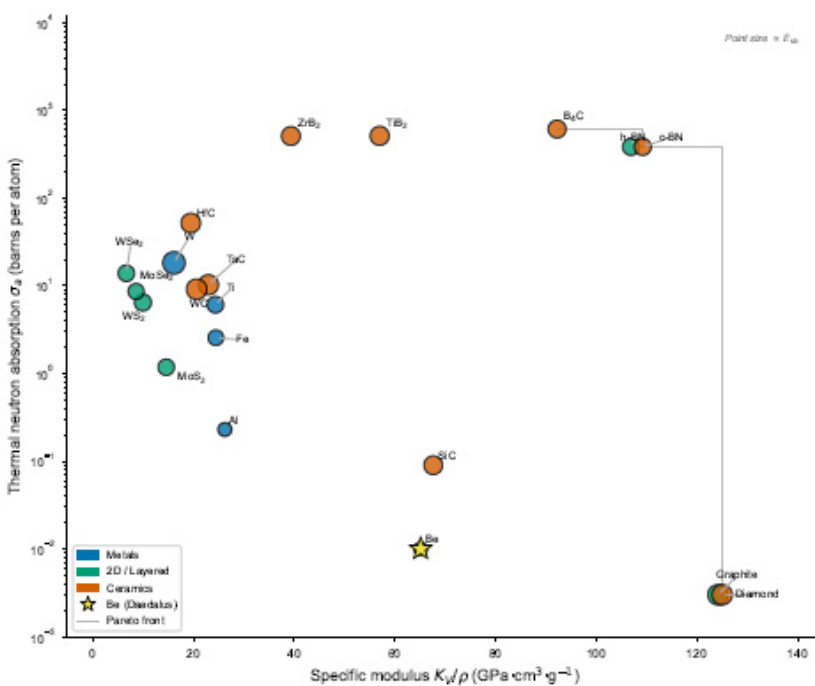


Constraint on the lifetime $L = 10^n$ of intelligent technological civilizations derived from the Fermi paradox. The expected number of co-existing civilizations N is shown as a function of the civilization lifetime for different assumptions about the probability f that a habitable planet produces a technological civilization. The shaded region corresponds to values for which $N \gg 1$, which are observationally excluded by the absence of detected extraterrestrial civilizations. The dashed line indicates the boundary $N = 1$ and is shown for reference.

Credit (graphic and caption): S Rahvar and S Rouhani, Figure 1

Beyond Beryllium: AI-Accelerated Materials Discovery for Interstellar Spacecraft Shielding

Yue Li (Nanyang Interstellar University, Singapore) et al have published this paper on materials for interstellar spacecraft shielding. Project Daedalus (1973-1978), the most detailed interstellar probe design study ever conducted, specified a 9 mm beryllium erosion shield to protect the spacecraft payload during its 5.9 light-year cruise to Barnard’s Star at 12% of the speed of light. This design, however, predated both the isolation of two-dimensional materials and the development of graph neural network (GNN) property predictors. The authors systematically screen 20 candidate materials—spanning conventional aerospace metals, transition metal dichalcogenides, and ultra-high-temperature ceramics—using density functional theory (DFT) data from the JARVIS database (76,000 materials) with independent validation by the Atomistic Line Graph Neural Network (ALIGNN). They evaluate candidates across four criteria: specific mechanical stiffness (K_V / ρ), sputtering resistance, thermal neutron absorption cross-section, and thermodynamic stability. Their screening identifies hexagonal boron nitride (h-BN) and boron carbide (B_4C) as dual-function materials offering simultaneous mechanical protection and neutron radiation shielding, and they propose a graphene/h-BN/polymer layered heterostructure shield design that achieves an estimated 47% mass reduction relative to the original beryllium specification. These findings will become immediately actionable upon the successful development of fusion pulse propulsion; they note that this remains an outstanding engineering challenge. See the paper here <https://arxiv.org/abs/2604.00571>.

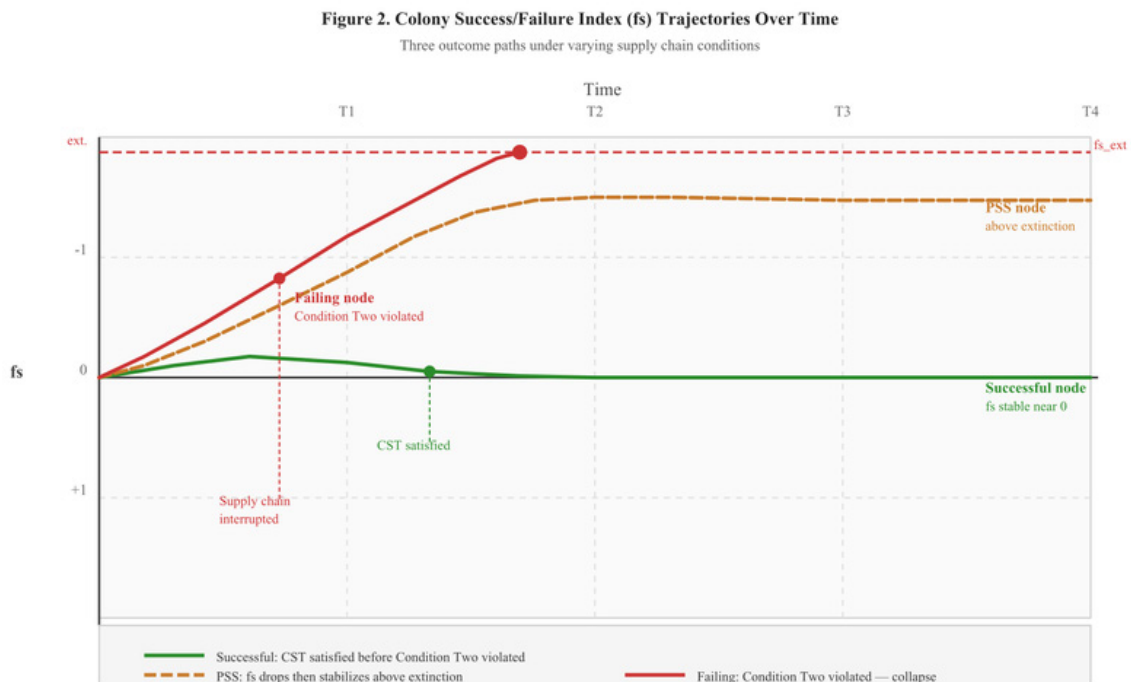


Multi-objective screening: specific modulus versus thermal neutron absorption cross-section. Point size is proportional to surface binding energy. Staircase line indicates the Pareto front. The gold star marks beryllium (Daedalus baseline). Credit (graphic and caption): Li et al, Figure 4

Civilization Supply Theory (CST): Supply Chain Constraints on Interplanetary and Interstellar Expansion

Michelle Cannon (independent researcher) introduces Civilization Supply Theory (CST), a framework for understanding the constraints governing the expansion and long-term survivability of technological civilizations. CST models civilization as a distributed supply network rather than a collection of independent nodes, emphasizing the necessity of supply chain closure for sustained operation. The theory proposes that only systems achieving full internal supply chain closure (Level 1 nodes) can maintain technological continuity without regression. Partial or prebuilt systems, including autonomous or AI-driven colonies, may extend operational lifetimes but remain subject to eventual degradation due to incomplete supply chains and cumulative failure. The model further demonstrates that over sufficiently long timescales, including cosmological scales, any system lacking full closure will experience regression with probability approaching one. This provides a potential explanation for the absence of persistent, large-scale, autonomous technological systems in observed space (Fermi paradox context). CST is substrate-independent and applies equally to biological and autonomous systems, suggesting that expansion is constrained not by energy alone, but by the ability to establish and maintain distributed, self-sustaining supply networks.

View the paper here: <https://zenodo.org/records/19422196>.



Colony Success/Failure Index (fs) Trajectories Over Time –
three outcome paths under varying supply chain conditions.
Credit (graphic and caption): Cannon, Figure 2

The Dyson Minds 2025 Workshop: SETI Around Black Holes

Olivia Curtis (The Pennsylvania State University, USA) et al have authored a paper in the Publications of the Astronomical Society of the Pacific. See <https://iopscience.iop.org/article/10.1088/1538-3873/ae5a02>.

The Dyson Minds 2025 Workshop, held at the Center for Brains, Minds & Machines at Massachusetts Institute of Technology (MIT) and organized by Penn State, MIT, and The Ultraintelligence Foundation, brought together researchers in astrophysics, engineering, artificial intelligence, computer science, and philosophy to examine “Dyson Minds”—large-scale post-biological intelligences powered by energy harvested from supermassive black holes (SMBHs). Building on the ideas of Dyson [1] and Good [2], participants explored the physical, engineering, behavioural, and observational consequences of civilizations embodied as machinery operating near the universe’s most powerful energy sources. The workshop aimed to develop new observational strategies capable of detecting signatures of such systems. Despite the highly cross-disciplinary scope, discussions centred on how a Dyson Mind might be constructed, how it might behave, and how those factors would shape strategies for the search for extraterrestrial intelligence. Key themes included the thermodynamic, mechanical, and stability limits of Dyson swarms; the trade-offs between power availability and communication latency in distributed minds; and how observability changes depending on whether Dyson Minds act as coherent entities or as loosely co-ordinated collectives. Across these topics, the consensus was that details of architecture and behaviour strongly influence observational signatures. A major recommendation was to apply anomaly-detection methods to archival datasets, including those from Wide-field Infrared Space Explorer, JWST, and the Event Horizon Telescope, to identify unusual sources potentially overlooked by standard reduction pipelines. By integrating insights from multiple disciplines, the meeting advanced concrete, observation-focused strategies for future technosignature searches around SMBHs.

Thermal adaptability and low-power survival-operation strategies for lithium batteries in deep-space cryogenic environments

As deep-space exploration transitions from short-term flybys to long-term residency, spacecrafts energy systems face severe challenges from extreme cryogenic environments typical of lunar nights. High-specific-energy lithium batteries are critical enablers, yet their adaptability is constrained by low-temperature limitations. This paper reviews thermo-electrochemical failure mechanisms and survival-operation synergistic strategies for lithium batteries in these environments.

[1] Physicist Freeman Dyson https://en.wikipedia.org/wiki/Freeman_Dyson.

[2] Mathematician Isadore Jacob Good https://en.wikipedia.org/wiki/I._J._Good.

First, critical failure modes are elucidated, including hindered mass transfer during electrolyte phase transitions, kinetic polarization, anode plating risks, and multiscale thermal stress. Subsequently, temperature maintenance technologies for the operation state are evaluated, focusing on the heat transfer limits of passive thermal protection systems like multi-layer insulation, aerogels, and phase-change materials. Furthermore, the review emphasizes low-power hibernation for the survival state, validating the energetic advantages of freeze-thaw cycles. It addresses electrolyte freezing safety in confined pores and rapid revival mechanisms based on internal Joule heating. Finally, a mission-cycle-based survival-operation thermal management model is proposed, and key scientific challenges regarding confined phase transition thermodynamics and non-equilibrium revival damage are identified. The full paper is behind a paywall, however extracts from the paper can be read here:

<https://www.sciencedirect.com/science/article/abs/pii/S2405829726002424>.

How to evaluate Breakthrough Starshot?

Paul Gilster and his Centauri Dreams blog has published a two-part analysis of the consequences of the Breakthrough Starshot initiative, penned by James Benford. Whilst some of the press coverage has discounted the project, these articles highlight the achievements and accomplishments.

"The fortunes of Breakthrough Starshot have been the subject of so much discussion not only in comments in these pages but in backchannel emails that it is with relief that I turn to Jim Benford's analysis of a project that has done significant work on interstellar travel and is still very much alive. Jim led the sail team for several of his eight years with Breakthrough Starshot and was with the project from the beginning. In this article and a second that will run in a few days, he explains how and why press coverage of the effort has been erroneous, and not always through the fault of writers working the story. Let's now take a look at what Starshot has accomplished during its intensive Phase I."

<https://www.centauri-dreams.org/2026/03/03/starshot-is-a-success-part-i/>.

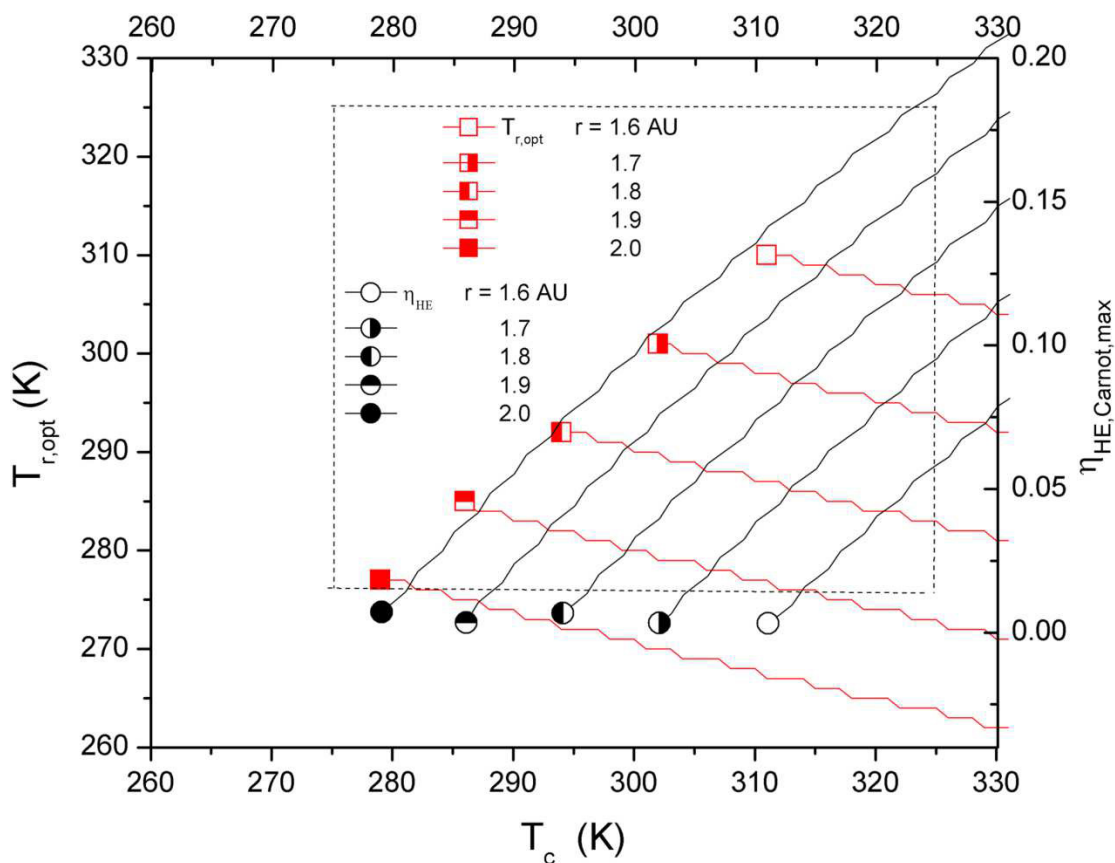
"The second part of Jim Benford's examination of Breakthrough Starshot concludes our look at the numerous issues advanced by Phase I of the project. Largely discounted in recent press coverage, the Starshot effort in fact completed a successful Phase I and left behind numerous papers that illuminate the path forward for interstellar flight. This is solid work on everything from laser arrays to metamaterials and the engineering of data return at light-year distances. Read on."

<https://www.centauri-dreams.org/2026/03/10/starshot-is-a-success-part-ii/>.

Feasibility constraints and detectability of habitable class B stellar engines at maximum performance

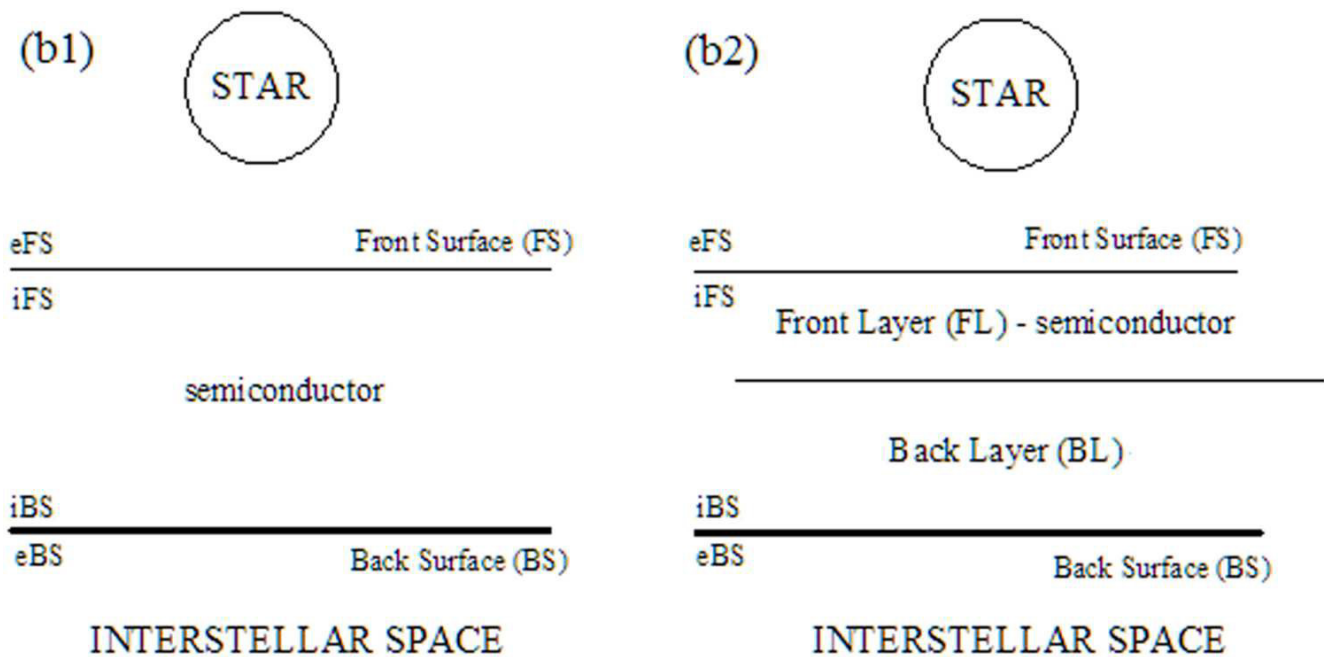
IOP Publishing has released a paper by Viorel Badescu (University Politehnica of Bucharest, Romania); see <https://iopscience.iop.org/article/10.1088/1402-4896/ae4a5c>.

Class B stellar engines (SEs) are hypothetical megastructures designed to collect the entirety of the radiation emitted by a star and transform its energy into mechanical, electrical or chemical work. This paper has two different objectives. First, a theory is proposed regarding the feasibility of building a class B SE. Second, based on the hypothesis that such class B SEs already exist in our galaxy, information is provided about their detectability. Numerical applications refer to the case of the Solar System and humanity for which the habitable temperature is restricted to an interval between 275 K and 325 K. It is shown that different mechanisms of work generation are involved for SEs based on metals and semiconductors (specifically silicon), respectively. The efficiency of mechanical work generation increases with the radius of a metal-based SE radius but the temperature remains habitable only for radii ranging between 1.6 AU and 2.0 AU, for which the radiation energy conversion efficiency is lower than 10%.



Dependence of the radiator temperature $T_{r,opt}$ and Carnot heat engine efficiency $\eta_{HE,Carnot,max}$ on the collector temperature T_c for several values of the class B stellar engine radius r . Values of T_c in the range of habitable temperatures $T_{habitable}$ are considered. The dashed area corresponds to habitable temperatures for both collector and radiator. The case of the solar system is considered ($T_s = 5772$ K, $R_s = 696340$ km) and $T_0 = 3$ K.
Credit (graphic and caption): Badescu, Figure 2

Conversely, very high quality silicon-based SEs can generate electrical work. In this case, the conversion efficiency decreases as the temperature and radius of the SE increase. When lower quality silicon cells are used, another layer of metallic material should be added as a broadband radiation emitter toward the interstellar space. In this configuration the SE is habitable for radii ranging between 1.0 AU and 2.2 AU. For a given radius, a maximum conversion efficiency exists, which is associated with the minimum cell temperature required for SE operation. The maximum efficiency value increases slightly with the SE radius. The search for class B SEs should focus on a 10 μm IR thermal signature. Continuous non-thermal signals peaked around the band gap energy of common semiconductors should be also sought. A class B SE engine composed of a large swarm of satellites or O'Neill cylinders may possess a distinct spectral and temporal signature, consisting of non-continuous and irregular thermal and non-thermal contributions received from the star and from the inner and outer surfaces of the SE.



Two configurations of a class B stellar engine generating electrical power; (b1) a semiconductor layer acts as star radiation collector, electrical work extractor and radiation emitter; (b2) a semiconductor front layer (FL) acts as star radiation collector and electrical work extractor, while a back layer (BL) of material serves as a broadband radiation absorber and emitter. Prefixes i and e denote 'internal' and 'external', respectively.

Credit (graphic and caption): Badescu, Figure 4