The Journals

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Here we list recent interstellar-related papers in the - **Journal of the British Interplanetary Society (JBIS)**, which has been published since the 1930s and in **Acta Astronautica (ActaA)**, the commercial journal published by Elsevier, with the endorsement of the International Academy of Astronautics.

JBIS

Two issues of JBIS (online), August and September 2023, have appeared since the report in our last issue, P43. Later issues are in print but not yet online.

Title	Author	Affiliation
Abstract/Précis/Highlights		

JBIS VOLUME 76 **2023 NO.8 AUGUST 2023 INTERSTELLAR ISSUE**		
Calculations of Particle Bombardment Due to Dust and Charged Particles in the ISM on the Project Starshot Gram-Scale Interstellar Probe	**Kelvin F Long**	**Interstellar Research Centre, Stellar Engines Ltd**
The Breakthrough Initiatives Project Starshot proposes to send a gram-scale laser driven spacecraft to the Alpha Centauri system in a 20 year mission travelling at v~0.2c. One of the challenges of this mission as the spacecraft moves through the interstellar medium is the presence of dust and gas (mostly hydrogen). The dust has a typical matter-density of 2.57×10^{-27} g/cm3 with typical particle mass being 3×10^{-13} g although some of the largest particles may be 5×10^{-9} g in mass. These dust particles will deposit ~1,012-1,016 MeV onto the spacecraft with an energy flux of order ~0.3 J/sm^2. We consider the erosion of the spacecraft frontal area due to dust and also heating effects. We attempt to characterise the likely environment for the Starshot mission and estimate the particle bombardment shielding requirements in terms of mass and thickness of material. Current analysis estimates that the likely erosion rates are of order ~10^{-11}-10^{-8} g/s and that the frontal area temperature for the models examined in this paper will be ~135.2 K depending on the ratio of frontal area to radiating area. For an assumed shielding material with atomic number range 3-13 (Lithium to Aluminium), and for spacecraft geometries with radii ~1 mm and cylindrical length ~5 mm, over a 21.5 year mission duration, this would suggest a shielding thickness of ~1.4-3 mm. This would also suggest a shielding mass in the range ~0.01-0.05 g; depending on the material choice, spacecraft size and chosen geometry. This would represent between ~1–5% of the total mass, assuming a spacecraft mass of 1g (driven by a ~102 GW laser power). We also examine the additional effects of charged particles and estimate the stopping power and penetration range for different materials. Finally, we briefly examine the potential to use the incoming energy flux as a power source for the transmission of an optical laser deep space communication system. The work presented highlights the close coupling in the Project Starshot spacecraft design between the vehicle geometry and the particle bombardment requirements.		

Interstellar Diplomacy	John Gertz	Zorro Productions
The Defense Department and NASA are investigating the possibility that aliens are currently surveilling Earth. This aligns with some search-for-extraterrestrial-intelligence (SETI) theorists who have concluded that ET's best strategy for opening a channel of communication is to send artificially intelligent probes to our Solar System for that purpose. This is a golden age for traditional SETI, which is currently well funded, with most of the world's radio telescopes now engaged in the hunt. One way or another, contact with aliens may be imminent. There has been no planning among nations for the aftermath of a first detection. This paper advocates for such planning and diplomacy.		
The Maximum Tolerable Gravity for Human Colonies	Barton Paul Levenson	-
Due in part to misinterpretation of a recent paper in the professional literature, the popular impression has taken hold that humans can tolerate living on a 4 or 5 g planet indefinitely. Experience from experiments in aerospace medicine imply that this figure is far too high. A maximum permanent tolerance level of 1.5 g for humans, suggested in 1964, has still not been superseded by any further research, and is likely close to the truth.		
Breakthrough Sun Diving: The Rectilinear Option	Greg Matloff, Les Johnson	New York City College of Technology (CUNY), NASA Marshall Space Flight Center
A near-term possibility for utilization of Breakthrough Initiatives Project Starshot technology is application of the sun diving maneuver as a replacement for laser acceleration of highly miniaturized photon sails to interstellar velocities. This possibility was discussed during the June 2022 Breakthrough Discuss meeting in Santa Cruz California. Here, we consider application of statite-type photon sail probes to achieve rectilinear trajectories to explore outer solar system and near-interstellar destinations. Statite-Type solar photon sails are sufficiently thin and reflective that solar radiation pressure force on the sail exactly balances the solar gravitational force. In such a force-free environment, the spacecraft exits the solar system at its pre-sail-deployment solar-orbital velocity. Here we consider departures from a circular 1 AU solar orbit, the perihelion of a 0.7-1 AU elliptical solar orbit and the perihelion of a 0.3-1 AU solar orbit. Possible outer-solar-system destinations of possible interest to Breakthrough Initiatives extraterrestrial-life/artifact-search researchers include Europa, Titan, Enceladus, Methone, and Arrokoth. More distant possible objectives are 'Oumuamua and the Sun's inner gravitational focus. To achieve a rectilinear trajectory, the sail must be orientated normal to the Sun and spacecraft areal mass thickness is 1.46 × 10-3 kg/m2. Current sail technology is reviewed to determine whether it can achieve the required areal mass thickness.		
Minimal Crew Size and Sensitive Reproductive Parameters on Multigenerational Interstellar Travel	Sano Satoshi	Japan Aerospace Exploration Agency
Multigenerational interstellar travel to exoplanets, as well as manned missions to the Moon and Mars, has been investigated in the world. Defining the minimum crew size of interstellar ships is one of the most important research areas for interstellar travel, because designing multigenerational interstellar ships requires defining a critical crew size, which factors into many variables, including food production, air/water control, and propulsion. Anthropologists and astrophysicists have recently tackled with the minimum crew size of interstellar ships in the field of "Space anthropology". Previously published computations in the field of space anthropology provided a critical crew number of 1,900- 2,000 (Sano, 2021) with constant reproductive parameters, but did not fluctuate reproductive parameters such as infertility, initial genetic diversity and number of children per woman. These parameters would fluctuate during the real multigenerational journey. Then, a more accurate estimate of the critical crew size would be obtained from the fluctuating parameters. This paper provides a critical crew size of 1,400-6,800 for interstellar travel using the fluctuating parameters, and clarifies which anthropological parameters are sensitive and how critical to be controlled aboard interstellar ships. It indicates that measuring infertility and controlling the number of children per woman for many generations onboard interstellar ships are essential to prevent extinction, and firstly quantifies the importance of high diversity of initial crew and procreation window for interstellar travel.		

Acta Astronautica

Acta Astronautica papers are published online before print. Three issues with relevant papers have appeared since the last issue Principium P43.

Title	Number+date	Author
Abstract or Summary		
The Fermi paradox and the Drake equation	Volume 215 February 2024	Carl L DeVito
The Fermi paradox and the Drake equation seem to be incompatible. Here we shall show that is not so, and the paradox actually justifies the assumptions made in formulating this equation. … The [Fermi] paradox here arises from the fact that, although most estimates of N give a large number, Fermi's question remains unanswered. Here we shall show that these two aspects of SETI are not incompatible; In fact, our investigation of the paradox justifies the assumptions Drake made in writing his equation.		
Meeting extraterrestrials: Scenarios of first contact from the perspective of exosociology	Volume 215 February 2024	Andreas Anton, John Elliott, Michael Schetsche
Decades ago, pioneers such as the Russian astronomer Samuil Aronovich Kaplan and the American sociologist Jan H Mejer had already considered the role of the social sciences in the study of extraterrestrial civilizations. But it is only because of the advances in scientific knowledge mentioned above that exosociology – as they called it – can really make a good case for devoting time and financial resources to the study of these questions: Today it seems conceivable (some even consider it probable) that humanity will sooner or later come into contact with extraterrestrial civilizations. Accordingly, it is the task of social science forecasting to develop scenarios for this event. An event that may or may not become a reality in the next few decades – but certainly could. It is clear that exosociology can ultimately only provide building blocks (albeit important ones) when assessing the possible consequences of first contact. This task is so enormous that it requires efforts, research findings and theories from a wide range of social science and humanities disciplines, as Steven Dick has convincingly demonstrated in his book Astrobiology. Discovery and Social Impact. Perspectives from the fields of law and psychology are no less necessary. Exosociology can be understood as a subfield of the much broader field of astrosociology, as conceptualised by Jim Pass a few years ago. Astrosociology is concerned with the entirety of human relations with space, including issues such as the commercialisation of space, the social significance of space exploration, and the social forms of possible future human colonies beyond Earth. Exosociology is therefore – in line with Kaplan and Mejer – that part of astrosociology that explicitly and exclusively deals with the potential encounter of humanity with extraterrestrial civilisations.		

BLISS: Interplanetary exploration with swarms of low-cost spacecraft	Volume 215 February 2024	Alexander N Alvara, Lydia Lee, Emmanuel Sin, Nathan Lambert et al.

Leveraging advancements in micro-scale technology, we propose a fleet of autonomous, low-cost, small solar sails for interplanetary exploration. The Berkeley Low-cost Interplanetary Solar Sail (BLISS) project aims to utilize small-scale technologies to create a fleet of tiny interplanetary spacecraft for rapid, low-cost exploration of the inner solar system. This paper describes the hardware required to build a ~10 g spacecraft using a 1 m^2 solar sail steered by micro-electromechanical systems (MEMS) inchworm actuators. The trajectory control to a NEO, here 101955 Bennu, is detailed along with the low-level actuation control of the solar sail and the specifications of proposed onboard communication and computation. Two other applications are also shortly considered: sample return from dozens of Jupiter-family comets and cometary nuclei imaging. The paper concludes by discussing the fundamental scaling limits and future directions for steerable autonomous miniature solar sails with onboard custom computers and sensors.

Are we visible to advanced alien civilizations?	Volume 216 March 2024	Z N Osmanov

We considered the question of how our artificial constructions are visible to advanced extraterrestrial civilizations. Taking the universality of the laws of physics, we found that the maximum distance where the detection is possible is of the order of 3,000 ly and under certain conditions Type-II advanced alien societies might be able to resolve this problem.

High-speed scientific spacecraft launches with commercial launch vehicles	Volume 217 April 2024	Ralph L McNutt, Steven R Vernon, Pontus C Brandt, Michael V Paul, Robert P Lusthaus

Reaching the outer solar system and interstellar space beyond has always been challenging due to the long distances and long travel times. Initial work on planetary gravity assists in the early 1960s by Minovitch and Flandro laid the basis for expanding reachable space with then-existing launch vehicles. Such gravity assists have been key enablers for orbital exploration missions to Mercury (MESSENGER), Jupiter (Galileo, Juno), and Saturn (Cassini-Huygens) by trading higher mass for lower launch energy from Earth (C3). They have also enabled close passes to the Sun (Parker Solar Probe) and moderately rapid solar system escape, coupled with fast flybys of various planetary-sized bodies: Mariner 10 (Mercury via Venus), Pioneer 10 (escape via Jupiter), Pioneer 11 and Voyager 1 (escape via Jupiter and Saturn), Voyager 2 (escape via Jupiter, Saturn, Uranus, and Neptune: the "Grand Tour"), and New Horizons (escape via Jupiter and Pluto). Two of these missions hold the first and second places for the most energetic launches (New Horizons: C3 = 157.7502 km^2/s^2; Parker Solar Probe: C3 = 152.222 km^2/s^2). Disadvantages in using Earth and Venus gravity assists to increase spacecraft injected mass to Jupiter and beyond include the time penalty and the need for a customized propulsion system to provide a deep-space manoeuver (DSM). For "timely" transits to Neptune with a large orbiter or rapid solar system escape with an Interstellar Probe, more capable launch vehicles can be enabling by pushing the injected mass versus C3 curves "to the right." While the most extreme speeds asymptotically away from the Sun (7–8 au/yr) can be achieved with fast Jupiter gravity assists and super heavy lift-launch vehicles (SHLLV) such as the Space Launch System (SLS) surmounted by multiple upper stages, solar system escape speeds larger than those achieved by Voyager 1 are possible with existing and upcoming large commercial launch vehicles. Such vehicles include the Falcon-Heavy, New Glenn, and Vulcan Centaur. Better performance accrues with the fully expendable versions of these vehicles and/or with "refilling" in a low-Earth orbit, with performance versus launch cost as a central trade. Even better performance can be projected with SHLLVs in development, such as the Starship Super Heavy and Long March 9. We discuss some of the possibilities and trades such newer vehicles can enable in the near term for continued – and more distant – exploration of the solar system and beyond.