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

Seven issues of JBIS have appeared online since our last issue, P49. They are – volume 77 issues #7 (July 2024), #8 (August 2024 Interstellar issue), #9 (September 2024), #10 (October 2024 Interstellar issue), #11 (November 2024) and #12 (December 2024 Interstellar issue). Of the 12 2024 issues six were Interstellar issues.

Volume 77 #8 August 2024 Interstellar issue		
A Case Study in Characterising Nuclear Propulsion Emission Signatures from Astrophysical Sources	Kelvin F Long	UK

The detection of propulsion and power emission signatures in deep space is made more difficult by the background of various astrophysical sources of different types. In this paper we consider the example of nuclear pulse propulsion, such as via using nuclear fusion reactions, and examine hypothetical scenarios for the expected emissions. We consider the case study of object XTE J1739-302, an astrophysical object believed to be a supergiant fast x-ray transient with a thermal bremsstrahlung temperature of 21.6 keV. We confirm its likely astrophysical nature, but demonstrate under what conditions its emission properties would match the expectations for an artificially generated propulsion signature as a means for guiding future observations, which would likely require a high Kardashev Type II advanced technological civilisation.

Migration to Gliese 710 Using Large Space Habitats Flying Rectilinear Trajectories	Gregory L Matloff	USA

Gliese 710 (GL710) is a K7 dwarf star with no currently known planets. Observations using the Gaia space telescope indicate that this star will pass within about 0.2 light years of the Sun in about 1.35 million years. During this close stellar encounter, GL710 might be a tempting target for far-future residents of terrestrial space habitats seeking to expand beyond the solar system. It is demonstrated that a large space habitat departing from a parabolic solar orbit with a 0.45 AU perihelion could reach this star at its closest approach to the Sun in ~1,000 years along a rectilinear trajectory at a constant velocity of 63 km/s. If acceleration of a 3×10^9 kg space habitat is provided by a 30 nm thick pure aluminum disc sail, sail radius is about 800 km. Peak acceleration at perihelion is about 0.003 g. It is also shown that a pure aluminum sail will likely have no thermal issues during the 0.45 AU perihelion pass. Because Gliese 710 is only about 300 million years old, visitors from Earth in the far future may elect to seed habitable planets of this star (if they exist) with terrestrial life.

Three Principles for the Application of Artificial Intelligence as a Future Tool in the Search for Other Intelligences in the Cosmos	Elio Quiroga Rodriguez	Spain

The author explores the integration of Artificial Intelligence (AI) in the Search for Extraterrestrial Intelligence (SETI) and discusses recent developments in this field. It highlights the detection of eight highly promising signals using historic Green Bank radio telescope in collaboration with Breakthrough Listen. Additionally, the study reveals signals from a dataset of 820 nearby stars, originally obtained from the Hipparcos catalog and analyzed using deep learning techniques, which suggest possible communication from extraterrestrial civilizations. The paper emphasizes the potential of AI in uncovering promising signals, while acknowledging the early stages of this approach. It also proposes three fundamental principles for AI's role in SETI, including the need to desensitize search criteria, explore diverse communication forms, and employ AI to create artificial constructs for analyzing non-human intelligence.

A Review of the Theoretical and Empirical Foundations of SETI	José Antonio Molina	Spain

The search for extraterrestrial intelligence (SETI) is sometimes perceived as a futile activity carried out by a few dreamers. However, since its beginnings SETI has had the support of eminent scientists and its theoretical and empirical foundations are solid. Indeed, SETI starts with an evidence: intelligence exists in the universe because we exist. Since intelligence is a natural phenomenon, it is more likely that we are a particular sample of it rather than the only sample in the entire universe. On the other hand, we know that intelligence can become a remotely detectable astronomical phenomenon, because we are. Consequently, SETI is searching for natural phenomena that we know are possible, so all criticisms about the lack of scientific validity of SETI are wrong. Also, the attention that a scientific project deserves should not be measured based on its chances of success, but by the importance of its consequences for humankind.

Sub-Scale Demonstration of an Axial Pulsed Magnetic Nozzle for Nuclear Propulsion Systems	Nathan Schilling, Naoji Yamamoto, Taichi Morita, Hideki Nakashima, Kento Koba & Jason Cassibry	Japan/USA

With current technology, a crewed mission to Mars takes 2-4 years, during which astronauts are subject to the dangers of cosmic rays and microgravity. Pulsed nuclear propulsion systems can reduce trip times by as much as 90%, due to their inherent high specific power (1-10 kW/kg). However, these systems face several technical challenges, namely high heat loads incident on the nozzle. Instead, it has been proposed to use a magnetic nozzle; a magnetic nozzle functions by directing the plasma exhaust with high-strength magnetic fields. Previous work investigated magnetic nozzles with the solenoidal topology, but recent work has suggested an alternate topology, the axial topology, to be more effective. However, this configuration has never been tested. In this work, the researchers conduct the first test of the axial magnetic nozzle. The nozzle is cylindrical, 0.12 m in diameter and 0.12 m in length with 40 struts. A current of 1 kA is run through each strut to produce a 1T field. The plasma is generated using a 1,064 nm Nd:YAG laser with a maximum energy of 0.65 J and a laser spot diameter of 0.5 mm. The researchers compare the experimental impulse bit with simulation results from the Smooth Particle Fluid with MAXwell equation solver (SPFMax) code. Impulse bit is estimated using a series of charge collectors. While the simulation predicts impulse bits between 6.8-7.3 μNs for the nozzle currents of 0 A and 1 kA, respectively, the experiment only measures thrust between 1.0-2.2 μNs for the same conditions. This difference is most likely due to differences between the computational model setup and experimental setup. Future work includes performing simulations that more accurately model the experimental setup, and devising alternate ways to more accurately estimate thrust from the charge-collector data.

Volume 77 No.10 October 2024 Interstellar Issue

Faster-than-Light Travel using Dark Energy Inflaton in a Compact Region of Spacetime	J A Morgan	USA

Dark energy dominates the mass-energy content of the present-day universe. A similar dominant component drove primordial inflatIon in the Big Bang. This paper explores how a sufficiently advanced civilization might manipulate a dark energy inflaton [1] for a form of faster-that-light travel. A solution of the Einstein gravitational field equations exhibiting highly anisotropic inflation in a compact region of spacetime illustrates the concept.

Detection of Warp Signatures for SETI	Travis S Taylor	USA

The search for extraterrestrial intelligence (SETI) has traditionally focused on electromagnetic signals. However, advanced civilizations may employ spacetime engineering methods, such as warp fields, that alter the fabric of spacetime itself. This paper explores theoretical approaches to detecting such warp signatures, including metric perturbation detection and experimental designs based on existing gravitational wave observatories.

Mission Architecture Calculations for the Enzmann Interstellar Spacecraft Concept	Kelvin F Long	UK

Strategies for sending human populations to other stars often involve large world ship structures, but must be preceded by lower mass, faster speed vessels carrying a smaller population of people to properly survey the planetary system of interest and any potential resources. Such a concept is presented by performing some modern calculations of the *Enzmann Slow Boat* starship which is a vessel designed to travel over interstellar distances within decades carrying a population of 100s-1,000s of people. Its unique design involves the use of a spherical mass of fusion fuel at the front of the vehicle which is replenished on arrival at the target system by mining from local gas giants. We demonstrate mission profiles using a 24-engine parallel thrust propulsion architecture for such a vehicle. In a modified concept we refer to as the *Long-Enzmann Slow Boat* it is envisaged that it would use gram-scale inertial confinement fusion capsules and may be aided with expellant propellant for thrust augmentation which reduces the quantity of thermonuclear fuel. This work is presented as a part of a larger attempt to construct interstellar roadmap planning and supplements the recently published world ship studies by this author.

The Ultimate Rocket, the Ultimate Energy Source, and Their Use in the Ultimate Future	Frank J Tipler	USA

The ultimate rocket is a rocket that has the highest specific impulse allowed by the laws of physics: Isp = c/g ≈ thirty million seconds. I show that new experimental results in cosmology suggest how such a rocket might be constructed. Basically, the observed cosmological matter-antimatter asymmetry shows that baryon number and lepton number are not conserved at high energies, and thus it must be possible to convert matter into pure energy. Standard Model baryogenesis allows the reaction p+e -> ν + $\overline{\nu}$, which would mean a rocket exhaust of neutrino-antineutrino pairs created from hydrogen atoms.

Neutrinos have very close to zero mass, so they travel at close to light speed. The reaction p + e -> ϒ + ϒ is also allowed, which would be the ultimate energy source. I show that the laws of physics require the universe to be spatially closed, end in a singularity, and require our descendants to engulf the entire universe and construct a universal computer.

[1] en.wikipedia.org/wiki/Inflaton

Volume 77 No.12 December 2024 Interstellar Issue

Torqued Accelerator Using Radiation From the Sun (TARS) for Interstellar Payloads	D Kipping & K Lampo	USA

The concept of exploring space using solar power is energetically appealing, but interstellar solar sails typically require extremely low areal densities (~0.8 g/m2). This work explores an alternative approach: storing solar energy as rotational kinetic energy, which is later released to propel a microprobe beyond the solar system. The proposed Torqued Accelerator using Radiation from the Sun (TARS) consists of two thin surfaces with contrasting albedos that gradually spins up over weeks to months while in a sub-Keplerian "quasite" orbit around the Sun. Though constrained by material strengths, careful design allows a phone-sized payload to reach interstellar velocities in less than a year, using commercially available materials (eg CNT sheets). The entire system spans tens of metres and has a mass in the order of a kilogram. Whilst there is no theoretical limit to the achievable speeds, practical designs grow exponentially in size as velocity targets increase, making interstellar flight feasible but relativistic speeds implausible. Several strategies, including the use of graphene sheets, gravity assists, the Oberth effect, and electrostatic confinement, could further maximise velocity. TARS is an attractive light sail technology when high-powered directed energy systems are impractical, offering a potentially low-cost solution for deploying small, sub-relativistic interstellar probes.

Genetic evolution of a multi-generational population in the context of interstellar space travels – Part II: Phenotypic effects of gene expression	Frédéric Marin, Camille Beluffi-Marin & Frédéric Fischer	France

In the first paper of this series, we included the effects of population genetics in the agent-based Monte Carlo code HERITAGE under the hypothesis of neutral phenotypic effects. It implied that mutations (genetic changes) had only neutral physical manifestations. We now relax this assumption by including genetic effects of mutation and neo-mutations (from radiations) onto the population's life expectancy, fertility, pregnancy chances and miscarriage rates. When applied to a population aboard a generation ship that travels at sub-light speed towards a distant exoplanet, we demonstrate that natural selection indirectly affects the genetic structure of a population via the contribution of phenotypes, in agreement with past studies in conservation biology. For large starting crews (about 500 individuals), the effect aligns with the neutral hypothesis and the frequency of alleles (for non-sexual chromosomes) is stable over centuries. Results are completely different if the spacecraft shielding, integrated into hull design, fails to efficiently protect the crew from high-energy cosmic rays and showers of secondary particles. We tested different scenarios, in which the level of radiation is either fixed at normal or extreme levels, or changing over time due to, eg shield degradation, on-board nuclear incident or the outburst of a supernova situated 50 light-years away.

Redefining Habitability: Adapting the Drake Equation for Exoplanetary Gas Giant Satellite Systems	Elio Quiroga Rodríguez	Spain

This work proposes a novel adaptation of the Drake Equation tailored to systems comprising gas giant planets and their satellites, with a focus on assessing the potential for life on these moons. We redefine the concept of the "habitable zone" to account for the unique conditions present in gas giant systems, particularly the possibility of liquid water existing beneath thick ice crusts on satellites due to gravitational tidal heating. The study presents mathematical models for tidal heating, thermal equilibrium, to reach finally into a modified Drake Equation which evaluates the likelihood of life in these environments. Additionally, we derive an equation to estimate the theoretical size of the habitable zone around a gas giant. This approach aims to expand our understanding of potential habitable environments beyond traditional terrestrial planets, encompassing moons like Io, Europa, Ganymede, Callisto, Titan, Ariel, Umbriel, Oberon, Titania or Triton, which orbit gas giants such as Jupiter, Saturn, Uranus and Neptune and are thought to home liquid oceans below an ice crust. We have many possible examples in our Solar System to play with and extrapolate to other star systems with gas giants.

Acta Astronautica

Acta Astronautica papers are announced online before print. These relevant papers have appeared since our last issue, Principium P49, which reported announced papers up to Volume 232, July 2025 - and they go up to and including Volume 235 October 2025

Unexplained starlight pulses found in optical SETI searches	Volume 233 August 2025	Richard H Stanton

Years spent searching more than 1,300 sun-like stars for optical SETI signals have finally yielded unexpected results. A "signal" of two fast identical pulses, separated by 4.4 s, was discovered in the light of HD89389. No single pulses, even remotely resembling these, have been found in these searches. Close examination of this signal reveals that several unique features of the first pulse are repeated almost exactly in the second. Comparison of this signal with those of airplanes, satellites, meteors, lightning, atmospheric scintillation and system noise, emphasizes their uniqueness. During the re-examination of historical data, another pair of similar pulses was found in an observation of HD217014 made four years earlier. Not fully explained at the time, this signal had been dismissed simply as "birds." After all pulses were examined in detail, and shown that they could not have been made by birds, several theories are proposed that might explain their origin. A theory based on edge diffraction is discussed in some detail. If correct, this theory should enable future observations to measure the distance to the occulting object, and using arrays of telescopes, determine its size, shape and velocity.

An overlooked Schelling point candidate for optical SETI: 'MiM'	Volume 235 October 2025	David F Gahan [1]

Recent SETI strategies have been attempting to confront the multipoint to multipoint nature of the signalling challenge, ie lack of prior knowledge of where to look, with broad sky surveys. 'Schelling point' is a concept from game theory suggesting that parties wishing to communicate can converge on the same solution if they make plausible guesses as to similarities in the other's analysis. This concept has been invoked in SETI to propose several candidate listening frequencies but with fewer proposals for points in space capable of unambiguous definition. Such a physical Schelling point could offer an opportunity for a simple and scalable SETI initiative. The only unambiguous location within the Milky Way proposed as a candidate SP is the galactic centre; however, this is also the location of the supermassive black hole Sgr A* which implies complex considerations.

This paper extends earlier work in considering locations defined by Local Group geometries. Key elements in the reasoning (and foundational to the game theory approach) are a series of conservative 'hunches' for the number, spread and population-dynamics of civilisations, and conservative hunches on technical capabilities (propulsion systems and probe technology), limited to those currently being studied by engineers. These hunches (while not intending to suggest any actual limits) are available to any intelligent species, and lead to the proposal of a new physical Schelling point, possibly optimum in the immediate environs of the Milky Way. This mid-point between the barycentres of the Magellanic Clouds ('MiM') can be reasonably defined in space and time and is in an observationally 'quiet neighbourhood' for examination by SETI. While no home world is considered at the MiM point, it might be favoured by a civilisation or civilisations unconcerned by time constraints as a suitable location for a beacon to send unambiguously artificial signals. It could be continually resupplied with the energy needed to maintain signalling for an arbitrarily long time (eg 100 MY), but on a restricted energy budget necessitating low-divergence signalling (hence 'optical'). The paper considers power, range, and potential signalling and detection strategies in order to propose an observational effort, and compares with a benchmark paper for optical SETI detection levels. NB Direct data transfer is not considered in this paper, only signal detection.

[1] David Gahan is a regular contributor to Principium. His article *Where do you look for ET?* based on this paper is in this issue. Find his first article on this subject *AMiTe Treffpunkt - A proposal for communication between Kardashev Type IIb civilisations* in Principium 32, February 2021 i4is.org/principium-32