

# The Journals

John I Davies

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

## JBIS

4 issues of JBIS (May, June, July, August 2022) have appeared since the report in our last issue, P38.

Title (open publication)	Author	Affiliation
<b>Abstract/Précis/Highlights</b>		
<b>JBIS VOLUME 75 NO.10 OCTOBER 2022 Interstellar Issue</b>		
<b>Intermediate Points for Missions to Interstellar Objects Using Optimum Interplanetary Trajectory Software</b>	Adam Hibberd	Initiative for Interstellar Studies (i4is)
<p>This paper explicates the concept of an 'Intermediate Point' (IP), its incorporation as a node along an interplanetary trajectory, and how it permits the determination and optimization of trajectories to Interstellar Objects (ISOs). IPs can be used to model Solar Oberth Manoeuvres (SOM) as well as <math>V_{\infty}</math> Leveraging Manoeuvres (VLM). The SOM has been established theoretically as an important mechanism by which rapid exit from the solar system and intercept of ISOs can both be achieved; the VLM has been demonstrated practically as a method of reducing overall mission <math>\Delta V</math> as well as the Characteristic Energy, C3, at launch. Thus via these two applications, the feasibility of missions to interstellar objects such as 1I/'Oumuamua can be analysed. The interplanetary trajectory optimizer tool exploited for this analysis, Optimum Interplanetary Trajectory Software (OITS), permits IP selection as an encounter option along the interplanetary trajectory in question. OITS adopts the assumption of impulsive thrust at discrete points along the trajectory, an assumption which is generally valid for high thrust propulsion scenarios, like chemical or nuclear thermal for instance.</p>		
<b>Probability or Determinism: How Rare is ETI?</b>	Barton Paul Levenson	-
<p>Snyder-Beattie et al (2021) propose based on Bayesian inference and the random timing of evolutionary transitions that the probability of a habitable planet hosting an intelligent species (<math>P_{in}</math>) is <math>&lt; 10^{-24}</math>. This would make Earth the only planet in the observable universe with a native intelligent species. A different approach is proposed here in which each evolutionary transition is treated based on what is known of planetary and biological conditions at the times of occurrence. In this light, <math>P_{in}</math> may be many orders of magnitude higher than the Snyder-Beattie et al estimate. Until such factors are better known, speculation on the value of <math>P_{in}</math> may be premature.</p>		

<b>Algorithms for Decoding Interstellar Messages</b>	Michael Matessa	METI International
<p>How would we determine the meaning of an interstellar message from a distant civilization? This paper describes algorithms for assigning meaning to symbols found in such a message. It is assumed the message is pre-parsed, resulting in symbols grouped into expressions. Algorithms assign meanings to symbols within an expression and meta-algorithms maintain a list of symbol meanings across expressions. The algorithms described in this paper are Equality-check, Counting-check, Function-check, Base-check, Approximation-check, Constant-check, and Planck-check. The meta-algorithms are Intersect, Prune, and Substitute. These algorithms have been implemented in software, and results from a sample message are given that assign meanings ranging from numbers to the concepts of mass and length. By developing algorithms, it is hoped that message decoding can grow from an art done by individuals to a science done with algorithms.</p>		
<b>Other Messages for Other Senses</b>	Michael Matessa et al	METI International
<p>For interstellar messages that we have sent so far, the underlying assumption in schemes for encoding/decoding is that the recipients are fundamentally similar to ourselves. But there have been criticisms of this assumption of equivalence approach because intelligence even on our own planet takes many different forms, and these forms are influenced by the senses of the individual. Jonas and Jonas (1976) describe hypothetical extraterrestrial species with alternate senses inspired by Earth animals. This current work further expands on the capability of these extraterrestrial species to understand messages that we would send. A continuum of similarity to humans is proposed, from species whose senses do not allow them to develop radio technology, to species who do but whose senses do not allow them to understand 2D images, to species with senses only slightly different than our own. Implications for message construction are considered, and recommendations for future message content are given. These recommendations include redundant sections with questions that require different senses (similar to how a person can see a number in a colorblind Probability or Determinism: How Rare is ETI? test only if they are not colorblind). Replies would tell us the sensory modalities we should be addressing with this particular extraterrestrial intelligence. Another recommendation would be to use information about a targeted planet to determine the most probable sense of inhabitants, and tailor messages to that sense.</p>		
<b>VOLUME 75 NO.11 NOVEMBER 2022</b>		
<b>Assessment of the Applicability of Small Modular Reactors (SMRs) as a Start-up/Restart Reactor for Nuclear Fusion Rocket Propulsion Engines (NFRPEs)</b>	Clésio Ismério de Oliveira	-
<p>Nuclear fusion as a power source is becoming a reality and the next step is its use as propulsion for interplanetary spacecraft. Once solved, fusion will have the highest specific power (kW/kg) of any other type of power production. Spacecraft propelled by Nuclear Fusion Rocket Propulsion Engines (NFRPE) will need a power source both to start and to sustain the reaction. An assessment was performed of 78 Small Modular Reactors (SMRs), analyzing and quantifying their ability to be adapted for use in this application. It was shown that UK SMR had the best potential with 92% applicability, the Stable S. R. Wasteburner SMR with 89%, eight SMRs (ACP100, CAP150, CANDU SMR™, NUWARD™, RITM-200M, GTHTR300, MHR-T, and SVBR- 100) with 86%. Further research is required to determine the exact requirements for a Start-up/Re-Start Reactor.</p>		

## Orbital Nuclear Power System (ONPS): The Foundation of an Interplanetary Civilization

Donald Wilkins

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Two seemingly unrelated problems could be resolved with the same solution and, as a pleasant side-effect, propel humanity into the Solar System. The first is the need for low-pollution power serving 21st century populations. Unreliable electrical energy cripples growth of many regions. Second, a thriving interplanetary society needs a surplus-generating industry, something equivalent to the tobacco or fur trade which funded initial colonization of North America. Without revenues from a thriving industry, space exploration relies upon fickle whims of political systems beset with other priorities. An Orbital Nuclear Power System (ONPS) offers advantages over other off-planet energy sources. A constellation of orbital nuclear reactors is cheaper to erect and provides more reliable power than an orbital solar power system (OSPS), and has a lesser impact on terrestrial ecology than any other energy solution. In addition, ONPS provides cheap power and broad bandwidth communications links necessary to exploit the Solar System's wealth and install thriving colonies throughout the inner Solar System.

## Acta Astronautica

Title	Number+date	Author	Affiliation
<b>Abstract/Précis/Highlights</b>			
<b>Dyson sphere building: On the design of the GTOC11 problem and summary of the results</b>	Volume 202, January 2023, Pages 889-898	Hong-Xin Shen et al	Xi'an Satellite Control Center, China
<p>The National University of Defense Technology and the Xi'an Satellite Control Center organized the 11th edition of the Global Trajectory Optimization Competition (GTOC11) in 2021. The GTOC11 problem was created as a link between the ninth and tenth editions of the Global Trajectory Optimization Competition to bridge the gap between the planetary and galactic civilizations by introducing an intermediate stellar civilization scenario. The problem involves the construction of a Dyson sphere, a theoretical mega-structure that encircles a star with platforms orbiting in a tight formation to capture the maximum energy from it. Challenges in astrodynamics including the construction-orbit selection, combinatorial flyby of multiple asteroids, and mass distribution among stations were considered in the Dyson sphere design. A total of 94 teams registered for the competition, of which 25 teams provided solutions and passed automatic verification on the website. In this article, we describe the selection of the problem and its design process. In addition, an overview of the entire competition and an analysis of its results are presented.</p> <p>Full text available via: <a href="http://www.sciencedirect.com/science/article/pii/S0094576522004532">www.sciencedirect.com/science/article/pii/S0094576522004532</a></p>			
<b>Solar sail with inflatable toroidal shell</b>	Volume 202, January 2023, Pages 17-25	V Ya Kezerashvili, R Ya Kezerashvili, O L Starinova	City University of New York / Samara National Research University, Russia
<p>In the framework of a strict mathematical approach based on classical theory of elasticity we present an idea of the deployment and stretching of the circular solar sail attached to the inflatable toroidal shell. It is predicted that by introducing the gas into the inflatable toroidal shell one can deploy and stretch a large size circular solar sail membrane. The formulas for the toroidal shell and sail membrane stresses and strains caused by the gas pressure in the shell are derived. The analytical expressions can be applied to a wide range of solar sail sizes. Numerical calculations for the sail of radii up to 100 m made of CP1 membrane and attached to the toroidal shell with the varied cross-section radius are presented. The normal transverse vibration modes of the sail membrane under tension caused by gas pressure in the shell are calculated. The feasibility of deployment and stretching of a solar sail with a large size circular membrane attached to the inflatable toroidal shell is demonstrated.</p> <p>Full text available via: <a href="http://www.sciencedirect.com/science/article/pii/S0094576522005045">www.sciencedirect.com/science/article/pii/S0094576522005045</a></p>			

**Development of the HeliosX mission analysis code for advanced ICF space propulsion**

Volume 202,  
January 2023,  
Pages 157-173

Kelvin Long

Interstellar Research Centre

This work presents some of the first results from a recently developed fusion propulsion code which calculates the performance of an advanced spacecraft design. HeliosX is a system integrated programming design tool written in Fortran 95 for the purpose of calculating spacecraft mission profile and propulsion performance for inertial confinement fusion driven designs. This code uses the vehicle configuration input and then calculates the likely mission profile for a given destination target. The key capability under development is the inclusion of the fusion propulsion system and an adequate modelling of its likely energy outputs and how this integrates into the mission profile. The results of a comparison to a concept from the literature are firstly presented for an interstellar flyby probe and then perturbations of this design to include updates and revisions to its input parameters and expected performance. Although the code is still being developed the early results show good potential to enabling a numerical tool for conducting spacecraft performance assessment of fusion based propulsion systems. The preliminary results of modelling different missions are shown for an interstellar target in 37-100 years trip times and 0.05-0.12c cruise speeds in flyby and rendezvous modes for orbital insertion to a distance 4.3-5.9 ly. A description is given for how the baseline concepts are being evolved since the code has been developed in parallel with the design process which aims to design improved vehicle concepts. Ultimately the calculations shown in this paper are working towards the development of a design tool which can facilitate the proper analysis of a range of different spacecraft designs and place them on a consistent modelling basis so that feasibility assessments can be made. Full text available via: [www.sciencedirect.com/science/article/pii/S0094576522005598](http://www.sciencedirect.com/science/article/pii/S0094576522005598)

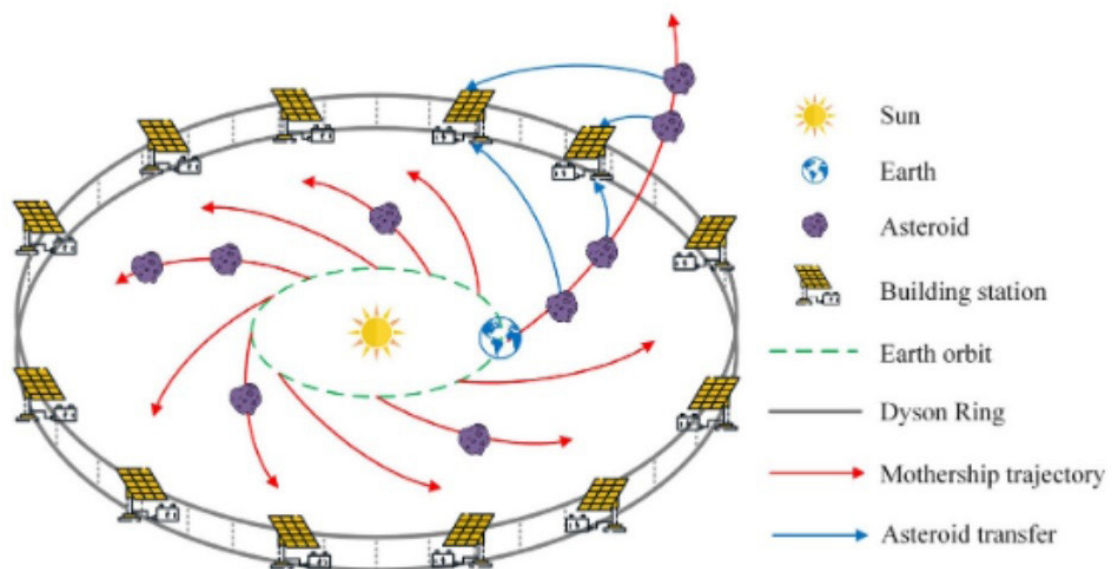


Illustration of the construction of the "Dyson ring" from  
*Dyson sphere building: On the design of the GTOC11  
problem and summary of the results, Fig. 1.*

Credit: Hong-Xin Shen et al