

IRG23 Preview

8th Interstellar Symposium, McGill University,
Montreal, July 10 – 13, 2023

John I Davies

The next IRG biannual symposium will be in July (irg.space/irg-2023/). Principium has previewed and reported these conferences since 2018. This is a glimpse of what will be happening in Montreal this year (Monday-Thursday, 10-13 July).


Background

The Interstellar Research Group is the business name of the Tennessee Valley Interstellar Workshop, a US-based not-for-profit. It was founded in 2014, based on informal gatherings in Oak Ridge, Tennessee, which began in 2004. It became the Interstellar Research Group (IRG) in 2020.




Speakers and Abstracts

The pre-announced speakers and presentations (as of 14/4/23) are summarised below with recent relevant publications. Note the abstracts here are abbreviated and the full abstracts will appear on IRG website before the symposium.

Alex Ellery	Hybrid Symbolic-Neural Approaches to Artificial Intelligence for Interstellar Missions	
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Interstellar flight represents an unforgiving environment for autonomous operations with many unknowns imposing the necessity for advanced artificial intelligence (AI). Evidently, interstellar distances preclude any human intervention from Earth. We take the view that the interstellar transit phase of an interstellar mission may be accommodated with a mixture of pre-programmed reactive symbol-manipulation-based intelligence implementing traditional Kalman filter-like algorithms. However, for in-situ exploration at the destination extrasolar system, near-human level capabilities will be required for full autonomy. The paper reviews and assesses state-of-the-art AI to enable robotic machines to perform complex interactive tasks on exoplanetary environments at near human-level competence concluding that this reveals several shortcomings in AI methods but hybridisation presents one approach that may be promising.

Professor Alex Ellery, Carleton University, is Canada Research Professor, Department of Mechanical & Aerospace Engineering and Director, Centre for Self-Replication Research. He is author of *Curbing the fruitfulness of self-replicating machines* [1], International Journal of Astrobiology V21#4 2022 and *Self-replicating probes are imminent - implications for SETI* [2], International Journal of Astrobiology V21#4, 2022.


Robert M Freeland II	Infrastructure Development Leading to the First Long-Duration Interstellar Probe	
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Long-duration interstellar probes - like the Z-pinch fusion-powered Firefly vessel developed through Project Icarus - would benefit significantly from the use of He3 as a fuel additive, yet He3 is almost completely non-existent in the inner Solar System. Moreover, the mass of deuterium required for these probes presents significant cost and environmental-impact concerns if sourced from Earth. This paper describes a step-wise plan connecting our current infrastructure to an infrastructure supporting long-duration interstellar exploration yielding a plausible, efficient road map for interstellar exploration that major space agencies might consider actually funding.

Robert M Freeland II was Deputy Project Leader and Board Member, Icarus Interstellar and primary architect of the Icarus Firefly interstellar probe study. He is author of *Plasma Dynamics in Firefly's Z-pinch Fusion Engine* in JBIS V71 August 2018 and *Project Icarus: Communications Data Link Designs between Icarus and Earth and between Icarus spacecraft* (co-author with Peter Milne and Michel Lamontagne) JBIS, V69, 2016

[1] scholar.archive.org/search?q=Curbing+the+fruitfulness+of+self-replicating+machines


[2] scholar.archive.org/search?q=Self-replicating+probes+are+imminent+%E2%80%93+implications+for+SETI

Louis Friedman	Real Interstellar Exploration Will Be Virtual	
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Use of the solar gravity lens is the only practical way we can achieve multi-pixel images of exoplanets. Solar sails with advanced technology materials and smallsat payloads can achieve fast velocities (>25 AU/year) to make use of the solar gravity lens practical. By sending small sailcraft with modest telescopes to the solar gravity lens foci of potentially habitable planets, we can explore them systematically and in detail for signs of life - the ultimate goal of space exploration.


Dr Louis Friedman is Executive Director Emeritus and Founder of The Planetary Society and Former Manager of Advanced Programs at NASA JPL.

Dr Friedman is a co-author of *Solar Sail Propulsion by 2050: An Enabling Capability for Heliophysics Missions* - 2023 (arxiv.org/abs/2301.01297) and of *A fast response mission to rendezvous with an interstellar object* - 2022, *Experimental Astronomy* volume 53, pages 945-960 (arxiv.org/abs/2106.14319).

Alex Gmerek	Searching for Extrasolar Life - An Astrobiology Payload for Interstellar Missions	
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To date, only one astrobiology-focused payload has flown to an extraterrestrial environment - Viking to Mars in 1976. These were highly specific to the search for photosynthetic activity as an example of universal biology. Recent more contextual developments have searched for water, be it extant or extinct. The paper will examine the type of biomarkers that can be searched for and in what context. It will propose astrobiology instruments at multiple scales - infrared/visible/ultraviolet panoramic camera; close-up imager for bio-morphological investigation; combined infrared Raman spectrometer laser-induced plasma spectrometer confocal microscope and tuned diode laser absorption spectrometer; protein chip to detect specific proteins; a nanopore instrument to detect charged backbone linear molecules (such as DNA, RNA, PNA, etc).


Alex Gmerek is currently a MASc. student at Carleton University and a researcher for the Center for Self Replication (CESER).

Jeffrey Greason	Sunbeam: Near-Sun Statites as Beam Platforms for Beam-Driven Rockets	
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Photon, particle, or macroscopic pellet beamriders have long been recognized as one of the key approaches to interstellar flight but previous solutions limit their application to either very small (gram scale) payloads or such large power levels as to constitute prohibitive capital costs to construct the required beam infrastructure. We sought solutions with very long beam ranges and very high specific power to produce beam solutions for macroscopic spacecraft to interstellar-relevant velocities. Relativistic electron beams appear to have potential for extreme range, potentially up to 100 AU. The challenge to make use of this technology is efficient and lightweight conversion of the electron beam to thrust.

Jeffrey Greason is Chief Technologist of Electric Sky, Chairman of the Tau Zero Foundation and a Commercial Space Industry Entrepreneur (XCOR Aerospace, Rotary Rocket).

He is co-author of *Wind-pellet shear sailing*, Acta Astronautica V197, 2022 (arxiv.org/abs/2205.14117) and *Dynamic Soaring as a Means to Exceed the Solar Wind Speed*, 2022 (arxiv.org/abs/2211.14643) also reported in Principium 40, February 2023, *Faster than the (Solar) Wind*.


René Heller	Maneuvering Interstellar Light Sails	
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With an intended speed of 20% c , the currently envisaged interstellar probes using photon sails would traverse the Earth-Moon distance in just about six seconds, with little time left for high-quality close-up exploration, for example of the planet Proxima b. However the stars α Cen A and B can be used as photogravitational swings to decelerate an incoming light sail and deflect it into a bound orbit around Proxima. Numerical simulations of the photon pressure and the gravitational force in the α Cen A, B, and C triple system show that an autonomous photon sail could be maneuvered through the system and into a bound orbit without the need for onboard fuel.

Dr Rene Heller is an Extrasolar Planet Researcher at Max Planck Institute for Solar System Research.

Dr Heller is a co-author of *TOI-2525 b and c: A Pair of Massive Warm Giant Planets with Strong Transit Timing Variations Revealed by TESS*, The Astronomical Journal, Volume 165, Number 4 2023 (iopscience.iop.org/article/10.3847/1538-3881/acba9b/meta) and *Pandora: A fast open-source exomoon transit detection algorithm*, Astronomy & Astrophysics, Volume 662, June 2022 (www.aanda.org/articles/aa/pdf/2022/06/aa43129-22.pdf).




Pascal Lee	N ~ 1: Alone in the Milky Way	
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The Search for Extraterrestrial Intelligence (SETI), as well as popular sci-fi culture, often premise that the number N of advanced civilizations in our Galaxy is large. A large N , however, is at odds with observation, hence the Fermi Paradox. This study reevaluates N on the basis of latest knowledge of the different factors affecting its value, using available data only and avoiding a priori biases. This study results in the adoption of likely values for R^* , f_p , n_e , f_l , f_i , f_c , and L of 20, 0.5, 1, 0.5, 2×10^{-4} , 0.1 and 104, respectively, which yields $N \sim 1$ and thus that intelligent societies in our Galaxy, and by extension in any galaxy, are likely few at any given time therefore SETI efforts should focus on extragalactic searches for greater chances of detection.

Dr Lee studies the most Mars-like places on earth—including Antarctica (5 visits) and the Haughton crater in the Canadian Arctic exploring how life thrives in such places, while refining our techniques for use in upcoming explorations on Mars.

Dr Lee is a planetary scientist at the SETI Institute, the Mars Institute, and the NASA Ames Research Center. He is co-author of *Handling Qualities Flight Test Techniques for Astronaut-Operated Unmanned Aerial Vehicles for Mars Exploration*, AIAA AVIATION 2020, and *A virtual REU program in Astrobiology and Planetary Science* at the SETI Institute, AGU Fall Meeting 2020.


Philip Lubin	Large Scale Directed Energy for Relativistic Flight	
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Recent advances in photonics and directed energy systems now allow us to realize the ability to project the high power over vast distances that is needed for space applications, including the ability to achieve relativistic flight among many other applications.

Our system consists of a phased array of optical amplifiers in a MOPA (Master Oscillator Power Amplifier) topology. This allows a completely modular and scalable approach with every sub-element being of modest power and size with the advantage of mass production and photonic integration. The same core technology can be used for many other purposes including planetary defense, stand-off composition analysis, space debris mitigation, power beaming to long range spacecraft and other distant assets, LEO and GEO power beaming from Earth and space among many others. This allows for a logical roadmap where milestones are immediately useful as the technology is matured.

Professor Philip Lubin is Director, Experimental Cosmology Laboratory, University of California Santa Barbara (UCSB). Professor Lubin pioneered photon sail propulsion for interstellar missions. He is co-author of *Relativistic propulsion using directed energy*, Proceedings of SPIE 8876, Nanophotonics and Macrophotonics for Space Environments VII, 2013 (core.ac.uk/download/pdf/19485607.pdf) and *Asteroid interception and disruption for terminal planetary defense*, Advances in Space Research Volume 71, Issue 3, 2023 (www.sciencedirect.com/science/article/pii/S0273117722009395). You will find numerous reports of Professor Lubin's work in past issues of Principium.




Gregory Matloff	Aerographite: A Candidate Material for Interstellar Photon Sailing	
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Aerographite has been suggested in a recent paper as a possible candidate for interstellar photon sailing. This paper begins by presenting known properties of this extremely low density, light absorptive, material. After a review of analytical tools, a number of possible interstellar missions are then considered. The first confirms that a thin-film Sun-accelerated probe deployed at the 0.4-AU perihelion of an initially parabolic solar orbit could reach Proxima/Alpha Centauri after a voyage duration of about 2 centuries. The next case examined is a thin-film probe accelerated to about 0.033c by an in-space laser array. Finally, it is shown that a combined aerographite-graphene hollow-body solar-photon sail may have significant advantages in accelerating a generation ship to an interstellar cruise velocity in excess of 900 km/s. Some of the unknowns regarding this substance that must be addressed before this material can be applied to interstellar sail application are also discussed.

Professor Greg Matloff is Emeritus Associate and Adjunct Associate Professor of physics at New York City College of Technology (NYCCT).

Prof Matloff has been involved in the interstellar endeavour for several decades. He is co-author of the "book on the subject", *The Starflight Handbook: A Pioneer's Guide To Interstellar Travel*, co-authored with Dr. Eugene Mallove, Wiley Science Editions, 1989 and numerous papers, most recently *Von Neumann probes: rationale, propulsion, interstellar transfer timing*, International Journal of Astrobiology 21, 2022 (www.cambridge.org/core/journals/international-journal-of-astrobiology/article/von-neumann-probes-rationale-propulsion-interstellar-transfer-timing/5202679D74645D3707248FE5D5FA0124) and *The Solar-Electric Sail: Application to Interstellar Migration and Consequences for SETI*, Universe 2022 (www.mdpi.com/2218-1997/8/5/252).


Co author of this paper is Dr Joseph E Meany - see his information under his paper *Mapping Nutrient Cycles for Establishing Extrasolar Colonies*.


Joseph Meany	Mapping Nutrient Cycles for Establishing Extrasolar Colonies	
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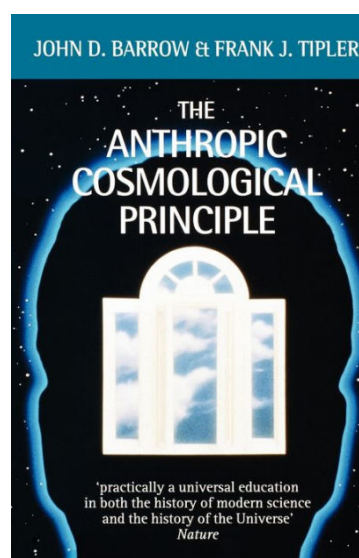
A transition from colony ship to the new planet surface will require careful stepwise development, wherein scavenged elements should be brought to bear to allow for sustainable habitation. The paper will include an outline of critical technical and biochemical cycles and a suggested roadmap for expansion of a crewed mission to develop on-planet extrasolar habitats. Dr Joseph E Meany is Associate Consultant at Booz Allen Hamilton. His recent works include *Quantitative characterization of photonic sail candidates using nanocantilever displacement*, Acta Astronautica 2022 and *Verification and Temperature-Dependent Rectification by HBQ, the Smallest Unimolecular Donor-Acceptor Rectifier*, American Chemical Society Omega, 2022 (pubs.acs.org/doi/full/10.1021/acsomega.2c01182).

◀ Other key Programme items


Abstracts were not yet available for these papers at the time of writing.

Rebecca McCauley Rench	The Search for Life and Habitable Worlds at NASA - Past, Present, and Future	
<p>Dr Rebecca (Becky) McCauley Rench is Program Scientist for the Curiosity and New Horizons missions, Planetary Science Division NASA Headquarters.</p> <p>Dr Rench is co-author of <i>Microbial population structure in a stratified, acidic pit lake in the Iberian Pyrite Belt</i>, Geomicrobiology Journal 2020 and <i>Global Extinction or a Space-Industrial Complex</i> STEPS Issue 3 2016 (www.potomac institute.org/steps/images/PDF/Articles/HertzlerSTEPS_2016Issue3.pdf).</p>		

Frank Tipler	The Ultimate Rocket and the Ultimate Energy Source, and Their Use in the Ultimate Future	
<p>Professor Tipler will announce a new approach to space propulsion, “the ultimate rocket”. Professor Frank J Tipler (www.franktipler.com/) is Professor of Mathematics and Physics at Tulane University, New Orleans. He has been a visiting academic at universities in Austria, Germany, Belgium, UK and several US universities. He is perhaps most famous for his work in reconciling theology and cosmology (the Omega Point cosmology) - and for his book (with the late John D Barrow), <i>The Anthropic Cosmological Principle</i>, OUP 1986.</p>		



Professor Tipler is the author of *Many-Worlds Quantum Mechanics is Neither Mathematically Nor Experimentally Equivalent to Standard Quantum Mechanics*, 2021, (arxiv.org/abs/2105.10431) and *Quantum nonlocality does not exist*, in Proceedings of the National Academy of Sciences 2014, (www.pnas.org/doi/abs/10.1073/pnas.1324238111).

Stephen Webb	Silence is Golden: SETI and the Fermi Paradox	
<p>Dr Stephen Webb is at the University of Portsmouth, UK.</p> <p>Dr Webb is author of <i>If the Universe Is Teeming with Aliens ... WHERE IS EVERYBODY?: Seventy-Five Solutions to the Fermi Paradox and the problem of Extraterrestrial Life</i>, Copernicus Books / Praxis Publishing Ltd 2002 and <i>Pondering the Fermi Paradox</i>, in <i>Searching for Extraterrestrial Intelligence</i>, Springer 2011.</p>		

In addition to the above papers there will be a Sagan session addressing the question "How would you select a crew of one hundred people for the first interstellar mission?" and, of course, a lot of informal conversation and gatherings of those interested in specific topic areas.



Join the Interstellar Community

You can be there for all these presentations and more. Perhaps as importantly you can participate in the informal conversations - see "The Hallway is More Important than the Podium..." in Principium 36 February 2022. Here is Joe Meany's shot from the 2021 symposium in Tucson, Arizona. Register at irg.space/irg-2023/. Students pay \$125 CAD before May 31 and \$150 CAD later, others pay \$550 CAD and \$600 CAD.

See you there!