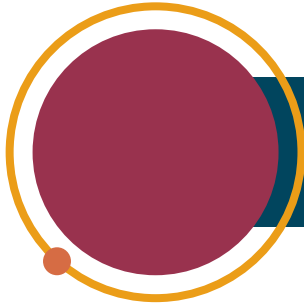


TVIW 6th Interstellar Symposium and NASA
Advanced Interstellar Propulsion Workshop

THE NEXT GIANT LEAP: AD ASTRA



WICHITA, KS  NOVEMBER 10-15, 2019
Hosted by Wichita State University & Ad Astra Kansas Foundation



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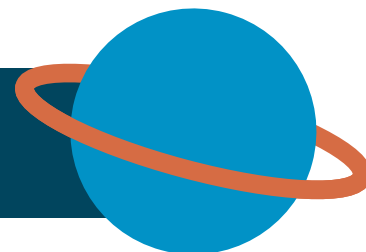
LUNAR



SYNCHRONOUS



WELCOME



WELCOME to the TVIW 6th Interstellar Symposium and NASA Advanced Interstellar Propulsion Workshop, presented by the Tennessee Valley Interstellar Workshop (TVIW) in collaboration with the National Aeronautics and Space Administration (NASA), and hosted jointly by Wichita State University and Ad Astra Kansas Foundation. We are glad to be able to present you with five days of stimulating and thought-provoking presentations that we hope will educate and excite you about our interstellar future, half from TVIW-selected and half from NASA-selected researchers. Join us in working to make interstellar exploration a reality--as John F. Kennedy said, "If not us, who? If not now, when?" Let's take The Next Giant Leap: Ad Astra!

 **Doug Loss, TVIW President**

ALIEN worlds beyond our solar system were first dramatized in the fictional writings of J.H. Rosny Aîné and with a short story Les Xipéhuz (1887); in the next 100 years, more stories burst onto the silver screen with the 1970s blockbuster movies such as Star Wars. Although that was all science fiction, by the 1980s academic researchers were proposing ways to search for alien worlds around distant stars, discovering their first in 1995 and culminated in receiving the Physics Nobel Prize last month for this new scientific breakthrough. It is fitting that we are hosting this latest TVIW 6th Interstellar Workshop with NASA's Advanced Propulsion Workshop where new ideas with potential velocities up to 5% the speed of light will be discussed. And, some day soon, will enable robotic spacecraft to reach one of these newly found worlds, such as that around Alpha Centauri, in 50 years. Along with other new propulsion ideas, interstellar scientific research and Space Policy and Ethics, I expect this meeting to be a renaissance in these studies. As its academic topic matures, it will help us advance these ideas from the fiction of more than 100 years ago to modern active science investigation, guiding us to study and explore alien worlds around distant stars.

 **Nickolas Solomey, General Chair**

ONLINE ACCESS

To access the TVIW symposium information on your smartphone, download the Eventor app on either Android or iPhone, then select Upcoming and the TVIW event (it'll be obvious). Click on the green circle in the lower right to subscribe to the event (at least that's how you do it in Android) and you can see the schedule, set your own personal agenda, rate presentations, etc.

Sessions are streamed live at <https://tviw.us/2019livestream/>. You can watch recordings of the sessions within two hours of the session end. Go to <https://tviw.us/2019livestream/>. You'll see a schedule. Select the link to the session you want to review. You can also see the recorded sessions on the TVIW YouTube Channel.

Twitter: TN Interstellar

To tag TVIW on Twitter, use @TVIWUS

Facebook: Tennessee Valley Interstellar Workshop – TVIW

To tag TVIW on Facebook posts, use @Tennessee Valley Interstellar Workshop

The general social media hashtag that the TVIW will be using for this week is: #TVIW2019

Feel free to add other hashtags such as:

#NextGiantLeapAdAstra #PioneeringInterstellarFlight #NextGiantLeap



SUNDAY, NOVEMBER 10, 2019

- 8:30 am** Registration opens in the Conference Center lobby
- 9:00 am** Seminars • **Simmons Room**
Robert E. Hampson, Ph.D. - Life in Space, People of the Stars
Ken Wisian, Ph.D., Maj. Gen. (ret.), Ken Roy, P.E., and John Traphagan, Ph.D. - Preparing for First Contact: Protocols and Implications
- 10:30 am** Coffee Break
- 12:00 pm** LUNCH (on your own)
- 1:00 pm** Seminars • **Simmons Room**
Tracie Prater and Matthew T. Moraguez - In-Space Manufacturing
Laura Montgomery, JD: Space Law - An Overview, Past, Present, and Future
- 2:30 pm** Coffee Break
- 5:00 pm** Registration opens in the Hotel lobby
- 7:00 pm** Opening Reception in the Hotel at Old Town lobby

MONDAY, NOVEMBER 11, 2019

TVIW 6th Interstellar Symposium

- 8:00 am** Welcome Remarks: Nick Solomey, Chair
- 8:30 am** Keynote: Greg Matloff - Starflight Review • **Keen Kutter Ballroom**
- 9:30 am** Marc Millis - Breakthrough Propulsion Study: Assessing Interstellar Flight Challenges and Prospects
- 10:30 am** Coffee Break
- 11:00 am** Geoff Landis - Power System for Miniature Interstellar Flyby Probe
- 11:30 am** David Messerschmitt - Some Challenges in Low-Mass Interstellar Probe Communication Downlinks
- 12:00 pm** LUNCH at the Distillery
- 1:00 pm** Keynote Speaker: Pete Klupar - Breakthrough Starshot • **Keen Kutter Ballroom**
- 1:30 pm** Deana Weibel - Inevitability, Adaptability, Destiny: Religious and Non-Religious Arguments for a Human Future in Outer Space
- 2:00 pm** Kelly Smith - Can A Complex Universe Provide a Religious Inspiration Without Religion?
- 2:30 pm** David Burke - Human-Machine Ethics: Experiments in Moral Responsibility
- 3:00 pm** Break
- 3:30 pm** Michael Massa - Securing the Stars: The Security Implications of Human Culture for Crewed Interstellar Flight
- 4:00 pm** Alexander Cohen - Damage to Relativistic Interstellar Spacecraft by ISM Impact Gas Accumulation
- 4:30 pm** Andrew Higgins - Strategies for Mitigation of Dust and Charged Ion Impact on Laser-Driven Lightsails

- 5:00 pm ADJOURN
- 7:00 pm Banquet: Presentation of the Eridani Awards from TVIW
- 8:30 pm Working Track: Terraforming 🌐 Simmons Room

TUESDAY, NOVEMBER 12, 2019

- 8:00 am Welcome Remarks: Nick Solomey, Chair
- 8:15 am Keynote: Joel Mozer - Perspectives from the USAF 🌐 Keen Kutter Ballroom
- 9:15 am Geoffrey Landis - The Physics of Negative Mass: Applications for Propulsion and Interstellar Travel
- 9:45 am Gerald Cleaver - Calculation and Analysis of the Curvature Invariants for Transversable Lorentzian Wormholes and for Warp Metrics
- 10:15 am Coffee Break
- 11:15 am Cathe Smith - Farmers in the Sky
- 11:45 am LUNCH at the Distillery
- 12:45 pm Timothy Swindle - Interstellar Material Within the Solar System
- 1:15 pm James Schwartz - Near-Earth Resources: Short-Term Limitations with Interstellar Consequences
- 1:45 pm Kenneth Roy - Terraforming Venus, and Similar Planets, using a Pneumatically Supported Shell
- 2:15 pm Katelyn Greene - Assessing Crewmember Musculoskeletal Health with Long-Duration Spaceflight
- 2:45 pm Coffee Break
- 3:15 pm Jeffrey Greason - A Reaction Drive Powered by External Dynamic Pressure as a Second Stage for Interstellar Flight
- 3:45 pm Alex Ellery - Will Self-Replication Technology Precede Interstellar Propulsion Technology? The Prospects for Interstellar Self-Replicating Probes and a Human Type III Civilization
- 4:15 pm Jamey Jacob - Inflatable Technologies for Interstellar Missions: Bounce House to the Stars
- 4:45 pm ADJOURN
- 7:00 pm Sagan Meeting 🌐 Keen Kutter Ballroom
Working Track: Terraforming 🌐 Simmons Room

WEDNESDAY, NOVEMBER 13, 2019

- 8:00 am Welcome Remarks: Nick Solomey, Chair
- 8:15 am Steve Durst - An Interstellar University in the Ad Astra State
- 8:45 am Gerald Jackson - Antimatter-Based Interstellar Propulsion
- 9:15 am Artus Davoyan - Interstellar Light Sailing
- 9:45 am Coffee Break
- 10:15 am Jacob Erlikhman - Analysis of Light Sail Geometries and Stability for Directed Energy Interstellar Propulsion
- 10:45 am Joesph Meany - Metamaterial-Enhanced Graphene as a Beamed Energy Sail for Interstellar Probes
- 11:15 am Report from the Working Track: Terraforming
- 11:30 am Group Photo
- 11:30 am LUNCH BREAK

WEDNESDAY, NOVEMBER 13, 2019 - CONTINUED

Nasa Advanced Interstellar Propulsion Workshop

- 1:00 pm Welcome Remarks: Jeff Sheehy, Chief Engineer, STMD
- 1:30 pm Andrews Higgins - Overview of Directed Energy Propulsion
- 2:00 pm Jason Cassibry - Overview of Highly Energetic Nuclear Processes
- 2:30 pm ADJOURN
- 4:00 pm Depart for Dinner and the Cosmosphere
- 10:00 pm Return to the hotel

THURSDAY, NOVEMBER 14, 2019

- 8:00 am Welcome Remarks
- 8:15 am Directed Energy & Highly Energetic Nuclear Processes Sessions

DIRECTED ENERGY SESSION

- 8:15 am Philip Lubin - Overview of Directed Energy for Relativistic Flight
- 8:45 am Prashant Srinivasan and Peter Krogen - Directed Energy: Sources (Moderator: Philip Lubin)
- 9:30 am Will Hettel and John Suen - Directed Energy: Beam Control (Moderator: Philip Lubin)
- 10:30 am Coffee Break
- 11:00 am Grover Swartzlander, Artur Davoyan, and Geoff Landis - Reflectors and Spacecraft (Moderator: John Suen)
- 12:00 pm LUNCH at the Distillery
- 1:00 pm James Early, John Brophy, Andrew Higgins, Sasha Cohen, and Chris Limbach - Intermediate Steps and Milestones and Hazards (Moderator: Geoff Landis)
- 3:00 pm Coffee Break
- 3:30 pm Jeff Sheehy, Chief Engineer, STMD; Les Johnson, NASA MSFC; and Ron Litchford - Panel: Roadmap and Needed NASA and Other Agency Support (Moderator: Philip Lubin)
- 4:30 pm ADJOURN

HIGHLY ENERGETIC NUCLEAR PROCESSES SESSION

- 8:15 am Introductory Comments
- 8:20 am Jason Cassibry - The ALPHA Plasma Liner Experiment (PLX) - First Steps Towards a Plasma Jet Driven Magneto-Inertial Fusion Reactor
- 9:00 am Theodore Mouratidis (Commonwealth Fusion) - QUELLER drive: Q Uranium Enhanced Linear Long Endurance and Range Drive
- 9:40 am Uri Shumlak - Fusion Space Propulsion System Based on the Shered Flow Stabilized Z Pinch
- 10:20 am Coffee Break
- 10:50 am Hafiz Rahman - Staged Z-pinchL: A Target for Fusion and a Possible Source for Interstellar Propulsion
- 11:30 am Charles Swanson - Beyond Pluto: Status of Direct Fusion Drive
- 12:10 pm LUNCH at the Distillery

- 1:10 pm Tom McGuire - Overview of the Lockheed Martin Compac Fusion Reactor (CFR) Project
- 1:50 pm Ryan Weed - Fusion and Antimatter: A Hybrid Approach to Reaching 0.1c
- 2:30 pm Robert Adams - State of Research in a Pulsed Hybrid Nuclear Propulsion Engine
- 3:10 pm Coffee Break
- 3:40 pm Ray Sedwick - Direct Drive Fusion Propulsion with Centrifugal Plasma Confinement
- 4:20 pm ADJOURN

- 7:00 pm Public Outreach Event and Author Panel
Robert Hampson, Dan Hoyt, Sarah Hoyt, Les Johnson, Geoff Landis, Toni Weisskopf

FRIDAY, NOVEMBER 14, 2019

- 8:00 am Welcome Remarks
- 8:15 am Directed Energy & Highly Energetic Nuclear Processes Sessions

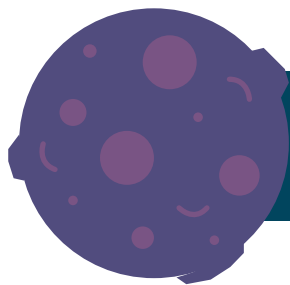
DIRECTED ENERGY SESSION

- 8:15 am Developing the Directed Energy Roadmap: Open Discussion with Directed Energy Group
(Moderator: Andrew Higgins)
- 10:30 am Coffee Break
- 11:00 am Developing the Directed Energy Roadmap: Open Discussion with Directed Energy Group
(Moderator: Grover Swartzlander)
- 12:00 pm LUNCH at the Hotel Old Town

HIGHLY ENERGETIC NUCLEAR PROCESSES SESSION

- 8:15 am Energetic Nuclear Processes Roadmap Development
(Moderator: Ray Sedwick)
- 10:30 am Coffee Break
- 11:00 am Energetic Nuclear Processes Roadmap Development
(Moderator: Ray Sedwick)
- 12:00 pm LUNCH at the Hotel Old Town

- 1:00 pm Plenary session: Directed Energy Presentation 🚀 Keen Kutter Ballroom
(Moderator: Philip Lubin)
- 2:30 pm Coffee Break
- 3:00 pm Plenary session: Highly Energetic Nuclear Roadmap Presentation 🚀 Keen Kutter Ballroom
(Moderator: Ray Sedwick)
- 4:30 pm Closing Remarks
- 5:00 pm ADJOURN



MEETINGS

WORKING TRACK: TERRAFORMING

MONDAY, NOVEMBER 11 8:30 pm 🌐 Simmons Room

TUESDAY, NOVEMBER 12 7:00 pm 🌐 Simmons Room

This will be a small-group discussion open to any and all participants in the Interstellar Symposium. The discussion will center on the key “journalist-style” questions of what, when, where, who, how and why - for example - How do we terraform? Whole planets? Moons? Worldships and sealed habitats? What do we need to include? Do we really need stinging insects and nuisance weeds?

The primary purpose of a Working Track is to ask the questions and brainstorm ideas for engaging the general public to educate, inform, and most of all, *encourage* participation in a truly interstellar society.

SAGAN MEETING

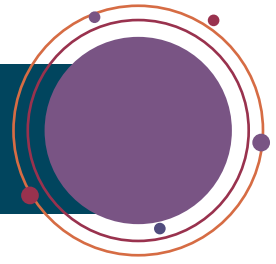
TUESDAY, NOVEMBER 12 7:00 pm 🌐 Keen Kutter Ballroom

Facilitated by Dr. James S.J. Schwartz

A two hour panel discussion named for a visionary Carl Sagan, who famously employed this format for his 1971 conference at the Byurakan Observatory in old Soviet Armenia, which dealt with the Drake Equation. The Sagan Meeting will feature four speakers who have been invited to give short presentations staking out a position on a particular question. These speakers will then form a panel to engage in a lively discussion with one hour of panel discussion and one hour of audience interaction on that topic.

This year’s Sagan Meeting will focus on the question: “What is the most ethically salient roadblock to space settlement? That is, what is the most important issue or problem that you believe must be resolved in advance of initiating space settlement?” Implications for interstellar settlement will also be discussed. Invited speakers include philosopher Dr. Kelly Smith of Clemson; linguist Dr. Sheri Wells-Jensen of Bowling Green State; anthropologist Dr. John Traphagan of U.T. Austin; and anthropologist Dr. Deana Weibel of Grand Valley State.

SPECIAL EVENTS



COSMOSPHERE



WEDNESDAY, NOVEMBER 13 🌐 4:00 pm

With 13,000 artifacts, including rare German V-1 and V-2 rockets, the Cosmosphere in Hutchinson houses the largest combined collection of American and Russian spacecraft in the world. Its SpaceWorks division restores U.S. spacecraft for museums all over the world—including the Smithsonian. Notable are the Apollo 13 command module Odyssey (on display) and the Liberty Bell 7. SpaceWorks did the restoration of mission control consoles at Johnson Space Center.

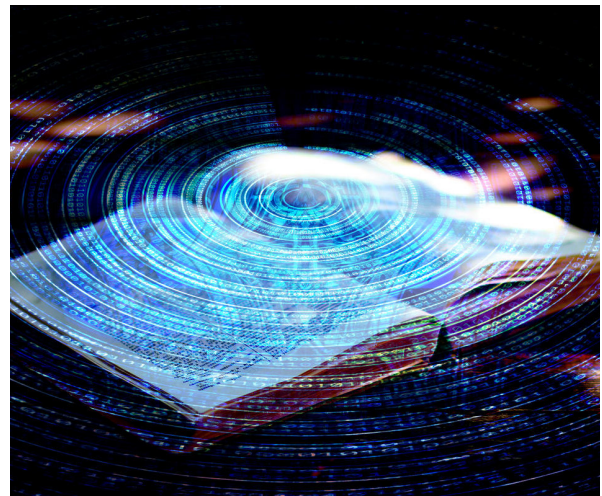
We have arranged for a bus to take attendees who have previously signed up to the Cosmosphere on Wednesday afternoon for tour and dinner. It is about an hour bus ride.

TVIW PUBLIC OUTREACH EVENT SCIENCE FICTION WRITERS PANEL

THURSDAY, NOVEMBER 14 🌐 7:00 pm
Keen Kutter Ballroom, Conference Center

We will be presenting a panel discussion by renowned science fiction writers to address the question: What are possible futures for the development of interstellar travel, given what you have seen at this symposium?

The panel will include: Robert Hampson, Dan Hoyt, Sarah Hoyt, Les Johnson, Geoff Landis, Toni Weiskopf
Barnes & Noble will have books of these authors and more for sale.





SPEAKERS

ROBERT ADAMS received both a Bachelor's and Master's in Mechanical Engineering from the University of Alabama at Birmingham. He has also received a Master's in Aerospace Engineering and Doctor of Philosophy (Mechanical Engineering) from the University of Alabama in Huntsville. He also finished most of the requirements for a Masters in Nuclear Engineering from the University of Tennessee in Knoxville. Before joining NASA Dr. Adams has served as a flight controller. He has served as principal investigator for several new propulsion concepts.

DR. JOHN BROPHY, a graduate of the Illinois Institute of Technology and Colorado State University, led a U.S. team in the evaluation of Hall thruster technology in the Soviet Union leading to its wide-spread adoption in the West. He initiated the NSTAR Project that provided the ion propulsion for Deep Space 1. He delivered the ion propulsion system for NASA's Dawn mission and co-led the study at Caltech's Keck Institute that resulted in the Asteroid Redirect Robotic Mission. He is a JPL Fellow and an AIAA Fellow. Dr. Brophy was awarded the Ernst Stuhlinger Medal for Outstanding Achievement in Electric Propulsion in 2015 and the AIAA Wyld Propulsion award in 2017.

DAVID BURKE is a Principal Scientist at Galois, Inc., where he leads the Machine Cognition research program, investigating techniques for integrating human decision-making with machine intelligence (and vice versa). Since joining Galois in 2004, his work has included conducting research into logics for reasoning about trust in the design of secure systems, approaches for ensuring robust decision-making in multi-agent systems, and the development of hybrid AI techniques for system security. His recent research experience include PI roles on DoD-funded projects focused on agile and adaptive human-machine teaming, techniques for reasoning under conditions of extreme uncertainty, and adversarial modeling for cybersecurity. Other current research interests include the specification and design of ethical behavior for robots in mission critical scenarios, epistemic game theory, and bio-inspired AI.

DR. JASON CASSIBRY is an associate professor in the Department of Mechanical and Aerospace Engineering and affiliated with the Propulsion Research Center at the University of Alabama in Huntsville. His research includes the theoretical and experimental study of magneto-inertial fusion and fission/fusion hybrids for applications to advanced propulsion for interplanetary space travel and terrestrial power. Specific research areas include 3D modeling of these plasmas using smooth particle hydrodynamics, modeling of the coupling between plasma accelerators and external

circuits, and pulsed z-pinch fusion. Dr. Cassibry has 15 years past the PhD in numerical modeling of magneto-inertial fusion and advanced propulsion. He is the PI of the Charger Facility, a 3 Terawatt pulsed power laboratory to be utilized for z-pinch applications for propulsion, terrestrial power, and laboratory astrophysics. He was a coauthor on the AIAA Best Paper by the AIAA Nuclear and Future Flight Propulsion Technical Committee, AIAA 2014-3520 "Developing the Pulsed Fission-Fusion (PuFF) Engine" which was awarded in April 2014.

DR. GERALD B. CLEAVER earned his Ph.D. in early universe cosmology and string theory at Caltech in 1993. Cleaver is Professor and Graduate Program Director of the Department of Physics at Baylor University in Waco, Texas. He heads the Early Universe Cosmology and String Theory (EUCOS) Division of Baylor's Center for Astrophysics, Space Physics and Engineering Research (CASPER). With CASPER colleagues Cleaver (i) explores quantum gravity effects in the early universe and the signatures of specific quantum gravity proposals, especially with regard to the cosmic microwave background (CMB), (ii) studies relativistic thermodynamics and physics & cosmology applications to cryptography, (iii) analyzes spacetime curvatures (and their possible divergences) for theorized spacetime wormholes, and (iv) investigates advanced spacecraft propulsion systems. Cleaver was a member of a NASA blue-ribbon review committee for advanced propulsion system proposals. He is on the international advisory board of the Journal of the British Interplanetary Society. Cleaver also enjoys writing about philosophical implications of a multiverse. Cleaver's hobbies include SCUBA, small boat sailing, snow skiing, and Taekwondo.

ALEXANDER "SASHA" COHEN is a Jr. Specialist with the Deepspace Group at UC Santa Barbara. In June 2019 he received a B.S. in Physics with a minor in Astronomy and Planetary Science from UC Santa Barbara. His specializations include computer aided design (CAD) in SolidWorks, finite element analysis (FEA) simulations, and fabrication of experimental systems. His work is focused on the design and construction of modular optical and photonic assemblies to be arrayed for directed energy propulsion research. Recently, he has been working with collaborators from UIUC, LLNL, and UCSB to develop a model of damage due to gas accumulation within a relativistic spacecraft travelling through the interstellar medium.

DR. ARTUR DAVOYAN is an Assistant Professor of Mechanical and Aerospace Engineering at the University of California, Los Angeles. His current research interests focus on laser-materials interaction at the nanoscale for applications related to propulsion, spacecraft thermal management and power. Among his recent

contributions are materials analysis and design of a laser propelled spacecraft for a Breakthrough Starshot mission, large-scale control architectures for laser beam forming, nanometer thick coatings for visible and infrared spectral management, and atomically thin photovoltaic cells for ultralight weight power systems. He also contributed extensively to electromagnetics, including microwave, terahertz and optical photonics, metamaterials, antennas, plasmonics, and nonlinear systems. Prior to UCLA, has been a fellow of Kavli Nanoscience and Resnick Sustainability Institutes at Caltech and worked at the University of Pennsylvania. He received his PhD in nonlinear physics 2011 from the Australian National University. He has also authored and co-authored 50 publications.

STEVE DURST is the director of the International Lunar Observatory Association, based in Hawai'i, USA, and its ILOA Galaxy Forum program: To advance 21st Century Education and see Humans on the Moon within the decade - the first giant step toward the Galaxy / Stars. He also is Editor and Publisher at Space Age Publishing Company, since 1976, and operates its Hawaii and California offices. Space Age publishes Space Calendar and Lunar Enterprise Daily, and supports pioneering enterprises such as the ILOA, Stanford on the Moon, and Ad Astra Kansas Newsletter and Foundation initiatives, and pursues a business plan consistent with establishing a third office on the Moon. He received a BA (1965) in European History and an MA (1966) in American History from Stanford University in California, and is self-taught in Asia / China history and culture. Since 2001 through a bi-annual feature in the acclaimed Ad Astra Kansas News, Steve has chronicled contemporary news developments in "Interstellar R&D", which includes 'Observation', 'Communication' and 'Transportation' sections that could serve as a Curriculum foundation and introduction for a rising Interstellar University in the Ad Astra State.

JAMES EARLY obtained his BS in Aeronautics & Astronautics at MIT. He followed with an MS in Mechanical Engineering (Propulsion) at Caltech, and a PhD in Aeronautics & Astronautics (Physics minor) at Stanford University. Early in his career (pun intended), he worked at NASA-Greenbelt, Douglas Aircraft-Culver City, Lockheed Missiles & Space-Sunnyvale, and Hughes Aircraft-Culver City.. Subsequently for thirty years, Dr. Early worked at Lawrence Livermore National Laboratory in activities primarily related to lasers, optics and systems design. He made major contributions to the Atomic Vapor Laser Isotope Separation Program. Some of his important papers include "Twenty meter space telescope based on diffractive Fresnel lens." 2003; 'Space debris de-orbiting by vaporization impulse using short pulse laser,' 2003; 'Use of a solar sail as a zone plate lens to enable fly-by missions with large telescope capabilities.' 2002; 'Dust grain damage to interstellar laser pushed lightsail.' 2000; and 'Space based shield to offset greenhouse effect,' 1989.

PROFESSOR ALEX ELLERY is a Canada Research Professor in Space Robotics & Space Technology at Carleton University, Ottawa, Canada. His research group covers a wide range of activities associated with space robotics with a special emphasis on biomimetics and astrobiology. He is currently concentrating on developing self-replicating machines to industrialize the Moon robotically. He is the author of two textbooks "An Introduction to Space Robotics" (2000) and "Planetary Rovers" (2015) as well as a popular science book in progress "Manna from Heaven" on using these self-replicating machines to construct fleets of solar power satellites to provide low-cost clean energy globally. Prior to immigrating to Canada from the UK, he was formerly at Surrey Space Centre founding their two robotics research groups. He is an alumnus of the International Space University as both student and instructor. His educational background comprises a BSc (Hons) Physics, MSc Astronomy and PhD Astronautics & Space Engineering.

JACOB ERLIKHMAN is a fourth year undergraduate student majoring in physics and mathematics at the University of California, Santa Barbara. He is currently working in the UCSB Experimental Cosmology Group, whose principal investigator is Professor Philip Lubin. He has designed conventional optics for the collimation of laser elements of a phased laser array, as well as diffractive optical elements as a cheaper, mass-producible alternative. Mr. Erlikhman has also designed optics for telescope missions and a multi-color camera for use on a 0.8 m Las Cumbres Observatory telescope. Currently, he is analyzing the stability of a light sail under acceleration from a 100 GW laser with numerical simulations in COMSOL and analytic analyses, as well as developing a path forward for manufacture of monochromatic diffractive optical elements for fiber laser collimation.

JEFF GREASON is an entrepreneur and innovator with 22 years' experience in the commercial space industry. He is the CTO of Electric Sky, developing long-range wireless power for air and space vehicle propulsion and other purposes; and Chairman of the Tau Zero Foundation, developing advanced propulsion technologies for solar system and interstellar missions. He has been active in the development of commercial space regulation and served on the Augustine Commission in 2009. Jeff was a cofounder of XCOR Aerospace and served as CEO from 1999 to early 2015, managing development of 11 different reusable rocket engines and 66 flights of piloted rocket aircraft. Previously, he was the rocket engine team lead at Rotary Rocket, and an engineering manager in chip technology development at Intel. He holds 25 U.S. Patents. He is also a Governor of the National Space Society.

KATELYN GREENE is a Biomedical Engineering PhD student in the Virginia Tech - Wake Forest University Center for Injury Biomechanics. She received her B.S. in Bioengineering from the University of California, Berkeley in 2017. She uses image analysis and computational modeling to study musculoskeletal changes in microgravity and how they influence astronauts' risk of spine injury with long-duration spaceflight missions to the International Space Station. Katelyn is excited to talk

about how this research will help us to better assess and predict crewmember health for longer missions to Mars and beyond!

ROBERT E. HAMPSON, PH.D. is THE (brain) scientist behind the science fiction for more than a dozen writers. He has assisted in the (fictional) creation of future medicine, brain computer interfaces, unusual diseases, alien intelligence, novel brain diseases (and the medical nanites to cure them), exotic toxins, and brain effects of a zombie virus. With over a dozen short stories published and in process, his fiction ranges from the Four Horsemen Universe-4HU (Chris Kennedy Publ.), to Baen's Black Tide Rising universe to the U.S. Army Training and Doctrine Command's Mad Science Writing contest (U.S. Army Small Wars Journal). He has just released the novel Do No Harm in the Four Horsemen Universe and is co-editor with Les Johnson of the mixed science and fiction anthology STELLARIS: People of the Stars (Baen). Dr. Hampson is a Professor of Physiology/Pharmacology and Neurology with over 35 years' experience in animal and human neuroscience. His professional work includes more than 100 peer-reviewed research articles ranging from the pharmacology of memory to the effects of radiation on the brain, and is leading a multi-institutional clinical research effort to develop a "neural prosthetic" to restore human memory. With more than two million words in scientific writing alone, communicating science to professionals and lay audiences is his greatest interest. He is known to many by his former pen-name "Tedd Roberts" or his internet handle "Speaker to Lab Animals," having given public talks on science, science fiction (and the science in science fiction) to professors, students and civic groups, government agencies as well as SF/F conventions.

WILL HETTEL (BS in Physics from Univ. of California, Santa Barbara) has done research in phased laser array development, WaferSat Launcher design and construction, FPGA programming, and wafer fabrication. He is presently a Developmental Technician at UCSB Department of Physics, and has published several articles in the Proceedings of the SPIE.

DR. ANDREW HIGGINS is a professor of Mechanical Engineering at McGill University, Montreal, Canada. He has over 25 years of experience in shock wave experimentation and modelling, encompassing shock and detonation waves in gas-phase and condensed-phase materials, with applications to advanced aerospace propulsion, defense, and fusion energy. He serves as the Managing Editor of Shock Waves, An International Journal on Shock Waves, Detonations, and Explosions. His two most recent projects have been: (1) Developing a hypervelocity launcher to launch projectiles to world-record velocities (exceeding 12 km/s) for orbital debris impact testing and (2) a research collaboration with General Fusion Inc. (Burnaby, BC) applying the implosion of liquid cavities to magnetized target fusion. In 2018, while on sabbatical from McGill, he was a visiting scholar at UC Santa Barbara in the Experimental Cosmology Group, working on problems

related to interstellar flight. Andrew Higgins has a PhD ('96) and MS ('93) in Aeronautics and Astronautics from the University of Washington, Seattle, and a BS ('91) in Aeronautical and Astronautical Engineering from the University of Illinois in Urbana/Champaign.

DAN HOYT is a systems architect for rocket trajectory software, when not writing or wrangling royalty calculations. Dan has appeared in premier magazines like Analog and several anthologies, notably Stellaris: People of the Stars (Baen) and Transhuman (Baen), and Dr. Mike Brotherton's NSA-funded Diamonds in the Sky; and has edited Fate Fantastic and Better Off Undead for DAW. His debut space opera, Ninth Euclid's Prince, is available on Kindle Unlimited. See more at danielmhojt.com.

SARAH HOYT was born in Portugal and now lives in Colorado with her husband, near her two adult sons. In between she took all sorts of improbable jobs in all sorts of improbable places, but none stranger than fiction writer in her third language. She's published over a hundred stories in magazines like Analog, Asimov's and Weird Tales, and written over thirty novels for three publishers. Along the way, her first book was a finalist for the mythopoeic award, her first space opera — Darkship Thieves — won the Prometheus award, and her novel Uncharted (with Kevin J. Anderson) won the Dragon award for alternate history.

DR. GERALD JACKSON received his doctorate in the field of accelerator physics from Cornell University, where he studied collisions between electrons and positrons. From 1985 until 2000 he was instrumental in improving the performance of the Fermilab proton-antiproton collider program through enhancements in the production, manipulation, and storage of antiprotons. Dr. Jackson was a leader in the design, construction, and commissioning of the innovative 2 - mile circumference antiproton Recycler ring, the last major particle physics accelerator built in the United States. Designed to increase Fermilab performance by 2.5X, the Recycler and other upgrades actually resulted in an increase of more than a factor of five. During his 14 years at Fermilab, he had been instrumentation department head, leader of Main Ring operations, and leader of many accelerator technology development projects. Since 2000 he has founded several companies, one working on antimatter propulsion problems for NASA and culminating in a 2016 crowdfunded study of antimatter production enhancements.

JAMEY D. JACOB is the John Hendrix Chair and Professor in the School Mechanical & Aerospace Engineering and Director of the Unmanned Systems Research Institute at Oklahoma State University. He is the author of over 200 papers in the areas of unmanned systems, aerodynamics, plasma dynamics, and space travel. He received his B.S. in Aerospace Engineering from the University of Oklahoma in 1990 and his M.S and Ph.D. in Mechanical Engineering from the University of California at Berkeley in 1992 and 1995, respectively. He spent 10 years as a professor at the University of Kentucky in the Mechanical Engineering Dept. He currently serves

on the Governor's Aerospace and Autonomous Systems Council and as president of the Unmanned Systems Alliance of Oklahoma. He founded the OSU Unmanned Systems Research Institute in 2015 to support ongoing activities in autonomous systems for surface, air, and space across the OSU campus and throughout Oklahoma. He is the faculty mentor for the OSU Space Cowboys, which focuses on technology development for manned space flight activities, particularly utilization of soft goods and inflatable applications for NASA eXploration HABitat. In addition to standard aerospace engineering topics, he teaches a course on the Physics of Science Fiction aimed at a broad university audience.

LES JOHNSON is a Principal Investigator of two interplanetary solar sail space missions at the NASA George C. Marshall Space Flight Center in Huntsville, Alabama. The first, Near Earth Asteroid Scout, scheduled for spaceflight in 2020, will use a 925 square foot solar sail to propel a small spacecraft to rendezvous with an asteroid. The second, Solar Cruiser, will demonstrate the ability of an 18,000 square foot solar sail-propelled spacecraft to perform scientific observations of the sun when it flies in 2024. During his career at NASA, Les served as the Manager for the Space Science Programs and Projects Office, the In-Space Propulsion Technology Project, and the Interstellar Propulsion Research Project.

PETE KLUPAR has worked in the Aerospace Industry for more than 35 years. Holding senior positions in Government (US Air force and NASA) and industry (startups to multinational corporations). Prior to being the Engineering Director at the Breakthrough Foundation, Mr. Klupar was Director of Engineering at NASA's Ames Research Center.

PETER KROGEN is a researcher in the physics department at the University of California at Santa Barbara. He received a M.S. and Ph.D. in Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, with a focus on laser system development. He has been active in the optical community performing research to further the state of the art in coherent synthesis of laser systems ranging from the mid-infrared to deep-ultraviolet and currently focuses on development of phased arrays for directed energy applications.

DR. GEOFFREY LANDIS was born in Detroit, Michigan. After going to college at MIT and graduating with degrees in Physics and Electrical Engineering, he worked in the Boston area for five years. After receiving his Ph.D. in physics from Brown University, Dr. Landis worked as a postdoctoral researcher at the NASA Lewis Research Center (now renamed NASA Glenn), then worked as a NASA contractor, and finally as senior scientist at the Ohio Aerospace Institute, before accepting his current job as a civil-service scientist in the Photovoltaics and Power Technology Branch at NASA Glenn Research Center in Cleveland, where he works on Mars exploration with the Mars Exploration Rovers. He currently lives Berea, Ohio with cats named

Azrael and Tyrael, several teddy-bears, more books than you can count in a year, and no goldfish. He is married to science fiction writer Mary A. Turzillo.

DR. CHRIS LIMBACH is an assistant professor at Texas A&M University and obtained his Ph.D. in Mechanical and Aerospace Engineering from Princeton University in 2015, with a focus on laser plasma generation, laser diagnostics and flow control. At Texas A&M, he directs the Laser Diagnostics and Plasma Devices Laboratory. His research involves developing novel laser measurement techniques for high-speed and non-equilibrium flows and plasmas discharges. He is also interested in applications of lasers and plasmas to space propulsion, gas and multi-phase ignition, and high-speed aerodynamic flow control.

RON LITCHFORD has is the Principal Technologist for the Launch & Spacecraft Vehicle Systems and Advanced Propulsion Systems at the Space Technology Mission Directorate.

DR. PHILIP LUBIN is a professor of Physics at UC Santa Barbara whose primary research has been focused on studies of the early universe in the millimeter wavelengths bands as well as applications of directed energy for planetary defense and relativistic propulsion. His group has designed, developed and fielded more than two dozen ground based and balloon borne missions and helped develop two major cosmology satellites. He is director of the NASA Starlight program, currently in a Phase II whose goal is to use directed energy for humanity's first interstellar missions. He is also concept director for the Breakthrough Starshot program whose goals are also to achieve relativistic flight with miniature spacecraft. He is co-recipient of the 2006 Gruber Prize in Cosmology along with the COBE science team for their groundbreaking work in cosmology as well as the 2018 Gruber Prize in Cosmology along with the Planck science team for their determination of fundamental cosmological parameter.

MIKE MASSA is a recently published author whose short stories and novels encompass SF, Mil-SF, Fantasy and post-Apocalyptic fiction, as well as non-fiction. His most recent novel, national bestseller River of Night, co-written with John Ringo, was released in July 2019. Unable to settle on a one format, Mike is currently working on more short stories, a novella and another novel. His non-writing employment spans years in the Naval Service (SEAL), investment banking, financial services and defense contracting. Mike is currently employed by an award-winning research university, integrating emerging machine learning and artificial intelligence technologies into practical applications for cyber defense. Or, you know, Skynet. Whichever comes first.

DR. GREG MATLOFF is a leading expert in possibilities for interstellar propulsion, especially near-Sun solar-sail trajectories that might ultimately enable interstellar travel. He is a tenured astronomy professor with the physics department of New York City College of Technology, CUNY, a consultant with NASA Marshall Space Flight Center, a Hayden Associate of the American Museum

of Natural History and a Corresponding Member of the International Academy of Astronautics. His papers on interstellar travel, the search for extraterrestrial artifacts, and methods of protecting Earth from asteroid impacts have been published in JBIS, Acta Astronautica, Spaceflight, Space Technology, Journal of Astronautical Sciences, and Mercury. His popular articles have appeared in many publications, including Analog and IEEE Spectrum. He served on a November 2007 panel organized by Seed magazine to brief Congressional staff on the possibilities of a sustainable, meaningful space program. Professor Matloff is a Fellow of the British Interplanetary Society and a Member of the International Academy of Astronautics. In addition to his interstellar-travel research, he has contributed to SETI (the Search for Extraterrestrial Intelligence), modeling studies of human effects on Earth's atmosphere, interplanetary exploration concept analysis, alternative energy, in-space navigation, and the search for extrasolar planets.

BRIAN MCCONNELL is with the Open SETI Data Archive. His paper on The Spacecoach, written with Alex Tolley, was published in the Journal of the British Interplanetary Society in 2010. His book, Beyond Contact: A Guide to SETI and Communicating with Alien Civilizations, is available from O'Reilly and Associates.

DR. THOMAS MCGUIRE is a Lockheed Martin Fellow and the Principal Investigator of the Compact Fusion Reactor Project at the Skunk Works in Palmdale, CA. With his team, he is looking to validate the promising plasma confinement scaling of a linear encapsulated ring cusp magnetic geometry to enable compact fusion reactors. He holds 8 unique patents on compact nuclear fusion, tessellated around the world, with more on the way. He has spoken on fusion at numerous conferences and symposia, including the Milken Global Conference and the National Academy of Engineering, Science and Medicine. He earned his B.S. in Aerospace Engineering at Penn State in 1999 and his Ph.D. in Aeronautical and Astronautical Engineering at MIT with a focus in nuclear physics and space propulsion in 2007. Some of his past research includes multi-gridded inertial electrostatic fusion, nuclear thermal rockets for fast Mars colonization, miniaturized star trackers, and air-breathing space propulsion. At Lockheed Martin, Tom has been a creative force behind projects varying from aerodynamics, electromagnetics, advanced materials, pervasive sensors, energy concepts and space technology as well as stretching the organization's reach with biologically inspired designs.

JOSEPH E. MEANY, Ph.D., (a.k.a. the Crimson Alchemist) is a material scientist from Atlanta, GA. He received his Ph.D. in Chemistry from the University of Alabama in 2016 and continues to work and volunteer in various science communication venues with a focus on how chemistry and nanotechnology impact society. He is a member and contributor to the Tennessee Valley Interstellar Workshop and the Tau Zero Foundation, promoting the development of new materials to solve challenges facing humans in earth and space. His first

book, with co-author Les Johnson, called Graphene: The Superstrong, Superthin and Superversatile Material that will Revolutionize the World was released in February 2018 by Prometheus Books. You can find it at tiny.cc/graphenebook.

DAVID G. MESSERSCHMITT is the Roger A. Strauch Professor Emeritus of Electrical Engineering and Computer Sciences (EECS) at the University of California at Berkeley. Although officially retired, he continues his research in interstellar communications with application to the search for signatures of extraterrestrial technology, and communication with interstellar space probes. He started his career at Bell Laboratories, and at UC Berkeley has served as Chair of EECS and the Interim Dean of the School of Information. His doctorate is from the University of Michigan, and he is a Life Fellow of the IEEE, a Member of the National Academy of Engineering, and a recipient of the IEEE Alexander Graham Bell Medal recognizing "exceptional contributions to the advancement of communication sciences and engineering".

MARC G. MILLIS led NASA's "Breakthrough Propulsion Physics" project, 1996-2007 (funded through 2002), and compiled the book, Frontiers of Propulsion Science (AIAA 2009) – the first scholarly book on the physics of non-propellant space drives and faster-than-light flight. Retired from NASA in 2010, he continues to examine advanced propulsion concepts and the methods with which to advance them. In the spring of 2017 and 2019 he worked with Martin Tajmar's SpaceDrive project at Germany's Technische Universität Dresden, which included giving a short course, "Interstellar Flight and Propulsion Physics." He also gave that course at Purdue University in the fall of 2017. Now a senior scientist at the Ohio Aerospace Institute, Millis is beginning the second stage of a NASA grant to assess the options for interstellar flight. The first stage report, on the NASA Technical Reports Server, is "Breakthrough Propulsion Study – Assessing Interstellar Flight Challenges and Prospects." His subject matter expertise spans physics, electronic engineering, cryogenic propellants, and electric space propulsion. Education includes a BS in Physics from Georgia Tech (1982), International Space University Summer Session (1998), and an MS in Physics Entrepreneurship from Case Western Reserve University (2006).

LAURA MONTGOMERY teaches space law at Catholic University's Columbus School of Law. In her private practice she specializes in regulatory space law, with an emphasis on commercial space transportation and the Outer Space Treaties. In 2017, she testified to the Space Subcommittee of the House Committee on Science, Space, and Technology, and to the Senate Committee on Commerce, Science, and Transportation's Space Subcommittee on Space, Science and Competitiveness on matters of regulation and international obligation. She has published articles on the Outer Space Treaty, human space flight, and launch safety, and writes and edits the space law blog GroundBasedSpaceMatters.com. Ms. Montgomery spent over two decades with the Federal Aviation Administration supporting the FAA in its authorization and regulation of launch, reentry, and the

operation of launch and reentry sites. She received her law degree from the University of Pennsylvania, and her undergraduate degree with honors from the University of Virginia. She also writes science fiction, which ranges from space opera to bourgeois, legal science fiction. Her author site is at www.lauramontgomery.com.

MATTHEW R. MORAGUEZ is a member of the MIR Strategic Engineering Research Group, and a Ph.D. Candidate in Aeronautics and Astronautics at MIR. Matt has a M.S. in Aeronautics and Astronautics from MIT (2018) and a B.S. in Aerospace Engineering from the University of Florida (2016).

THEODORE MOURATIDIS is a PhD candidate at MIT working on the SPARC nuclear fusion reactor. He was born and raised in Melbourne, Australia. After beginning his college at Monash University in Melbourne, he transferred to MIT in 2013 and graduated in 2016 with an BS double major in Aerospace Engineering and Physics. He has research experience in space propulsion at MIT, and in experimental and computational plasma physics during research stints at both Princeton and Stanford. After deciding to pursue graduate school at MIT, in 2018 he received his Masters degree in AeroAstro working on using ion emitters to charge aircraft to mitigate lightning strikes. His passion for interstellar propulsion, particularly using fusion, led him to also becoming involved with the PSFC (Plasma Science and Fusion Centre) since 2016, and eventually beginning his PhD work on the high temperature superconducting toroidal field coils for the SPARC fusion reactor, which has the goal of producing breaking even fusion power. Theodore is also a competitive powerlifter on the national and international stage, is writing an educational fiction novel series in physics for middle school children, loves thrilling mountaineering expeditions, and plays the piano.

DR. JOEL B. MOZER, a Senior Leader Executive, is Chief Scientist at Headquarters Air Force Space Command, Peterson Air Force Base, Colorado. Dr. Mozer has more than 30 years of space science, engineering, management and financial experience working space and ground systems for the Department of Defense. In addition to the Integrated Experiments Division, he served as Chief of the Battlespace Environment Division and led the Air Force Research Laboratory's Space Weather Center of Excellence and was a scientist at the National Solar Observatory at Sacramento Peak. Before coming to AFRL, Dr. Mozer worked at the Air Force's Radar Attenuation and Scattering facility at Holloman Air Force Base where he developed measurement and analysis techniques to study the radar cross section of low-observable aircraft and technology. Prior to that, he worked for the Army's Atmospheric Sciences Laboratory where he developed techniques to quantify the effects of natural and man-made battlefield obscurants on electro-optical sensors. A number of the methods and procedures developed by Dr. Mozer are in current use at Air Force and Navy operational weather forecasting centers.

JIM PEARSON is the Director of Aerospace Products at NeXolve (previously SRS Technologies and Mantech NeXolve). Over the last 30 years, he has been part of the NeXolve team that has collaborated with NASA and others to develop thin film technologies and products. These technologies and products include: polyimide resins, thin films, and coatings (CP1, TCP1, Corin), large deployable thin film structures (NSD, NEAS, FURL, JWST Sunshields, satellite thermal blankets), thin film solar concentrators and RF antennas, PV arrays, and various thin film support structures including metallic TracBooms and inflatable structures. The team has additionally developed facilities, processes, and mechanisms for the fabrication of large deployable structure.

DR. TRACIE PRATER is an aerospace engineer in the Materials and Processes Laboratory at NASA Marshall Space Flight Center, where she is currently supports technical integration activities for the in-space manufacturing (ISM) project. Using the International Space Station as a testbed, ISM is responsible for developing the manufacturing capabilities needed to produce parts on demand during long duration, crewed space exploration missions. She also serves as a subject matter expert for NASA's Centennial Challenge on 3D Printing of Habitats, a public competition for additive manufacturing of structural habitats using recyclable materials and in situ resources. She has a PhD in mechanical engineering from Vanderbilt University.

DR. HAFIZ UR RAHMAN has over five decades of experience in the field of fusion-energy and space physics research. He has been a faculty member with University of California, Irvine and Riverside during his tenure from 1981 to 2012. His research spans three areas of experiment, theory and computational physics. His particular emphasis on research has been on the experiments and computational modeling of dense Z pinches for fusion energy, field reversed configurations (FRC) and laboratory simulation of space plasma structures like magnetosphere and comets, and propagation of neutralized plasma beams and dusty plasmas. He has directed the Space Simulation Laboratory at Institute of Geophysics and Planetary Physics (IGPP) at UCR, from 1986 to 2000. He served as PI on projects funded by NASA, NSF, US Air Force, DOE and NRL. He was the principal investigator on a joint staged Z-pinch effort between UC Riverside and UC Irvine, funded by US department of Energy in late 90's. He was also the principal investigator on Staged Z-pinch Target for Fusion project funded by ARPA-E under alpha program from 2015-2019 and achieved the major milestones. He has many publication and patents related to fusion energy and nuclear medicine.

KENNETH ROY is a newly retired professional engineer who is currently living amidst the relics of the Manhattan Project in Oak Ridge, Tennessee. His professional career involved working for various Department of Energy (DOE) contractors in the fields of Fire Protection and Nuclear Safety during which time he maintained a DOE "Q" security clearance. Such contractors included Martin Marietta Energy Systems Inc, Lockheed Martin

Corporation, Bechtel Jacobs Company, LLC, and Isotec Systems, LLC. Kenneth is a founding member of the not-for-profit corporation Tennessee Valley Interstellar Workshop (TVIW Inc.) and remains active in that organization. He is a graduate of the Illinois Institute of Technology and the University of Tennessee at Knoxville in engineering. He enjoys reading science fiction, history, alternative history, military history, and books on space exploration and terraforming.

DR. JAMES S.J. SCHWARTZ (Department of Philosophy, Wichita State University), is a leading, internationally-recognized researcher of the philosophy and ethics of space exploration. He is the founding coordinator of the Wichita Space Initiative, the author of *The Value of Science in Space Exploration* (Oxford University Press, 2020), and the editor (with Tony Milligan) of *The Ethics of Space Exploration* (Springer, 2016). His publications have appeared in *Advances in Space Research*, *Journal of the British Interplanetary Society*, *International Journal of Astrobiology*, *Acta Astronautica*, *Space Policy*, *Astropolitics*, *Futures*, *Environmental Ethics*, *Ethics & the Environment*, *Theology & Science*, and *Philosophia Mathematica*. He has also contributed invited chapters to six edited volumes on the ethics and philosophy of space exploration, and speaks frequently at space exploration, ethics, and policy events - including two previous TVIW meetings (2016 and 2017). A major theme of his research is the idea that the scientific knowledge and understanding we derive from space exploration is uniquely valuable, and that space science should remain a key stakeholder in conversations about future space exploration policies and initiatives. For more information about Dr. Schwartz and his research, please visit www.thespacephilosopher.space.

DR. RAYMOND J. SEDWICK is a Professor of Aerospace Engineering and Director of the Space Power and Propulsion Laboratory (SPPL) at the University of Maryland where he has been since Fall of 2007. He is recognized as a Keystone Professor within the A. James Clark School of Engineering and also directs both the Aerospace Engineering Honors Program and the Center for Orbital Debris Education and Research (CODER). Dr. Sedwick's current research includes RF plasma generation of water vapor, decomposing nitrous oxide as a green propellant, ion plume and micrometeoroid material impact damage, orbital debris remediation, and novel fusion confinement for space and terrestrial power applications. His broader research interests include a variety of in-space power generation and propulsion technologies, with particular interest in nuclear systems and the applications of plasmas. He is an Associate Fellow of the AIAA, a former Associate Editor of the *AIAA Journal of Spacecraft and Rockets* (2010-2019), and served as the Chair of the AIAA Nuclear and Future Flight Technical Committee (2016-2018). Dr. Sedwick received a BS in Aerospace Engineering from Penn State University in 1992, and an MS and PhD from the MIT Department of Aeronautics and Astronautics in 1994 and 1997.

DR. JEFFREY SHEEHY is chief engineer of the Space Technology Mission Directorate. He holds a Ph.D. in chemical physics and has over 25 years of experience in space technology research, development, and demonstration. He has led research and development projects related to high energy density chemical propellants, plasma propulsion, astrophysics, materials science, and spacecraft thermal protection at NASA's Ames Research Center in Silicon Valley, the Air Force Research Laboratory, and NASA's Marshall Space Flight Center in Huntsville, Alabama. He was deputy chief engineer at NASA for the Orion Launch Abort System from project inception through the Pad Abort 1 flight test, and he has overseen several spaceflight demonstration projects on a wide range of technologies as program and mission directorate chief engineer. He is author or co-author of more than 40 peer-reviewed journal articles as well as five book chapters and 30 technical reports.

URI SHUMLAK received a B.S. from Texas A & M University and a Ph.D. from UC Berkeley. After finishing his graduate degree, he was a National Research Council postdoctoral fellow at the U.S. Air Force Research Laboratory in Albuquerque, New Mexico. He is currently a tenured professor of Aeronautics and Astronautics in the Aerospace & Energetics Research Program at the University of Washington. He was recently a Faculty Scholar at Lawrence Livermore National Laboratory and the Erna and Jakob Michael Visiting Professor at the Weizmann Institute of Science. He has served on numerous professional committees and as president of the University Fusion Association. Prof. Shumlak's research areas are plasma physics, innovative magnetic plasma confinement for fusion energy, space propulsion, and theoretical & computational plasma modeling. His work includes theoretical and experimental investigation of the stabilizing effect of sheared flows in magnetically confined plasmas. In addition to his experimental research, Prof. Shumlak develops plasma simulation algorithms that use approximate-Riemann solvers and high-order finite element methods for studying the time evolution of plasma dynamics governed by high-fidelity models that include the multi-species continuum kinetic and the 5N – 13N-moment multi-fluid descriptions.

CATHERINE SMITH earned a BS in Entomology, and a BS in Agronomy from the University of Wisconsin and subsequently a MS in Entomology from the University of Tennessee. She currently works as a Molecular Biologist tracking veterinary disease strains for autogenous vaccine production where she uses next-gen sequencing and metagenomic techniques to aid in diagnostics and novel pathogen discovery. Catherine has been a consultant on alien design for numerous science fiction authors, and she recently contributed a short story of her own to the Baen anthology "Stellaris: People of the Stars."

KELLY SMITH is a philosopher of Biology who holds appointments in Philosophy & Religion as well as Biological Sciences at Clemson University. His research is extremely interdisciplinary, encompassing the search for life on other planets (astrobiology), the relation between science and religion, theoretical issues in

biology, explanation in complex systems, and all things bioethical. He has published his work in a variety of journals including Theology and Science, Biology & Philosophy, Philosophy of Science, Astrobiology, Futures, Biological Theory, and the Journal of the American Medical Association. His latest project is organizing a new group, the Society for Social and Conceptual Issues in Astrobiology (SSoCIA), which is dedicated to the exploration of the many “broader” questions posed by astrobiology and space exploration more generally. Kelly believes deeply in the renaissance idea that humanities and the sciences have valuable insights to offer each other and is passionate about areas where these overlap in public policy, science, and critical thinking.

NICKOLAS SOLOMEY received his Ph.D. at the University of Geneva in 1992. A professor of physics at Wichita State University, his research includes experimental, particle, nuclear and astro-particle physics, particularly on quark flavor physics by rare decays of hadrons, CP violation, neutrino oscillation, the study of nuclear states of matter and cosmic ray physics. Currently co-spokesman of the Fermilab E907 experiment. He is author of the book *The Elusive Neutrino*, editor of the conference series on Hyperon, Charm and Beauty Hadrons, and has over 180 referred articles in physics resources. Current experiments include MIPP, NOvA and cosmic ray R&D, also the NASA NIAC project “Astrophysics and Technical Study of a Solar Neutrino Spacecraft”.

PRASHANT SRINIVASAN is a Postdoctoral Scholar in Prof. Philip M. Lubin’s Experimental Cosmology group at UC Santa Barbara. He received an M.S./PhD. in Physics from Purdue University, Indianapolis. He is currently working on development of laser phased array technologies, which include YDFA sources, photonics, investigation of phase noise in fiber links and phase locking schemes. When away from the lab you will find him competing in cross-country/track and field meets across California.

JOHN SUEN is currently a researcher affiliated with the Professor Phil Lubin’s Experimental Cosmology group at the University of California, Santa Barbara. His current research is in modeling and feedback mechanisms of large-scale directed energy optical phased arrays as well as the design and modeling of photonic sails. He is also the principal of Oxford Defense North Carolina, an applied research firm focused on optical, infrared and microwave metasurfaces to actively control electromagnetic radiation. He received his PhD from UC Santa Barbara in the subject of terahertz systems and was a postdoctoral researcher at Duke University where he developed dynamic metamaterials in the terahertz and infrared.

DR. CHARLES SWANSON is the senior scientist at Princeton Satellite Systems. He completed his Ph.D thesis on the PFRC-2 plasma confinement and heating experiment at the Princeton Plasma Physics Laboratory in September 2018. Its title was “Measurement and

characterization of fast electron creation, trapping, and acceleration in a high-mirror-ratio, low-beta magnetic mirror.” Prior to beginning his graduate work, he interned at SpaceX, working on Electromagnetic Interference for the Dragon and Falcon spacecraft. Before settling into his thesis work, he modeled and studied the re-capture of secondary electrons by complex surfaces, such as fibrous and fractal materials. He wrote a Monte-Carlo simulation code and an analytic model to predict the amount of secondary electron suppression. Dr. Swanson has experience in diagnosing and modeling both cold, collisional edge plasmas and hot, collisionless core plasmas. He has mentored eight undergraduate interns at the Princeton Plasma Physics Laboratory. The projects included: diagnosing plasmas using Langmuir probes, fast-framing cameras, and x-ray detectors; developing high efficiency RF amplifiers for fusion; and simulating the DFD rocket using UEDGE.

GROVER SWARTZLANDER has pioneered optical radiation pressure for over 20 years, including optical force and torque from optical vortices, cambered refractive surfaces, gravitational assist analogs in optics, and most recently, light sails comprised of diffractive optical elements, included a passive optical beam rider. He is a Fellow of the Optical Society of America and a NASA NIAC Fellow.

TIM SWINDLE is a Professor of Planetary Sciences and Geosciences, Head of the Department of Planetary Sciences, and Director of the Lunar and Planetary Laboratory (LPL) at the University of Arizona. In his personal research, Professor Swindle has been studying the timing of events throughout the history of the solar system using extraterrestrial materials – meteorites and samples returned by the Apollo astronauts – since the time he was a graduate student at Washington University in St. Louis, where he received his PhD. He has served as a member of the field team for the Antarctic Search for Meteorites four times. From 2016 to 2019, he was Chair of the Steering Committee of NASA’s Small Bodies Assessment Group, which provides input from the scientific and engineering community on NASA missions and policies relating to asteroids, comets, Kuiper Belt objects, and other small bodies. He is currently a Collaborator on the OSIRIS-REx asteroid sample return mission, which LPL is leading, and asteroid 8690 is named “Swindle” in his honor.

DR. JOHN TRAPHAGAN is the Professor of Religious Studies and in the Program in Human Dimensions of Organizations and Mitsubishi Fellow at the University of Texas at Austin. He also holds a visiting professorship at Waseda University in Tokyo, Japan. Traphagan received his BA in political science from the University of Massachusetts Lowell, MAR in ethics from Yale University, and PhD in anthropology from the University of Pittsburgh. He has also been a National Institutes on Aging postdoctoral fellow at the University of Michigan and a Fulbright Scholar to Japan. He has published more than 75 scientific papers as book chapters or in scholarly journals including: *Alzheimer Disease and Associated Disorders*, *Research on Aging*, *Ethnology*, the

Journal of Cross-Cultural Gerontology, the Journal of Anthropological Research, the Journal of Ritual Studies, The Asian Pacific Journal of Anthropology, Asian Anthropology, the Journal of Intergenerational Relations, the Georgetown Journal of International Affairs, the Brown Journal of World Affairs, Zygon: The Journal of Religion and Science, the International Journal of Astrobiology, and the Journal of Adult Development.

ROB ADAMS received both a Bachelor's and Master's in Mechanical Engineering from the University of Alabama at Birmingham. He has also received a Master's in Aerospace Engineering and Doctor of Philosophy (Mechanical Engineering) from the University of Alabama in Huntsville. He also finished most of the requirements for a Masters in Nuclear Engineering from the University of Tennessee in Knoxville. Before joining NASA Dr. Adams has served as a flight controller. He has served as principal investigator for several new propulsion concepts.

CAPTAIN RYAN WEED is an USAF Test Pilot and Positron Physicist dedicated to demonstrating and advancing antimatter propulsion methods for the purpose of human exploration of the solar system and beyond. As founder of Positron Dynamics Inc, Dr. Weed leads a small team in Livermore, CA, where he designed and built a positron beamline facility and develops high specific impulse positron-based propulsion concepts. During his PhD work at Australian National University Centre for Antimatter-Matter Studies, he built the world's first buffer gas trap positron lifetime spectroscopy beamline and designed experiments studying antimatter-matter interactions. Following his PhD, Dr. Weed worked at Blue Origin in Kent, WA, where he designed and implemented an Instrumentation laboratory for cryogenic rocket fuels. Dr Weed was also a technical author on a winning proposal for a \$10M NASA Innovative Lunar Demonstrations Data (ILDD) contract during the Google Lunar X-Prize. Dr Weed is a 2018 NASA Innovative Advanced Concepts Fellow, studying asteroid retrieval using a radioisotope positron propulsion system.

DR. DEANA L. WEIBEL is a Professor at Grand Valley State University in Allendale, Michigan, jointly appointed in the Department of Anthropology and the Department of Integrative, Religious and Intercultural Studies (IRIS). While most of her early work focused on religious pilgrimage and sacred places (such as Rocamadour, France and Chimayó, New Mexico), current work examines the religious perspectives of people involved in space exploration. A recent sabbatical involved ethnographic fieldwork at the NASA Human Research Investigators Workshop, the Kennedy Space Center, the Mojave Air and Space Port, the Jet Propulsion Laboratory and the Vatican Observatory. Weibel's interview subjects have included engineers, astronauts, astronomers, test pilots and aerospace physicians, and her goal is to better understand how scientific and religious perspectives are separated and/or integrated among people whose work gives them expert knowledge about "the heavens". Relevant publications

include "Malinowski in Orbit: 'Magical Thinking' in Human Spaceflight" (with Glen E. Swanson), "Magnetism and Microwaves: Religion as Radiation," "Up in God's Great Cathedral': Evangelism, Astronauts, and the Seductiveness of Outer Space," and "Pennies from Heaven: Objects in the Use of Outer Space as Sacred Space."

TONI WEISSKOPF is an American science fiction editor and the publisher of Baen Books. She is an alumna of Oberlin College, from which she graduated in 1987, and was immediately employed by Baen Books, where she served as executive editor until the death of founder Jim Baen in 2006, at which point she took over as publisher. She has edited a number of their anthologies under the name T.K.F. Weisskopf, and won the Phoenix Award in 1994 for excellence in science fiction, the Rebel Award in 2000 for lifetime achievement in Southern Science Fiction Fandom. Weisskopf was the editor guest of honor for the 2010 North American Science Fiction Convention, ReConStruction, and twice been nominated for a Hugo Award for Best Editor, Long Form.

KEN WISIAN, PH.D., Major General (retired), is Executive Director of the Disaster Research Program, Center for Space Research, University of Texas at Austin. He has published/presented work in subjects as diverse as geophysics, defense, artificial intelligence and deep space exploration, and developed executive courses in innovation and cyber warfare. Dr. Wisian holds a Ph.D. in geophysics from SMU, an M.S. in Strategic Studies from the US Army War College, an M.S. in Geology from Centenary College, and a B.A. in Physics from the University of Texas at Austin. General Wisian is also a graduate of the US Air Force Test Pilot School, with more than 70 hours of medium and high-risk test flights. He served in the Air Force and Air National Guard for 33 years and his commands included a C-130 Operations Group and an MQ-1 Predator Wing. General Wisian has combat time in Iraq, Afghanistan and the Balkans. His combat medals include the Bronze Star and Air Medal.

ATTENDEES

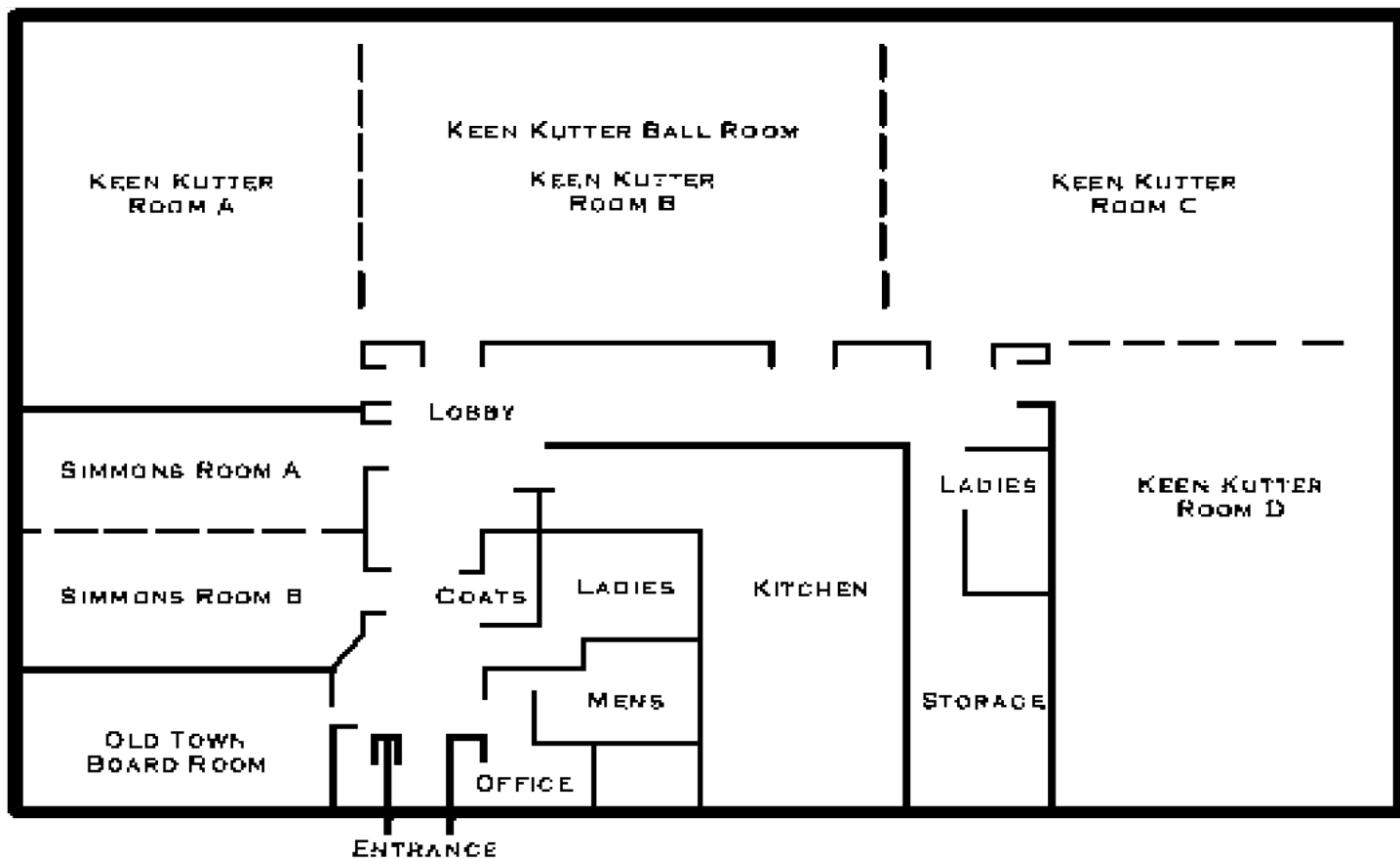


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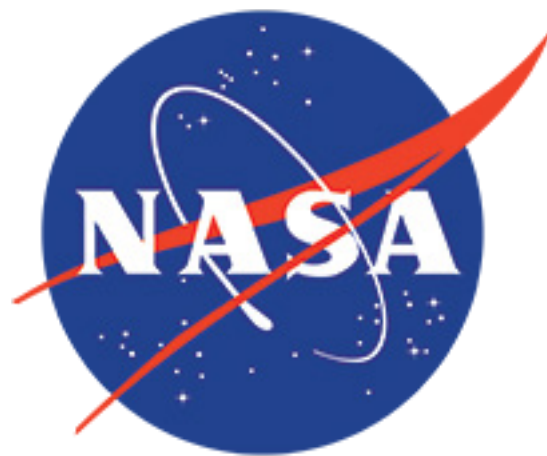
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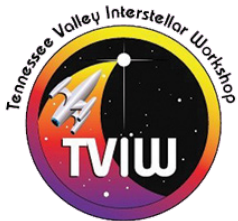
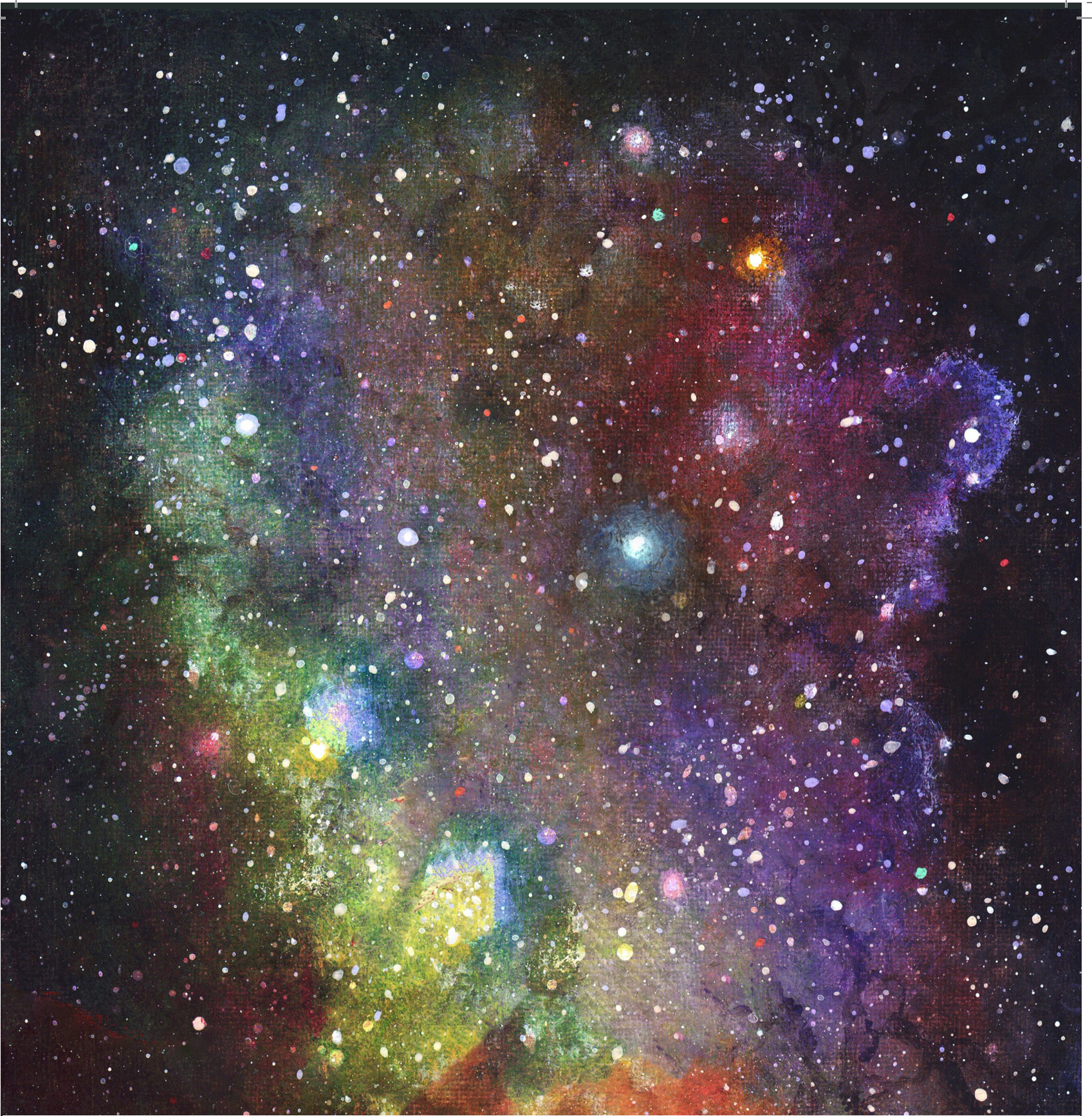
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