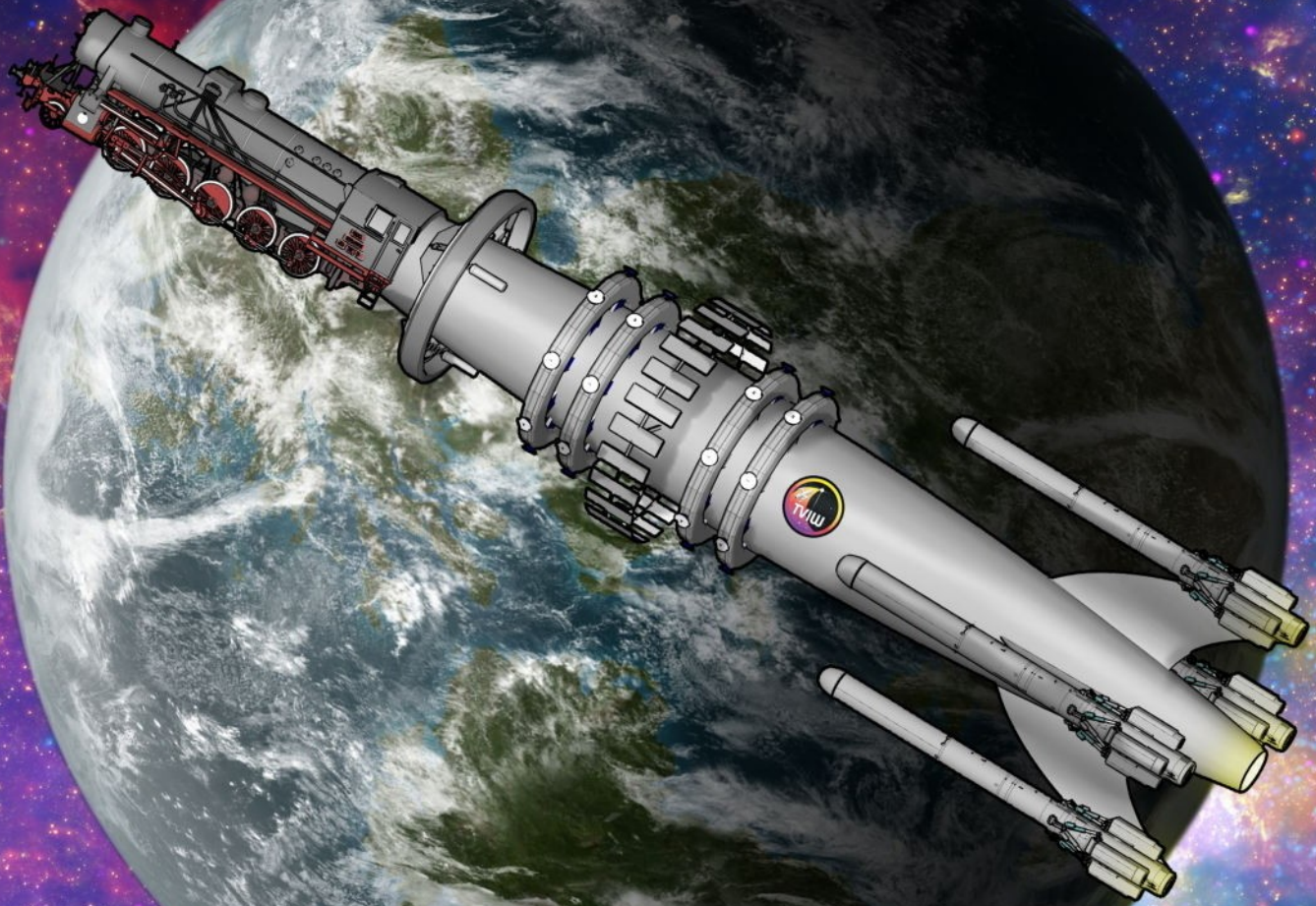


Tennessee Valley Interstellar Workshop

From Iron Horse to Worldship



Becoming an Interstellar Civilization

Chattanooga, TN
2016.02.28 – 2016.03.01



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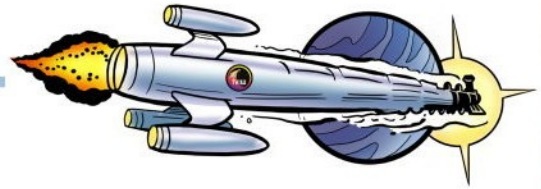


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Welcome



Dear Colleagues,

It is with great pleasure that I welcome all of you to the Fourth Symposium of the Tennessee Valley Interstellar Workshop (TVIW) under the Chairmanship of Les Johnson and for the first time in Chattanooga, Tennessee, using the theme, ***From Iron Horse to Worldship: Becoming an Interstellar Civilization***. In particular, I would like to thank the Board of Directors, the Organizing Committee, the Program Committee, our Sponsors, and all those who have volunteered their time and effort before, during, and after the Symposium to make the event happen.

As to the Symposium itself, we anticipate 19 talks on everything from human colonization to miniature probes at relativistic speeds; Seminars on Terraforming, Space Conflict, Advanced Propulsion, and Geoengineering; Working Tracks on Life Systems Engineering for Worldship, Homo Stellaris, Space Solar Power, and Space Mining; Kaffeeklatches and Posters on subjects of current interest. In addition, there will be a reception, meals, a Hospitality Suite, and a Public Outreach event.

Sincerely yours,

John F. Preston,
President, TVIW Inc.

Welcome to the 4th Symposium of the Tennessee Valley Interstellar Workshop in historic Chattanooga, Tennessee. In keeping with the TVIW's founding goal of engaging the engineering and science expertise along the Tennessee River valley, we chose Chattanooga for this year's venue because of its vibrant embrace of the future via it being America's first 10-gigabit-per-second internet connected city and a hub for the Tennessee Valley Authority (TVA) – a hugely successful, long-term investment begun in the 1930's to provide reliable electrical power for what was then an underdeveloped region. It is THIS kind of forward thinking that will enable the interstellar future we all seek.

Get ready to have your paradigms challenged, your minds expanded and your friendship and collaborative circles enlarged as the Symposium proceeds. We have a most-excellent slate of plenary lectures scheduled, including our opening Keynote address, "***Cutting the Umbilical Cord to Earth***," from Dr. John Lewis, and 18 additional original talks on interstellar-related topics such as life sciences, space science and propulsion, and new approaches to SETI. We have high expectations of our four Working Tracks and new-this-year Kaffeeklatches.

TVIW isn't just about programming. We're having our traditional Sunday night reception, Monday night banquet, Tuesday night Public Outreach Event (with several notable science fiction authors participating), and, of course, our famous Hospitality Suite where you can relax and imbibe your favorite beverage on your own personal schedule.

Be sure to explore our venue, the historic Chattanooga Choo-Choo Hotel and help us fulfill the theme of this year's Symposium, "***From Iron Horse to Worldship: Becoming an Interstellar Civilization***."

Les Johnson
Chair, TVIW 2016 Symposium

TVIW 2016 Symposium Organizing Committee

Loraine Glynn
Eric Hughes
Les Johnson
Robert Kennedy

Dru Kirkpatrick
Martha Knowles
Bart Leahy
Yohon Lo

Greg Matloff
Joe Meany
Dru Myers
John Preston

Ken Roy
Brandy Spraker
Brent Ziarnick

Plenary Speakers

KEYNOTE SPEAKER

Dr. John S. Lewis, Ph.D., University of Arizona and Deep Space Industries

John S. Lewis is Professor Emeritus of Planetary Sciences and Co-Director of the Space Engineering Research Center at the University of Arizona. He was previously a Professor of Planetary Sciences and Chemistry at MIT, as well as a Visiting Associate Professor at California Institute of Technology in 1973, and a Visiting Professor at Tsinghua University in Beijing, China for the 2005-2006 academic year. In 1971 he predicted the existence of deep oceans beneath the icy crusts of Europa and other ice-rich moons.



PLENARY SPEAKERS

Ben Beers, Geocent, LLC at NASA Marshall Space Flight Center (MSFC)

Mr. Beers received dual bachelor's degrees in Aerospace Engineering and Engineering Science and Mechanics at the Pennsylvania State University, and had previously worked for Pratt & Whitney's commercial aviation sector. His work at MSFC Advanced Concepts Office (ACO) has consisted of developing small, inline launch vehicle concepts to support the NASA Engineering and Safety Center and has also supported various Space Launch System development tasks.



Dr. James N. Benford, Ph.D., President of Microwave Sciences, 100 Year Starship

Dr. Benford is the President of Microwave Sciences, Inc. a contracting firm specialized in High Power Microwave (HPM) systems. Microwave Sciences provides expert services from conceptual designs to hardware, HPM effects testing and power beaming. Dr. Benford has been active in advanced research in private companies for 40 years and is experienced in transitioning research results into commercial products. He has published over 135 scientific papers and has written six books on physics topics.



Dr. Jason Cassibry, Ph.D., University of Alabama at Huntsville (UAH)

Dr. Cassibry is an associate professor in the Department of Mechanical and Aerospace Engineering, University of Alabama in Huntsville. Prior to his appointment in the department, he worked as an assistant research professor at the UAH Propulsion Research Center. His research includes the development and utilization of smooth particle hydrodynamics in the study of plasma acceleration, in-space propulsion, and fusion energy science. He is the PI on the Charger 1 facility, a 550 kJ, 3 Terawatt pulsed power machine to be utilized for fusion propulsion research.



Dr. Gerald Cleaver, Ph.D., Baylor University

Gerald is a 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 Division of Baylor's Center for Astrophysics, Space Physics and Engineering Research. Cleaver has written over 85 peer-reviewed physics journal articles and conference proceedings. He is co-author of an elementary particle physics textbook, referee for eight physics journals, and member of the international advisory board of the *Journal of the British Interplanetary Society (JBIS)*.

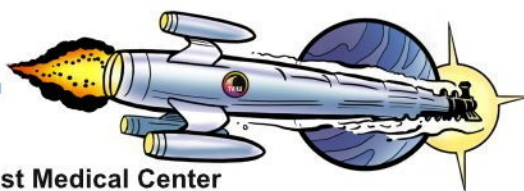


Angelo Genovese, Initiative for Interstellar Studies (I4IS)

Angelo received a Master's Degree in Aerospace Engineering at the University of Pisa, Italy. He has worked as Electric Propulsion Engineer for the Italian space propulsion research centre "Centropazio" in Pisa; he moved to the Austrian Research Centres in Vienna, Austria, where he contributed to the development of a Indium Field Emmison Electronic Propulsion (FEEP) Micro-propulsion System for the ESA. He is presently working at Thales Deutschland on the development of the innovative ion thruster HEMPT. He is on the Board of Directors of I4IS.



Plenary Speakers



Dr. Robert E. Hampson, Ph.D., Wake Forest Baptist Medical Center

Dr. Hampson's research focuses on functions of the hippocampus in the brains of laboratory animals and humans. His research on the neural encoding of memory in rats, monkeys, and humans has contributed to development of a hippocampal prosthesis for restoration of memory, which will be tested in humans within the next few years. Dedication to science advocacy and brain awareness has led him to be an advisor to science fiction authors and to represent neuroscience and biology at science fiction conventions throughout the southeastern US.



Eric Hughes, TVIW and Narthex Enterprises

Eric is a cypherpunk and mathematical physicist educated at Berkeley, with a deep background in security and Silicon Valley's venture capital scene. He is the architect of the Working Tracks concept, and has supported TVIW since 2012 with technical content, strategic advice, and IT.



Dr. Al Jackson, IV, Ph.D., NASA JSC (Retired)

Dr. Jackson earned his doctorate in relativistic astrophysics from UT-Austin in 1975. At NASA's Johnson Space Center, Houston, he performed: flight crew training, mission planning software, orbital debris modeling, and engineering simulation. Dr. Jackson has research experience and published articles in planetary physics, astrodynamics of interplanetary dust and Earth orbital debris, and interstellar flight.



Les Johnson, TVIW, Author and NASA Technologist

Les Johnson is a physicist and the Technical Advisor for NASA's Advanced Concepts Office at the Marshall Space Flight Center where he serves as the Principal Investigator for the NASA Near-Earth Asteroid Scout solar sail mission. Les is an author of science fiction and science fact; his books include *Going Interstellar*, and *Rescue Mode*, with co-author Ben Bova. Les was the featured 'interstellar explorer' in the January 2013 issue of National Geographic magazine. He thrice received NASA's Exceptional Achievement Medal and has 3 patents.



Lt. Gen. Steven L. Kwast, Commander and President of Air Univ., Maxwell Air Force Base

Lt. Gen. Kwast provides full spectrum professional military education, professional continuing education, and academic degree granting. He leads the intellectual and leadership center of the U.S. Air Force, graduating more than 50,000 resident and 120,000 non-resident officers, enlisted and civilian personnel each year. Additionally, he is responsible for officer commissioning through Officer Training School and the Reserve Officer Training Corps.



Kelvin F. Long, Initiative for Interstellar Studies (I4IS)

Kelvin is a physicist and aerospace engineer. He is also the Executive Director and co-founder of the Initiative for Interstellar Studies (I4IS), a not-for-profit organization founded in the United Kingdom, as well as the former Vice President and co-founder of the US non-profit Icarus Interstellar. He is the founder and Managing Director of the aerospace consultancy Stellar Engines Ltd, and Director and co-founder of the company Nebula Sciences Ltd. He has authored several books, including *Deep Space Propulsion: A Roadmap to the Stars* and the editor of the I4IS volume *Beyond the Boundary*.



Dr. Philip Lubin, University of California at Santa Barbara

Dr. Lubin is a professor of Physics at the University of California, Santa Barbara, whose primary research has been focused on studies of the early universe in the millimeter wavelengths bands. 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 co-recipient of the 2006 Gruber Prize in Cosmology along with the Cosmic Background Explorer (COBE) science team for their groundbreaking work in cosmology. He has published more than 200 articles.

Plenary Speakers

Dr. Greg L. Matloff, New York College of Technology, City University of New York

Greg Matloff is a leading expert in possibilities for interstellar propulsion, especially near-Sun solar sail trajectories that might assist interstellar travel. He is a professor with the Physics Dept. of the New York City College of Technology, of the City University of New York, a consultant with NASA MSFC, a Hayden Associate of the American Museum of Natural History, a Member of the International Academy of Astronautics, and a Fellow of the British Interplanetary Society.



Rex Ridenoure, CEO and Co-Found, Ecliptic Enterprises Corporation

Rex was a spacecraft systems engineer and space mission engineer/architect during the first half of his 38-year space career, working on Viking/Mars; some of the earliest communications satellites deployed from the Space Shuttle; the Hubble Space Telescope; Voyager/Neptune, Lunar Observer pre-project and Deep Space One. For the past 19 years he has been a 'NewSpace' entrepreneur and executive at Microcosm, SpaceDev, BlastOff and Ecliptic. Ecliptic is the prime contractor for the privately funded LightSail-A and LightSail-B CubeSat missions.



Ken Roy, P.E., TVIW

Ken Roy is a retired engineer currently working for several DOE contractors. He has published technology speculation pieces in such venues as the *Journal for the British Planetary Society*, and the *United States Naval Institute Proceedings*. His current interests include terraforming, geoengineering and interstellar colonization.



Dr. James S.J. Schwartz, Ph.D., Wichita State University

Dr. Schwartz specializes in philosophy of mathematics, and in the ethical and other philosophical questions raised by space exploration. His publications have appeared in *Philosophia Mathematica*, *Environmental Ethics*, *Ethics & the Environment*, *Space Policy*, and in several volumes of Springer's *Space and Society* series. He is co-editor with Tony Milligan of the forthcoming volume *The Ethics of Space Exploration*.



Dr. Cameron Smith, Ph.D., Portland State University

Dr. Smith is a prehistorian at Portland State University's Dept. of Anthropology. In the last decade he has extended his interests from the distant human past to include human evolution and adaptation in the distant future. His work with Icarus Interstellar focuses on the genetic and cultural evolution of our descendants as they disperse beyond our solar system. His technical work has been published in *Acta Astronautica* and *JBIS*, and co-authored *Emigrating Beyond Earth: Human Adaptation and Space Colonization*. He is currently writing a book, *Principles of Space Anthropology: Establishing a Science of Human Space Settlement*.



Bruce M. Wiegmann, NASA Marshall Space Flight Center

Mr. Wiegmann is the Prime Investigator for the Heliophysics Electrostatic Rapid Transit System, which is one of seven 2015 NASA Phase II NASA Innovative Advanced Concepts (NIAC) selected for further development from NASA's Space Technology Mission Directorate. He is the first MSFC recipient to win a Phase II NIAC award. He has supported the MSFC Advanced Concepts Office leading studies relating to: 1) On-orbit debris removal, 2) Electrodynamic Tethers, and 3) Cost effective methods to get NASA Research and Technology payloads to orbit.

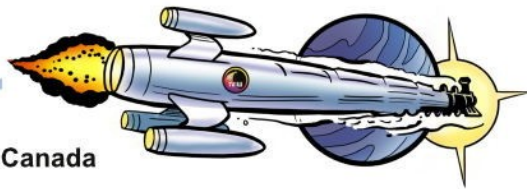


Niki Werkheiser, NASA Marshall Space Flight Center

Niki is the Project Manager for the NASA In-space Manufacturing (ISM) Initiative. In this role, she is responsible for developing the technology roadmap and implementation plans which will result in the manufacturing technologies and processes required to enable on-demand, sustainable operations for Exploration Missions to destinations such as Mars. She has served as the Project Manager for NASA's Ares Crew Safety and Reliability Office, and has spent the majority of her career in NASA's Space Shuttle and ISS Programs Payload Offices. She has a Masters in Gravitational and Space Biology, a B.A. in Russian Studies, and a B.S. in Biology.



Poster Presenter



Dr. Andrew J. Higgins, Ph.D., McGill University, Canada

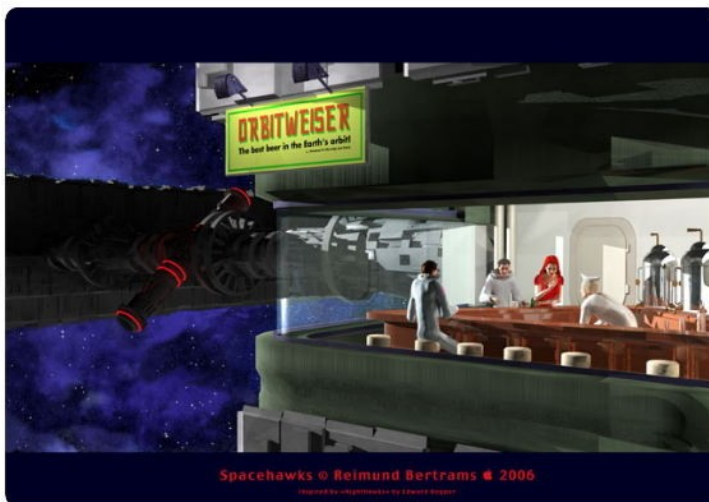


Dr. Higgins is an associate professor of Mechanical Engineering at McGill University. He has over 25 years of experience in shock wave experimentation, modelling, and simulation, encompassing shock and detonation waves in gas-phase and condensed-phase materials, with applications to advanced aerospace propulsion, defense, and fusion energy. His research at McGill has included using energetic materials to launch projectiles to world record velocities (exceeding 10 km/s) for orbital debris impact testing. He has a PhD and MS in Aeronautics and Astronautics from the University of Washington, Seattle, and a BS in Aeronautical and Astronautical Engineering from the University of Illinois in Urbana-Champaign.

Kaffeeklatsch

Kaffeeklatsch (kaf-fee-klatsch) – an informal gathering at which coffee is served (from German, kaffee=coffee, klatsch=gossip.)

The TVIW version is not focused on gossip, but on the discussion of subjects of common interest. Kaffeeklatsches are for those who are not interested in, or are unable to commit to a working track. They will run in parallel with the working tracks and are less structured discussions that let you get together with like-minded people to discuss topics of your choice. Participants will be self-selected at the symposium itself. Coffee will be provided. Whiteboards will be provided on request.



Spacehawks by Reimund Bertrams
Inspired by "Nighthawks" by Edward Hopper

Possible topics include:

- The Fermi Paradox
- What's Really Going on at the WTF Star (aka 'Tabby's Star')
- The Implications of a Spacefaring Civilization
- Achieving LEO without Going Broke
- Getting a Job at NASA
- Conflict in Space (Follow on to the Paid Sunday Seminar)

Future working tracks can begin to germinate in these groups. Signup sheets will be provided at the **Registration Desk**. There you can see what topics have been proposed and signup to participate in one. If you don't see a topic you like, then propose one, we'll add it to the list.

Social Media

Not everyone will get to attend TVIW, which gives you the opportunity to share what's going on via Twitter and Facebook. So we can keep track of the traffic from the Workshop, we invite you to add the hashtags **#TVIW** or **#TVIW2016** to your posts. If you would like the organizers to be aware of a post, copy our account: **@TVIWUS**. Also, feel free to add other hashtags, including **#IronHorseToWorldShip**, **#HumansToTheStars**, or **#GoingInterstellar** to get people in social media talking about the exciting ideas at this event.

Working Track 1:

Homo Stellaris

Led by Dr. Robert Hampson, Deputy Cathe Smith, Moderated by Sandra Medlock.

We know that interplanetary and interstellar exploration and colonization are going to require many changes – they may be physical (i.e. physiological adaptations) or genetic changes (if society permits) to the human body; they will most certainly be psychological and sociological. This track will discuss the changes implied and necessary to becoming Homo Stellaris—the people of the stars.

Questions to consider:

Should humans expect to adapt new worlds to our human physiology (i.e. terraforming) or should we adapt human bodies (i.e. genetic engineering) to the new environment?

Should we strive to find new worlds—whole planetary ecosystems—or concentrate on building worldlets and worldships out of asteroids and dwarf planets?

What sort of societal and psychological changes will be necessary to encourage and prepare humanity for these changes?

What can we do right now to start our society on these paths—knowing that it might take 100 years before the technology is ready to support interstellar exploration and colonization?

TVIW is a working group, with an emphasis on outcomes that can be started now to prepare for eventual interstellar missions. We propose to generate for proposal an anthology of short fiction and non-fiction (edited by Les Johnson, Kelly Lockhart and Robert Kennedy, tentatively titled "Homo Stellaris") as our work product. The anthology would specifically deal with the changes that humanity will undergo between the current day and the first interstellar voyage.

Dr. Robert E. Hampson, Ph.D., Wake Forest Baptist Medical Center

Dr. Hampson's cutting edge research focuses on restoring memory function in humans following damage due to drugs, disease, head injury or (space) radiation. Not having enough to do under his own name, he also writes science fact and fiction articles as Tedd Roberts (the "Speaker to Lab Animals"), studies Krav Maga, and plays trombone in a brass octet.



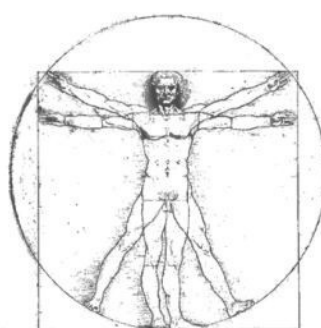
Catherine (Cathe) Smith

Cathe Smith has worked as a crop scout, a lab tech in molecular genetics, and an insect geneticist wherein she identified more than a dozen new species of the genus *Orchesella* (Springtails) for her Master's thesis. She lives in Western Tennessee, is an active science fiction fan and futurist, First Dan black belt in Han Mu Do, and seeks out new uses for crochet hooks and yarn.



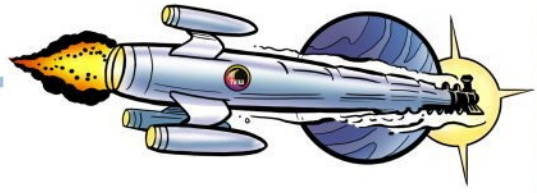
Sandra Medlock

Sandra Medlock has been a technical editor, interviewer, journalist, school teacher, writer, music teacher, church musician and choir/band director. She lives in South Central Texas and currently directs a supplemental curriculum academy for home-schooled students, where she describes her principal function as "herding cats."



Working Track 2:

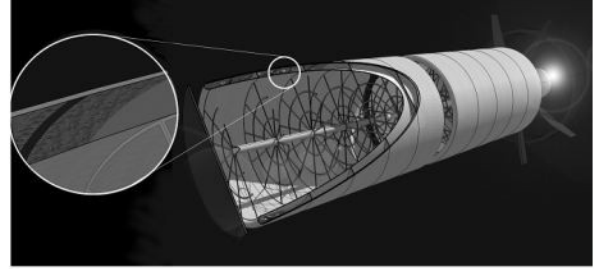
Life Systems Engineering for the Worldship



Led by Cassidy Cobbs, Moderated by Michel Lamontagne P.E.

After the 2014 Workshop, participants from "A-for-Astro", "B-for-Bio" and "D-for-Design" tracks joined together with some students from International Space University led by Prof. Chris Welch to continue this highly interdisciplinary work. A credible worldship design comparable to Arthur C. Clarke's "Rama" was published as "**Ecological Engineering Considerations for I.S.U.'s Worldship Project**" in JBIS, vol.68, no 3-4, Mar-Apr 2015.

We never stopped collaborating, and have now added more people and disciplines: systems/structural/nuclear engineers, evolutionary biologists, anthropologists, etc. With the basic engineering in hand, we now turn to the life systems that would support the passengers and precious payload of life.



Questions we may deal with this year:

What needs to be engineered inside a worldship anyway?

Everything (probably not possible)? Almost nothing (toss it all in and see what happens)?

Feed ourselves with agri/aquaculture or an artificial food factory?

How many cycles to replicate and "close" (CO₂, nitrogen, water, oxygen, iron, calcium, phosphorus, every single element?)

Ethical questions:

If a worldship cannot survive without a "brain," is it still a mere machine or is it on the way to being-hood itself?

Would such a worldship have rights?

Would its ecosystem be "deserving" of legal protection?

Can one shut down a world ship, ethically?

Possible outputs:

Answers to the above questions; a taxonomy of missions from robotic flybys that drop off seed packages to completely self-contained long-lived motile worlds; recommendations for a sequence of experimental ecologies to answer, or at least constrain, the "nature vs. nurture" question (must all the life live out long generations all the way or can we sleep all the way to wake at the end?).

Cassidy Cobbs, Sloan Kettering Center

Cassidy Cobbs has a MS from Vanderbilt, where she studied ecology and evolution, authoring a paper on a horizontal gene transfer event from fungus to flies. She currently works at Memorial Sloan Kettering Cancer Center, doing traditional and next-generation gene and genome sequencing. Her sole qualification for space travel/engineering was attending Advanced Space Academy in Huntsville at age 14.



Michael LaMontagne, P.E., Icarus Interstellar

Michel LaMontagne is a French-Canadian mechanical engineer, practicing in the fields of heat transfer and ventilation, with a passion for space. An accomplished artist, he has been designing spaceships since he was 12 years old, and has been waiting for reality to catch up!



Program Grid

All plenary talks will be held in Finley Hall. Parallel events and meals are in the rooms noted below. Posters are displayed all day at Gallery Foyer, and presenters will be available at Kaffeeklatches in Centennial Hall.

Sunday, February 28, 2016

5:00 PM Opening Reception in the Penn Station Room (Sponsored by Baen Books)

Monday, February 29, 2016

7:00 AM Continental Breakfast in the Gallery Foyer

8:00 AM Introduction and Orientation by General Chair (Les Johnson/TVIW, Author)

Keynote Speaker: "Cutting the Umbilical Cord to Earth" (Dr. John Lewis/Univ. Arizona, Deep Space Industries)

9:00 AM "Propulsion Technology Assessment: Science and Enabling Technologies to Explore the Interstellar Medium" (Ben Beers/NASA MSFC)

9:30 AM "Advanced Ion Propulsion Systems for Interstellar Precursor Probes" (Angelo Genovese/I4IS)

9:55 AM Coffee Break in the Gallery Foyer

10:25 AM "Invited Remarks Concerning America's Far Future in Deep Space" (Lt. General Steven L. Kwast, Commander & President, Air University, Maxwell Air Force Base, Mobile AL)

10:55 AM "Conceptual Filters in Space Exploration: Rethinking the Rationale for Planetary Protection" (Dr. James Schwartz/Wichita State University)

11:25 AM "A Lunar Settlement as a Prototype for Eventual Interstellar Settlements" (Ken Roy, P.E./TVIW)

11:55 AM "Power Beaming Leakage Radiation as a SETI Observable." (Dr. Jim Benford/100 Year Starship and Microwave Sciences)

12:20 PM Lunch in Imperial Ballroom

1:20 PM "Human Health in Space: What's Being Done, What Needs To Be Done?" (Dr. Robert Hampson/Wake Forest School of Medicine)

1:40 PM "An Adaptive Framework for Permanent Human Space Settlement" (Dr. Cameron Smith/Portland State University)

2:00 PM "In-space Manufacturing: Pioneering the Next Frontier" (Niki Werkheiser/NASA MSFC)

2:30 PM "Proton Beam Reduction - Primary Extraction from Generic Asteroid Material" (Eric Hughes/TVIW and Narthex Enterprises)

2:55 PM Coffee Break in the Gallery Foyer

3:20 PM Working Tracks and Kaffeeklatches

Track 1: "Homo Stellaris" (Led by Dr. Robert Hampson/Wake Forest Baptist Medical Center, Deputy: Cathe Smith, and Moderated by Sandra Medlock) in Finley

Track 2: Life System Engineering in the Worldship (Led by Cassidy Cobbs/Sloan-Kettering Memorial, and Moderated by Michel Lamontagne, P.E./Icarus Interstellar) in Gallery A1

Track 3: Space Solar Power and Orbital Industry (Leader/moderator: Lt. Col. Pete Garretson/Air University USAF, and Deputy: Robert G. Kennedy III, P.E./TVIW and Ultimex Group) in Gallery B

Track 4: Space Mining: Primary Processing of Olivine-based Asteroidal Material (Co-leaders: Eric Hughes/TVIW & Narthex, and Matt Ernst) in Gallery A2

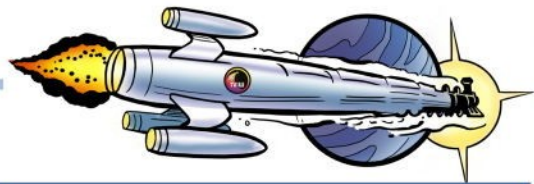
Kaffeeklatches in the Centennial Hall

6 - 8 PM Dinner and Presentation in the Roosevelt Room (Sponsored by Digital Oilfield Solutions)

"SETI, Interstellar Diffusion & Stability Equilibrium Hypothesis in Galactic Civilizations" (Kelvin Long/I4IS)

8:00 PM Parallel Birds-of-a-Feather (BOF) Working Track Sessions in the rooms previously identified

Hospitality Suite in the Norfolk Room will be open very late.



Tuesday, March 1, 2016

7:00 AM Continental Breakfast in the Gallery Foyer

8:00 AM Second Day Greetings by General Chair (Les Johnson/TVIW, Author)

"Electric Sail Propulsion to Enable Quick Heliopause and Beyond Scientific Missions of Discovery" (Bruce Weigmann/NASA MSFC)

8:40 AM "Progress in Fusion Propulsion Research at the University of Alabama in Huntsville" (Dr. Jason Cassibry/ University of Alabama, Huntsville)

9:10 AM "Matter-Antimatter Propulsion via QFT Effects from Parallel Electric and Magnetic Fields" (Dr. Gerald Cleaver/Baylor University)

9:35 AM Coffee Break in the Gallery Foyer

10:05 AM "The Laser Powered Interstellar Ramjet (LPIR) Revisited" (Dr. Al Jackson/NASA JSC Retired)

10:35 AM "The LightSail Program: Solar Sailing from a CubeSat Platform" (Rex Ridenoure/Ecliptic Enterprises)

11:05 AM "Interplanetary Exploration: Application of the Solar Sail and Falcon Heavy" (Dr. Greg Matloff/City University of New York)

11:30 PM Lunch in Imperial Ballroom

12:30 PM Parallel Working Track Sessions and Kaffeeklatsches Continued

Track 1: "Homo Stellars" in Finley Hall

Track 2: Life System Engineering in the Worldship in Gallery A1

Track 3: Space Solar Power and Orbital Industry in Gallery B

Track 4: Space Mining: Primary Processing of Olivine-based Asteroidal Material in Gallery A2

KaffeeKlatsches in Centennial Hall

3:10 PM Coffee Break in the Centennial Hall

3:35 PM Parallel Working Tracks Report to Full Audience in Finley Hall

4:15 PM "Roadmap to Interstellar Flight " (Dr. Philip Lubin/University of California, Santa Barbara)

Closing Remarks and Annoucement for TVIW 2017 by General Chair

5:00 PM Dinner on Your Own or Meet and Snack in Hospitality Suite

Please Join Us for the TVIW Public Outreach Event at 7 PM

7:00 PM Offsite TVIW Public Event: "Interstellar Travel, and Science Fiction Becoming Science Fact – Science Fiction Authors Panel." Event co-sponsored by WayPaver Foundation with Introduction by Chattanooga Mayor Andy Berke.

Book Sale provided by Barnes and Noble, and Book Signing

Additional Information and Directions on Page 14-15

Wednesday, March 2, 2016

Morning No Planned Structured TVIW Activites. See Flyer for Fun Things to do In Chattanooga

12:00 PM Lunch on your own, or just meet and snack in the Hospitality Suite with potent potables, sponsored by The Ultimax Group, Inc.

3:00 PM Dead Dog Session in the Hospitality Suite, i.e. Let's Talk About What to Improve for Next Symposium.



Working Track 3:

Space Solar Power and Orbital Industry

Led by Lt. Col. Peter Garretson and Robert G Kennedy III, P.E.

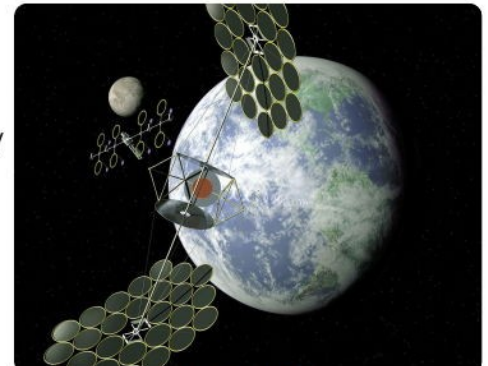
Three basic classes of interstellar missions (based on known physics) have been described:

- (1) Forward's "Starwisp", a kilogram-class robotic probe launched by beamed power for $>0.10c$ flybys;
- (2) Multi-kiloton-to-megaton Daedalus-style ship driven by fusion or antimatter @ $<0.10c$, maybe robotic/maybe crewed, probably flyby or sub-package drop off; and
- (3) Gigaton-range worldship/ark traveling at $\sim 0.01c$.

The premise to both this working track and **Space Mining** is the same: any one of these missions, even the flyby of the closest star, will be such an enormous enterprise requiring literally astronomical amounts of energy and matter, that it can only be accomplished with off-world resources. That other track is about the *matter*, this one is about the *energy*.

Questions:

- How does space solar power advance any of these missions?
- What are the thresholds to meet, and what is the necessary timeline?



Credit: NASA

Our national space program is guided by "Decadal Surveys" — collaborations of a broad community that highly influence investment priorities. The Decadal Survey for Planetary Science is considered the finest example of collaborative priority-setting in federal government. Though well established for space sciences like astronomy and astrophysics, such documents (call them "Centennial Surveys"?) have not been officially created either for the interstellar or space development communities.

Here's our chance to inform that process early. This track already assumes that the United States wants to be a star-faring civilization, and that a space-solar power industrial base would be enabling to interstellar flight in multiple synergistic ways. We also assume that interstellar and space solar power advocates can make common cause articulating a strategy of capability development that advances both, and that such a consensus would help guide national investments to make both goals more likely to happen.

So imagine you're having dinner with the next President, who says, "I believe in this 100-year starship and unlimited green energy stuff. I want my legacy to be putting America on the road to the stars. Tell me what a credible timeline would look like to build the industrial base to send probes and ships to the stars. What would be my goals and investments between now and America's Quadricentennial (2176)?"

Lt. Col. Peter A. Garretson, U.S. Air Force

Lt. Col. Garretson is an instructor of joint warfare at the US Air Force's Air Command and Staff College. A senior pilot and winner of the NSS Space Pioneer Award, he has served as airpower strategist and policy advisor to the USAF Chief of Staff, plus 4 years as Chief of Future Technology for HQ USAF Strategic Planning. He was the first serving US officer to serve as a visiting Council on Foreign Relations fellow at India's premier strategic think tank, the Institute for Defense Studies and Analysis. He was a collaborator in a number of strategic documents, including the DARPA 100 Year Starship.

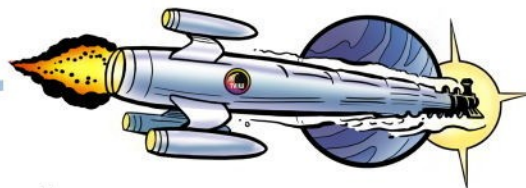


Robert G. Kennedy, III, P.E., Co-Founder of TVIW

Robert is the co-founder of TVIW and its principal benefactor for its first three years. He spent a year working for the House Subcommittee on Space back in the 90s, does green energy for interesting clients all over the planet in his day job as a senior systems engineer, and moonlights as a geoengineer for which he was invited to Moscow in 2011 by the Russian Academy of Science and their national weather service to address them about space-based geoengineering.



Working Track 4:



Space Mining: Primary Processing of Olivine-Based Asteroid Material

Led by Eric Hughes and Matt Ernst.

The premise to both this working track and **Space Solar Power** is the same: any sort of interstellar mission, even a robotic flyby of the closest star, will be such an enormous enterprise requiring literally astronomical amounts of energy and matter, that it can only be accomplished with off-world resources. That other track is about **energy**. This one is about the **matter**.

Other than some poorly-documented industrial work on the Cold-War-era Soviet space stations, there has been almost no R&D of techniques to prospect and process materials in extreme cold, vacuum and microgravity. The focus of this working track is to compare two possible ways to extract crude elemental silicon from asteroidal olivine.

Why? Silicon is the most abundant and efficient material for the production of photovoltaic cells. Thanks to geological ages of weathering, terrestrial engineers get to start with 98%-pure silicon dioxide for raw material, literally as cheap as dirt. Space-based mining and chemical engineers won't be so lucky. Olivine is a mixed magnesium-iron silicate containing 14-20% silicon by mass. It is a promising source for space-based production of industrial materials because of the broad utility of iron, magnesium, and silicon, coupled with its abundance and relatively simple composition.

Lunar samples from the Apollo program showed that olivine is abundant on the Moon, and spectroscopic remote sensing programs have established that some asteroids are composed mostly of olivine. Few if any of the terrestrial processes developed under both gravity and air pressure are suitable for space—the "Chemical Engineering in Space" manual has yet to be written, and the larger field doesn't even have a name yet.

Here, we intend to figure out how to get that silicon out of the olivine.

Eric Hughes, TVIW and Narthex Enterprises

Eric is a cypherpunk and mathematical physicist educated at Berkeley, with a deep background in security and Silicon Valley's venture capital scene. He is the architect of the Working Tracks concept, and has supported TVIW since 2012 with technical content, strategic advice, and IT support.



Matt Ernst

Matt Ernst has a M.S. in scientific computing from Washington State University. His professional interests include distributed systems, machine learning, and high-integrity software; after-hours passions include weakly-post-scarcity economics, post-fossil energy, and participatory science.



TVIW Public Outreach Event Night

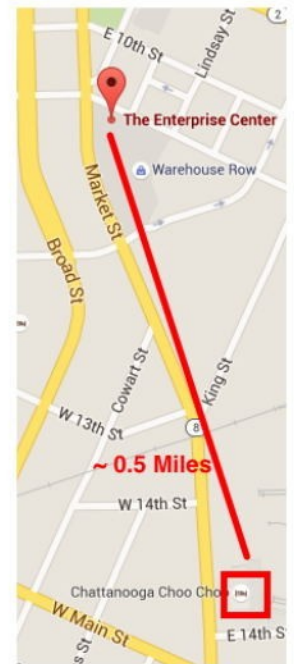
Is traveling to another star possible? If so, then how? These are but two of the questions to be answered at a night of science and science fiction in downtown Chattanooga at the Enterprise Center. Scientists and engineers from around the world are gathered in Chattanooga to discuss how humanity might one day reach the stars -- and to help make this dream a reality.

Please join Chattanooga Mayor Berke and the attendees of the 4th TVIW as they bring the science fact of future interstellar travel to Chattanooga. Also speaking will be the dreamers, a panel with New York Times Best Selling science fiction authors whose works highlight possible futures in which humans roam the space between the stars. The panel will be moderated by Toni Weisskopf, Publisher of Baen Books. The event is co-sponsored by WayPaver Foundation. Book signing will follow the event.

Time: Tuesday, March 1, 2016 at 7 pm

Place: Enterprise Center (5th Floor)
Edney Innovation Center/Building
1100 Market Street

Directions: From the Choo Choo, turn **RIGHT** on Market St.
Walk toward the Aquarium on Market St. for about (0.5 miles).
Turn right on the corner of 11th and Market.
You will see the entrance to the Edney Building on your right.
Google and Apple Maps are accurate



Barnes & Noble will be at TVIW's Public Event. They will have a selection of books by the authors on the panel as well as other books of fact and fiction related to interstellar subjects. This will be a fundraiser for TVIW as Barnes & Noble will donate a percentage of the sales of the books.

Additionally, if anyone from TVIW shops online at BN.com from **Sunday, February 28 through Sunday, March 6**, they can use the voucher code **#11800398** and the online sales will go to TVIW as well. If you go to the **Barnes & Noble store at Hamilton Place Mall** during this period, please mention that you are with TVIW and a portion of the in-store sales will go to us.

WAYPAVER FOUNDATION

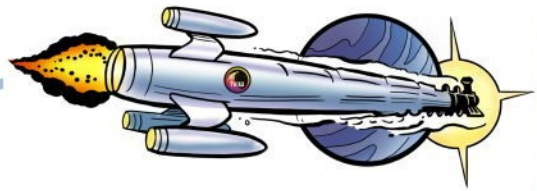
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(Hamilton Place)
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Public Outreach Event



Guest Speakers



Dr. Gregory Benford is a science fiction author and astrophysicist on the faculty of the Department of Physics and Astronomy at the University of California, Irvine. He is the author of over twenty novels, including ***Bowl of Heaven*** and ***Shipstar***. He is a two-time winner of the Nebula Award and a four-time Hugo Award nominee.



Prior to becoming a full time author, Dr. Charles E. Gannon was a Distinguished Professor of English at St. Bonaventure University and a Fulbright Senior Specialist. His is the author of the ***Fire With Fire*** series and collaborates on the New York Times Best Selling series: the Starfire military science fiction series ***Extremis*** and Eric Flint's ***Ring of Fire*** series.



Sarah A. Hoyt has over 23 published novels in science fiction, fantasy, mystery, historical mystery, historical fantasy and historical biography. Her short stories have been published in ***Analog***, ***Asimov's***, ***Amazing Stories***, ***Weird Tales***, and a number of anthologies from DAW and Baen. Her space-opera novel ***Darkship Thieves*** was the 2011 Prometheus Award Winner.



Les Johnson is a science and science fiction author, and a NASA scientist. Les was the featured Interstellar Explorer in National Geographic magazine, a technical consultant for the movie, ***Europa Report***, and is leading an asteroid rendezvous mission for NASA. His ***Going Interstellar*** anthology describes future interstellar journeys and he serves as the Chair of the TVIW 2016.



Geoffrey Landis is a NASA scientist working on planetary exploration, interstellar propulsion, solar power and photovoltaics. Supported by his scientific background, Landis also writes hard science fiction and has won a Nebula Award, two Hugo Awards, and a Locus Award.



Jack McDevitt is science fiction author whose novels frequently deal with attempts to make contact with alien races, and with archaeology or xenoarchaeology. His two main series are the ***Alex Benedict*** series and the ***Priscilla Hutchins*** series. He won the 2006 Nebula Award for Best Novel and has been nominated an additional sixteen times.

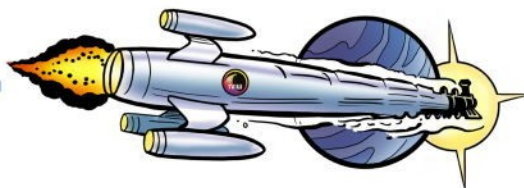


Toni Weiskopf is a science fiction editor and the publisher of Baen Books. She edited a number of anthologies, won the Phoenix Award in 1994 for excellence in science fiction, and was a Hugo Award nominee. She is an alumna of Oberlin College.

Attendee List

<u>Name</u>	<u>Affiliation</u>
Beall, Jim	U.S. Navy, Retired
Beers, Ben	NASA MSFC
Benford, Greg	Writer; University of California, Irvine
Benford, James	Microwave Sciences, President
Blackwell, Pamela	Retired
Boros, Leigh A.	Biomedical Engineer
Burke, David	Galois, Inc.
Cassibry, Jason	University of Alabama, Huntsville
Cleaver, Gerald	Dept. of Physics, Baylor University
Cobbs, Cassidy	Solan Kettering Center
Cole, John	NASA (Retired)
Cornett, Glenn, MD, PhD	Navitas Pharma, CEO
Cramer, Peter	FARO Technologies, Inc.
Cress, Bill	Breakthrough Technologies Corp.
Early, Jim	Lawrence Livermore National Laboratory (Retired)
Ernst, Matt	sciencemadness.org
Ethridge, Edwin, PhD	Space Resources Extraction Technology, Inc.
Fields, David	Roane State Community College
Fischer, Richard	NASA MSFC
Fisher, Naomi	
Fowler, Benjamin	Student, University of Alabama
Freeland, Robert	Icarus Interstellar, Director
Gannon, Chuck	Writer
Garretson, LTC Peter	U.S. Air Force
Genovese, Angelo	I4IS
Gilster, Paul	Tau Zero Foundation/Centauri Dreams
Glynn, Lorraine	TVIW/DragonCon Space Track Director
Gray, Patrick	WayPaver CTO
Hampson, Robert E.	Wake Forest Baptist Medical Center
Haney, Daniel R.	Computational Chemist
Henson, H. Keith	
Hewitt, David	Dynetics, Inc.
Higgins, Andrew	McGill University, Canada
Hollingham, Richard	BBC/Boffin Media
Houts, Mike	NASA MSFC
Hoyt, Dan	Technology Service Corporation
Hoyt, Sarah	Writer
Hoyt, E. Marshall	Student
Hughes, Ashleigh	Student
Hughes, Wood	
Hughes, Eric	Narthex Enterprises
Jackson, Albert A	Lunar and Planetary Institute
Jackson, Barbara	Oak Ridge National Laboratory (Retired)
Johnson, Carol	
Johnson, Les	TVIW 2016 Chair, Writer, NASA MSFC
Johnson, Matt	
Kennedy III, Robert G., PE	TVIW, Director
Kirkpatrick, Andrew	Student, University of Tennessee
Knowles, Martha	TVIW, Director
Kwast, Lt. Gen. Steven	Air University, President
Lamontagne, Michel	Track leader
Landis, Geoffrey A.	NASA Glenn Research Center
Lewis, John	University of Arizona; Deep Space Industries
Lo, Yohon	TVIW, Director; HAL5
Long, Kelvin	Initiative for Interstellar Studies (I4IS)

Attendee List



<u>Name</u>	<u>Affiliation</u>
Loss, Douglas	
Lubin, Philip	University of California, Santa Barbara
Lynch, Michael, PE	Metropolitan Atlanta Rapid Transit Authority
Mackenzie, Bruce	Director, Mars Foundation
Matetich, David	Grad Student, University of Alabama
Matloff, Greg	NYC College of Technology, City University of New York
McDevitt, Jack	Writer
McDevitt, Maureen	
McKamey, Steve	Consultant
Meany, Joe	Student, University of Alabama
Medlock, Sandra	
Millis, Marc G.	Tau Zero Foundation
Monroe, Oz (Oscar Barnes)	Writer's Research Camp
Montgomery, Edward E.	NASA (Retired)
Morton, Karen D., P.E.	Engineer
Myers, Dru	Student
Oakley, Christine	Oakley's Books, Owner
Preston, John	TVIW President
Rather, John D. G.	RCIG, Inc.
Ridenoure, Rex	Ecliptic Enterprises Corp.
Roy, Ken, P.E.	TVIW, Director
Roye, Beth	Digital Oilfield Solutions
Roye, Jay	Digital Oilfield Solutions
Rupp, Roger	Tennessee Valley Authority (Retired)
Sandlin, Cape	Student
Schwartz, James	Wichita State University
Scott, Walter M., III	Retired Engineer
Sherriff, Abigail	International Space University
Smirnov, Anton	Webmaster, LLMSDR
Smith, Cameron	Portland State University
Smith, Catherine	
Snead, Mike, PE	Spacefaring Institute LLC, President
Sparkes, Hannah	Student
Stevenson, Rhonda	Tao Zero Foundation, Executive Director
Stockton, Nick	Wired Magazine
Swinney, Rob	Initiative for Interstellar Studies (I4IS)
Taylor, Patricia	
Tevepaugh, Carol	Water Oak Resources, LLC
Tevepaugh, Jim	Water Oak Resources, LLC
Trieber, Connie	Staff
Trieber, John	Staff
Vacaliuc, Bogdan	Oak Ridge National Laboratory
Watkins, John	BBC/Boffin Media
Weisskopf, Toni	Publisher, Baen Books
Werkheiser, Niki	NASA MSFC
Wicklund, Lin	Writer
Wiegmann, Bruce	NASA MSFC
Wohlrab, Philip	Virginia Army National Guard
Woosley, Jim	Woosley & Associates
Zeidler, Stefan	Initiative for Interstellar Studies (I4IS)
Ziarnick, Brent	U.S. Air Force

Notes



**Until Next Time... Look Up at the Stars and Dare to Dream Big. Something Really Big!
See you at TVIW 2017 in Huntsville Alabama!**

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