Have Starship, Will Travel

The Newsletter of the Tennessee Valley Interstellar Workshop

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Newsletter Contents

Wrap-Up of TVIW's 6th Interstellar Symposium

The 6th Interstellar Symposium and 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—was held in Wichita, KS on November 10-15, 2019. We heard incredible talks and held productive roundtable discussions regarding multiple aspects of interstellar exploration.

The Sunday Seminars returned this year. We were lucky to include new sessions on In-Space Manufacturing (presented by Tracie Prater and Matthew Moraguez) and Space Law (presented by Laura Montgomery). Dr. Rob Hampson gave a seminar on Life in Space. The First Contact seminar/working group discussion was chaired by Ken Wisian, Ken Roy, and John Traphagan. This seminar/working group will likely evolve into an ongoing working group with a presentation to be given at the next TVIW symposium. See the "TVIW First Impressions" article later in this newsletter for more information. All of the seminars were well attended, and we will absolutely bring them back for the next symposium.

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Testing Possible Spacedrives
featuring Marc Millis

Marc Millis (pictured), former head of NASA's Breakthrough Propulsion Physics project, recently returned from another trip to Germany, where he worked with Martin Tajmar's SpaceDrive project at Germany's Technische Universität Dresden. Millis is in the midst of developing an interstellar propulsion study from a NASA grant even as he continues to examine advanced propulsion concepts and the methodologies with which to approach them. Recent coverage of experimental work into spacedrives in both the popular and scientific press has raised public interest. Now a member of TVIW's board, Marc has been talking about the techniques for studying these matters with Paul Gilster, editor of *Centauri Dreams*. Paul floated a question to Marc:

"In the years since the end of the Breakthrough Propulsion Physics project, you have emerged as the spokesman for a sane, balanced view of propulsion ideas that may grow out of new physics, or maybe I should say, new discoveries that extend our current thinking. When you are approached by journalists, what have you seen as the major misunderstandings that people voice about these issues? What mistakes are most common?"

To which Marc responded: First, thank you for the compliment of being a sane voice on edgy propulsion physics. I can't help but chuckle a bit, knowing that my ponderings on such things do not always feel "sane." I hope that another message of mine is getting through – that it's okay, even needed, to be wildly imaginative – so long as those wild ideas are later tempered with impartial rigor.

Now, about those common mistakes, it's easy for folks to get misled. Most of our information comes from short, journalistic distillations of longer, more complex scientific publications. A lot gets lost in translation. Worse, beyond the difficulties of mere translation, there is distortion from clashing norms. "Science is slow, patient, precise, careful, conservative and complicated. Journalism is hungry for headlines and drama, fast, short, very imprecise at times" [quoting Kathy Sawyer (then of *The Washington Post*) in the book, *Worlds Apart: How the Distance Between Science and Journalism Threatens America's Future*, Hartz & Chappell, 1997]. In other words, most of what you read about science is a junk food facsimile of what was one a carefully prepared, nutritious meal of information.

One consequence is that developments can look excessively promising – exaggerating their performance, readiness, or both. In reality, it can take years, perhaps decades, for new developments to make their way into use. This happens so often that there is even a diagram to convey it – the "Gartner Hype Cycle." After an innovation trigger, there follows the stages of: peak of inflated expectations, trough of disillusionment, slope of enlightenment, and plateau of productivity. Another perspective, from Les Johnson, is that the actual performance of a technology is inversely proportional to its technology readiness. So, take such articles with a healthy dose of "wait and see." *(…continued on page 3)*

TVIW FIRST CONTACT
IMPRESSIONS FROM MICHAEL LYNCH

I attended the First Contact seminar at the most recent Tennessee Valley Interstellar Workshop and thoroughly enjoyed it. Ken Wisian, John Traphagan, and Ken Roy gave a well thought out presentation on the issues and possibilities of actual contact with aliens. I came away with a call to action as well as the suspicious feeling that I, and the other people who attended the event, had somehow stumbled on the leading edge of what humanity's protocol would be if there was ever first contact with an extra-terrestrial intelligence. According to the presenters' research there is not a first contact policy in place for an actual physical meeting with aliens or their probes, which to me seemed surprising. There was an effort made to see if the folks at NASA or SETI had such a policy in place and it seems that they don't. Someone mentioned that there might be a first contact policy somewhere in the basement archives of the Vatican which I found slightly humorous.

It was pointed out that this is a very low probability but high consequence event that must be handled carefully. We discussed the various scenarios that can take place that included some uncomfortable ones. For example, we were reminded that it didn't work out too good for the Native Americans when the technologically superior Europeans arrived on their shore. We came to the conclusion that a first contact coverup hasn't already happened as it is difficult to keep a secret if there are 2 or more people involved over a long-time frame. Aliens from TV and the movies are mostly of a human-centric/humanoid type with cultures that mimic human cultures and probably don't properly prepare us for the truly alien beings and civilizations that might exist and with which we will have to deal.

Ken Wisian mentioned that probably the first principle of a First Contact Protocol should be similar to the Hippocratic Oath in medicine which is "first do no harm". For first contact it would be something like "don't make the other party make a snap judgement". We discussed various scenarios which can be summarized as 2 ships meet each other in space, 2 ships pass each other but do not meet, there is a rendezvous in space, we arrive at a destination, ETI arrives at Earth. We discussed that the first contact will have an ETI that will probably be far more technically superior than us. It could well be that first contact will be with a probe.

We left TVIW with a homework goal of beginning further exploration of what a First Contact Protocol should look like, The group intends to continue the discussions and research on this topic with a goal of presenting a paper at the next TVIW Symposium on a set of rational first contact protocols for humanity and meeting next year at the University of Texas at Austin for a working session.

If you are interested in assisting this effort going forward, contact Ken Wisian kwwisian@gmail.com.

WRAP-UP OF TVIW'S 6TH INTERSTELLAR SYMPOSIUM

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The Monday morning keynote speech, given by Professor Greg Matloff of CUNY, reviewed the range of options for achieving interstellar flight. That was followed by Marc Millis, (Ohio Aerospace Institute), who provided the attendees a refresher on the challenges of interstellar flight, and then an update on the NASA grant for assessing the research options to achieve it. The afternoon keynote by Engineering Director Pete Klupar from Breakthrough Starshot gave us a glimpse into the state of the project. This was especially helpful since we had so many presentations from Prof. Phil Lubin's group at UCSB, covering the progress they've made on high-power laser propulsion.

Tuesday morning featured a particularly outstanding presentation by Dr. Joel Mozer, Chief Scientist at the US Air Force Space Command. Dr. Mozer presented a summary of recent Air Force "space futures" plans, which posited the most optimistic and pessimistic outlooks for space development in the next 30 years and how each might affect the goal of advancing interstellar flight.

Throughout the event, presentations took more detailed looks at a broad range of specific topics, such as minimum-mass power supplies, and the implications of humans in space (culturally, biologically, etc.). Presenters Dr. Deana Weibel (Professor of Anthropology at GVSU) and Dr. Kelly Smith (Professor of Philosophy & Biological Sciences at Clemson) attended at the invitation of Organizing Committee member Dr. James Schwartz. The philosophical and ethical implications of space exploration and colonization are not negligible, and each presentation raised considerable discussion during the question-and-answer period after each talk.

All three presenters were joined by Dr. John Traphagan (Professor of Religious Studies and Anthropology at UT Austin) and Dr. Sheri Wells-Jensen (Professor of English at Bowling Green SU) at the Sagan Meeting Tuesday evening. The Sagan meeting, a two hour panel discussion, focused on the questions: "What is the most ethically salient roadblock to space settlement, the most important issue or problem that must be resolved in advance of initiating space settlement?"

TVIW was proud to begin a new tradition this year. Dr. Greg Matloff and two TVIW volunteers (John Trieber and Matthew Johnson) were presented with the first-ever Eridani Awards. Matloff was recognized with the first Eridani Professional award for his decades of contributions to the interstellar community. Trieber and Johnson were recognized for their continuing dedication to TVIW operations. Trieber has been an invaluable resource running the AV systems at the past four Interstellar Symposia; Johnson is a talented and careful IT administrator.

Our team also introduced a new experiment this year, livestreaming the sessions for free to those who could not attend the meeting in person. We felt that our impact could be increased by making the information as widely available as possible, in real time. People tuned in from the United States, Europe, and South America! The talks will be edited for audio balance, and will be uploaded to the TVIW YouTube Channel. They are currently available on the TVIW website at

https://tviw.us/2019-presentation-video-archive/

The bus trip to the Cosmosphere Space Museum was a popular evening activity on Wednesday night. The experience was a worthy addition to the tours we have offered at past TVIW symposia, which have included Oak Ridge National Lab and the U.S Space and Rocket Center in Huntsville. Participants were treated to a private dinner adjacent to a replica of Space Shuttle Endeavour and an SR-71 Blackbird, as well as the original Apollo 13 capsule. After dinner the museum was open for browsing, offering exhibits on the planets, rovers, and the Space Race (even featuring sections of the Berlin Wall). The evening ended with a viewing of Apollo 11: First Steps Edition in the museum's planetarium.

Thursday evening provided a chance for participants to relax and dream with a panel of science fiction authors discussing their work and how it is informed by real science and feasible engineering. The panel was moderated by Baen Books Publisher, Toni Weisskopf, and included authors Robert Hampson, Dan Hoyt, Sarah Hoyt, Les Johnson, and Geoff Landis, all pictured below.

In addition to the normal three-day symposium topics, from broad science advances important to interstellar development, the meeting included a special two-and-a-half-day NASA Advanced Propulsion Workshop focusing on Directed Energy Propulsion and Highly Energetic Nuclear Processes for Propulsion (Fusion and Antimatter). The NASA Advanced Interstellar Propulsion Workshop started Wednesday afternoon with keynote talks by Andrew Higgins (Directed Energy Propulsion) and Jason Cassibry (Highly Energetic Nuclear Processes). This was a new addition to our regular sessions and served to inform NASA's requirement to deliver to the US Congress a notional plan for launching a true interstellar mission (with a spacecraft traveling at least 0.1 c) no later than the 100th anniversary of the Apollo 11 moon landing in 2069. The two technology communities (of discipline experts) met in parallel sessions and developed near- and mid-term technical milestones necessary to advance their specific technologies and meet the 2069 goal. The Directed Energy group outlined a five-year-plan for answering open questions regarding the phased-array lasers and fundamental sail materials. The Highly Energetic Nuclear Processes group outlined five-year goals for fission, fusion, and antimatter propulsion missions.

We at the TVIW would like to thank our collaborators at NASA, Wichita State, and Ad Astra Kansas for their efforts in making this such a successful meeting.

During the meeting, Stephen Fleming and TVIW President Doug Loss jointly announced that TVIW will be partnering with The University of Arizona to host the 7th Interstellar Symposium in the fall of 2021. While it is too early to release any further details, we look forward to seeing all the Wichita and previous symposia participants, as well as any other interested attendees, at the next TVIW symposium, to be held in Tucson!

TESTING POSSIBLE SPACEDRIVES
FEATURING MARC MILLIS

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Another pitfall is our romantic appeal for the lone inventor who triumphs against the establishment. This is why stories about an outlier inventor can get undue coverage (e.g. EmDrive). While that storyline is great for entertainment, the reality is that it takes many workers to advance an idea – more than just those who had the original inspiration. Further, the negative stigma about the critiques levied at new ideas is misleading. Granted, there will be the occasional pedantic dismissal that adds only drama, but real progress requires critical scrutiny. It is a normal process that happens to all the ideas, good and bad. The challenge is to sort out the reflexively dismissive reactions from the constructive critiques, to improve and move forward. The good ideas advance as their shortcomings are faced and resolved. The shortcomings of bad ideas are unresolvable.

The last misleading spin is when science and technology are presented like commerce. Commercialism is so ubiquitous that it is easy to assume that's how everything is done - selling the latest hot item. A consequence is that technological concepts are often presented as advocacy pitches - commercials. This not only happens with journalism, but unfortunately also at technical conferences. Though commercials are effective when there are customers with cash to burn, that is seldom the case with new propulsion concepts. Worse, to move a new concept forward, both its pros and cons need to surface – where its shortcomings must be faced and resolved.

Another unproductive skew of the commercial mindset is to only pay attention to ideas that are on the verge of fruition (with visions of fame and fortune dancing in their heads?). While it might be good business sense to seek only those ideas that are nearing fruition, the history of science and technology shows that progress is made in lots of less glamourous (and unprofitable) steps before a new discovery or device can be realized.

When I created NASA's "Breakthrough Propulsion Physics" project, I deliberately steered away from that prior emphasis on hot-topics. Instead, I shaped the program to create incremental progress – by focusing on the less glamorous, smaller research steps that might eventually mature into new theories, new devices. Even though we did not make any breakthroughs, that

project produced more progress than the prior 'hot topic' mode, progress that continued for years even after the funds ran dry.

As an aside, some of the more significant references that I drew upon for that strategy came from: Foster's 1988, *Innovation: The Attacker's Advantage* (when and how to pursue new ideas); Dyson's 1997, *Imagined Worlds* (tool-driven revolutions), and Kuhn's 1962, *Structure of Scientific Revolutions* (paradigm shifts).

Testing those new ideas is a part of the process, just not the totality of it. And when doing those tests, one must avoid the temptation to expect a quick and cheap test to be enough. I made that mistake once or twice. Other organizations still do. The urge for quick and cheap results in a series of repeated tests that end up taking longer and costing more than a legitimate test. And with that, it is important to stress that the tests be impartial and with the focus on reliable results.

Herein is some general advice, largely based upon what I wrote in a recent essay in *Centauri Dreams*. As a reader, when you see a new article claiming a breakthrough, here is how to judge it by separating the self-serving sensationalism from the less glamorous and grueling work of getting the facts right. Pay attention to how the idea is being investigated, rather than on its implications. Sensationalism feeds off the implications. The sanity check is in the "how." If the researchers are carefully investigating something with a focus on accurate findings – then that is valuable work, regardless if the idea turns out to be right or wrong. If the researchers are, instead, promoting their new idea while glossing over the weak points – then those are red flags. If you sense that an article is sensationalism without substance, then please do the rest of us the service of ignoring it – of not reposting it.

So let's look at some controversial topics with all this in mind. Two recent articles, one in *Scientific American* [1] and the other in *Acta Astronautica* [2], prompted this update about the experimental tests of possible spacedrives. In short, the experimental methods are improving, but definitive results are not yet in hand. While this update is mostly on the "Mach Effect Thruster," it also touches on the infamous "EmDrive," as well as a refresher on the general quest for spacedrive physics.

First, what is a spacedrive? Presently, a spacedrive is still a goal rather than a proven device. The ambition is to find a fundamentally different way to propel spacecraft rather than rockets or sails. Rockets are limited by having to carry their entire journey's reaction mass with them (propellant). Sails are limited by one-directional photons (or particles) from an external source. Imagine, instead, if there was some way for a spacecraft to interact with its surrounding spacetime to move in any direction and be limited only by the amount of available energy. That ambition is the essence of a spacedrive.

That detail – of interacting with spacetime to induce motion – is a matter of undiscovered physics. That makes it harder to grasp, harder to explain, and harder to solve. It's easier to grasp engineering challenges that are based on known physics, since there are already operating principles to cite. With spacedrives, the operating principles are works-in-progress – more akin to lines of inquiry than having complete packages ready for scrutiny. Though theories for faster-than-light warp drives do exist (one type of spacedrive), the physics of the required negative energy is still debated – which itself is a prerequisite to devising how to engineer a warp drive. In addition, though there are experimental replications of thrusts from possible spacedrives, separating experimental artifacts from actual thrusts is also, still, a work in progress – and the main point of this update.

Before getting to the latest experiments, here is a bit more background behind the challenges of a spacedrive. At first blush, such wishful thinking might seem to violate conservation of momentum – a crucial detail. Conservation of momentum is easy to grasp for a rocket; the rearward-blasted propellant matches the forward momentum of the spacecraft. The situation is less obvious with spacedrives. There are a least 3 approaches to address conservation of momentum: 1) using a reaction mass indigenous to space or spacetime, 2) negative inertia, or 3) exploring the physics about inertial reference frames – the backdrop upon which the conservation laws are defined.

The majority of this update is related to the 3rd option – inertial frames. For new readers, a more complete introduction to various approaches and issues of both spacedrives and faster-than-light flight are spelled out in the book *Frontiers of Propulsion Science* [3]. If you're curious about that broader coverage, that book and subsequent papers are one starting point.

Back to inertial frames and conservation laws: An inertial frame is such a ubiquitous property of spacetime that it is often taken for granted. It is what allows accelerated motion to be felt – the reference frame for Newton's F=ma and the subsequent conservation laws. If you've never thought about it before, this can be hard to grasp because it's so foundational. One useful book is *Mach's Principle: From Newton's Bucket to Quantum Gravity* [4], which articulates several different attempts to represent how inertial frames exist. What makes this book particularly useful is that it compiled workshop discussions about the differing approaches. Those discussions are illuminating.

One of those attempts is called "Mach's Principle," which asserts that the surrounding matter of the universe gives rise to the inertial frame properties of space. Or stated differently, "inertial here, because of matter, out there." A similar perspective is something called "inertial induction." The implication of these is that inertia is more than just a property of mass. Inertia is an interaction between mass and spacetime – and perhaps with undiscovered nuances.

Perhaps an analogy might help. When you plot trajectories on graph paper, you usually don't give much thought to the paper. The paper is just some fixed, reliable background upon which the more interesting details are plotted. But what if the paper was not uniform nor constant over time? What if the trajectories might vary because of the properties of the paper itself? In this case, the rules for plotting on graph paper would have to be updated to account for the rules about the paper itself. Here, the graph paper is analogous to an inertial frame and "plotting trajectories" is analogous to Newton's F=ma and subsequent conservation laws. If there are deeper details about inertial frames and their effect on inertia, then Newton's F=ma and the conservation laws would have to be refined to incorporate those finer details.

In terms of Einstein's general relativity – an established refinement of Newton's laws – inertial frames and momentum conservation are treated only locally. I'm not sure quite how to put this in words, so I'll defer to examples. With the warp drive, Einstein's equations describe the local effects on spacetime from the warp drive itself, but cannot describe how (or if) momentum is conserved across a whole journey, encompassing the departure and arrival points as a total picture. Similarly, the

momentum conservation of traveling through a wormhole cannot be described. While the local effects at each throat can be described, the bigger picture encompassing both the entry and exit throats and the mass that went through, cannot. There is room for more advances in physics.

Mach's Principle and Inertial Induction are still open investigations in general physics, though not a dominant theme. Their relevance to spacedrives is because Mach's Principle was a starting point for what is now called the "Mach Effect Thruster." It began around 1990, when a reexamination of Mach's Principle led to new hypotheses about fluctuating inertia, which then led to a 1994 patent for a propulsion concept [5]. Experiments followed. By 2016, three other labs were observing similar thrusts, which led NASA to award a 2017 NIAC grant for further investigations.

The original theory, from James Woodward of the University of California at Fullerton, showed that the inertia of a mass would fluctuate with a change of power of that mass. At first, varying the power of the mass took the form of charging and discharging a capacitor – where the capacitor was that mass. By doing this with two capacitors, while also changing the distance between them (via a piezoelectric actuator), a propulsive force was claimed to be generated (see figure and caption).

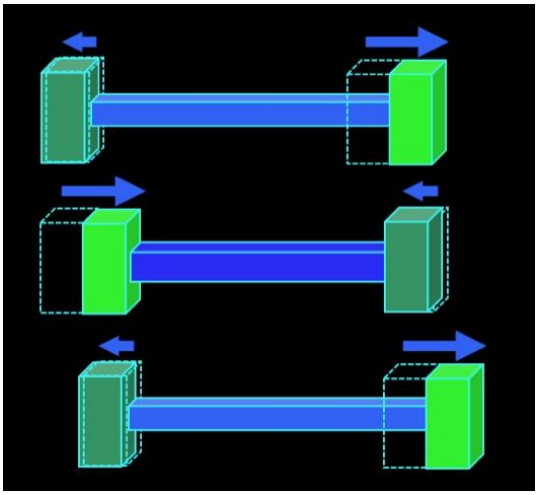

Figure 1. Transient inertia applied for propulsion: While the rear capacitor's inertia is higher and the forward capacitor lower, the piezoelectric separator is extended. The front capacitor moves forward more than the rear one moves rearward. Then, while the rear capacitor's inertia is lower and the forward capacitor higher, the piezoelectric separator is contracted. The front capacitor moves backward less than the rear one moves forward. Repeating this cycle shifts the center of mass of the system forward.

Since the center of mass of such a system moves without the opposite motion of a reaction mass, it appears to violate conservation of momentum, but does it? Since inertia is no longer constant, the usual equations do not fit without some reconsideration. This is a debated issue – debated in a constructive way. One version asserts how momentum conservation is indeed satisfied [6]. Others would prefer that the original fluctuating inertia equation be further advanced to explicitly address the conservation laws. Another desired refinement is to have the original equations explicitly connected to the experimental hardware – to show what parameters of that hardware are the most critical.

Armed with an apparently working device, Woodward and his team concentrated on improving the experiments rather than that additional theoretical work. Over the years of making modifications to the device to amplify the effect, the 'fluctuating inertia' capacitors and the piezoelectric actuator were merged. Now a stack of piezoelectric disks serves both the functions of the inertial fluctuations and the oscillating motion. The power that affects the inertia now includes the mechanical motion too.

This is where the *Scientific American* article is worth mentioning. That article gives a decent review of the history and status of the Mach Effect Thruster (which also goes by the name "Mach Effect Gravity Assist (MEGA) Device") as conducted by Jim Woodward and Heidi Fearn. It includes some perspectives that are useful to read separately, instead of needing to repeat those here. It addresses other aspects of the bigger picture of pursuing these kinds of research inquires.

The other article that prompted this update is in the journal *Acta Astronautica*. In addition to Woodward's team, a group at the Technical University of Dresden, Germany, led by Martin Tajmar, secured funding for a broader project to research spacedrives in 2017. That group is one of the 3 labs that replicated the Woodward results in 2016. The recent Acta Astronautica article is an update on their experimental hardware and procedures, in preparation for careful testing of the Mach Effect Thruster, the EmDrive, and other possible spacedrive effects.

A preceding work by Tajmar that fed into this latest update was an attempt to advance Woodward's original fluctuating inertia equations into a form that mapped to the experimental hardware [7]. With such equations a new thruster could be designed to maximize the thrust and experimental predictions could be made for the existing hardware. To span the possibility of debated assumptions (such as what kind of power affects the inertia; mechanical, electrical, other?), more than one version of such equations was derived for future tests.

Though this paper is more about the testing methods, in the course of that preparatory work, it became evident that none of the analytical models match the data. The models predicted correlations between the thrust and operating frequencies that were not observed. If the Mach Effect Thruster is indeed working, it is not producing thrust per these models derived from the original theory. Hence, that thruster is now considered a "black box" – a term used to denote a device whose operating principles are unknown, and where the test program concentrates on seeing if, and under what circumstances, it functions.

To test the thrusters, they are placed on the end of a torsion beam that can twist horizontally (vertical axis). The term "torsion" means that the beam is sprung, its rotation is limited and proportional to how much thrust occurs at the tip. This is the same concept as the Cavendish balance that measured Newton's gravitational constant. When the thruster is pointed one way, the beam deflects one direction. When pointed in the other direction, the beam deflects in the other direction. And the third important orientation is when the thruster is pointed in a direction where it should not deflect the beam. By comparing the actual deflections in each direction (and under different operating conditions), the performance of the thruster can be assessed.

Deciphering actual thrust from all the other things that can look like thrust is difficult. A major clue for a false positive is if the beam is deflected when the thruster is not pointed in a thrusting direction. Another major clue is revealed when the power is

delivered to a dummy device instead of to the thruster – to see if simply delivering the power through the apparatus affects the apparatus. Another possible effect is from the peculiarities of the balance beam itself while powered up (e.g. thermal drift of the electronics). When testing the thruster in a thrusting direction, there might be slight shifts in the center of mass as the thruster warms up – where that thermal effect might look like thrust. And then there is the challenge of how vibration might shift the position of the balance beam. There are more possible side-effects than these, but these are the major ones.

Another false positive that merits separate mention is confirmation bias. Confirmation bias is not an instrumentation phenomenon, but a psychological phenomenon. After people reach a conclusion, they tend to filter evidence to fit their preconceived notion, rather than letting the data speak for itself. It happens way more often than it should. It is so insidious that we seldom know when we are guilty of it ourselves. Our bias skews, well, our bias. The important lesson here, for you the audience, is how to spot those biases when you come across new articles. If an article sounds like they it's trying to prove or disprove, rather than decipher and conclude, then its findings are likely skewed.

The *Acta Astronautica* article comes across like an investigation in progress, rather than a conclusion in search of evidence (or advocacy). The article outlines the performance limits of their hardware and the procedures used to distinguish the aforementioned side-effects from potential genuine thrust. To measure a claimed thrust of 2 μN, the thrust stand has demonstrated a sensitivity of 0.1 μN, as well as plots of the background noise showing less than ± 0.02 μN. The procedures include calibration with known forces before and after each run, measuring the thermal drift of the electronics, and automated operation that repeats a set of runs 140 times to get ample data to average. The tests are conducted in vacuum and the thrusting directions can be changed during a test sequence remotely without having to break vacuum or risk affecting other configuration settings.

Other than the aforementioned conclusion that the Mach Effect Thruster is not following analytical models, there are no other conclusions to report. Sample data is shown for the Mach Effect Thruster (more than one version) and the EmDrive, but only to illustrate the measurements that can be made, rather than any attempt to report on the viability of either of those thrusters.

In closing, conferences are coming up where more progress will be reported. Consider this article a preparation for interpreting these next series of papers. Carl Sagan's adage, "Extraordinary claims require extraordinary evidence," is exactly the tactic here. The results only have as much substance as the fidelity of the tests. This most recent progress bodes well for that fidelity. The prior tactic of "quick and cheap" experiments to test other claimed devices turned out to be neither quick nor cheap. Promotional material and sensationalistic articles are easy to create. Reliable findings are harder, less glamorous, and take longer.

The implications of a genuine new propulsion method, plus the independent replications, are driving the perseverance to wade through these complications. If it turns out that a new propulsion method is discovered, then not only will we have a more effective way to propel spacecraft, but also a new window into the lingering mysteries of physics. The less obvious value is if it turns out to be a false positive. In that case the years-long ambiguity will be resolved, and the lessons learned will make it easier to assess future claims of new thrusters.

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2020 TVIW SCHOLARSHIP PROGRAM

TVIW is happy to continue its tradition this year in offering our annual scholarship program. This is the fourth year we have been able to offer the program, setting up students with an interest in interstellar research to succeed in their scholastic goals.

This year is something special. The $2,500 scholarships this year include the Tim Bolgeo Memorial Scholarship, supported by Baen Books (https://www.baen.com/). The scholarships are merit-based, and require all applicants to complete an essay with their application forms. The deadline for all applications is May 15, 2020.

"The Tennessee Valley Interstellar Workshop was created to foster and assist the study, research and experimentation necessary to make human interstellar travel a reality, with untold benefits to life on Earth," said TVIW President Emeritus John Preston. "We can imagine no better way to demonstrate that goal than the creation of these scholarships, helping new generations of thinkers, builders and explorers to set their sights on the stars."

Details about the Graduate and Undergraduate level applications can be found on our website at

https://tviw.us/2020-scholarships/

Please pass this along to aspiring students!

FROM HERE TO THE STARS EPISODE 8

In Episode 8, Stephen Euin Cobb, Host of "Future and You" podcast, interviews Dr. Joseph Meany, Postdoctoral Research Associate for Savannah River National Laboratory and a member of the Board of Directors for TVIW about some of his work on materials science related to interstellar travel.

Check it out on TVIW's YouTube page or at

https://youtu.be/GNxjaUcgNYo

UPCOMING INTERSTELLAR AND SPACE EVENTS

February 22, 2020. TVIW's livestream of Professor Alex Ellery's presentation, "Will Self-Replication Technology Precede Interstellar Propulsion Technology? The Prospects for Interstellar Self-Replicating Probe & a Human Type III Civilisation."

March 26-29, 2020 (Oxford, MS). SSoCIA biannual meeting. Website: https://egrove.olemiss.edu/ssocia/

May 28-31, 2020 (Dallas, TX). International Space Development Conference. Website: https://isdc2020.nss.org/

October 12-16, 2020 (Dubai, United Arab Emirates). International Astronautical Conference. Website: http://iac2020.org/

October 31, 2020. Twenty Years of Continuous Human Presence on International Space Station.

2020. Boeing's CST-100 Starliner Crewed Flight Test launch to the ISS.

2020. SpaceX's Crew Dragon Demo 2 launch to the ISS.

SEEKING INPUTS FOR UPCOMING ISSUES OF HSWT

We invite your contribution to this newsletter of nominally 200-500 words, written on an Interstellar topic that you think is of compelling importance.

Please send your submissions in MSWord format to Abby Sherriff, TVIW Newsletter Editor, and to Paul Gilster, TVIW Director at Large.

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Until Next Time…
Look Up at the Stars
and
Dare to Dream Big.