Have Starship, Will Travel

The Newsletter of the Interstellar Research Group

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Newsletter Contents

Warp Drives and Wormholes — The 2021 Interstellar Research Group Symposium

BY. COLIN WARN

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There are some times in life where days go by in months. There are some times in life where months go by in days. From September 25th to September 27th 2021, I got the opportunity to experience, at the Interstellar Research Group's (IRG) 2021 Symposium in Tucson, AZ, what it felt like for years of life to go by in a matter of hours.

The Interstellar Research Group, formerly known as the Tennessee Valley Interstellar Workshop, is an American-based research group focused on problems related to interstellar travel. Everything from advanced propulsion techniques such as warp drives, to the latest terraforming techniques, are discussed among the top scientists in the country in efforts to make science fiction a reality. And it's not just work that's being done on paper: There's some serious money going into these projects thanks to funding sources such as DARPA and NASA.

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IRG 2021: The Hallway is More Important than the Podium…

BY. JOE MEANY

…as the saying goes. Lots of information is shared at the podium, years of work among teams of people putting considerable effort into the breakthroughs that define careers. But the dynamic is always the same: a lead researcher lecturing in a one-way transfer of information to an audience of (let's be honest) varying attention spans and topical understanding.

One of the high purposes of the IRG Interstellar Symposia is to catalyze the discovery process by breaking down that monolithic communication model. The IRG Symposia are designed purposefully to facilitate information *exchange*. By limiting the number of speakers, IRG intends to build in multiple opportunities for informal conversations over the coffee breaks, catered meals, and the "Hospitality Suite," a purposeful carryover from the entertaining con suites found at classic sci-fi conventions. What are some of the things that happened in these spaces, which underscore the importance of in-person meetings?

Coffee breaks, strategically situated to stimulate both the legs and the mind, give the audience a designed opportunity to query presenters with in-depth discussion before the memory fades. Lectures are designed within static time constraints, and we all know that the truly *interesting* questions can't be addressed within the confines of a quick Q&A. I had one such discussion with Jeff Greason and Andrew Higgins about their design for the accelerated particle beam. Having a background in materials science, particularly one focused on carbon-based nanomaterials, I was struck by their suggestion to use ionized fullerenes (balls of electrically conductive carbon) in their design. We had a lovely back-and-forth, and I got to shine a little by pointing out other possible material candidates based on ionization energies and how efficient different materials might be to use based on their mass-to-charge ratios. The conversation wrapped neatly within the 30 minutes of the break, and we still got to have our coffee and brownies during the chat.

Joseph Meany talks laser sail characterization with Steve Durst and Matthew Gorban during the poster session.

The catered lunch (and walk over to it) are also a perfect time to hold discussions, catching up with old collaborators or just getting to know the other folks at the conference. Lunch spent networking with new colleagues is one of those benefits, and I had the pleasure of meeting Colin Warn, an interesting fellow from Washington state who wants to work on publicity with IRG in the near future. I also had the pleasure of catching up with Brent Ziarnick, who has finally returned from a hiatus from IRG while his career required all of his professional energies. Brent was the lunch speaker so he had to eat quickly, but the rest of the discussions around the table were professionally lively.

The atrium of this particular Marriott was well-suited to collaborative conversations, as comfortable padded seats with high backs were situated around tables to seat four to five individuals. Groups of tables clustered nearby enabled small groups of individuals to overlap nearby conversations as chance allowed it. I saw this happen no less than three times over the course of the symposium, where nearby conversations would meld together (akin to a reverse osmosis) from small groups into larger, more energetic, exchanges. The height of the atrium carried laughter to the rafters well into the evenings. Even with the muted public attendance, the conversations were engaging. Attendees regaled others with tales about their early careers in aerospace research; suggested job or business opportunities; coached junior researchers about how to grow as professionals in the field; and genuinely shared in the dreaming that makes interstellar enthusiasts of us all. Gerald Jackson, founder of HBAR Technologies, was particularly generous with his advice and guidance. I greatly appreciated the opportunity to spend as much time with him as I did.

This year, the Hospitality Suite was home to a reception for the multitude of volunteers who came together to make the convention a success. Local students sat down to local pizza and snacks to refresh from their labors, mingling with IRG staff and each other. At the session I was able to refresh my connection with Robert Freeland, a long-time contributor to IRG and Project Lead with Icarus Interstellar. After the technical tours, the Hospitality Suite provided a nice quiet place to relax and refresh. I sat with Yvonne Mayfield and Mark Prusten. Mark shared episodes from his long career in computer modelling for both the sciences and special effects industry. It was absolutely fascinating to hear about early graphics processing, something completely outside of my experience. As a mere consumer of art, I certainly take special effects rendering for granted. Yvonne and I also had a useful conversation, suggesting where IRG could improve in its inclusivity efforts, particularly with students. I'm glad she brought up the subject, as it reminded me why I came to the IRG board in the first place: if IRG is to last as an organization, it needs to include a growth model that accentuates student involvement.

When I attended my first Symposium with the IRG (then, the TVIW), TVIW co-founder Robert Kennedy had asked me to attend something I'd never heard of before. He asked me to come along to a "dead-dog" session. It was a phrase I'd never heard of before, but as a plucky graduate student who was still rather enthralled with being asked to tag along with these fun spacey folks, I obliged. In the dead-dog session we broke down what went wrong and what went right with the session. Much of the discussion centered on pre-planning logistics which I'd not been privy to, so that conversation went a little over my head. But then the attention of the room turned to me. What did I, someone unfamiliar with the history of the organization and the context out of which it sprung, think of the conference? Did I get anything out of it? What could have been done better? Even though my leadership position within IRG was still several years off, the leadership was taking careful notes of the feedback I provided for the *next* symposium.

This year's dead dog session proceeded in that same spirit. Colin Warn attended along with Martha Knowles, Ken Roy, Doug Loss, Andrew Higgins, and Andrew's graduate student assistant Matthias. While there was certainly plenty of feedback solicited from Colin and Matthias, we also geared the conversation toward our *next* goal: Montreal in 2023! This month, IRG and Andrew Higgins are getting underway to plan the 8th Interstellar Symposium to be held in summer 2023. Looking forward to seeing everyone there!

Brenda Staudenmaier and Ken Roy enjoy the Art Show together.

Doug and Ruby Loss tour Biosphere 2.

It's pizza time for the symposium volunteers at the Hospitality Suite. Organizing Chair, Stephen Fleming takes a few precious moments off his feet.

WARP DRIVES AND WORMHOLES — THE 2021 INTERSTELLAR RESEARCH GROUP SYMPOSIUM

BY. COLIN WARN

Colin Warn is an Associate Propulsion Component Engineer at Maxar, with a Bachelor of Science in mechanical engineering from Washington State University. His research interests dip into in everything from electric spacecraft propulsion, to small satellite development, to machine learning and machine vision applications for microrobotics. He currently has two papers on the topics of nuclear gas core rockets and interstellar braking mechanisms that have been published in the Journal of the British Interplanetary Society. When he's not working on his research, you can find him teaching music production classes or practicing martial arts.

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This is a group whose videos I had been consuming ever since I was a freshman in college, as the primary reason I switched from producing music full-time to mechanical engineering was to make humanity an interstellar species. I vowed if I ever got the opportunity to partake in the conference I would jump on it, so when my poster on "Interstellar Braking Techniques for Spacecraft Moving at Relativistic Speeds" was accepted, I had to find a way to make it to Tucson without bankrupting myself. Thankfully, Washington State University's Honors College agreed to cover all the expenses of my trip, so this "report" from yours truly is a little something I'm putting together as a thank you to the incredibly generous patrons who made this possible.

I started off my attendance at the conference by sitting down with Mark Medley, Deputy Editor for the Globe, to talk with him one-on-one over dinner about the future of interstellar travel for a new book he's writing on projects that take multiple human lifetimes to complete. Sat down with him over pizza at a nearby restaurant, an hour and a half later the waitresses had to kick us out because we were still talking right up until closing time.

A small selection of the incredible attendees I interacted with: Mark Medley (blue shirt to my direct left), Douglas Loss (green shirt, far right), Albert "Al" Jackson (black shirt directly above me), Dr. Brent Ziarnick (grey Corduroy with a white shirt directly below me), Stephen Fleming (bottom left), and Dr. Sonny White (navy blue blazer, light blue towards the top left).

I then embarked on two of three incredible tours I would experience on the trip: The laboratory in which the largest telescope mirrors in the world are being manufactured for the Giant Magellan Telescope, and the Laboratory of Tree Ring Research. The latter was especially interesting: It was until the field of dendrochronology, birthed by this lab, that many archaeological sites could be dated right down to the year. After a couple drinks at a local space-themed art show sponsored by the University of Arizona, I then settled down for the night for the first full day of the conference. I couldn't have imagined the incredible moments I was about to have over the next few days.

My first interaction was with Dr. Gerald Jackson (Gerry to everyone), one of the top antimatter researchers in the world, and working on some propulsion projects with the technology that, after hearing about them, I'm not sure I'm allowed to reveal publicly. In addition to being razor sharp, he had incredible stories that would stop anyone in their tracks (not many people are approached by the CIA because they pulled out the wrong books in Cornell's library, for instance). Of course, he was just the warmup.

Pre-conference mingle session.

I then met Douglas Loss, president of IRG, one of the most down to earth people I've ever met. He put me onto old classics such as Black Betty, and we talked about the early days of the conference. I ran into Dr. Amelia Greig, someone who I hadn't seen since 2018 and wasn't expecting to run into, who had given me a few incredibly helpful pointers back in 2018 when I was in the early days of developing a Hall Effect thruster for Washington State University's Cougs in Space organization. Had a blast catching up with her and listening to her work on using plasma arcs to harness water from asteroids (a project which she was receiving a NASA grant to explore).

At lunch with the Helicity Space team.

Then the conference really began to pick up, and I had to start pinching myself to make sure I wasn't in a dream. I ran into Dr. Kevin Parkin, a researcher whose work on beamed energy microwave propulsion I had been reading ever since freshman year, and talked with him about what was in store in his role as one of the lead scientists on Project Starshot(humanity's best idea given the current understanding of physics for realistically sending robotic probes to other star systems). I sat down for dinner with Dr. Sonny White, head of NASA's advance propulsion research division "Eagleworks," who was at the conference to promote his new organization, the Limitless Space Institute, which was pouring millions of dollars of funding into some of the crazy ideas being pursued by researchers there. After getting his card to see if there was any way I could help with some of the projects he was funding, I had a serendipitous conversation with a lady named Marta from Helicity Space whose organization was, unironically, working on a nuclear fusion driven rocket with funding from NASA and some angel investors. Sitting down for lunch with Dr. Setthivione "Sett" You and Dr. Stephane Linter to talk about their fusion drive technology for over an hour, I couldn't believe the number of times words such as "plectonemic plasmas," "frozen fields," and "z-pinches" were used unironically, and I loved absolutely every minute of it. I got to hear Sett and Gerry argue, unironically again, for a good twenty minutes on whether Sett's fusion drive idea was actually possible due to problems such as Lawson criterion limitations.

But despite these heavy hitters, these weren't the most inspiring people I met there. The ones that really gave me perspective were Matthew "Matt" Gorban and Mathias Larrouturou, two students who were presenting on "Variable Mass Propellantless Propulsion Drives" and "Dynamic Soaring as a Means to Exceed the Solar Wind Speed" respectively. Despite the fact that Mathias was a few years younger than me, and Matthew was just a few months older than me, they were both working on advanced propulsion concepts that even some PhDs would have a hard time following.

Nothing could've elucidated this point further when Dr. Gabriele Rizzo, an Airforce Laboratory Researcher who studies warp drives in his free time, was presenting on "faster than light warp drive" concepts. "You see half of that warp drive research he's citing as previous work?," Matthew asked me, "that's all my research." Then he proceeded to answer questions Gerry, the antimatter propulsion researcher, had about specific aspects of warp field design, while also writing a question to correct Dr. Rizzo on some of his slides while doing this. Now do you see why I was pinching myself?

Me, sitting as a fly on the wall, while Matthew Gorban (blue shirt) and Mathias Larrouturou (black blazer) discuss the dynamic soaring of plasma waves with Dr. Andrew Higgins and Jeffrey Greason.

I could go on and on with stories to turn this into a small book. I got to witness one of the funniest talks from Dr. Brent Ziarnick, an assistant professor at the Air Force's Air Command and Staff College, who was one of the most down to earth people I've ever met despite the amount of "street-smart" wisdom he had for everyone at the conference. I got to tour Biosphere 2 from the two directors of the lab John Adams and Kai Staats, which contrary to news stories is actually an incredible success and was one of the early pivotal labs which experimentally showed that an increase in CO2 would lead to detrimental effects for humanity. During the final dinner in which Homer Hickman, the author of the book which would eventually turn into the movie "October Sky," told incredible stories about his life, the IRG conference acknowledged yours truly as one of its $2500 scholarship winners in front of everyone. I learned from Dr. Andrew Higgins and Mathias that the "Roadmap to Nuclear Gas Core Rockets" whitepaper I had published in the Journal of the British Interplanetary Society ended up being pivotal in convincing other academic journals to publish their work on beamed energy thermal propulsion systems. Did I mention all the other incredible meal-time conversations I had with people like Dr. Joseph E. Meany and Steve Durst, or running into Albert "Al" Jackson who, oh, just so happened to work on the Apollo moon lander?

This whole experience would not be possible without the tireless work of the IRG executive team and volunteers. I wanted to give a very big, special thank you to Stephen Fleming, Douglas Loss, and Martha Knowles in addition to the dozens of other people whose work behind the scenes made this event one of the most smoothly and incredibly executed conferences I've ever been a part of: And do so in a hybrid format to boot!

The next IRG Symposium will be held in Dr. Higgins' home-base of Montreal at McGill University in 2023, and needless to say these two years can't go by fast enough. If you have any sort of interest in making humanity an interstellar species, this is an event you can't miss.

Thank you so much again to the IRG team for putting together an incredible event, and thank you so much to Washington State University's Honor College for funding my trip. It'll be a memory that I'll cherish forever, and hopefully the first of many IRG conferences for me. Ad Astra.

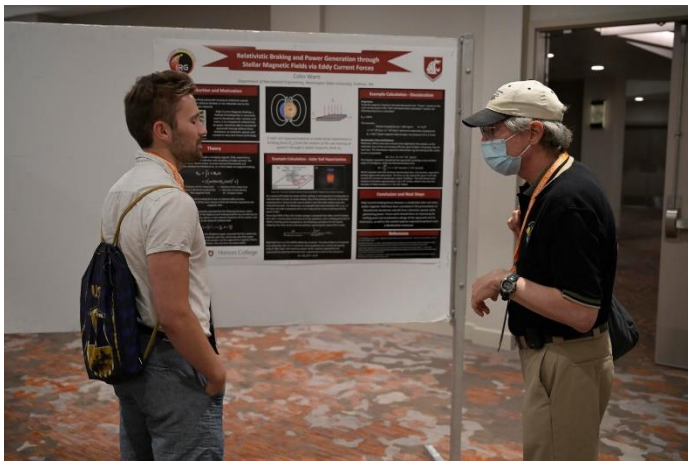
Inside Biosphere 2 with director John Adams.

Yours truly getting acknowledged for one of the three IRG 2021 scholarships. Pictured also is Dr. David Messerschmitt, a wealth of information regarding communication sciences and engineering.

Biosphere 2 Tour with members of the IRG Conference.

John Adams showing another section of Biosphere 2.

The massive bellows required to maintain Biosphere's pressure.



Yours truly presenting his poster at the hour-long poster session (no my eyes weren't closed the whole time I promise).

2021 SCHOLARHIP WINNERS

Following a competitive process with many high-quality applicants, the Interstellar Research group has chosen three students as the recipients of our 2021 scholarships. With the support of Baen Books (who sponsor the Tim Bolgeo Memorial Scholarship), Rob and Ruann Hampson, and Jay and Beth Roye, we are awarding these deserving students one graduate scholarship ($2500) and two undergraduate scholarships ($2500 each). These scholarships were created to encourage the next generation to study science, technology, engineering, and math (STEM) fields that support the research needed to get humanity to the stars.

Our winners are David Webb (graduate), Morgan Barkhurst (undergraduate), and Colin Warn (undergraduate).

Read the graduate essay below. The two undergraduate essays were included Issue 24.

GRADUATE SCHOLARSHIP WINNING ESSAY CLIMATE CHANGE AND INTERSTELLAR EXPLORATION

BY DAVID WEBB

David Webb, our graduate-level winner, and winner of the Tim Bolgeo Memorial Scholarship, has held senior positions at various social and environmental impact funds, many focused on frontier and emerging markets. He has led investments across Sub-Saharan Africa and Southeast Asia for funds focused on the rising middle class, financial inclusion, ocean conservation, reforestation and climate change

David is pursuing his Master's in Climate and Society at Columbia University. He received an A.B. in Economics and Government with specialization in International Relations from Dartmouth College, and is a CFA Charterholder. He is also a member of the Editorial Board of the journal, Capitalism & Society, at the Center on Capitalism and Society at Columbia University.

"Knowing is not enough; we must apply. Willing is not enough; we must do," said German polymath Johann Wolfgang von Goethe. The mercurial scientist, playwright and statesman captures a good summary for our times. It is not enough to have all the tools and all the inspiration. There is no substitute for action.

As the existential threat of climate change mounts, humans have once again turned their attention to the stars. Mars. SpaceX. Blue Origin. But what would seem to many as a backup plan – interstellar exploration and colonization – is in fact a necessary goal for today's human societies. Put more simply: the challenge is not to conquer climate change here on Earth *or* find somewhere else to live. Rather, it is both.

Scientific climate change research and the interaction with society, which is the topic of my master's degree, is important not only for addressing the current environmental crisis on Planet Earth. But it is also significant for understanding the climates of other celestial bodies, and perhaps more importantly, the ways that large problems are solved through collective action. Interstellar exploration will be facilitated by an understanding of the factors that influence climate change. These lessons will be invaluable for comprehending the conditions of other planets, and for stabilizing our own.

As a student of the Master's in Climate and Society at the Columbia Climate School at Columbia University, I will study solutions to the challenges presented by climate change that have sprung from climate science, social science and public policy. The science, technology, and broad understanding of climate knowledge will enrich my understanding of dissecting and solving problems on planetary-sized scales. Once we can truly understand our own planet, then we can approach interstellar exploration with a confidence and expertise necessary to establish outposts throughout the solar system.

For the past six years, I have worked in impact investing in developing countries. I spent significant time in Sub-Saharan Africa, investing in companies growing with the rising local middle and consumer classes. These included the only Liberian healthcare clinic to stay open during the civil war and the Ebola epidemic, East Africa's largest producer of lifesaving antiretroviral and antimalarial medicines, and one of the largest microfinance institutions. I later relocated to South East Asia to lead an ocean conservation impact and sustainable finance fund. This fund would invest in fisheries companies in the Philippines and Indonesia and then work with the companies to improve the sustainability of their operations as well as the surrounding fisheries communities.

At the centre of many of the greatest issues facing the human and natural world is climate change and the substantial social and natural consequences it will bring. My analysis of the fishery industries of Indonesia and the Philippines laid bare unsolved tragedies of the commons and collective action challenges. Though overfishing and crude fisheries practices were often the primary recipient of the blame, climate change was playing a role in what can only be described in many areas as ecological collapse. Changes in ocean temperature, circulation, oxygen concentration, acidification, surface wind, storms and salinity due to climate change is wreaking havoc on the marine ecosystems. Positive feedback loops abound.

My previous work has been focused on social development and conservation in developing countries. This has involved highly quantative analysis and has been based at the interconnectedness of economics, natural science and social science systems. I have seen first-hand the complicated collective action disasters that plague many societies. I want to study climate change because innovation and technology present exciting new ways to solve many of these significant challenges. Big data, ecosystem management, sustainable and blended finance, artificial intelligence and machine learning, mathematics and mapping, income equality, improved policy: each piece is important to achieving the stabilization of natural and human systems on a long term and large scale.

NASA is one of the is one of the keenest observers of climate, and spends billions of dollars watching the Earth's atmosphere, oceans, land, ice and biosphere. The ability to take a truly global perspective is fundamental to understanding how interstellar networks will function. In addition, gaining mastery of the

mechanisms of climate and the complexities surrounding heating and cooling will prepare us for future interstellar outposts.

Many people today see climate change and space travel as competing forces: for attention, funding, and imagination. But this is not true. Both are big pieces in the continuum of human existence and solving both are necessary for us as humans to continue to exist as a species.

My subsequent career objectives and future impact ambitions are to explore whether market-based capitalist mechanisms in conjunction with policy frameworks can be used to bring about environmental conservation, ecological recovery, climate change mitigation and sustainable development. The complexity of the interaction between market systems and technology is giving rise to changes and challenges at a pace that could not have been previously anticipated. The possibilities of innovation and technology to address the causes of climate change will be nothing short of transformative for our society.

Massive amounts of attention need to be directed into adapting and transforming society for sustainable development. With the world population predicted to be eleven billion people by the end of the century, the current path of humanity is likely disastrous. That alone seems to justify significant analysis of sustainable development methods to prepare for the mounting stress to natural and human systems. Though many of the consequences of climate change are now apparent and even more yet to be discovered, I would like to be an informed agent of change that focuses on the ability of societies to mitigate, decelerate and possibly reverse the momentum of climate change.

It is exactly this global, cosmic-sized mentality that is necessary to address climate change that will tilt people's heads up to the stars. One of the greatest hurdles in dealing with climate change is a large cadre of people who are skeptical that humans can have that much of an affect on the earth. "The earth is a complicated place" they say, "who are we to guess what is going on." But we are not guessing. We are applying scientific principles to understand the reality around us on a global scale. That sort of confidence – to solve problems of extreme size – is what will then bring us to look to other planets as something that can be understood. Something that can be charted, just like an uncut trail in a forest, or an invisible atmospheric phenomenon. Interstellar exploration takes great courage and confidence. And so does solving climate change.

The focus of my master's research will be to combine many of the new developments in AI, blockchain, the Internet of Things (IoT) and machine learning and apply them to sustainable finance and climate mitigation strategies. I intend to become a climate expert that is skilled at analysing data on a local and planetary level. And then I will apply that analysis to ways that climate change can be slowed and mitigated on Earth.

AI is improving data verification and quality while generating new data and analysis that can be applied to forest conservation, deforestation and land degradation. Blockchain technology brings an open and transparent platform for the monitoring and management of forests and carbon. Blockchain recording and accounting increases trust and decreases fraud. There is also the ability of high-resolution imaging, from planes or from satellite images, to monitor forest conservation. These type of imaging technologies can track canopy growth, tree count, density, soil moisture and humidity, which are all important metrics for forest conservation and carbon predictions. They will also be important tools for surveying a new planet.

By creating a blockchain for climate change and tokenizing carbon, it will create a whole ecosystem for the monitoring, reporting and verification of data related to climate change. The complete stock of greenhouse gases will be able to be quantified, and carbon credits will be originated. In addition, it decentralizes and democratizes the data available as well as the funding. It creates a completely new asset class and enhances and accelerates our path towards climate change mitigation and reversal.

Blockchain and AI also have the potential to create a decentralized market for energy that incentivizes energy-saving and low-carbon alternatives. There are ways that these new technologies can manage our energy consumption better, reduce the carbon footprint of energy, improve efficiency, and ultimately reduce climate change. In the same way that cryptocurrency has become a disruptive technology, so has renewable energy, and there is great potential in increasing adoption when combining these two forces. The acceleration of clean energy options will make powering interstellar travel a reality. But so much of this new technology will come out of fighting climate change here on Earth. Which is why the close relationship between the two – the climate change crisis and interstellar travel dream – is so exciting.

Tokenization and blockchain technologies can allow a much wider spectrum of investors to participate in sustainable finance projects. It can promote social and financial inclusion by making the impact investing asset class more accessible. It can also use the power and transparency of the blockchain to increase trust between stakeholders. By increasing trust and transparency, even more investors can participate. If larger pools of capital are able to be gathered and directed towards sustainable finance and impact investing opportunities, their relative cost decreases. The result is that makes solving some of the most significant social and environmental problems, cheaper.

Though many of these technologies will be crucial to reducing the impact of climate change, the second piece, policy and adoption, is just as crucial. I intend to study the ways in which societies can use these technologies as tools to mitigate climate change and slow down environmental degradation. Our society has been so rapidly digitized that these are often the only solutions that people look to when trying to solve large problems. Simple things like putting a price on pollution, adaptation, funding, reporting, and activism, are all low-tech but high impact solutions. Not everything in interstellar travel and new planet colonies is about technology. This is not the Jetsons. So much of the big and structural work, that is often invisible to us humans, falls into the realms of social science, anthropology, and politics. Many of the STEM specialists will be instrumental in getting us onto the next planet. But I don't know if I want to see a society designed and ruled by engineers.

This understanding of how to solve collective action problems will be invaluable here on Earth as well as in interstellar travel and life. The great explorers of history on Earth and in space have understood the importance of teamwork. But the many interstellar challenges that the future holds is not comparable to the crew of Columbus's ships and the colonizers that followed, nor the team of Neil Armstrong and NASA. It is vastly more complicated and involves many more people. Climate change has become the

collective action problem for our generation. It requires massive actions, sacrifices and intelligence across billions of people. It incorporates countries and people of different levels of development, perspective, resources and preferences.

Having the technology is not enough. Have the desire is not enough. As Goethe says, "We must do." Climate change presents a challenge of scale and complexity similar to interstellar travel and life. It encompasses the entire world, and all the tiny micro-connections that pull Planet Earth into a single being. If we can not understand those connections – at the smallest as well as the largest level – then we are doomed to fail in space. Settling a new planet with an incomplete understanding of our own is a very dangerous mission. The climate scientists will be crucial to bringing vital knowledge to a new planet, as well as ensuring our old planet remains inhabitable. I will be able to demonstrate how the climate of new planets are structured and how the consumption of resources will impact the habitability of new planets. In addition, new information from new planets may actually teach us things about Planet Earth and ways that we can reverse the damage here that has already been done.

What distinguishes climate scientists from others, is that they analyse the environment from the community to the planetary scale. This is a crucial quality for interstellar travel as well a new planet colonization. With my climate training, I will be able to analyse large amounts of data on a local and planetary level. This will be useful, because micro and macro factors need to balance when building a human civilization on a new planet.

The climate crisis is one of the greatest threats facing humanity. The challenges are massive and immediate. Finding vital solutions are of utmost importance for the present and for future generations. But for future interstellar generations, the dynamics and variability of climate change, quantitative models of climate-sensitive natural and human systems, managing and adapting to climate, and applications of climate and society will be fundamental themes in their societies. Many of the new technologies that will be developed to fight climate change will undoubtedly be used on future human colonies on far away planets. Not to mention how new human societies will organize and deal with shifting climates and disasters.

As a climate expert, I will also be able contribute to the choice of planet for a new human colony. Ideally, it will be a planet with the right balance of water, heat and soil, and not excessive storms or natural disasters. Many of the energy technologies that have accelerated with the climate change mitigation movement, such as solar and wind power, batteries and electric vehicles, will be instrumental in building a functioning society on a new planet.

While we confront that challenges of the day here on Earth, it is important that we continue to contemplate the vast potentialities of the cosmos. To confront and explore the universe is humanity's ultimate challenge. But to achieve stability here on earth, and to assess new frontiers in space, more knowledge of climate is needed. The climate experts will be an important part of interstellar travel and the establishment of a human civilization on a new planet. And just as importantly, the health and stability of Planet Earth is likely a mandatory requirement for interstellar travel far into the future. The mothership needs to be set right before we can successfully launch and maintain new interstellar societies.

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https://smile.amazon.com/ch/46-4572727

UPCOMING INTERSTELLAR AND SPACE EVENTS

28 February 2022. Axiom-1 private astronaut mission to the International Space Station.
Early 2022. SpaceX Starship spacecraft first orbital launch.
April 2022. NASA's Artemis I uncrewed lunar orbital test flight.
4 April 2022. 37th Space Symposium in Colorado Springs, CO. Website: https://www.spacesymposium.org/
Summer 2021. NASA's James Webb Space Telescope starts performing scientific observations, peering deeper into the cosmos than ever before.
1 August 2022. NASA's Psyche mission launch.
Late 2022. First test vehicle flight for India's Gaganyaan space mission.