20 Year Plan for Interstellar Space Propulsion

Interstellar space propulsion with the Interstellar Research Group is very much at the same point in its timeline that rocket propulsion was with the Verein für Raumschiffahrt in the 1930s. Many lessons between both groups can be drawn, though hopefully the former of these groups will keep an eye on who is in power if the military begins to take interest.

Step 1: Develop the technology

Step one is to create a roadmap that uses feasible technology at an affordable price-point. Humanity would love to go to another star system, but not if it bankrupts them in the process. In addition, a 20-year analysis on promising interstellar propulsion technologies should be based on current physics. As much as warp drives and worm holes would be great, they are currently not possible in our current understanding.

A quick flip through K. F. Long's "Deep Space Propulsion" [1] shows us the most promising realms:

- Electric propulsion
- Nuclear fusion and fission propulsion
- Beamed energy propulsion
- External nuclear pulse propulsion
- Antimatter propulsion

Out of these five technologies, external nuclear pulse propulsion and the combination of beamed energy, potentially in combination with electric propulsion, are the two most promising areas. If humanity had to travel to another solar system by 2025, external nuclear pulse propulsion would likely be the only way forward due to systems such as Project Orion and Project Daedalus being the interstellar propulsion technologies with the highest Technology Readiness Level (TRL).

If given a longer time horizon however, analysis by Lubin [2] concludes that beamed energy will outperform every other technology: Even a perfectly efficient antimatter propulsion system. Given the rocket equation significantly penalizes carrying the power source on board, the lowest cost interstellar solution will only happen if one keeps the power source at home and beams the energy. The problem of beam diffraction and spreading for beamed energy systems can be mitigated through photon-particle self-guiding effects. [3] Recent research has shown that combining beamed energy with direct drive electric propulsion, in addition to enabling high speed interplanetary travel. [4] This may be a crucial steppingstone in soliciting the funding for a more ambitious Project Starshot that beams this energy onto gram sized wafers that reach Alpha Centauri in 20 years. The same beamed energy system could be used for both applications.

Therefore, given our current understanding of physics, the most cost effective, viable option for interstellar travel in twenty years will be a beamed energy system. The power for this system will likely be generated by nuclear plants or solar energy. To avoid the geopolitical concerns of putting into the hands of a single country a high-powered laser which has the potential to deorbit or destroy any spacecraft it wants, the beamed energy system should either be distributed among many countries or should be placed on the far side of the moon. The later of these options is more likely, as the photon-particle self-guiding effects have only been shown to work in environments at sub-Kelvin levels so far.

<u>Step 2: Develop the will</u>

To fund a major undertaking such as sending a probe or humanity to another star system, one must look at the motivations for similar historical undertakings. Neil deGrasse Tyson, when talking about his blurb in The Columbia Encyclopedia of the 20th Century, argues that there are three reasons a major project historically gets funding: War, praise of a deity or royalty, or the promise of economic return. [5] If a strong advocacy case is to be built for the need of interstellar exploration, an argument which uses any or all of these three reasons will have the strongest effect.

The development of beamed energy, the technology that will likely be the backbone of interstellar travel, will primarily advance thanks to the large budgets of defense contractors harnessing the technology for applications such as missile and drone defense. Much like NASA’s Hubble was a military satellite design repurposed for stellar observation, the beamed energy propulsion systems of tomorrow will likely be the repurposed beamed energy systems of the military today.

Further colonization of our own solar system will likely need to be the next step before serious conversation about funding for interstellar missions is solicited. The case for exploring other solar systems is much more difficult to make if our own solar system has been barely explored. As elucidated in step one, the same beamed energy propulsion systems that will be used to send probes to other solar systems can be combined with modern electric propulsion systems to enable high speed exploration of our own solar system: Killing two birds with one stone. Therefore, a near-term plan for building advocacy towards interstellar space propulsion should bring awareness and research funding to the areas which will enable quicker transit times of our own solar system.

Additionally, efforts to sustain the rising enthusiasm around space exploration should be continued. The world has seen the dawn of a new space age, a Space 2.0, thanks to companies such as SpaceX and Blue Origin. Voracious public appetites for movies such as Interstellar and The Martian show that a new wave of enthusiasm is growing and stronger than ever. The first US astronauts flown back to the space station on the first American made rocket in a decade garnered millions of views from around the world. Billions of dollars are being poured into contracts to set up lunar colonies. Millions are being poured into the electric propulsion technologies that, when connected to direct drive beamed energy sources, will enable rapid exploration of the solar system.

In conclusion, for a reader who is interested in practical next steps in advocating for interstellar missions, continue to advocate for the current trend of interplanetary travel. When possible, bring more awareness, research, and funding to beamed energy technologies. Finally, aim to create so much economic abundance in society that every citizen does not have to worry about where the next meal is coming from, but rather whether the latest class of citizens will survive their trip to Mars.

Works Cited

[1] K. F. Long, Deep Space Propulsion: A Roadmap to Interstellar Flight, 2011.

[2] P. Lubin, "A Roadmap to Interstellar Flight," *Journal of the British Interplanetary Society,* 2016.

[3] C. Limbach, "PROCSIMA: Diffractionless Beamed Propulsion for Breakthrough Interstellar Missions," 2019.

[4] J. Brophy, "A Breakthrough Propulsion Architecture for Interstellar Precursor Missions: Phase I Final Report," *NTRS - NASA Technical Reports Server,* 2018.

[5] N. d. Tyson, Interviewee, *The Future of Colonizing Space.* [Interview]. 11 March 2018.