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Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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DIRECTED ENERGY - THE PATH TO RADICAL PROPULSION ADVANCEMENT- ENABLING LONG RANGE POWER BEAMING FOR RAPID INTERPLANETARY AND THE FIRST INTERSTELLAR MISSIONS

Abstract

High power directed energy solutions offer a radically different approach to both space propulsion and long range power applications. All current propulsion systems that leave the Earth are based on chemical reactions. Chemical reactions, at best, have an efficiency compared to rest mass of 10-10 (or about 1eV per bond). All the mass in the universe converted to chemical reactions would not propel even a single proton to relativistic speeds. While chemistry will get us to Mars it will not allow rapid interplanetary nor interstellar capability. Barring new physics we are left with few realistic solutions. None of our current propulsion systems, including nuclear, are capable of the ultra high speeds needed for rapidly exploring the solar system and for the future capability of relativistic flight to enable interstellar exploration. However, recent advances in photonics and directed energy systems now allow us to realize the ability to project the high power over vast distances that is needed for space applications. When operated in direct drive photon momentum exchange, extremely high speeds including relativistic flight become possible. When used in indirect drive mode where the beamed power is converted to electrical power to drive high Isp ion engines, we can realize high mass missions in our solar system at vastly higher speeds than chemistry. These approaches allow missions from wafer-scale spacecraft capable of speeds greater than 0.25c that could reach the nearest star in 20 years to 10 kg spacecraft travelling at 0.02 c to large missions, including human capable, that enable rapid interplanetary capability including very rapid missions to Mars. Photonics, like electronics, and unlike chemical propulsion is an exponential technology with a current double time of about 20 months. The same core technology can be used for many other purposes including planetary defense, stand-off asteroid composition analysis, space debris mitigation, power beaming to long range spacecraft and other distant assets, LEO and GEO stabilization among many others applications. This would be a profound change in human capability. We will discuss the many technical challenges ahead, our current laboratory prototypes and recent data on kilometer baseline arrays, long coherence length amplifiers, low cost large aperture optics as well as the many transformative implications and complexities of this program. We are currently in three Phase II NASA RD programs. We will discuss the roadmap ahead and both the short term and long term milestones allowing a logical and cost effective approach.