Human Exploration of the Solar System as a Precursor to Interstellar Travel: Outlook and Realities

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Abstract

Technical speculation about the possibilities of space travel began with Konstantin E. Tsiolkovsky at the beginning of the 20th century[1], building upon notions of rockets from centuries earlier[2]. Only with the Second World War and the competition in space between the U.S. and the Soviet Union during the ensuing Cold War were sufficient funds available to develop what has become known as astronautics to the point that robotic and human spacecraft became possible. To date, the culmination of the human program has been the Apollo landings on the Moon and the building and permanent habitation of the International Space Station (ISS). At the same time there has been a recurrent backdrop of the idea of humans traveling out from the solar system to the stars, with the topic developed somewhere between science[3] and science fiction[4], given the enormity of that task[5]. Nonetheless, it seems prudent to examine the realities and requirements of the "easier" problem of human travel throughout the solar system, to inform both the longer-term possibility of human travel beyond the asteroid belt, as well as the shorter-term goal of the human exploration of the Mars system[6]. While missions to Mars can be accomplished with chemical and/or nuclear thermal propulsion[7], continuous, low-thrust missions will be required to decrease flight times to acceptable durations for more distant targets[8,9]. For human flight the duration, living space, and expendables (food, water, and air) all become part of a significant trade space, which also reflects risk postures, both with respect to radiation tolerance and contingency strategies. In the absence of some type of induced, artificial hibernation (for which no near-term technologies currently exist) mission lifetimes will likely be limited to ~5 years. Provision of supplies, if not forward positioned, recycling efficiencies and reliabilities, living volume, and the target system all then drive the required mass and, hence, required propulsion[10]. Closure of the engineering design depends upon physical characteristics of the means of propulsion, bookkept as the specific mass of that system, which must include propulsion hardware, energy generation conversion and efficiency, and radiation of waste heat[11]. Implementation is highly dependent upon materials and system reliabilities, preplaced infrastructure, and the adopted form of nuclear energy for power and propulsion. Significant structural masses will be required for such missions with assembly in space or on Earth and/or with materials brought from Earth or mined at the Moon or Near-Earth Asteroids (NEAs). The approach taken also become part of the trade space[12]. None of these issues is new. What is new is now-available space technology, the role of even newer technologies, and the development and implementation costs, all of which we have real experience over the past five decades. In the absence of disruptive, implementable, propulsion technologies, we can visit the types of requirements that may then be needed for recurrent human Mars travel[13], and for initial human forays to the asteroid belt and the planets of our solar system beyond. The experiences of actual human expeditions throughout the solar system – not unlike the initial expeditions to Antarctica – will inform us of what the possibilities for *homo ad astra* might be when the coming century dawns[6].

Keywords: Interstellar Travel, Human Space Exploration, System Engineering

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The purpose of the Solar Polar mission is to place a payload into a short period, circular polar orbit about the Sun. The Interstellar Probe mission is to place the spacecraft on a heliocentric escape trajectory that will reach 100 to 1000 AU in 10 to 20 years in the direction of the solar apex.Â The mission concept has a long history of interest as a precursor to eventual travel to the stars (Wallace, 1999). The conceptual basis for the current design was laid out in 1990 (Holzer, 1990) when preliminary science objectives and a strawman science payload were described. ...Â To provide a first-order cut at many of the engineering realities associated with such a mission, we consider a probe that can be launched with available vehicles and infrastructure. solar luminosity, M the solar mass, S the cross sectional area. of the sail presented to the solar radiation, m the mass of the sail, and Î·rad = A + 2R the radiation pressure coupling eciency of the sail, which depends on the absorptiveâ€"reective properties. of the sail material.Â 1. Travel characteristics of a solar radiation driven aerographite (Ï = 0.18 kg mâˆ'3) hollow sphere with a shell thickness . Tracks were computed through numerical integration of the total in force Eq. (3) divided by the sail mass, which equals the sail acceleration.Â The orbits of the solar system outer planets and of Pluto are indicated by their initials. (b) Radial velocity of the sail with respect to the Sun as a function of time. 8. Human Exploration of The Solar System as a Precursor to Interstellar Travel: Outlook and Realities. Ralph L. McNutt Jr. Johns Hopkins University.Â Declared Consensus by participants of the Foundations of Interstellar Studies Workshop on interstellar flight, 13-15 June 2017 in the City of New York. The firmest foundation for interstellar studies is a community united by a common goal, to travel to and explore space beyond the Solar System, but committed to the mastery of their individual fields and interests. We have assembled here in the great city of New York to advance the state of interstellar studies, especially in regard to the type of engines to propel our future vessels across the stars. IntroductionHuman beings have studied our solar system for thousands of years, but it was only in the last few centuries that scientists started to really figure out how things work. The era of robotic explorationâ€"sending uncrewed spacecraft beyond Earth as our eyes and earsâ€"is only a little more than 55 years old. A fleet of space robots is out there right now exploring destinations from the Sun to distant planets orbiting faraway stars. Significant Events. Notable Explorers.Â "See the beauty of the world with your own eyes and learn to see the corresponding beauty that mathematical calculations tell you is present." More about Stephen Edberg. Sarah Noble. Unfortunately, the Interstellar Medium around our solar system and the nearby stars is especially thin, and scientist have calculated that thereâ€™s just not enough hydrogen there to fuel a Bussard Ramjet. "It's not the ideal part of the galaxy," Crawford said.Â And although Crawford is an advocate of human exploration of the solar system, he said that interstellar distances are too vast to make a human voyage conceivable within the next few hundred years. "I think humans can explore the planets more effectively than robots, and I also think there are cultural reasons for sending humans into space, to broaden our range of experiences and enrich human culture," he said.