SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FAR FUTURE (D4)
Novel Concepts and Technologies (1)

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LIGHT(LY) STEPPING TO THE STARS: NANOSATS AND LIGHTSAILS AS INTERSTELLAR PRECURSORS

Abstract

Advances in nano-technology, bio-engineering, robotics and information processing are enabling nano-spacecraft (1-10 kg) and perhaps even pico-spacecraft (¡ 1kg) to be used in evermore sophisticated and ever lower cost missions. Practical-sized LightSails can be used to propel nano-spacecraft to high solar system escape speeds to reach unexplored distances in interstellar space with reasonable flight times. Such missions could be the precursors for robotic and even virtual human spaceflight to the stars – missions previously thought to be centuries in the future or even science fiction fantasies may now be only 75-100 years from possibility.

This paper will report on a study to examine the feasibility of nano-spacecraft to make meaningful interstellar precursor missions which both advance the requisite technologies of interstellar flight and return valuable science data at extra-solar system destinations. Example destinations include the Kuiper Belt, the heliosheath, the heliopause, the solar gravity lens focus and the Oort Cloud. The solar gravity lens focus is of particular interest since observations of potentially habitable exo-planets may be greatly enhanced there. We can imagine a number of low-cost nano-spacecraft sent to foci that align with a number of candidate planets eventually helping to choose the destination of an interstellar mission.

The feasibility of nano-spacecraft will be principally dependent upon the ability to provide sufficient power for science and communications, to communicate over large distances and the performance of a miniaturized payload. In addition the materials technology to enable the LightSail to fly very close to the Sun in order to achieve the high escape velocity is crucial. The paper will examine potential mission requirements and technological solutions to enable these interstellar precursors.

Among the specific concepts that will be discussed are 1. Imaging extra-solar planets at the solar gravity lens focus 2. A deep-space communications Multi-spectral Occultation Relay System Experiment (MORSE) to encode mission data on occulted starlight. 3. Generating of a few watts of power in a nano-spacecraft. 4. The practical maximum area for a deployable LightSail on a nano-spacecraft with high temperature and strong radiation limits. 5. The practical use of the LightSail beyond 5 AU.

From this study will emerge novel technological solutions to advance flight beyond our solar system and eventually to the stars and a specific mission concept, perhaps to the solar gravity lens focus, to extend human scientific understanding beyond our own solar system.