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Things To Do While Coasting Through Interstellar Space

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Abstract

Interstellar transportation over periods shorter than the human lifetime requires speeds in the range of 0.2 c to 0.3 c. These speeds are attainable using beamed momentum propulsion as presented in previous papers by numerous authors[1-5]. The issue then becomes survival of the spacecraft, especially if human cargo is to be carried. This paper reviews the interstellar environment using the latest data available with respect to radiation and dust particles, and reports on a systems engineering study to design a spacecraft that could not only survive an interstellar trip, but also gather needed resources in situ during transit. Unless there is a breakthrough in Faster Than Light (FTL) propulsion, spacecraft with this sort of "live off the land" capabilities will be necessary if mankind is ever going to venture beyond the solar system.

Keeping humans healthy and sane in a small closed environment for several decades is not impossible, just very difficult. Issues like radiation and weightlessness must be addressed as well as more mundane things like breathable air, food, water, and warmth. Finally, some form of purposeful activities and companionship is necessary or the creatures exiting the spacecraft at the target star could be far from the human norm.

These requirements are addressed in a series of trade studies examining alternate approaches to interstellar spacecraft design. These hypothetical spacecraft designs identify initial cruise mass, crew volume, power, and approaches for reducing hazards such as radiation and loss of atmosphere.

Introduction

This paper will address the major issues with respect moving humans through interstellar space at small fractions of the speed of light. For the purposes of this paper, the design interstellar trip will last for thirty years and cover ten light-years. The vessel will contain four inhabitants initially with some provision for adding children. Start mission mass should be minimized and a mission cost of $2.2 M/kg will be assumed as the cost to accelerate the system to 0.3 c[1]. This assumes 4 $\times 10^{15}$ joules per kilogram at 0.3 c, 50% acceleration efficiency, and one mil per kilowatt-hour as the cost of beamed power in deep space.

Interstellar Environment

Interstellar space is not completely empty. It contains diffuse atoms of every element (but mostly hydrogen and helium), plus very sparse grains of dust formed by atoms pushed out of stellar coronas by stellar winds[7]. These constitute a collision hazard, but also a resource that could be utilized under the right circumstance. Interstellar space is also full of cosmic rays, which are actually completely ionized atoms accelerated to very high-energy states.

Most galactic cosmic rays have energies between 100 MeV (corresponding to a protons at 43% of the speed of light) and 10 GeV (corresponding to 99.6% of the speed of light).