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Propulsion tradeoffs for a mission to Alpha Centauri

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Abstract

Considering the first interstellar mission to Alpha Centauri we will necessarily obey the physics of special relativity, rather than of classical Newtonian mechanics. From this viewpoint, several issues were recently discussed by one of the two authors (L.D.) in his Master's thesis written under the supervision of the senior author (C.M.).

The relevant conclusions were that a “relativistic” mission to Alpha Centauri might be feasible with the following requirements:

- (1) The speed profile should be the so-called “relativistic hyperbolic motion”.
- (2) The propulsion system should be one of the followings:
 - (a) Antimatter (specific impulses of the order of the speed of light).
 - (b) Carlo Rubbia's “nuclear propulsion” based on taking aboard a black body source (“take half the Sun with you!”).
- (3) An adequate protection system against impacts from space debris (a critical problem not adequately solved at the moment).
- (4) The telecommunication system should be based on the Karhunen–Loève Transform (KLT) for data compression and filtering, as theory of the optimal relativistic telecommunications outlined long ago by one of us (C.M.).

With all the above remarks, the authors think they outlined a basic, but technically sound, theory for the first interstellar special-relativistic flight to Alpha Centauri.

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1. Introduction

Through this work we will study fundamental problems that one has to face for an interstellar relativistic mission design, as carried out by Luca Derosa in his Master's thesis [1].

We will choose the *hyperbolic motion* as speed profile, so we will consider spaceships following a rectilinear path with a constant acceleration referred to as

the proper reference system (i.e. constant proper acceleration), and we will also see that such a motion implies many important advantages (e.g. a close connection with the relativistic rocket equation also named “Ackeret equation”).

The main part of this work will consist of choosing the propulsion system. The choice will be done in order to have the most suitable system for an interstellar space mission, making a comparison among electric propulsion, nuclear propulsion and antimatter propulsion.

We will touch the problem of spaceship protection systems from interstellar debris, cosmic rays and external electromagnetic radiations. It is a huge problem

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