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A FEASIBILITY ANALYSIS OF INTERSTELLAR RAMJET CONCEPTS

Abstract

The major limitation of interstellar travel is the high energy needed to accelerate a vehicle to a velocity close to the speed of light in order to have travel times in the order of decades. The original Bussard interstellar ramjet concept was proposed to attain high velocities and short flight times for interstellar travel fueled by fusion energy of interstellar gas (hydrogen). However, several problems such as the extreme conditions necessary to initiate fusion, the slow first proton-proton nuclear fusion reaction, the requirement of higher number density of hydrogen for initial operation, the large required radius (around 100-1000s of km) of the scoop, drag exceeding the thrust produced by the exhaust particles, etc. were identified, so throwing into question the feasibility of this idea. Since then, several ramjet variants such as the ram-augmented ramjet, laser-propelled ramjet and other supporting concepts such as the ramjet runway, use of the carbon-nitrogen-oxygen cycle instead of proton-proton nuclear fusion, etc., have been proposed to make interstellar ramjets potentially more promising for future interstellar travel.

Following a literature review of the interstellar ramjet concept, this paper presents a feasibility analysis of the different interstellar ramjet variations. Next, it offers suggestions on potential spatial operational regions for ramjets and examines the underlying assumptions made by past researchers. Based on this, it describes a range of resulting fundamental and technical gaps. It concludes by identifying credible potential solutions, assessing the most promising ones and offering a roadmap for further research to improve the capability of the interstellar ramjet concept