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Author: Ms. Aayusha Singh
other, India

Mr. Amrit Roy
other, India
Mr. Om Singh
India

RELATIVISTIC EFFECTS ON SPACECRAFT IN INTERSTELLAR TRAVEL: EXAMINING TIME DILATION AND RELATIVISTIC ENERGY IN DEEP SPACE MISSIONS.

Abstract

With the increasing feasibility of deep space exploration, interstellar travel has become a critical area of investigation within astrophysics and aerospace engineering. This paper examines the pivotal role of relativistic physics, specifically time dilation and relativistic energy demands, in missions approaching a significant fraction of the speed of light. Leveraging Einstein's Special Relativity, we explore the implications of time dilation on astronauts' aging, communication, and mission logistics, with a detailed analysis of the extraordinary energy requirements needed to sustain such speeds. Through comparative studies of propulsion technologies, including antimatter propulsion, warp drives, and ion propulsion, this research evaluates each method's potential to achieve and maintain relativistic velocities, weighing propulsion efficiency against the massive energy challenges. Computational models and simulations further quantify the dual influence of time dilation and relativistic energy demands, offering insights critical to future mission design, human factors, and interstellar logistics. Our findings highlight a roadmap for the development of propulsion systems that balance near-light-speed travel feasibility with astronaut safety and mission sustainability, setting foundational benchmarks for the future of interstellar exploration.

Keywords: Interstellar Travel, Time Dilation, Relativistic Energy, Special Relativity, Deep Space Missions, Antimatter Propulsion.