IAF SPACE PROPULSION SYMPOSIUM (C4)
Disruptive Propulsion Concepts for Enabling New Missions (9)

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CRYOGENICALLY MODERATED POSITRON PROPULSION SYSTEM FOR DEEP SPACE EXPLORATION

Abstract

Humanity's quest for deep space exploration demands propulsion technologies that are efficient, capable of generating sufficient energy, and reliable. Traditional propulsion techniques have limitations in all these aspects. To circumvent this, antimatter propulsion techniques which are still in their infancy need to be explored as a practically viable alternative. This concept paper expedites the design and development of a cryogenically-moderated antimatter propulsion system. Since Dirac's prediction of the existence of antimatter through his relativistic wave equations, the incorporation of the annihilation of antimatter into deep space propulsion technologies has been recognized. The total energy released per unit mass in a matter-antimatter annihilation is around $9 \times 10^{10} MJ/kg$, which is 10 billion times the value of current combustion techniques. The proposed propulsion system works on the principle of radioisotope positron propulsion, in which Na_{22} is used as a source. Na_{22} has a half-life of 2.6 years and a broad energy spectrum that requires suitable moderation, which is accomplished by using a cryogenic moderator. The existing literature and practice consist of a metal-core moderator, but for deep space travel, a rare-gas moderator (RGM) is more desirable owing to its better efficiency. Neon gas is cryogenically cooled on a copper surface in a conical geometry. A buffer gas trap (BGT) is used in series to store and pulse the positron beam downstream. This allows us to control the rate of annihilation in the ionization chamber with Xenon and the ensuing Xenon ions produced are accelerated using a modified Kaufman thruster. Cryogenic moderators operating with BGTs can also be integrated with any ion thruster of choice. The proposed matter-antimatter propulsion system holds considerable promise in terms of enabling novel mission concepts and augmenting the capabilities of existing missions, thereby positioning it as a highly promising avenue for future deep space endeavors.