A MAGNETO-INERTIAL FUSION DRIVEN ROCKET*

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The future of manned exploration and development of space depends critically on the creation of a world has pursued with the vast majority of its research investment, are wholly inappropriate for space transportation. The straightforward application of a reactor based fusion-electric system creates a colossal mass and heat rejection problem for space applications. A practical path to fusion propulsion can only be achieved by creating fusion under conditions that can work in the context of space. Here a fusion propulsion system must (1) provide for the resultant fusion energy to be directly converted into electrical and propulsive (directed) energy, and (2) cannot be so massive or complex as to require hundreds of launches or large scale assembly and maintenance in space.

What is considered here is a stratagem for a fusion-based propulsion system that satisfies these criteria. The key to achieving this stems from current research being done at MSNW on the magnetically driven implosion of metal foils onto a magnetized plasmoid target to obtain fusion conditions. A logical extension of this work leads to a method that utilizes these metal shells to not only achieve fusion conditions, but to serve as the propellant as well. An array of low-mass lithium foils are inductively driven to converge radially and axially to form a sufficiently thick blanket surrounding the target plasmoid while compressing the plasmoid to fusion ignition conditions. Virtually all of the radiant, neutron and particle energy from the plasma is absorbed by the encapsulating, thick metal blanket thereby isolating the spacecraft from the fusion process and eliminating the need for large radiator mass. This energy, in addition to the intense Ohmic heating at peak magnetic field compression, is adequate to vaporize and ionize the lithium blanket. The expansion of this hot, ionized metal propellant through a magnetic nozzle is used to directly generate electrical power from the back emf, as well as produce high thrust at the optimal exhaust velocity. The energy from the fusion process, along with the waste heat, is thus utilized at very high efficiency permitting the fusion propulsion system to be realized at significantly lower mass and input energy. This, together with the inherent simplicity allows for both low cost and rapid development. It is possible to test most of the critical elements in smaller scale laboratory experiments. A sub-megajoule breakeven experiment for concept validation will be described in detail, as well as the scaling physics relevant to this approach.

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