DPLS Impulse Drive

What is the proposed concept?

The thesis is to study the implementation of an innovative impulse thrust producing technology for use in NASA missions involving in-space main propulsion. A DPLS Impulse Drive for propulsion is based on the dual position latching solenoids (DPLS) (also referred to as a Bi-Stable Permanent Magnet Actuator). Variations of the DPLS is already being used for actuation in US patents #9,136,052, # 9,702,477, #10,024,453, #10,236,109, and #10,508,481 with the principal electronics for operating a DPLS in US patent #9,343,216; all invented by the principle investigator. The rights to most of these patents have already been given to NASA. The DPLS has been under study by the principle investigator since 2008 with many prototypes fabricated and tested. The largest DPLS built has a 8-inch diameter with 4000 lbs. of holding force, weighs about +50 lbs. and moves a bit across a surface when activated. The smallest DPLS built was a 0.5-inch diameter device with 6 lbs. of holding force. As report [e.g., 1], load cell measurements were taken on an ~1.5-inch diameter DPLS with 100 lb. of holding force, showing a 20 lb. impulse force (20% the holding force) after stop of armature motion, which was about 8 lbs. higher that the initial reversed thrust caused by the armature motion. Whereby, the basic physics is technically credible and can be related to the impulse created by the rapid motion (applied voltage phase) of the piezoelectric mass in the Mach Effect Thruster (MET) [e.g., 2] previously funded under NIAC, with the DPLS Impulse Drive having a much higher impulse force per cycle.

What makes it exciting?

The DLPS produces an impulse force by redirecting the magnetic field from a permanent magnet using a pulsed magnet coil to cause acceleration of an armature over a small distance. The magnetic field produced by the magnet coil does not go against the magnetic field of the permanent magnet. Therefore, no demagnification of the permanent magnet occurs. Further, since the duration of the pulsed current to the magnet coil is a few milli-sec per pulse, the magnet coil remains at a much lower temperature than occurs with similar continuous current driven devices. The armature is dual poled, free to accelerate under the magnetic force, and magnetically latches in two linear directions. The impulse force is created from the acceleration and capture (latching) of the armature in the DPLS. Whereby, 180-degree rotation of the DLPS allows for a second impulse force in the same direction as the first. Rotation is then analogous to the relaxation (zero voltage) phase that occurs with the piezoelectric in the MET.

The DLPS Impulse Drive then has the revolutionary capability to produce thrust without the irreversible ejection of propellant, eliminating the need to carry propellant as required with most other propulsion systems.

The DPLS Impulse Drive is not a rocket, it does not expel fuel mass, and does not suffer from the velocity restriction of rockets. Freedom from the need to expel propellant means very high velocities will be achievable simply by providing electrical power and adequate heat rejection for the drive system. Ultimately, after more development and once proven in flight, the DPLS Impulse Drive could be used for primary mission propulsion, opening up the solar system and making interstellar missions a reality. Whereby, a mission to MARS or beyond is possible in the near future using RTG power and arrays of rotating DPLS. A future goal would be an interstellar mission to at least 0.10 c.

Is the concept unexplored?

The concept of using a DPLS Impulse Drive is Ground Breaking, as it has not been considered for space propulsion previously. Given the high impulse force capability of a DPLS, this study would open a new Science and Technology Area that could enable new propulsion concepts toward new missions in the future as yet to be foreseen.

Why is the concept credible and technically sound?

This exciting TRL 1 technology is ready to take the next step to providing propellantless propulsion, first in incremental NASA small scale missions, but later enabling revolutionary new deep space exploratory capabilities beyond anything achievable by conventional chemical, nuclear or electric propulsion systems. Our Principal Investigator has uniquely developed this unexplored opportunity, breaking new ground in both science and engineering. Finally, it is technically credible – if bold and unconventional – and is fully consistent with modern physics, with DPLS devices having been laboratory demonstrated and patented into various devices since 2008. Further, a new acceleration model has been developed that has been used to predict the impulse from a DLPS as well as from a simple solid rocket motor and the MET [*e.g.*, 1, 3]. However, once the impulse force of a DPLS is experimentally known, the total thrust is simply the impulse time (times) frequency (times) impulse force. That is, a single 8 lb. net impulse DPLS with an impulse time of 0.004 sec and pulsed 100 per sec, equates to a thrust of 0.004 X 100 X 8 = 3.2 lb.-force (4.45 N). Whereby, no new physics is needed.

Briefly, what do you plan to accomplish in the Phase I study.

Our initial Phase I effort will have four tasks, two experimental, one research study, and one analytical:

1. Design and develop a DPLS Impulse Drive with two (or more) rotating DPLS to increase the impulse frequency, in order to provide long duration thrust at levels required for practical propulsion applications.

2. Design and development a wireless power supply and electrical systems to provide feedback and control of the input pulsed DC current to the magnet coils as the multiple DPLS system rotates.

3. Research current shock absorber technology to determine the best shock absorbing method to reduce vibrations from the impulsing and rotating DPLS devices.

4. Conduct an engineering feasibility study for an orbit-maneuvering test to move a ~5,000 Kg mass including a modest 25 Kg of payload, a distance of at least 200,000 m.

References

1. Robertson G. A., "Acceleration Mechanics for New Propellant-less Space Drives, presented at the Advanced Propulsion Workshop, El Segundo, CA, November 2017.
2. Fearn, H. *et al*., NIAC Phase 1 and 2, Mach Effects for in Space Propulsion: Interstellar Mission, 2017–2018.
3. G. A. Robertson, Propulsion Physics under the Changing Density Field Model, JANNAF, 2012 and presented at the Advanced Space Propulsion Workshop 2012.

DPLS Impulse Drive for In-Space Propulsion

What is it?

DPLS Impulse Drive

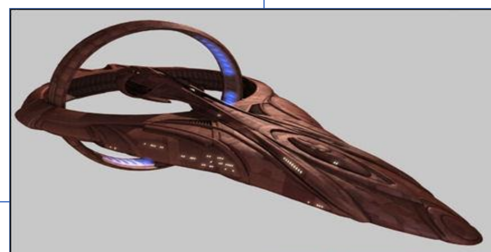
- A propellantless propulsion device
- Consistent with Modern Physics
- Electrical energy in, unidirectional reaction out

How can it be used?

The DPLS Impulse Drive can potentially replace any in-space propulsion system, from reaction/attitude control to primary spacecraft propulsion

Study Approach

1. Design and develop a DPLS Impulse Drive with two (or more) rotating DPLS to increase the impulse frequency and thrust.
2. Design and development a wireless power supply and electrical systems to provide feedback and control.
3. Research current shock absorber technology for reduction of vibrations to payload.
4. Conduct an engineering feasibility study for an orbit-maneuvering test.



Preliminary Orbit-Maneuvering Spacecraft Design

Potential & Benefits

- The DLPS Impulse Drive will produce thrust orders of magnitude above the MET previously studied under NIAC, which is still under development with milli-Newton thrust.
- Scalable electrically – powered propulsion w/o exhaust.
- Potentially fast transit times for solar system and beyond.