Mach Effects for In-Space Propulsion: An Interstellar Mission

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The MEGA Drive does not explore: Propellantless propulsion is a prerequisite for interstellar travel

The MEGA Drive

"Inertia here arises from mass out there"

The Propulsion Challenge

The vast amount of propellant needed for conventional rockets eliminates them as realistic options for long-distance missions. We must do better.

The Interstellar Spacecraft Design, Components & Mission

The Interstellar Mach Effect Spacecraft – 1 (IMES-1)

Three primary tasks:
1. Improve current laboratory-scale devices to provide long duration thrust for practical propulsion (e.g., chipfed pulsar AC).
2. Design and develop power supply and electrical systems to provide feedback and control of the input AC voltage and frequency to improve the efficiency of the MEGA drive.
3. Using the data from steps 1 and 2 above, design a probe to carry a 400 kg or greater payload to a rendezvous with Proxima Centauri b within 20 years with data to be recorded and transmitted back over 5 additional years.

The MEGA Drive

The MEGA Drive does not explore:
- Thrust due to the interaction between the gravitational potentials of the sun and the second time derivative of the mass-energy of the probe.
- Inertial mass fluctuations are then generated in the device. This thrust, however, is undesirable and leads to uncontrolled forward or reverse motion at an inappropriate frequency.

How does this work?
- A gravitational mass fluctuation is produced, which is then absorbed into the center-of-mass.
- The net force is then expected to omega (displacement by impeding it)

Energy and Momentum
- The kinetic energy of the spacecraft comes from the gravitational mass fluctuation.
- The power is used to create the kinetic energy of the device.

Power Generation
- The minimum model of complexity to illustrate the rate of change of the center of momentum is a system of two masses m1 and m2 coupled by a spring.

A dashpot is also necessary for realistic modeling of the amplitude of vibration, but for simplicity, the rate of change of COM momentum can be used to determine the effect. For this illustrative purposes the following assumptions are made:
1. no damping
2. very weak gravitational field
3. uniform gravitational field with respect to the dimensions of the drive
4. small mass and spring rate
5. small spring

The minimum model is an arbitrary reference point, noting that the extension is observed on an extension. This can be shown to be one of the ways of changing the center of momentum (COM) is given by the first time derivative of the variable mass as follows:

\[ \dot{m} = m \alpha \]

Where m is the mass of the spacecraft, \( \alpha \) is the acceleration, and \( \dot{m} \) is the rate of change of mass.

(1) Does the device during operation change mass, and if so, how?

In our experiments using a device with an initial mass of 2 kg, the mass is observed to fluctuate from a minimum of 30 kg to a maximum of 100 kg with a zero to peak amplitude of one on a peak-to-peak mass of 70 kg (the mass of the spacecraft invokes a non-conservative change which is equal to the zero point). This is a mass fluctuation and unit mass on the order of one part in 10^5.

The theoretical mass fluctuation is \( \Delta m = \Delta m_0 \times 10^{-5} \) for a 100 kg device.

(2) How does the MEGA drive work?

The MEGA Drive is a system of two masses m1 and m2 coupled by a spring.

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(3) Why hasn't this force been seen in experiments before?

The force measured by experiments is due to both the parametric and mechanical effects. The parametric effect is found in the spacecraft elliptical motion, which is resonant and is represented by a high order mass which is unresounceable. These experiments included the lower end of the mass range, and the acceleration was too low for any measurement to be made in the spacecraft used.

The primary source of force is given by the parametric effect, which is due to the interaction of the spacecraft with the gravitational field. This force can be calculated using the following equation:

\[ F = \frac{m \alpha}{\sqrt{m_1 m_2}} \]

(4) Doesn't the MEGA drive result in free energy, and therefore used for energy generation?

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(5) Why doesn't the MEGA drive violate General Relativity?

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(6) What natural systems might exhibit MEGA drive effects?
Could these be observed, and how?

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