Propellant-less propulsion based on electromagnetic resonant cavities: EM-Drive

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LTU Atmospheric Science. Investigation of propellant-less propulsion based on electromagnetic resonant cavities
EM-Drive

Roger Shawyer’s first prototype 2001

Alleged Thrust 16mN for an input power of 850W
2008  *Yang Juan*  Northwestern Polytechnical University (Xi’an) China 750 mN/2500 W

2011  *Guido P. Fetta*  The Cannae Drive (Q-drive)  **Alleged Thrust:** 8-10 mN  /  10.5 W
2013-2014 *Harold G. White*  Eagleworks - NASA

Tapered Cavity Test (EMDrive)

Cannae Test (Cannae drive)
M. Tajmar’s prototype with Waveguide, Magnetron 2015

Tajmar said that: “Our test campaign cannot confirm or refute the claims of the EmDrive but intends to independently assess possible side-effects in the measurements methods used so far. The nature of the thrusts observed is still unclear. Additional tests need to be carried out to study the magnetic interaction of the power feeding lines used for the liquid metal contacts.”
$m_i = m \left(1 - \frac{2c^2}{|a|\Theta}\right) = m \left(1 - \frac{\lambda}{4\Theta}\right)$

$c$ is the speed of light, $\theta$ is twice the Hubble distance, $a$ is the magnitude of the relative acceleration of the object relative to surrounding matter and $\lambda$ is the wavelength of the Unruh radiation it sees.

$F = \frac{-PQl}{c} \left(\frac{1}{W_{big}} - \frac{1}{W_{small}}\right)$

$F$ is the force generated,
$P$ is the input power
$Q$ the quality factor
$l$ the axial length of the cavity
$c$ the speed of light
$W$ denotes the cavity width.
Figure 7. A graph showing the acceleration along the x-axis and the ratio between the inertial and gravitational mass along the y-axis. For the assumption of an equivalence principle there is the straight dashed line $m_i = m_g$. MoND agrees with this until the acceleration is as low as $a_0$ and inertial mass suddenly reduces. MiHsC approximates the equivalence principle for high (normal) accelerations, but reduces the inertial mass in a new gradual way for tiny accelerations.
Acceleration anomaly on edges of Galaxies

Dark Matter?

Fritz Zwicky in 1933: galaxy clusters

Rubin and Ford in the 1970s: Saint James Way or Milky Way
Photon-loop: a “clean” experiment
F \sim 4\pi rb PQ/c \left(1/rb - 1/rs\right)

Small Radius (rs): 30 mm
Big radius (rb): 150 mm
Number of turns: 2018
Total weight: 620 \pm 10 g
Length of threads: 4825 \pm 3 mm
Power of laser: 100 mW
Nominal oscillation resonance 0.2290 Hz

1 µm displacement equivalent to 1.3 µN
Q = 204.6

Figure 15. Plot of the amplitude of vibrations for a ratio of frequencies.
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Damping ratio $\zeta = \gamma / \omega_0 = 0.00244 \pm 0.00007$

Quality factor $Q = \sqrt{k \cdot m / b} = 205 \pm 2$
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Average

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1 µm displacement equivalent to 1.3 µN
Resonant thrust 0.04 µN/W
Laser light
Pendulum position
Force due to Photon momentum absorption

Light Power = 100 mW = \(\frac{dNp}{dt} \cdot h \cdot \nu\)

\[= \frac{dNp}{dt} \cdot c \cdot h/\lambda\]

\(P=\frac{h}{\lambda}\)

Force = Power/c = \(3 \times 10^{-10}\) N = \(3 \times 10^{-4}\) \(\mu\)N
Magnetic Force \( \sim 2 \times 10^{-10} \) N
Conclusions

- There is a photon-thrust effect in the amplitude (4 times larger than noise level - third harmonic)

- Magnetism, thermal, photon momentum and any optostriction effects are estimated to be much smaller.

- Is eventually Dark matter not needed?!
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