

# Optimization of Miniaturized Resonant Microwave Cavities for Use in Q-Thrusters



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## Background/Relevance

- Quantum vacuum plasma thrusters (Q-thrusters) are a recently discovered type of propulsion system that are hypothesized to operate due to momentum interaction with the virtual particles that make up the quantum vacuum.

## Innovation

- Q-thrusters are hypothesized to produce thrust as long as they are powered. They do not require reaction mass. This innovation could revolutionize space exploration. As long as there is electricity, the thruster has the ability to accelerate the spacecraft.

## Key Results

- Used COMSOL to make RF and heat transfer Multiphysics models to simulate microwave heating effects on the cavity.
- Began preliminary design considerations for Q-thrusters, antennas, and test equipment.
- Partnered with NASA EagleWorks laboratories to develop understanding of Q-thrusters.

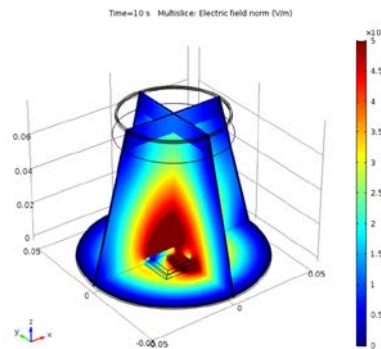


Fig. 1: A COMSOL model of a Q-thruster cavity driven by a micropatch antenna showing electric field density.

## Approach

- Model Q-thruster cavities and driving antennas in COMSOL to build an understanding of electrical and thermal effects and their possible contribution to real world experimental error.
- Develop a Q-thruster module for use on a CubeSat.
- Construct a sensitive torsion pendulum that can measure force in the  $\mu\text{N}$  range.
- Use the force pendulum and Q-thruster to investigate physical theories governing the behavior of Q-thrusters.

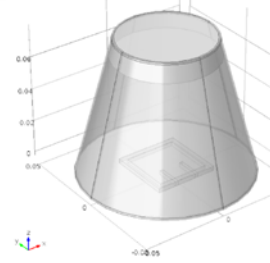


Fig. 2: A COMSOL mesh model of a Q-thruster.

## Conclusions

- Industry review of available miniaturized RF equipment has been completed.
- Necessary RF equipment has been designed and modeled in COMSOL including: Resonant cavity, micropatch antennas, and dielectric inserts.

## Future Work

- Construct a sensitive torsion pendulum.
- Construct a Q-thruster.
- Use coupled Q-thrusters to investigate the current theory of operation.