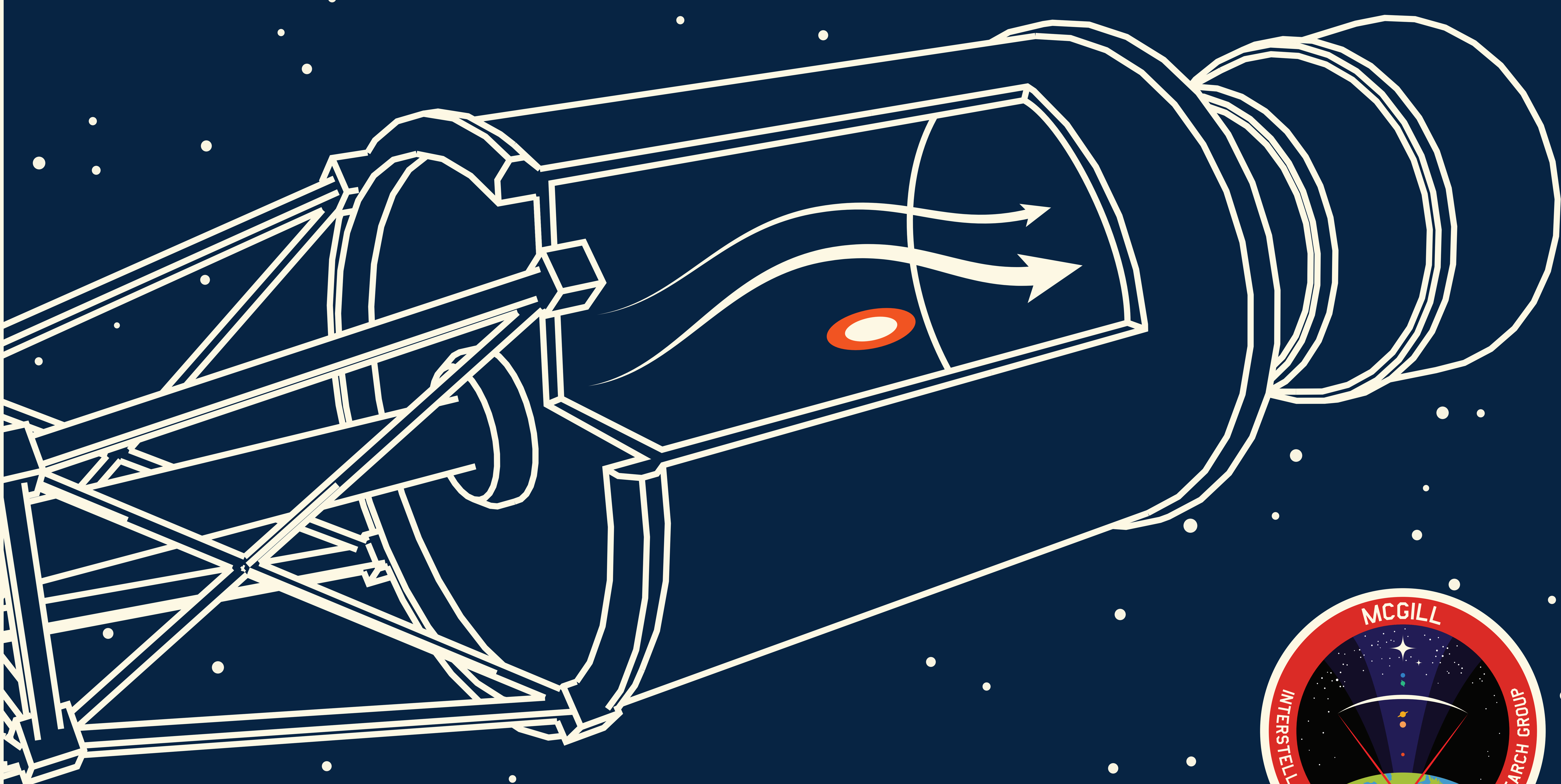
LASER-THERMAL PROPULSION for *Interplanetary Travel*



Zhuo Fan Bao, Emmanuel Duplay, Alp Tanriover, Andrew Higgins

Overview

Moore's law development of fiber lasers enabled cheap, modular and scalable phase-locked laser arrays that can act as a single optical element. This allows for large lasers to be beamed out over long distances into space.

Extensive work on laser thermal was conducted in the 1970-80s, and this work is a revisit of them in light of new 1 micron lasers.

Motivation

Taking advantage of this disruptive technology, laser thermal propulsion can accelerate to the necessary ΔVs for missions to Mars and Jupiter using a 10 m array within an hour timeframe.

The heating chamber is the crux of laser thermal propulsion and requires further work. This is crucial to understanding how laser light is converted into enthalpy, and eventually thrust.

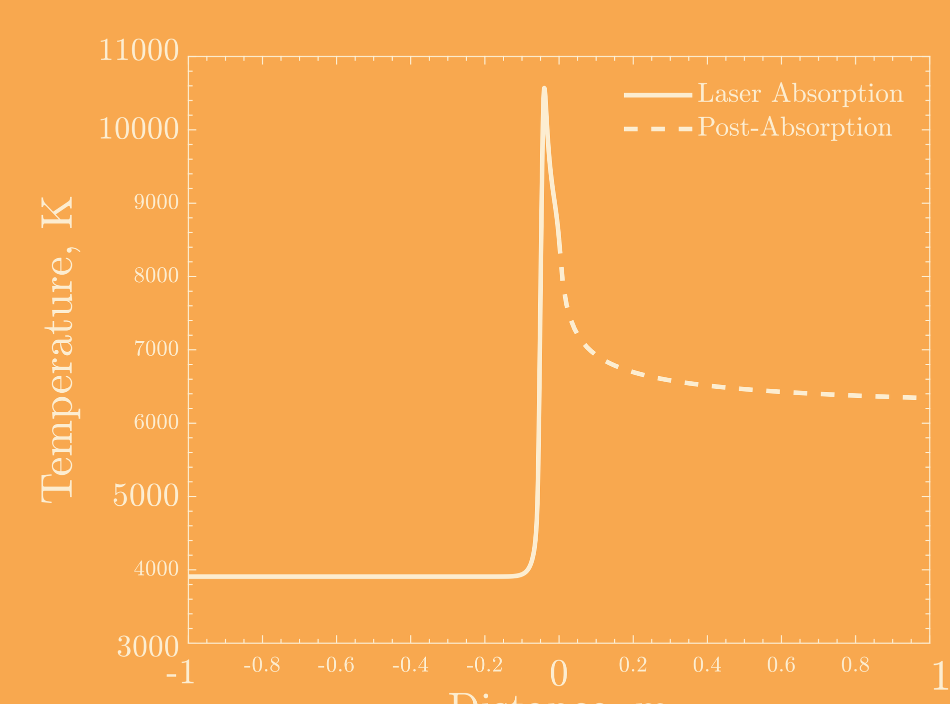
Heating Chamber

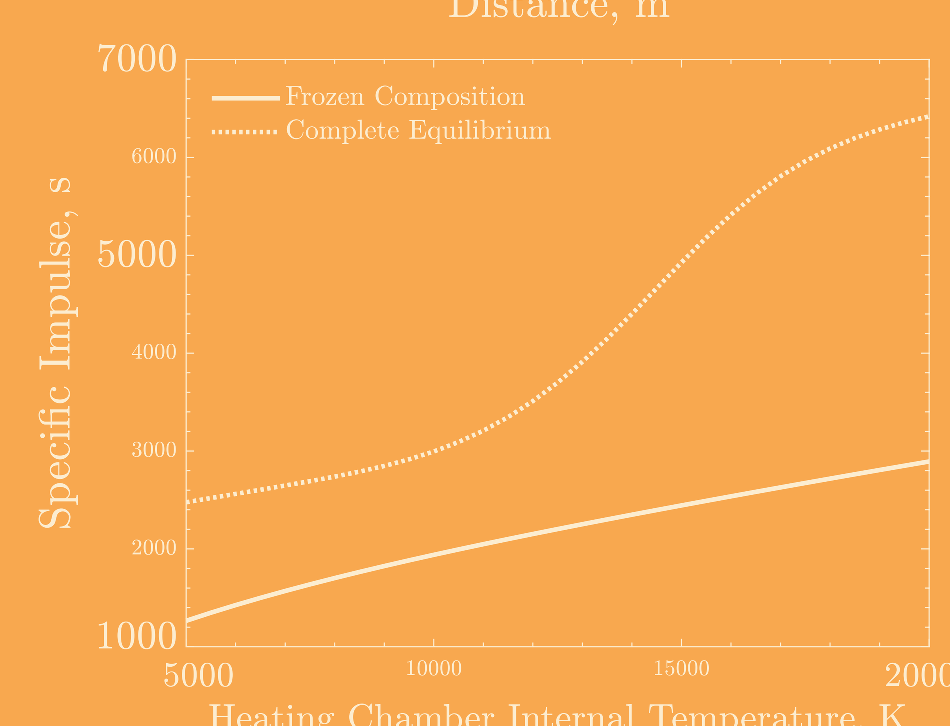
A hot plasma forms in the middle of the heating chamber and converts laser energy into enthalpy through gas absorption mechanisms (photoionization and inverse bremsstrahlung).

A one-dimensional ODE scheme (Keefer) was developed using the conservation laws to model the temperature profile of the plasma. The model was constructed assuming one-dimensionality, constant pressure, conductive heat transfer inside the plasma and radiative heat transfer outside.

Nozzle Expansion

The hot gas is then expanded using a nozzle to convert enthalpy into thrust. To justify the high I_{sp} this propulsion method claims to achieve, the I_{sp} possible for various chamber temperature is bounded by a frozen equilibrium expansion and a complete equilibrium expansion.





Acknowledgments

This work is supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) and the McGill Summer Undergraduate Research in Engineering (SURE) program. Thanks to Philip Lubin, Carl Knowlen, Mélanie Tétreault-Friend, and Pascal Hubert for their insight and feedback.

NSERC CRSNG

McGill