Concept Demonstration of Directed Energy Propulsion with Metasurface Lightsails

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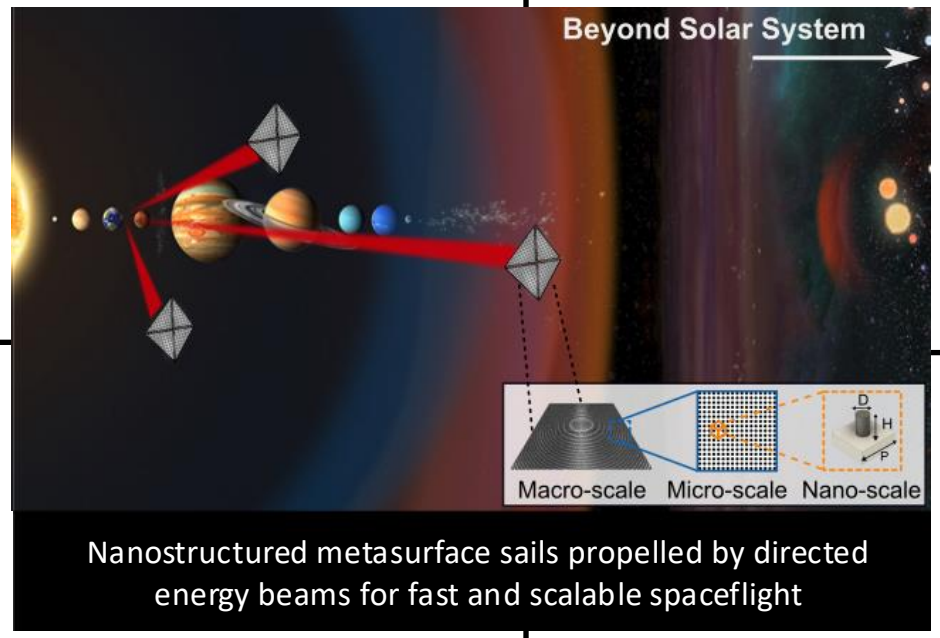
Research Objectives

Goal: Propulsion of nanostructured light sails with high-power laser beams for fast, frequent, and scalable space missions.

Innovation: Computational and experimental opto-mechanical approaches to enable ultralightweight, stable, and high-thrust photonic metasurface light sails.



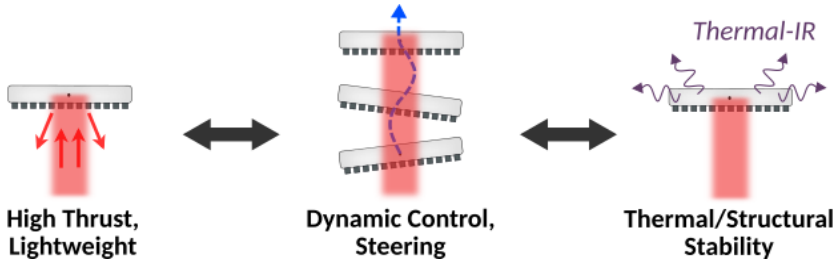
Nanostructured metasurface sails propelled by directed energy beams for fast and scalable spaceflight

SOA: Conventional fueled propulsion methods are limited by the rocket equation and solar sails are limited by low-intensity sunlight; optical actuation by lasers is primarily limited to nano/microscale particles and objects.

- ❖ Start TRL: 1
- ❖ End TRL: 3

Approach

- Computational modeling of beam-sail interactions; multi-scale optomechanical design; modeling of lightsail propulsion dynamics
- Nanofabrication and lab-scale experimental investigation; test, refine, and inform a pathway for technology scale-up.



Potential Impact

- Ultrafast, including relativistic velocities, to enable deep space and possibly interstellar spaceflight.
- Sails that could be much smaller than solar sails and deployed in large number (swarms) for fast and frequent missions.
- Ability to actively direct and steer sail in any target direction.
- *Benefits:* Advance the development of ultra-thin and lightweight space structures, space thermal management with multispectral photonic materials, fundamental understanding of coupled optical, structural, and thermal material limits.