A Self-Stabilizing Metasurface Laser Sail To Explore The Stars

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Laser Propelled Spacecraft





Starshot Breakthrough Initiative

How fast is 1/5th the speed of light?





- Took the first close up pictures of Pluto in 2015
- One of the fastest man made objects

Gif from Clay Bavor





Force is determined by the reflected/refracted light

If we control how the light reflects/refracts, we can control the optical forces

Laser Sail

Metasurface Based Laser Sail

- Thin, lightweight structure with subwavelength scattering elements
- Controls the phase and magnitude of reflected/refracted light



Metasurface Example







Example Metasurface

Metasurface Motion





Designing a Stable Sail





Idealized Metasurface to Generate Stable Coefficients





Full-Wave Simulation





Local Optical Forces on Metasurface





What's next?

 Incorporate optimization techniques that can take advantage of throughput computing to more efficiently explore the parameter space

 Generate a sail based on a set of dynamic force coefficients without human intuition

 Improve the efficiency of our realistic sails by using optimization based metastructures



Figure courtesy of Greg Holdman



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