Plasmonic Force Propulsion Revolutionizes Nano/PicoSatellite Capability

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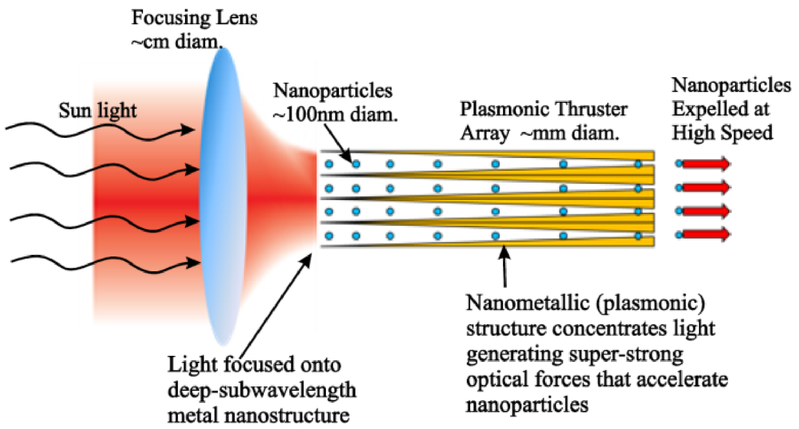
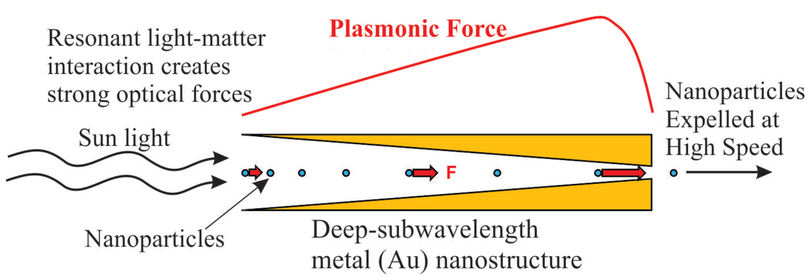
The Concept

- **Plasmonic Force Propulsion**



- **How It Works**

1. Sun light is focused onto deep-subwavelength metallic nanostructures through a lens
2. Resonant interaction and coupling of light with the nanostructure excites surface plasmon polaritons that generate a strong gradient optical force field
3. Nanoparticles (e.g., glass beads or metallic particles) are accelerated by the gradient force field and expelled at high speeds



Exciting Potential

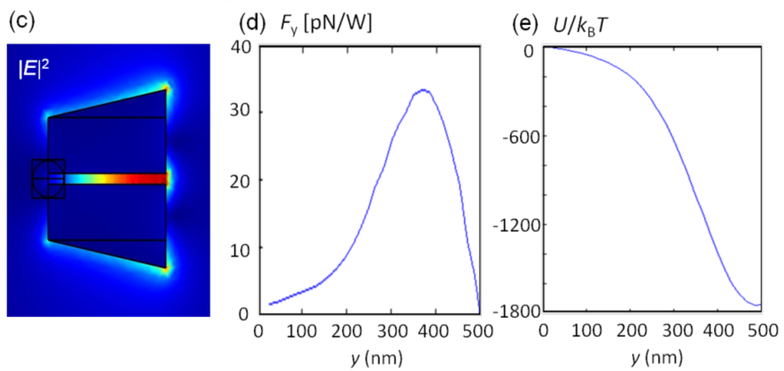
- NASA continues to focus on smaller spacecraft

Nano / Cube / Phone / Picosatellites

- Propulsion provides Smallsat Maneuverability
- **No Spacecraft Power!**: Direct energy conversion solar-to-propulsive thrust
- **Minimal Mass/Volume Requirement**: ~1% of cubesat constraints
- New small satellite capabilities : Precise orientation for imaging, sensors, samples, formation flight

Feasibility of the Concept

1. Preliminary simulations of asymmetric thruster geometry show strong gradient optical force for accelerating nanoparticles



2. Plasmonic thruster arrays can produce useful thrust at reasonable specific impulse: 1.5 μN at 141 sec (2000 thruster array, 10^6 particles/sec, 25μmx5mm array size)

Approach to Conduct the Study

Goal: Assess the feasibility of plasmonic force propulsion for nano/pico satellites

Objective: Evaluate key mission parameters for a nano/pico-satellite using plasmonic force propulsion in attitude control and precision pointing

Approach: Use numerical and analytical modeling to predict plasmonic thruster propulsion performance and then use that information as an input to evaluate key attitude control and precision pointing parameters

Plasmonic Force Field Predictions
-Uses our existing plasmonics model
-Studies:
-Gradient geometry
-Gradient angle
-Solar light effects
-Nanoparticle mass effects

Used In →

Propulsion Performance Predictions
-First order principles
-Predicts thrust, Isp
-Incorporates:
-Nonlinear force profile
-Nanoparticle mass
-Variable acceleration distance
-Nanoparticle expulsion rate

Used In →

Mission Context Assessment
-Precision pointing control system context
-Predicts control resolution and pointing precision
-Based on similar analyses for LISA, GOCE, and ExoPlanetSat
-Comparison with SoA reaction wheels, colloid EP

Team Members Expertise

- **Joshua Rovey** – Space Propulsion
- **Xiaodong Yang** – Plasmonics, Photonics

Supported By:

NASA

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