# Metamaterial particles for orbital environment remediation

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## Research Objectives

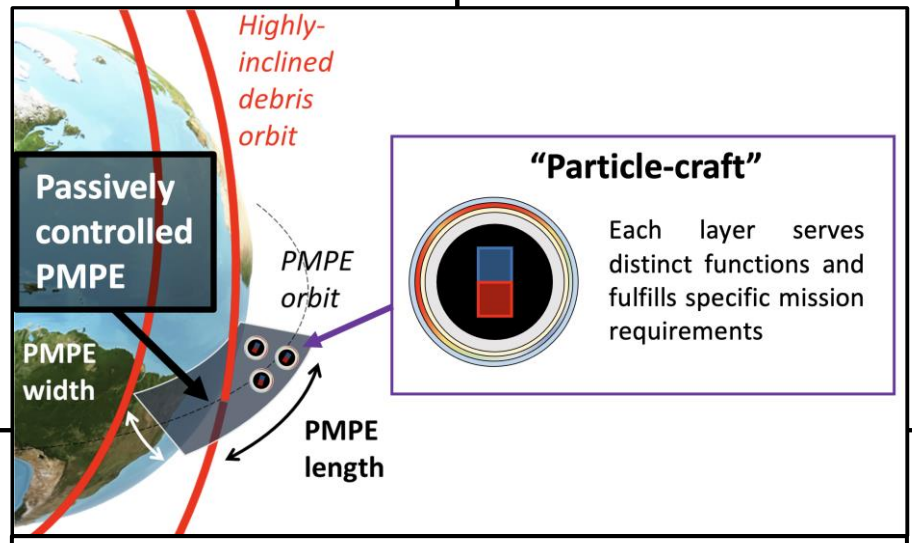
**Goal**: Devise programmable metamaterial particulate ensembles (PMPEs) for active debris removal (ADR) of the debris < 1 cm.

**Objective 1.** Derive PMPEs design principles and demonstrate PMPEs technical performance measures (TPMs) across relevant ADR scenarios.

**Objective 2.** Measure the survivability of key metamaterial properties to selected space environments effects.

**Objective 3.** Initiate the formulation of a technology demonstration payload.

*Exit TRL 3 by demonstrating critical functions*




*Left: PMPE operating as an equatorial sweeper to clean highly inclined orbits. Right: Conceptual design of a metamaterial particle constituting the PMPE.*

## Approach

**PMPEs.** By engineering geometry, optical, and thermal property variations of each constituent particle in relation to environment variations we can manifest a collective dust cloud movement and behavior beyond what is achievable with natural deorbiting and diffusion.

**Objective 1.** Multi-physics ADR simulations will be realized by integrating standard models. Probabilistic continuum dynamics simulations are planned for large-scale, long-horizon predictions.

**Objective 2.** Space environment tests will be conducted on candidate or representative metamaterials for PMPEs.

**Objective 3.** Formulation will be integrated with educational activities on campus.

## Potential impact

**Target debris population.** < 1cm.

**Mission duration.** Mission duration may range from a few months to a few years, depending on PMPE mass.

**Debris removed in one year.** Cloud size and mass influence the number of debris removed. Many configurations are available with existing or planned launch vehicles.

**Cost.** Cost-benefit analysis is included in the design of PMPEs configurations.

**Scenarios.** PMPEs may be amenable for environment stabilization (as a distributed sweeper), responding to a rapidly unfolding breakups (by reducing launch vehicle interface requirements), recovering from a space conflict (by scaling to cover larger areas), and preventing care (as coatings).