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Electromagnetic Formation Flight (EMFF)

Propulsion systems based on the use of consumables, specifically propellant, suffer from the inherent shortcoming that they may be operated only over a finite lifetime. In addition, some telescope missions can be adversely affected by propellant that may either deposit on optical surfaces or create a local plume that can obscure the line of sight to objects of interest. In cases where multiple spacecraft are free-flying relative to one another, and there is no need to control the center of mass of the system as a whole, a combination of electromagnetic fields and reaction wheels can be used to control all of the relative degrees of freedom of the system, without the use of propellant. Separated spacecraft interferometry (such as NASA's TPF Mission) is one type of mission that fits perfectly into this regime, both in the limited need for actuation as well as the susceptibility to thruster plumes.

Research conducted over Phase I of this project identified the critical technologies to make electromagnetic formation flight (EMFF) viable, and each was assigned a TRL. In addition, system trade analyses were conducted using the current state of the art to demonstrate that not only does EMFF compete favorably with thruster based systems, but it can be used to enable more aggressive missions as well. In addition to the original mission set, which focused primarily on interferometery, a much broader set of applications for EMFF has been identified. Some of the fundamental physical questions pertaining to the controllability of systems that would use EMFF have been addressed, and in fact the ability to control a simple 1 DOF system has been demonstrated in the laboratory.

The Phase II research proposed will 1) attempt to estimate the cost associated with developing the critical technologies through TRL 7, 2) conduct further system trades to establish the performance benefits that can be expected from this advancement, as well as possible missions that would be enabled, 3) advance the understanding of the dynamics and control of such systems and 4) establish a roadmap for inserting EMFF as a technology into future NASA missions.