High-Acceleration Micro-Scale Laser Sails for Interstellar Propulsion

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We proposed to develop a conceptual system architecture and to evaluate physical and technical limitations for a revolutionary relativistic propulsion concept which may enable interstellar probe missions to be launched at 1/10 light speed or more within 40 years. This propulsion concept is based on an innovative combination of the well-established concepts of laser-pushed light sails and particle-beam propulsion. The key innovation is the realization that a series of N small light sails can be accelerated more easily than a single large sail of the same total mass; in particular, the transmitter optical aperture area can be a factor of N smaller than for the single sail. Transparent dielectric sails (as opposed to metal-film sails) can withstand very high fluxes, which allows N to be large, potentially 10^6 or greater. A larger vehicle, sufficient to carry high performance sensor and communications payloads, can be accelerated over a long period – months or years – by a comparatively modest laser, using momentum transferred from a "beam" of sequentially-launched microsails. Under NIAC Phase I, we will review laser-dielectric interaction models and data to determine approximate limits on microsail flux, and attempt to identify, analyze, and quantify other system limitations such as mechanical stresses on sails. These results will be used to develop a preliminary architecture and define a development program. A particularly interesting feature of microsails is that they can be tested in the laboratory using existing lasers. If Phase I results are promising, significant experimental work on interstellar propulsion may be possible within the scope of a NIAC Phase II effort.