Description of a Proposed On-Orbit Calibration Procedure for SIM Based On Spacecraft Maneuver

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ABSTRACT

The astrometric performance of the Space Interferometry Mission (SIM) relies on precise measurements of the optical pathlength difference of the starlight through the arms of the interferometers that comprise the SIM instrument, and on precise relative distance between a set of fiducials that define the baselines of the interferometers. The accuracy of these measurements can be affected by various phenomena. Some of them are time-dependent (e.g., time-varying temperatures of components), while others are relatively static and repeatable (e.g., diffraction and polarization effects due to controlled translations and rotations of components). In this work we are concerned with the instrument errors of the latter type and in their compensation. In particular, a procedure for on-orbit calibration of the instrument error function is defined, and a proof of concept of its viability is presented. On a given grid of stars, the proposed procedure generates approximations of the gradient of the instrument error function at a discrete set of field points corresponding to the star locations via a specialized set of maneuvers of the spacecraft. These gradient approximations are then used to estimate the error function via a least squares procedure in a manner that is very analogous to the wavefront reconstruction problem in adaptive optics systems. An error analysis of the procedure is presented providing further insights into the connections between instrument errors and the grid reduction solution. Finally, numerical results are presented on a randomly generated grid of stars that demonstrate the feasibility of the method.