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IRASSI INFRARED SPACE INTERFEROMETER: MISSION ANALYSIS, SPACECRAFT DESIGN AND FORMATION FLYING OVERVIEW

Abstract

IRASSI is an astronomy mission aimed at observing stellar disks and protoplanetary regions using a constellation of five free-flying telescopes. In these regions of the cosmos, important chemical and physical processes in the far-infrared radiation spectrum can be observed, specifically between 1 and 6 THz, which aid scientists in understanding how pre-biotic conditions in Earth-like planets are formed. The IRASSI telescopes are projected to operate around the Sun-Earth/Moon L2 point, located approximately 1.5 million kilometers away from Earth, in the anti-Sun direction. This location provides a stable thermal environment and an unobstructed view of the sky. The distinguishing characteristic of this mission, however, is its free-flying concept. Rather than relying on a formation control mechanism, IRASSI relies on the knowledge of the inter-satellite distances, i.e., the baselines. IRASSI employs interferometric technology based on heterodyne detection to extract information about a target with very high spatial resolution (¡0.1 arcsec). Interferometry involves superimposing (phase-shifted) electromagnetic wavefronts, detected and recorded by each telescope, and measuring their interference (correlation). By dynamically changing the baselines of the free-flying telescopes, one can correlate the wavefronts at different locations. Interferometry is therefore dependent on very accurate measurements of the baselines of the telescopes – at micrometer level. In order to provide these required baseline measurements, IRASSI uses a dedicated ranging system. Each set of observations ultimately produce a synthesized image of the observed target. Since there is a relation between the produced image quality and the formation geometry and dynamics, understanding the evolution of the free-flying formation over time is critical for the success of the scientific phase. Additionally, it is important to stabilize the individual telescopes during the observations to avoid disturbing the baseline measurements. Formation adjustment and station-keeping maneuvers, for example, must occur outside astronomy observation periods. Similarly, reaction-wheel-induced microvibrations, thermomechanical distortions and other disturbance sources must be minimized. This poses a challenge, given that the IRASSI telescope are estimated to be nearly 2.5 tons, measuring up to 5 meters at their longest section. In this context, the present paper begins with an overview of key mission analysis results, regarding orbit selection and station-keeping maneuvers. The architecture of the IRASSI telescopes is thereafter provided, together with an analysis of the expected magnitudes and sources of disturbances. Finally, a description of a general IRASSI formation geometry is presented and the results of the modeled formation dynamics are discussed within the scope of the science objectives.