IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Navigation Technologies (1)

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METHODS FOR NAVIGATION IN THE NEARBY INTERSTELLAR MEDIUM

Abstract

Recent years have seen an increased interest in sending dedicated spacecraft to explore the nearby interstellar medium (NISM). Such a mission would be instrumented to study the so-called heliosphere on the outskirts of our Solar System, where the solar wind and helopspheric magnetic field interact with interstellar environment (e.g., cosmic radiation). While the scientific value of such a mission is clear, the design and operation of a spacecraft to accomplish this mission is difficult. Indeed, due to the immense distances involved, navigation is expected to be amongst the most challenging tasks. This work explores a variety of navigation observables and frameworks that one might use to navigate a mission within the NISM. Detailed models are presented for all of the major sources of navigation information, including Earth-based radiometric tracking, visible-spectrum star sightings, X-ray pulsar navigation (XNAV), StarNAV, and others. The utility of these observables is then studied within an orbit determination framework, along with consideration of the quality of state knowledge most likely required to operate in the NISM. Issues related to time-keeping are also discussed. Numerical results are presented as a way to illustrate the efficacy of various approaches.