Paper ID: 85121
oral

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IPB)

Author: Mr. Mattia Carosi
Thales Alenia Space Italia (TAS-I), Italy

L1 EARTH-MOON X-RAY PULSAR ASSISTED NAVIGATION

Abstract

The utilization of orbits close to Lagrange Points for various space missions has garnered significant interest in recent years. This peculiar dynamics, governed by the Circular Restricted Three-Body Problem (CR3BP), offer unique opportunities for satellite positioning and navigation.

The CR3BP is a simplified mathematical model used in celestial mechanics to describe the motion of a small object under the gravitational influence of two larger objects, typically celestial bodies like planets or stars, when their relative motion is primarily influenced by their gravitational attraction.

The Lagrange points L1 and L2 are two of the five points in space where the gravitational forces of two larger celestial bodies (i.e. Earth-Moon or Earth-Sun) in a CR3BP system create a stable equilibrium. In the Earth-Moon primaries configuration L1 is located along the line connecting Earth and Moon, closer to the smaller one. Earth-Moon L1 is a popular location for various space missions, including space telescopes like the James Webb Space Telescope.

To effectively estimate the dynamic vector state of an object within the Earth-Moon L1 orbit, a profound understanding of the CR3BP is crucial. The resulting mathematical model allows for the prediction of object trajectories and orbits with reasonable accuracy, given appropriate initial conditions.

Pulsars are highly energetic and compact astronomical objects known for their incredibly regular and precise emission of X-rays and gamma-rays. They are often utilized as signals for absolute positioning of objects in space due to their unique characteristics. These pulsars are rapidly rotating neutron stars that emit beams of high-energy radiation from their magnetic poles. This remarkable regularity, combined with the vast distances over which their signals can be detected, makes X-ray and Gamma-ray pulsars ideal for absolute positioning in space.

In some cases, pulsar observations and DSN data can be combined to enhance the determination of the orbit of space objects. The combination of these technologies can be particularly valuable for space missions requiring precise orbit determination, such as scientific or exploration missions within the solar system.

This paper aims to provide a navigation and positioning system tailored for objects in Earth-Moon L1 orbit represents a significant leap in space technology. By harnessing the dynamics of the CR3BP and integrating DSN and pulsar measurements, this system opens up new horizons for space missions, ranging from fundamental scientific research to practical applications.