Lunar reference systems framework

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Abstract

The definition of a lunar body-fixed coordinate system is essential to locate a point on its surface and to establish accurate cartography. These two objectives are particularly crucial in the context of present lunar space exploration. In addition, a reference system could reveal the relative movement of the surface.
At present, two slightly different reference systems are commonly used to define the lunar body-fixed coordinate system: the Mean Earth/Rotation Axis (or polar axis) (ME) reference system and the principal axis (PA) reference frame.

The former has been used at the beginning of lunar observation and it is commonly adopted for archiving and data distribution proposes of lunar surface or topography. The latter corresponds to the orientation where the lunar tensor of inertia is diagonal that is a natural reference system to model and to integrate the equations of motion. It is directly determined from lunar laser ranging measurements. The transformation between the two reference systems (PA, ME) is realised by three static rotations that depends on the lunar gravity field coefficients and dissipative models. Consequently, this transformation is dependent to a lunar ephemeris.

In preparation of future lunar missions, we present a review on actual lunar coordinate systems and present a new determination based on the Integration Numérique de l'Observatoire de Paris lunar ephemerides (INPOP) with a determination of a lunar time scale. In addition, we present the expected accuracy and discussed the differences with other lunar coordinate frame realisation. Finally, we provide recommendations for future lunar coordinate system.

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