Science Goals for the Lunar Occultation Observer (LOCO) Mission Concept

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The Lunar Occultation Observer (LOCO) is a new y-ray astrophysics mission concept proposed to have unprecedented sensitivity in the nuclear regime (~0.1-10 MeV). Top-level science goals are consistent with those formalized in the recent Decadal Survey on Gamma-Ray Astronomy review “New Worlds, New Horizons in Astronomy and Astrophysics”, and include, but are not limited to:

- Energy: to time domain astronomy, al-sky surveys, gamma-ray astrophysics, galaxies & black holes, and to extend knowledge across electromagnetic spectrum. LOCO will also be uniquely capable of answering questions in solar physics and possibly planetary science. The breadth of science enabled by observations in the nuclear regime — from probing the most cataclysmic events in the Cosmos, to understanding the life cycle of matter in our Galaxy, to probing energetic processes on our nearest star, to the search for one of If’s fundamental components (water) — is significant. Next-generation capabilities for high-sensitivity observations such processes will be transformational.

The transformational potential is clear. The specifications for this primary instrument are driven by the y-ray astrophysics observations. While observations in other electromagnetic regimes can also leverage the LOCO, high-sensitivity investigations in the range 0.1-10 MeV are uniquely enabled there. Lunar and solar science are integral to any successful lunar-based endeavor operating on a single primary goal. For example, the Mosaic y-ray albedo is the dominant source of background at MeV energies. The albedo is produced by cosmic-ray bombardment of the regolith, and therefore its intensity is directly related to the flux of primary cosmic-rays entering the inner solar system, which in turn is affected by the solar cycle and related activity. A lunar scientific platform, therefore, represents an opportunity for synergistic investigations spanning topical areas in astrophysics, solar physics, and planetary/lunar science.

Interdisciplinary science investigations (solar, planetary) leveraged by our primary nuclear astrophysics goals will be transformative — due in part to the requirement for a meter-class y-ray spectrometer with excellent energy resolution (~0.5% FWHM @ 0.662 MeV), and its operation from lunar orbit. The specifications for this primary instrument are driven by the astrophysics goals, yet provide a unique, and critical, set of capabilities in the other topical areas. As an example, the baseline spectrometer configuration will have a sensitivity:

- ~10% greater than COMPTEL, the last large-scale nuclear astrophysics survey mission
- ~10% greater than RHESSI, the most recent high-energy solar mission
- ~10% greater than the Lunar Proportional Gamma-ray Spectrometer

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Goals & Decadal Review

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The Moon is a unique location for experimental astrophysics and it’s beneficial characteristics can be brought to bear on challenges in high-energy astrophysics, solar physics, and planetary sciences in particular. In particular, the lunar environment provides a unique environment for solar (MeV) y-ray astrophysics observations. While observations in other electromagnetic regimes can also leverage the LOCO, high-sensitivity investigations in the range 0.1-10 MeV are uniquely enabled there. Lunar and solar science are integral to any successful lunar-based endeavor operating on a single primary goal. For example, the Mosaic y-ray albedo is the dominant source of background at MeV energies. The albedo is produced by cosmic-ray bombardment of the regolith, and therefore its intensity is directly related to the flux of primary cosmic-rays entering the inner solar system, which in turn is affected by the solar cycle and related activity. A lunar scientific platform, therefore, represents an opportunity for synergistic investigations spanning topical areas in astrophysics, solar physics, and planetary/lunar science.

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