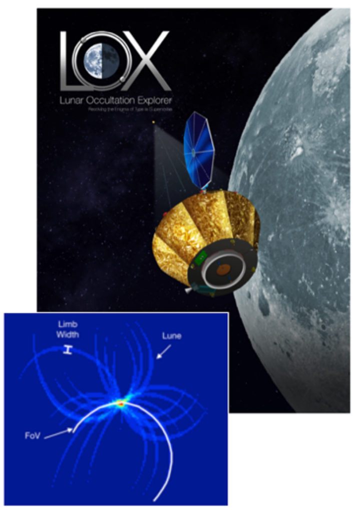
Ex Luna, Scientia: The Lunar Occultation eXplorer and Nuclear Astrophysics from the Moon. R. S. Miller[1], M. Ajello[2], J. F. Beacom[3], P. F. Bloser[4], A. Burrows[5], C. L. Fryer[4], J. O. Goldsten[1], D. Hartmann[2], P. Hoeflich[6], A. L. Hungerford[4], D. J. Lawrence[1], M. D. Leising[2], P. Milne[7], P. N. Peplowski[1], T. Sukhbold[3], L.-S. The[2], Z. Yokley[1], and C. A. Young[8], [1]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723 (richard.s.miller@jhuapl.edu), [2]Clemson University, Clemson, SC 29634, [3]The Ohio State University, Columbus, OH 43210, [4]Los Alamos National Laboratory, Los Alamos, NM 87545, [5]Princeton University, Princeton, NJ 08544, [6]Florida State University, Tallahassee, FL 32309, [7]University of Arizona-Steward Observatory, Tucson, AZ 85721, [8]NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: Astronomical investigations from the Moon afford new opportunities to advance our understanding of the cosmos. Of particular note are observational techniques that leverage the lunar environment to provide capabilities or performance enhancements not easily achieved using other approaches. The Lunar Occultation eXplorer (*LOX*) is uniquely enabled by the Moon and will utilize the advantageous lunar environment to transform our understanding of thermonuclear supernovae, galactic nucleosynthesis, and the cosmic lifecycle of matter and energy.



To date, observational techniques in the nuclear gamma-ray regime (0.1–10 MeV) have solidified around a single detection methodology—Compton scatter telescopes—that require complex implementation, development, and operational resources to advance their capabilities. The associated technology and cost constraints have limited significant progress in astrophysics at MeV energies for almost a quarter century [1, 2] (*Schönfelder et al*., 1992, 2000); in fact, from 1980 until today, sensitivity has improved by only a factor of ten. This contrasts markedly with advances in soft X-ray, hard X-ray, GeV gamma-ray, and TeV gamma-ray astrophysics.

LOX directly challenges this paradigm to provide a unique set of time-domain capabilities [3]. Simplicity is a hallmark of *LOX*. It significantly reduces mission complexity, mitigates the need for technology development lifecycles by eliminating the need for complex, position-sensitive detectors or kinematic event reconstruction, and dramatically reduces cost and resource constraints, while also delivering performance capabilities needed to transform nuclear gamma-ray (MeV) astrophysics [3]. In its baseline configuration *LOX* is capable of surveying the entire sky at a bolometric sensitivity $<10^{-7}$ cm^{-2} s^{-1} MeV^{-1}, near-continuous monitoring of astrophysical light curves, and arcminute source localizations. *LOX* can be implemented as a free-flyer or as an attached payload aboard other assets in lunar orbit like the Lunar Gateway [4].

Concept Overview: *LOX* is enabled by the innovative use of the Moon as a natural occulting disk and the encoding of temporal modulation as astrophysical objects rise/set along the lunar limb. Source detection, localization, flux characterization, and long-duration monitoring are based on time-series analysis of occultation event ensembles, detailed knowledge of the lunar and spacecraft ephemerides, and a rigorous statistical framework. *LOX*'s lone instrument, the Big Array for Gamma-ray Energy Logging (BAGEL) is highly scalable, limited only by available mission mass and power resources. *LOX* benefits from 20+ years of successful lunar exploration using gamma-ray spectrometers and mimics the operational profile of planetary orbital geochemistry investigations. The dense lunar regolith, absence of an appreciable atmosphere or magnetosphere, and well-characterized radiation environment enhance performance over terrestrial implementations.

Summary: *LOX* is a mature, low-risk, high-heritage, and cost-effective next-generation mission concept capable of addressing decadal survey questions in nuclear astrophysics to ultimately reveal critical new details about the lifecycle of matter and energy in our galaxy and beyond.

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