Luna Solar Occultation Explorer (LunaSOX)

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Abstract. The ongoing age of ARTEMIS will enable many potential opportunities for heliophysical, astrophysical, and planetary observations from lunar orbit and from the surface. The lunar platform may become preferable for some astronomical observations as compared to Earth because of the growing problem there of light interference in the night sky by reflected sunlight from many thousands of communications and other satellites. The Moon's lack of a substantial atmosphere eliminates the common Earth-bound astronomical problem of light scattering by atmospheric turbulence and of scattered sunlight in the nighttime sky even at totality during solar eclipse observations. From the ground on Earth there are only semiannual opportunities for such observations. Spaceborne coronagraphs can observe the solar corona continuously from high altitude earth orbit or L1 but have limited angular resolution and brightness sensitivity. These coronagraphs are limited in resolution by diffraction at the edges of external occulters and by internal light scattering for internal (e.g., Lyot) occultation techniques. There has been a conspicuous gap in coverage of the inner corona at visible-band wavelengths since the failure of the LASCO C1 instrument on SOHO in mid-1998. This gap has only rarely been filled by the occasional ground-based observations of a few minutes at totality for each eclipse event. In a white paper submitted for the ongoing heliophysics decadal survey, and in earlier (Habbal et al., 2013) and more recently submitted (Cooper et al., 2023) publications now in review, we proposed the multi-mission concept of the Lunar Solar Occultation Explorer (LunaSOX). The full inner and outer solar corona could be observed from astronomical telescopes in lunar orbit, and from the surface as landed operations progress toward permanent lunar bases, whenever and wherever the bright solar disk is occulted by the lunar limb with respect to the telescopes. This approach could provide one-thousand times increases in brightness sensitivity for the outer corona to 10 R_{sun} and beyond as compared to those from Earth at eclipse totality. As seen from distances of several lunar radii the lunar limb provides a sharp but irregular occulting edge with total topographic variation of 16 km and local spatial uncertainty of ten meters from Lunar Reconnaissance Orbiter (LRO) measurements. Edge diffraction fringes are only a few meters in height at the limb for the solar observations from an orbital platform. Cadence and duration of the LunaSOX coronal observations would depend on the orbit parameters or surface location. Hourly cadence with thirty second duration for each eclipse event would be available from LRO-type circular orbits at low altitude, while 12-hour cadence at up to two hours in duration would occur in elliptical orbits, e.g. 1x10 R_m as for the two presently orbiting ARTEMIS 1 and 2 satellites at the Moon. Observations of the rising and setting solar corona over the local horizon could be done from the equatorial to mid-latitude surface at lunar monthly cadence but with much larger telescopes otherwise primarily doing astrophysical and solar system observations. We review the science objectives and technical requirements for LunaSOX observations.