THE LUNAR ENVIRONMENT HELIOSPHERIC X-RAY IMAGER (LEXI): A LUNAR SURFACE INSTRUMENT TO OBSERVE THE SOLAR WIND-MAGNETOSPHERE INTERACTION. M.R. Collier[1], B.M. Walsh[2], F.S. Porter[1], D.G. Sibeck[1], N. Thomas[3], K. Kuntz[4], H. Connor[5], C. Paw U[2], R. Nutter[2], and J. McShane[2], [1]NASA's Goddard Space Flight Center, Greenbelt, Maryland, [2]Boston University, Massachusetts, [3]NASA's Marshall Space Flight Center, Huntsville, Alabama, [4]Johns Hopkins University, Baltimore, Maryland, [5]University of Alaska, Fairbanks

Introduction: The lunar surface provides an Earth observation platform with many advantages. One advantage is the distance from Earth, about 60 R_E, that allows us to monitor the terrestrial system as a whole from the outside – a vantage point typically unobtainable from traditional low-apogee heliophysics missions but fully accessible from the Moon.

Soft X-ray Imaging from the Lunar Surface: One of the terrestrial imaging techniques that can benefit from an observing platform on the lunar surface is soft X-ray imaging of solar wind charge exchange emission. Within the heliosphere, flowing plasma in the solar wind routinely encounters environments of dense neutrals surrounding comets, moons, and planets. In these regions, high charge state heavy ions from the solar wind exchange charge with these neutral atoms surrounding the body. At Earth, an electron is transferred from an exospheric neutral hydrogen atom in the magnetosheath or cusp to a high charge state solar wind ion. The newly acquired electron, initially in an excited state, rapidly transitions to a lower energy state and releases a soft X-ray photon, typically with energies from 0.1-2.0 keV. Emission lines have been identified from a variety of high charge state species including C^{+6}, O^{+7}, O^{+8}, Mg^{+12}, and Fe^{+13}.

Imaging Plasma Boundaries: Regions such as the Earth's magnetosheath and cusps, where dense solar wind plasma is collocated with dense exospheric neutrals from the Earth, are bright emitters of soft X-rays. The magnetopause boundary delineates a region of high solar wind density (the magnetosheath) from one of low density (the magnetosphere). As such, the boundary will be readily identifiable through a strong gradient in soft X-ray flux.

The LEXI Instrument: The Lunar Environment heliospheric X-ray Imager (LEXI, see Figure 1) is a wide field-of-view soft X-ray telescope designed to image the Earth's magnetopause from the lunar surface. The instrument is being developed as part of NASA's Lunar Science Instrument and Technology Payloads (LSITP) and is scheduled for deployment on the lunar surface in late 2022 on a commercial lander within NASA's Artemis program. The telescope focusses light using micropore lobster-eye optics onto a detector plane. The instrument will allow researchers to study the Earth's magnetopause with images of soft X-rays emitted from solar wind charge exchange.

LEXI Science: LEXI will provide the first high cadence global images of the of the dayside solar wind-magnetosphere interaction. This will enable researchers to distinguish between long-competing models of magnetic reconnection. LEXI will answer the question: under what conditions is magnetic reconnection temporally steady versus bursty? Magnetic reconnection is a fundamental physical process, that occurs at Earth and places within the heliosphere, as well as throughout the universe where it operates in stellar atmospheres, planetary environments, and accretion disks around neutron stars and black holes. Rather than providing incremental progress through improving an existing observation, LEXI will provide transformative results through a fundamentally new measurement – a wide field-of-view image of the magnetopause.

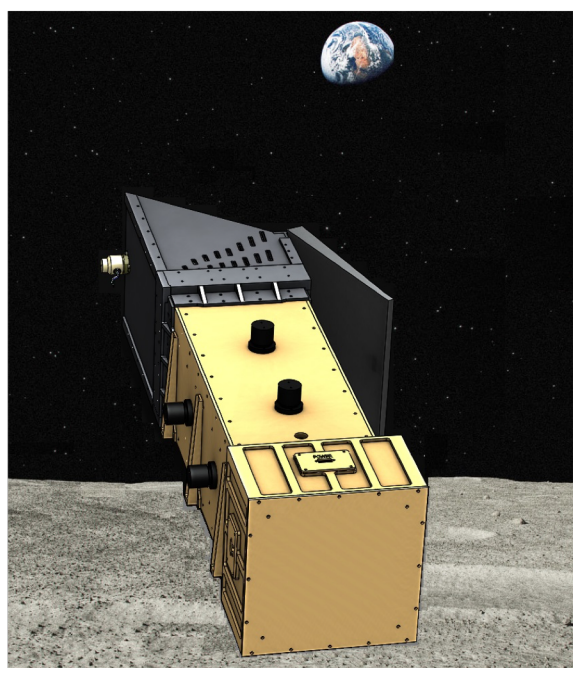

Figure 1. The LEXI instrument.