Observing the Magnetosphere in Soft X-rays: The Lunar X-ray Observatory (LX). D. G. Sibeck[1] and M. R. Collier[1], and F. S. Porter[1] ([1]NASA/GSFC, Greenbelt Road, Greenbelt, MD 20771, david.g.sibeck@nasa.gov).

Abstract: Lunar orbit and the lunar surface provide unique vantage points to image the dynamics of the global solar wind-magnetosphere interaction [1]. Wide field-of-view soft X-ray imagers have now been developed to the point where they can be used to track the emissions generated when high charge state solar wind ions exchange electrons with neutral hydrogen in the Earth's outer exosphere [3]. Simulation results demonstrate that integrated line-of-sight emissions of these soft X-rays with energies ~0.25 keV map the locations of the Earth's bow shock, magnetosheath, magnetopause, and cusps [6]. Global images of the dayside magnetosphere with cadences on the order of 2-5 min and spatial resolution of ~0.125 Earth radii (R_E) will suffice to track the dynamic motion of these plasma structures in response to both varying solar wind dynamic pressure and interplanetary magnetic field orientation [8]. In particular, the images can be used determine the rate at which the magnetopause and cusps erode in response to magnetopause magnetic reconnection driven by southward interplanetary magnetic field turnings and to determine the nature of subsequent recoveries in the locations of the magnetopause and cusps driven by magnetic reconnection within the Earth's magnetotail. Given accurate magnetohydrodynamic model predictions, the very same soft X-ray observations can be used to deduce the properties of the Earth's exosphere as a function of solar cycle, e.g. determine its radial density profiles and identify any deviations from spherical symmetry.

Imagers in the same locations can also provide important information concerning the composition of the lunar exosphere and its variability [7], particularly if information is obtained concerning individual line emissions. A reexamination of past ROSAT observations confirms that the emissions are present and shows that they can be used to infer lunar limb column densities [2]. Soft X-ray observations of emissions resulting from charge exchange in the lunar exosphere could be used to map exospheric composition as a function of latitude and longitude and as a function of varying solar wind conditions. They could be used identify the effects of entries into and exits out of the Earth's magnetotail on solar wind sputtering. They might be used to detect the effects of meteoroid bombardment on the exosphere. Since soft X-ray emissions depend not only on exospheric but also solar wind plasma density structures, they can be used to map the low density lunar wake and mini-magnetospheres above magnetic anomalies generated by the solar wind's interaction with the Moon. These and other tasks are described by [8].

Finally, a wide field of view soft X-ray imager pointed in the antisunward direction during northern hemisphere winter will be able to quantify the dimensions and intensity of emissions from the helium focusing cone formed when and where the Sun's gravitational forces focus neutral Helium ions entering the heliosphere [4, 5]. Emissions might be expected to vary as a function of solar wind conditions.

We propose to place a prototype imager on the Deep Space Gateway, followed by a larger and more powerful instrument on the lunar surface. The prototype LXO imager features slumped microchannel plate optics, a large area CCD, and passive cooling. It comprises a "lobster-eye" optic using a 12x12 element array of 4 cm x 4 cm Nickel-coated square pore microchannel plates slumped a 50 cm radius with a very large field-of-view. A flat plane of to four 6 cm x 6 cm CCDs is placed half way to the focal point to provide imaging with moderate spectral resolution.

The effective area is about 12 cm^2 at 500 eV with a point spread function of less than four arc minutes, and an anticipated energy resolution of about 50 at 500 eV. Total power consumption is estimated at 11 W during operations, which includes 6.7W for primary input for the CCD plane and associated electronics with a passively cooled CCD and 4.3W primary power for a coldfire processor. The entire package weighs about 17 kg. Dimensions are 66x50x50 cm^3. The instrument should not point at the Sun or be covered when it does. It can operate through temperatures from -10 to 40 C.

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