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AXIOM: Advanced X-ray Imaging Of the Magnetosphere

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AXIOM is a concept mission which has been proposed in response to the European Space Agency's 2010 Cosmic Vision M3 Mission call, in view of a 2022 launch. AXIOM aims to explain how the Earth's magnetosphere responds to the changing impact of the solar wind in a global way never attempted before, by performing wide-field soft X-ray imaging and spectroscopy of the magnetosheath, magnetopause and bow shock, at high spatial and temporal resolution.

Plasma and magnetic field environments can be studied in two ways – by in situ measurement, or by remote sensing. These two techniques are complementary. In situ measurements provide precise information about plasma behaviour, instabilities and dynamics, but cannot provide the global view which is necessary to understand the overall behaviour of the plasma. Remote imaging provides excellent information about global configurations and overall evolution, but cannot provide the same level of local information that is required to fully understand the local plasma physics. Whilst some parts of the magnetosphere have been remotely sensed, the majority remains unexplored using remote measurements.

We propose a new approach: to use remote X-ray imaging techniques, which are now possible thanks to the relatively recent discovery of solar wind charge-exchange (SWCX) X-ray emission, first observed at comet Hyakutake, and subsequently found by XMM-Newton to occur in the vicinity of the Earth's magnetosphere, and to peak in the sub-solar magnetosheath, a region where both solar wind and neutral exospheric densities are high.

In this presentation we describe how an appropriately designed and located X-ray telescope, supported by simultaneous in situ measurements of the solar wind, can be used to image the dayside magnetosphere, magnetosheath and bow shock, with a temporal and spatial resolution sufficient to address several key outstanding questions concerning how the solar wind interacts with planetary magnetospheres on a global level. The relatively small, low-resource AXIOM model payload incorporates a wide-field soft X-ray telescope, based on MCP optics and CCD detectors, for imaging and spectroscopy of the Earth's magnetosphere, a proton and alpha particle sensor designed to measure the bulk properties of the solar wind, an ion composition analyser which aims to characterise the populations of minor ions in the solar wind that cause SWCX emission, and a magnetometer for accurate measurements of the strength and direction of the solar wind magnetic field. Details of the mission profile and programmatics will also be presented.