

Magnetosphere-surface Interactions at Mercury

<ul style="list-style-type: none"> Nightside X-ray emissions from Mercury's surface provide understanding of magnetosphere-surface interactions Investigate MESSENGER's nightside X-ray events: dependence on magnetosphere, solar activity, and planet's orbit Opportunity to study the first data from the ESA/JAXA BepiColombo mission, and from Leicester's MIXS instrument 	Level	PhD
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	Second Supervisor	Dr Adrian Martindale
	Application Closing Date	20 th January 2023
	PhD Start date	September 2023

Project Details:

BepiColombo is the first interplanetary dual-spacecraft mission, comprising the ESA Mercury Planetary Orbiter (MPO) focusing on the planet, and JAXA Mercury Magnetospheric Orbiter (MMO) dedicated to the space environment. The main science mission for BepiColombo begins in Spring 2026, and will greatly enhance the results obtained by NASA MESSENGER (2011-2015).

The Mercury Imaging X-ray Spectrometer (MIXS) is the only UK instrument on the BepiColombo payload, designed and built at Leicester. By observing fluorescence X-rays generated when solar X-ray photons and charged particles interact with the surface regolith, MIXS will be able to measure the atomic composition of Mercury's surface on the sunlit side of the planet. When energetic electrons hit Mercury's surface (Image 1), they also generate characteristic X-rays from the surface.

Consequently, MIXS will allow us to determine the complex interaction between Mercury and its space environment through X-ray observations (particularly) on the nightside of Mercury.

The project involves investigation of previous MESSENGER measurements, including X-ray fluorescence spectra, magnetic field, and energetic particles from Mercury's magnetosphere. The student will also analyse the FIRST data from BepiColombo MIXS towards the end of the project, providing new insights on magnetosphere-surface interaction. This will be a very exciting time to be part of this new mission!

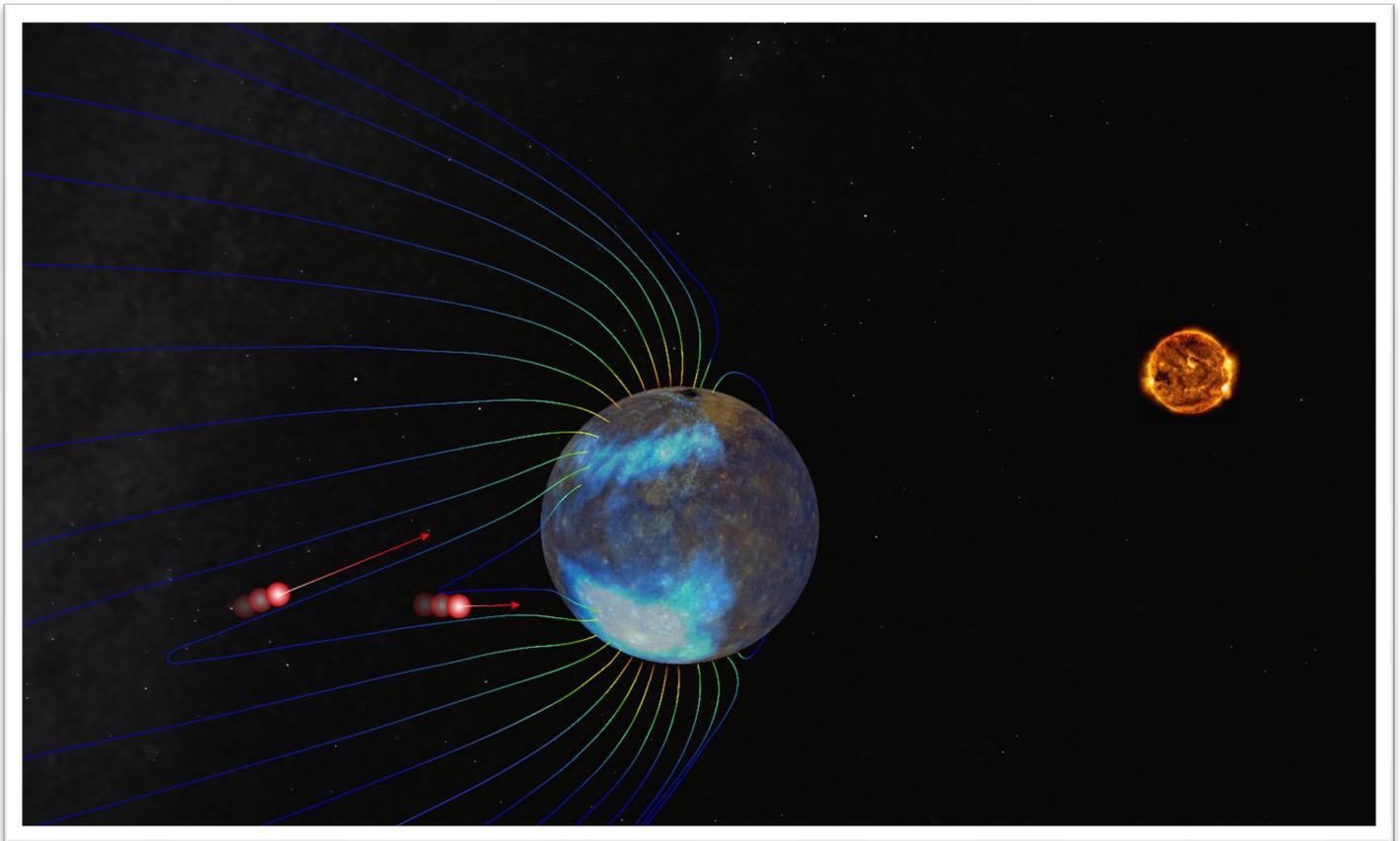
An element of the project could involve laboratory experiments (exploiting our in-house ground reference facility) to investigate the production of fluorescent X-ray emission from various analogues of Mercury's surface under bombardment from controlled electron sources.

The project will have three main aims:

We will focus on particle and magnetic field measurements taken by MESSENGER in regions magnetically conjugate to previous observations of particle induced X-ray emission (PIXE), in order to understand the particle populations responsible for the X-ray emissions.

We will undertake an analysis of how PIXE events measured through the lifetime of the MESSENGER mission are influenced by solar activity and with orbital eccentricity of Mercury.

We will receive and analyse the FIRST data from the ESA/JAXA BepiColombo mission and this project will focus on the interpretation of the nightside observations of X-ray fluorescence produced by the magnetosphere-surface interaction.



A schematic of electrons being accelerated in Mercury's nightside magnetosphere and precipitating onto the surface to form the bands of "auroral" X-ray fluorescence measured by MESSENGER, which are associated with the northern and southern open-closed field line boundaries

References:

- Bunce et al. [2020], MIXS Instrument Paper, <https://doi-org.ezproxy4.lib.le.ac.uk/10.1007/s11214-020-00750-2>
- Lindsay et al. [2016], Nightside X-ray Emissions, <https://doi.org/10.1016/j.pss.2016.03.005>
- Winslow et al. [2017], ICME Catalogue, <https://doi.org/10.1002/2016JA023548>
- James et al. [2017], Upstream Solar Wind at Mercury, <https://doi.org/10.1002/2017JA024435>

How to apply:

Include with your application:-

- CV
- Degree Certificates and Transcripts
- Details of any study currently being undertaken
- Personal statement
- Enter the supervisor's name and project title in the Proposal Section (no proposal required)
- Enter contact details of two academic referees in the boxes provided or upload reference letters if already obtained.
- Evidence of English language if applicable.
- In the funding section include: Ref: Bunce - UKRI (STFC)

The University of Leicester School of Physics and Astronomy has advertised a number of PhD opportunities. If you are applying for more than one University of Leicester project, please indicate if this is your first, second or third choice, in your application.

Further information on how to apply and funding can be found [here](#)