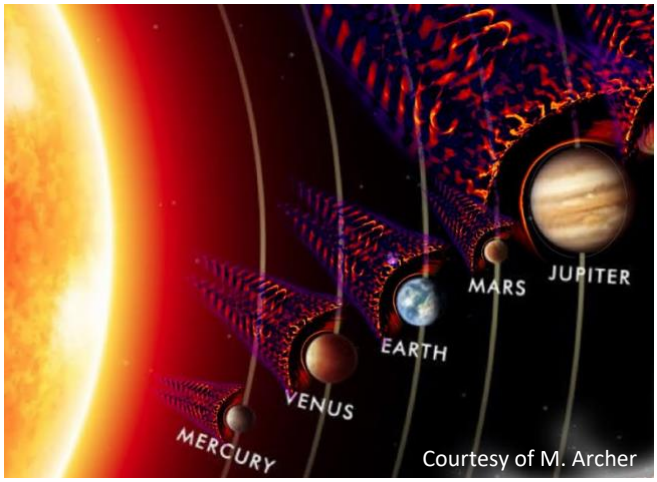

Structure of shock waves across the Solar System

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Shock waves are seen throughout the universe and the closest one is the Earth's bow shock, standing in the solar wind upstream of our magnetosphere. Similar shock waves form ahead of other planets in our solar system, as well as coronal mass ejections from the Sun, stars, supernovae, and other astrophysical objects. Shock waves are one of the main accelerators of high energy particles in space.

We can study the shocks in our own solar system in detail with instruments onboard scientific spacecraft that directly measure the electromagnetic fields and particles as they fly through the shocks. Naturally, the most comprehensive observations are of the Earth's bow shock. In this project, you will use these near-Earth datasets, spanning decades of variable solar wind conditions, to make comparisons with measurements from other Solar System environments. You will investigate fundamental physical processes that lead to formation of structures and acceleration of particles. These have applications to both remote astrophysical objects and to forecasting solar energetic particle events hazardous to our modern society.

During the project you will learn to analyse and visualize large datasets. You will develop new data-analysis tools in preparation for future space missions such as HelioSWARM (expected launch 2028). There is also an option to enhance the project with numerical simulations.

You will be supported by colleagues both at QMUL and across the world. The project follows from the activities of an international team that I am leading. You can check out its website at: https://www.issibern.ch/teams/heliosysspec/

Please contact me for further information.

Please see details of the application process at
https://www.qmul.ac.uk/spcs/astro/teaching/phd-programme/

Deadline January 31, 2023.

Further reading:

Lucek et al., 2008. https://doi.org/10.1029/2007JA012756
Masters et al., 2013. https://doi.org/10.1038/nphys2541