Exploring the diversity of solar wind-cometary interaction

PhD project
Space & Atmospheric Physics Group
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Comet Interceptor mission [Credit: G. Jones, UCL/MSSL]

Comets are compelling natural labs for plasma physics, hosting a large range of collisional regimes with heliocentric and cometocentric distances, which cannot be replicated in labs on Earth. When comets approach the Sun, their outgassing increases and a coma is formed. This very extended envelope of gas, which gets partially ionised, interacts with the solar wind. The European Space Agency (ESA) Rosetta mission, which escorted comet 67P, revealed a very different picture of the solar wind-comet interaction as a function of the outgassing activity: for instance, at very low activity the solar wind ions reached the cometary surface, while near perihelion they could not penetrate the inner coma. Outgassing activity was significantly higher during the fly-by of comet 1P/Halley by the ESA Giotto mission. A bow shock was detected upstream of the comet and a very large diamagnetic cavity formed around the nucleus. This encounter provided however only two cuts (inbound/outbound) through the plasma environment.

The newly selected ESA Comet Interceptor mission, which is currently planned to be launched in 2029, aims at visiting a dynamically new comet which will penetrate in the inner Solar System for the first time. The encounter will happen near 1 AU and active outgassing conditions are anticipated. The mission offers multi-point measurements of the plasma boundaries and regions through the presence of three probes, two from ESA and one from the Japan Aerospace Exploration Agency (JAXA).

The aim of the proposed modelling project is to assess how the solar wind interacts with a highly outgassing comet and how this interaction evolves under different interplanetary and cometary conditions. Such a tool will not only shed lights on the physics at play, but will also be critical in preparation of operations for Comet Interceptor as well as to ultimately help building a 3D picture of the solar wind-comet interaction from the multi-point observations.

The student will join the cometary group which has led the analysis and interpretation of the rich Rosetta dataset through multi-instrument approach and physics-based models. The group is also leading the magnetometer on the probe B2 on the upcoming ESA Comet Interceptor mission. The student will benefit from close interaction with the plasma physics group through its high-standing expertise in 3D computational magneto-hydrodynamics. The project is highly collaborative and will benefit from international exposure in close links to the Comet Interceptor mission.