**University of Leicester Future 100 PhD Scholarship**

**Project Reference: PHYS-Sanchez-Cano**

**Section 1 – *Supervisor Information***

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| **First Supervisor** | Dr Beatriz Sanchez-Cano |
| **School/Department** | Physics and Astronomy |
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| **Proposed Second Supervisor** | Professor Mark Lester |

**Section 2 – *Project Information***

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| **Project Title** | Dynamics of ionospheres of unmagnetised planets: Venus and Mars |
| **Project Highlights:** | 1. | Comparative planetology at Venus and Mars, focusing on their ionosphere’s interaction with the solar wind and space weather. |
| 2. | The unique combination of multi-spacecraft datasets offers the potential for exciting new discoveries on both planets, including data from MAVEN, Mars Express, Venus Express, BepiColombo, Solar Orbiter. |
| 3. | Leicester’s involvement in a number of missions in the Solar System, such as Mars Express, ExoMars, BepiColombo, SMILE, JUICE, or JWST offers a unique immersive experience on planetary research. |
| **Project Overview** |
| Mars and Venus are the only planets in our Solar System that do not currently have a global dipole magnetic field and, therefore, their atmospheres are in direct contact with the incoming solar wind. Moreover, they are the closest planets to Earth but their environments have evolved under very different conditions. Therefore, the solar wind interaction with each planet is strongly modulated in different complex ways by their local magnetic and atmospheric environments. This is an important open problem at the moment, particularly during Space Weather events (i.e. large scale solar disturbances), and a critical factor to understand the habitability conditions of a planetary system.This PhD project focuses on comparative planetology between Venus and Mars, with the aim of investigating the response of the Venusian and Martian plasma systems to solar wind variability, focusing on the dynamics of their ionospheres and how they compare. For that, three main aspects are planned to be investigated:1. The spatial and temporal evolution of both ionospheres during the solar cycle and seasons using numerical and empirical models and multispacecraft data sets.
2. The short-term ionospheric dynamics during active solar conditions (i.e. space weather activity)
3. The role of solar particle precipitation in both ionospheres and plasma systems.

This PhD project will provide the best characterisation so far of the dynamics of the solar wind interaction with different unmagnetised planets, giving essential clues on the different evolution of their upper atmospheres. The supervisors of this project are Co-Investigators of the MARSIS instrument on Mars Express and coordinators of the Mars Upper Atmosphere Network (MUAN), which will provide unique opportunities to the PhD candidate to collaborate with colleagues from different international institutions. Moreover, Leicester’s current involvement in Mars’ exploration with Mars Express and ExoMars as well as on other planetary missions such as BepiColombo, SMILE, the Jupiter Icy Moons Explorer (JUICE), or the James Webb Space Telescope (JWST), offers a unique immersive experience on planetary research to the successful PhD candidate.  |
| **Methodology**  |
| This is a data analysis and ionospheric modelling project. For Mars, you will use ionospheric and plasma data from Mars Express, the well-suited plasma package from the Mars Atmosphere and Volatile Evolution mission (MAVEN) mission, and other available missions. For Venus, you will use ionospheric and magnetic data from the Pioneer Venus Orbiter, Venus Express orbiter, and from the recent flybys of Venus by BepiColombo and Solar Orbiter. For modelling, you will use the well-established numerical model IPIM (Blelly et al., 2019, 10.1016/j.pss.2019.02.008) that can be run for both Venus and Mars and the empirical model NeMars (Sanchez-Cano et al., 2013, 10.1016/j.icarus.2013.03.021), which will need to be adapted for the Venusian case. Some prior background in coding and ionospheric science is desirable. An example of the methods and research can be found in these references:* B. Sánchez–Cano, et al., (2018), Spatial, seasonal and solar cycle variations of the Martian total electron content (TEC): Is the TEC a good tracer for atmospheric cycles*? Journal of Geophysical Research: Planets*, 123, 1746–1759. <https://doi.org/10.1029/2018JE005626>
* B. Sánchez–Cano, et al., (2019), Origin of the extended Mars' HF radar blackout of September 2017, *Journal of Geophysical Research Space Physics*, 124, 4556– 4568. <https://doi.org/10.1029/2018JA026403>

This project and the vibrant environment at the Planetary Science Group will allow the PhD candidate to develop important skills such as in research, communication, public speaking, work management, critical thinking, leadership and collaboration.  |