**University of Leicester Future 100 PhD Scholarship**

**Project Reference: RI-SPACE-Hutchinson**

**Section 1 – *Supervisor Information***

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| **First Supervisor** | Dr Ian Hutchinson |
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| **Proposed Second Supervisor** | Melissa McHugh |
| **Additional Supervisor** | John Bridges |

**Section 2 – *Project Information***

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| **Project Title** | The search for signatures of life with the ExoMars Raman Laser Spectrometer | |
| **Project Highlights:** | 1. | ExoMars rover surface operations & data exploitation |
| 2. | Optical Spectroscopy instrumentation for future missions |
| 3. | The search for signatures of life |
| **Project Overview** | | |
| ESA’s ExoMars rover is due to be launched in September 2022 and will land at Oxia Planum in June the following year. The scientific objectives of the mission are to search for signs of past and present life on Mars and to characterise the water/geochemical environment as a function of depth in the planet’s shallow subsurface. To achieve these goals, the rover will traverse the surface of the planet and collect and analyse samples recovered from depths of up to 2m below the surface using a complex suite of analytical instruments.  One of the instruments on the rover, the Raman Laser Spectrometer (RLS), has been developed by a group of European partners including Spain, the UK, France and Germany. The UK team were responsible for the development of the instrument’s camera system and central data processor (the University of Leicester, RAL and Teledyne e2v) and the UK team will play a full role during ExoMars surface operations. The team at Leicester have developed a comprehensive range of laboratory instruments and analogue samples to help prepare for mission activities and successful exploitation of the data returned (correct spectral interpretation depends on a detailed understanding of the specific environmental context and sufficient pre-characterisation of similar samples).  Raman spectroscopy is a non-destructive scattering technique that provides rapid chemical composition information and is frequently used for analytical studies in a broad range of industries (e.g. healthcare, security, mining, nuclear power, soil science). Due to recent advances in instrument sub-system technologies (including miniaturisation and robustness), Raman spectrometers are frequently proposed for exploration missions (the technique can provide specific information on the mineralogical structure of materials and  hydration states as well as verification of the presence of organics). For example, the NASA Mars2020 mission incorporates two instruments that can operate in Raman spectroscopy modes (SuperCam and SHERLOC). Consequently, the next 3 years will see a substantial amount of data returned from the first generation of such instruments and a detailed understanding of the technique and the performance of the instruments will be key to fully understanding the value of the data returned by the missions. | | |
| **Methodology** | | |
| This project involves the analysis of data returned by the ExoMars RLS instrument. The work focusses on planetary surface science, expertise in optical spectroscopy techniques (& instrumentation) and the retrieval and detailed laboratory characterisation of targeted analogue samples that enable the capabilities of the RLS to be fully understood in two key areas: preservation and identification of organics in clay-rich sediments and the analysis of mixed sulphate-clay successions. Research activities will include the use of flight-like instrumentation in Leicester and Madrid.  The student will get the opportunity to participate in regular science and instrument team meetings before and after launch (in order to learn about the latest ExoMars and RLS results) and will contribute to data interpretation activities (building on the laboratory based characterisation of mission analogue samples and detailed instrument performance modelling). This research will also be used to inform instrument payload proposals for future mission opportunities.  **References**  Balme, M. R., Curtis-Rouse, M. C., Banham, S., Barnes, D., Barnes, R., Bauer, A., Yeomans, B. (2019). The 2016 UK Space Agency Mars Utah Rover Field Investigation (MURFI). PLANETARY AND SPACE SCIENCE, 165, 31-56. doi:10.1016/j.pss.2018.12.003  Bedford C., J. C. Bridges, S. P. Schwenzer, R. C. Wiens, E. B. Rampe, J. Frydenvang, P. J. Gasda. 2019 Alteration trends and geochemical source region characteristics preserved in the fluviolacustrine sedimentary record of Gale crater, Mars. Geochim Cosmochim Acta <https://doi.org/10.1016/j.gca.2018.11.031>.  Bridges J.C., Hicks L.J, Treiman A. (2019) Carbonates on Mars. In ‘Volatiles on Mars’. 1st edition. Elsevier. Editors Filiberto and Schwenzer. pp 426.  L. Demaret, H. Lerman, IB. Hutchinson, M. McHugh, G. Eppe, C. Malherbe, “Raman analyses of Al and Fe/Mg rich clays: instrument challenges and optimisation for planetary surface exploration missions”, Astrobiology, 2021  Malherbe, C., Hutchinson, I. B., McHugh, M., Lerman, H., Harris, L. V., Ingley, R., Eppe, G. (2019). Minerals and microstructure identification using Raman instruments: Evaluation of field and laboratory data in preparation for space mission. Journal of Raman Spectroscopy. doi:10.1002/jrs.5685  L. Mandon, A. Parkes Bowen, Cathy Quantin-Nataf, J. C. Bridges et al. (2021) Morphological and Spectral Diversity of the Clay-Bearing Unit at the ExoMars Landing Site Oxia Planum. Astrobiology, <https://doi.org/10.1089/ast.2020.2292>  M. McHugh, IB. Hutchinson, H. Lerman, HGM Edwards, R Ingley, “The development and testing of a prototype Raman spectrometer for the ExoMars mission”, JRS, 2021  Moral, A. G., Rull, F., Maurice, S., Hutchinson, I. B., Canora, C. P., Seoane, L., Forni, O. (2019). Design, development, and scientific performance of the Raman Laser Spectrometer EQM on the 2020 ExoMars (ESA) Mission. Journal of Raman Spectroscopy. doi:10.1002/jrs.5711  E.B. Rampe, D.F. .. J.C. Bridges, et al.,. (2020) Mineralogy and geochemistry of sedimentary rocks and eolian sediments in Gale crater, Mars: A review after six Earth years of exploration with Curiosity. https://doi.org/10.1016/j.chemer.2020.125605  Rull, F., Maurice, S., Hutchinson, I., Moral, A., Perez, C., Diaz, C., on behalf of the RLS Team. (2017). The Raman Laser Spectrometer for the ExoMars Rover Mission to Mars. Astrobiology. doi:10.1089/ast.2016.1567  Turner, S., S. P. Schwenzer, J. C. Bridges, E. B. Rampe, C. C. Bedford, C. N. Achilles, A. C. McAdam, N. Mangold, L. J. Hicks, J. Parnell, A. A. Fraeman, M. H. Reed 2021 Early Diagenesis at and below Vera Rubin ridge, Gale crater, Mars. Meteoritics and Planetary Science https://doi.org/10.1111/maps.13748 | | |