**Building improved models of the location of the Earth’s plasmapause**

---

Space is not a vacuum. It is permeated with plasma. In fact, roughly 99% of the baryonic (non-dark) matter in the Universe is in this 4th plasma state of matter. Plasma behaves very differently to solids, liquids and gases. The freely moving charged particles (negatively charged electrons and positively charged ions) in a plasma mean that the dynamics are controlled via electromagnetic forces (Maxwell’s equations) [1]. Earth’s magnetosphere comprises of the Earth’s dipolar geomagnetic field, and the plasma contained within. The dynamic and multi-scale solar-terrestrial interaction of the solar wind with Earth’s magnetosphere gives rise to many fundamental, interesting and important physics and engineering challenges and risks, aka “Space Weather” [2]. The Earth’s “Van Allen” Radiation Belts are contained within the magnetosphere, and contain some of the highest energy particles, presenting numerous dangers to spacecraft, and are currently the subject of intense study [3, 4].

In this project, you will use MATLAB to analyse data from the recent NASA Van Allen Probes satellite mission [5,6] (also known as Radiation Belts Storm Probes (RBSP)) to investigate key components of the radiation belts, to better understand some implications for space weather. A better understanding of the radiation belts and the associated risks is a crucial science and engineering challenge [7,8,9], as society becomes ever more dependent on satellite technologies.

---

[1] Plasma Physics - Richard Fitzpatrick. <https://farside.ph.utexas.edu/teaching/plasma/Plasma/index.html>

[2] Cannon, RAE Report on Extreme Space Weather (2013) [www.raeng.org.uk/spaceweather](http://www.raeng.org.uk/spaceweather)

**(^^^ Paul Cannon is a professor in this department ^^^)**

[3] Koskinen, H., & Kilpua, E. (2022). Physics of Earth’s Radiation Belts: Theory and Observations. (Astronomy and Astrophysics Library). Springer Nature Switzerland AG. <https://doi.org/10.1007/978-3-030-82167-8>

[4] Li & Hudson, JGR Space Physics, 124 (2019) <https://doi.org/10.1029/2018JA025940>

[5] Mauk, B.H., Fox, N.J., Kanekal, S.G. et al. Science Objectives and Rationale for the Radiation Belt Storm Probes Mission. Space Sci Rev 179, 3–27 (2013). <https://doi.org/10.1007/s11214-012-9908-y>

[6] Kletzing, C.A., Kurth, W.S., Acuna, M. et al. The Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) on RBSP. Space Sci Rev 179, 127–181 (2013). <https://doi.org/10.1007/s11214-013-9993-6>

[7] Hands, A. D. P., Ryden, K. A., Meredith, N. P., Glauert, S. A., & Horne, R. B. (2018). Radiation effects on satellites during extreme space weather events. Space Weather, 16, 1216– 1226. <https://doi.org/10.1029/2018SW001913>

[8] Horne, R. B., Phillips, M. W., Glauert, S. A., Meredith, N. P., Hands, A. D. P., Ryden, K., & Li, W. (2018). Realistic worst case for a severe space weather event driven by a fast solar wind stream. Space Weather, 16, 1202– 1215. <https://doi.org/10.1029/2018SW001948>

[9] UK Cabinet Office National Risk Register <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/952959/6.6920_CO_CCS_s_National_Risk_Register_2020_11-1-21-FINAL.pdf>