Radiation damage in the Gaia focal plane: in-orbit data, charge-transfer simulations, and the impact on the astronomy achievable

**Supervision team:** David Hall, Jesper Skottfelt, Ben Dryer, Andrew Norton

**External supervisor:** N/A

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**Description:**

Launched in December 2013, the ESA Gaia mission has the ambitious aim of mapping a staggering 1 billion astronomical objects over its 5 year (plus 1-4 year extension) lifetime. The Gaia focal plane is formed of 106 custom-designed e2v CCDs. The detectors are subject to radiation damage whilst in orbit and the results so far suggest that this damage is much lower than that predicted pre-launch.

The contributing factors to this lower level of damage are still unconfirmed, although there are several candidates for this variation. One is the increased optical background from light scattering from fibres and ice on the end of the baffle. Another is the impact of the devices being irradiated in-orbit more than 100 K lower in temperature than in the pre-launch test campaigns. Current research at the OU suggests that both factors have a major impact on the level of damage received. Simulations developed for the ESA Euclid mission using similar detectors (Skottfelt), albeit of a different design, are showing great promise in aiding an understanding of the physics behind the processes of radiation damage in these detectors.

Although the OU’s pre-launch research on Gaia radiation campaign data (Hall and Dryer) has ended, data is now being returned from orbit. Using this information, alongside developing the OU simulations to the Gaia detectors, the student will be able to get real information on traps developing in the CCDs in-orbit, feeding this information back into other mission research (e.g. Euclid, SMILE, WFIRST etc).

The student will then go on to look at how the radiation damage will affect the Gaia RVS output from an astronomy perspective during the mission (Norton). Smearing caused by CCD radiation damage can lead to an increased blending of the object of interest with fainter background objects and this could therefore lead to an increased uncertainty in the radial velocity measurements. As the radiation damage builds over time, the uncertainties will also increase and an analysis of this effect and a possible way to correct for it (linking with OU Euclid and SMILE research), would therefore be of major interest. Impacts of this damage on the astronomy research made possible by Gaia will form the final part of the thesis, linking between the Space Instrumentation and Astronomy research in the School, and will have benefits to other space astronomy missions such as ESAs Euclid and PLATO missions.
The outputs of this research would have the added benefit that they would feed into S818: Masters in Space Science and Technology. The Gaia case study, co-written by Andrew Norton and David Hall, provides a link between astronomy and detector technology through teaching. Consideration of the impact of one on the other during the PhD through this cross-disciplinary research would provide further links not only between astronomy and space instrumentation research, but also between the teaching and research in the Masters in Space Science and Technology (S818).

Qualifications required:

A first class or upper second class MSc/BSc degree in Physics, Astronomy or a related discipline.