Investigating radiation damage of the Gaia focal plane using simulations and in-orbit data

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Description:

The Gaia space telescope is one of the most successful Europeans space missions, currently producing more papers than the Hubble Space telescope. Its purpose is to measure positions and movements of more than 1 billion stars in and around the Milky Way using a large focal plane of 106 custom-designed Charge Coupled Devices (CCDs) from Teledyne-e2v. Gaia was launched in 2013, initially thought to be running for 5 years, but its mission has been extended until the end of 2022 with an indicative extension to the end of 2025, hoping to increase the precision of the measurements.

In space Gaia is subject to a high flux of radiation, mainly from the Sun, which can damage the detectors and thus detriment the scientific data. The radiation damage of the Gaia focal plane has been much lower than expected based on pre-launch predictions. The reason for this is still being investigated, but several factors are believed to influence this. These include an increased optical background due to scattered light, and that pre-launch radiation damage studies were performed on devices irradiated at room temperature, while they in space are kept at -115°C. Another important factor is that the current solar cycle has been very quiet, however, during this second part of the Gaia mission, the Sun will go into a new active period, which will increase the rate of radiation damage to the detectors. To be able to push the detection limit to the required faint levels, it is important to understand how these factors influence the scientific data, so the necessary corrections can be applied. At the Centre for Electronic Imaging (CEI) at the Open University, simulation capabilities have been developed for the VIS instrument on ESA's Euclid mission, which has proven to aid the understanding of the physical processes behind radiation defects in the detectors. By adapting the simulations to work with the Gaia detectors, the student will be able to simulate how the radiation damage affects the scientific data. The student will then be able to compare these simulations with pre-launch test data and post-launch calibration data, available through the collaboration with George Seabroke (ex-CEI, now MSSL). This will help constrain the physical parameters of the radiation damage such that the correction algorithms might be improved. This work will lead into the final part of the project, which will be to work with the Gaia Radial Velocity Spectrometer (RVS) data, used to measure radial velocities. Radiation damage leads to smearing of the spectral data, causing biases in the radial velocity measurements. Using the improved correction algorithms, the biases of these data might be recovered.

The use of in-orbit data will further improve our understanding of the radiation damage created in space, knowledge that can be of use to other missions currently underway (e.g. Euclid, Smile, WFIRST/Roman).

References:

1. Seabroke et al. (2012): https://academic.oup.com/mnras/article/430/4/3155/1112659
2. Skottfelt et al (2017): http://oro.open.ac.uk/49146/

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