CMOS Image Sensors for Precision Astronomy

Supervision team: Dr Konstantin Stefanov, Prof Andrew Holland and Dr Ulrich Kolb

Lead contact: Konstantin.Stefanov@open.ac.uk

Description:

This project will investigate the application of CMOS image sensors for high performance astronomy. This is expected to greatly expand our knowledge of the relatively new science-grade CMOS imaging technology and to help use it in future ground and space-based telescopes.

CCDs are now the main sensors in virtually all scientific telescopes at visible wavelengths, including Hubble and VLT, and are the device of choice for planned future telescopes such as LSST, E-ELT and Euclid. There is a wealth of information and experience gained from using CCDs in astronomy for over 40 years. Still, CCD research is ongoing for some of the most demanding applications involving precise shape measurements of galaxies, and models are being developed to explain how the non-uniform sensor response is affecting the results.

Over the last decade the performance of CMOS image sensors (CIS) has improved markedly. Thanks to the introduction of pinned photodiode (PPD) and backside illumination (BSI), science-grade CIS are beginning to compete with CCDs in areas such as spectroscopy, microscopy, low light level and high sped imaging. It is very attractive to use CIS for astronomy too, especially where high frame rate is required for studies in high time resolution astrophysics, transiting exoplanets and trans-Neptunian objects. The performance of CIS for such applications is not known well, and in particular very little experience has been accumulated so far to support precision astronomy. This studentship is intended to conduct detailed research into the performance of CIS to help understand the behaviour of these complex devices and evaluate their use for precision astronomy measurements.

The project will make use of the CIS113 CMOS image sensor, manufactured by e2v. CIS113 is a large, low noise BSI device with 1920×4608 16 µm square pixels, and can operate at up to 20 frames/s. In addition, another CIS designed by the OU using deep depletion is expected to become available during the studentship and will be studied as well. The characterisation will be carried out in collaboration with OU astronomers conducting related research at international and OU facilities. The Open University operates the 17-inch remote-controlled telescope PIRATE, used for photometric monitoring of transiting exoplanets, periodic variable stars and transient sources. At the CEI the student will perform detailed measurements on CIS, including the point spread function which could be responsible for shape distortions, photo response non-uniformities, dark current distribution, transistor “glow” and operation at low temperatures. During the industrial placement at e2v the student will perform detailed electro-optical device characterisation using industry-standard test methods and equipment, which are not available at the CEI. The student will also provide feedback to the design of new CMOS devices at e2v, taking into account the experimental results.

Qualifications required: A first class or upper second class MSc degree in physics, electronics engineering or related discipline.