Projects 1 and 2: Pulsars and Fast Radio Bursts with REALTA and I-LOFAR

I-LOFAR – the Irish node of the Low Frequency Array (www.lofar.ie) is a new radio telescope currently in operation in Birr (Co Offaly). Designed to observe objects at low radio frequencies (10-240 MHz), the telescope can be used as part of the Europe-wide network of LOFAR telescopes (http://astron.nl/~moss/lofar/LOFARQuickStartGuide-v1.1.pdf) or in "stand alone" mode. UCC is a core member of the I-LOFAR consortium. There are several key science themes that LOFAR will address, including extragalactic studies, solar physics, cosmic ray physics, the transient radio sky, and radio pulsars.

We are currently commissioning the UCC funded "REALTA" high speed computer cluster on I-LOFAR. With high speed GPUs and ~0.4 petabytes of storage, we have a powerful means of studying variable radio sources, on the shortest timescales.

The first two projects on offer here involve REALTA observations of

(i) Radio Pulsars and
(ii) "Fast Radio Bursters", or FRBs.

Project (i) involves the study of radio pulsations from neutron stars, and how they are affected by scattering and dispersion as they propagate through the interstellar medium. These effects are particularly dramatic at the low radio frequencies of LOFAR.

Project (ii) involves a search for FRB counterparts on low radio frequencies, which have only been observed at frequencies > 400 MHz. Their detection by I-LOFAR would be a useful step in trying to understand the sources of these extremely luminous, very short-period flares.

This project will be a collaboration between UCC Physics, TCD and the DIAS.

Project 3: TESS photometry of Cataclysmic Variables and X-ray Binaries

Cataclysmic variables (CVs) are binary star systems consisting of a star undergoing mass loss, to a white dwarf. X-ray binaries are similar systems, but in this case the accreting star is a neutron star, or black hole. They are highly variable, often exhibiting outbursts over timescales of weeks to months.

NASA's TESS mission has been in orbit for more than a year, and is designed to carry out an all sky observing programme to accurately monitor the brightness of 500,000

stars, over the mission lifetime. Although the main scientific goal is to look for extrasolar planet transits, TESS has also observed many 100 CVs, and some LMXBs. This type of extensive monitoring is important for understanding how the variable accretion disk interacts with the compact object at it's centre, and how, for example, the inner disk is affected if the object has a strong magnetic field.

This extensive dataset has not yet been mined for the purpose of studying these systems, and the purpose of this project is to do just that. It will be carried out in collaboration with colleagues in Armagh Observatory and Manchester University.

Project 4: X-ray and optical observations of dynamically formed ultra compact binaries

In the cores of dense globular clusters and galaxies, the number of stars per unit volume is such that they scatter off each other, sometimes merging, or forming binary systems. When one of the stars is a compact object (black hole, neutron star or white dwarf), the binaries become visible as bright X-ray (1-10 kev) emitters. X-ray image (0.5-10 keV) of a globular cluster.
The student will:
• Analyze Chandra X-ray images of globular clusters and perform the astrometry required to localize the positions to within < 0.5''.
• Relate these measurements to HST observations of the same field, identifying optical counterparts to the X-ray sources on the basis of their spectral energy distribution and variability.
The HST observations are required because of the very crowded nature of these fields. These measurements will allow us to identify new white dwarf, neutron star systems, and address the existence of black holes in globular clusters.
