Master's project proposal, University of Cape Town

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A radio study of the optically-discovered black hole X-ray binary AT2019wey

In 2019 the optical transient source AT2019wey was discovered by the ATLAS telescope. It was soon realised that this was a rare example of a previously unknown accreting stellar mass black hole in a binary system being discovered in the *optical* band. This optical emission arises from the outer accretion disc around the black hole, and the rapid rise in optical emission indicates an accretion-driven outburst. Subsequent observations identified the expected X-ray (inner accretion disc) and radio (relativistic jet) counterparts. The system is very interesting for a number of reasons:

- AT2019wey has one of the **shortest-period black hole candidates known (~2.7 hr).** There are hints that the behaviour of X-ray binaries at very short orbital periods differ from the norm. The short orbital period also implies a **very low-mass donor (≲0.3 M⊙).**

- It had a **hard-state–dominated outburst**, possibly a failed state transition, although in the past year it may have undergone for the first time a 'traditional' hard-to-soft state transition (or indeed multiple transitions, resulting in strong flares).

- The **early optical detection**, providing a rare opportunity to see catch the rising phase of the outburst, as mass accretion rate increased and the accretion disc brightened.

- The **high galactic latitude** and measured proper motions strongly support an origin for the black hole in a supernova explosion which provided a natal kick.

At Oxford, via our long-running transients programme on the AMI-LA radio telescope, we have made approximately 100 radio observations, with a large number of detections, and data acquisition is still ongoing. These data have not to date been published in any form.

Analysis of these data and comparison to X-ray and optical data obtained with other facilities will allow us to understand the production and energetics of the relativistic jet in this system. This is the key goal of this project: reduction and analysis of the AMI-LA data, and then using them in the broader context of existing knowledge and other observations to piece together the astrophysics of what is going on in this system. The teams associated with both supervisors have extensive experience with all aspects of the project.

No specific experience is required for this project, although some familiarity with X-ray binaries, as well as radio and X-ray astronomy, would be helpful. A relevant background paper on AT2019wey is here and generally on accretion state and jets in X-ray binaries here.