Accretion and jets from stellar-mass to supermassive black holes

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Propositions of this thesis

1. The power budgets of hard state black hole X-ray binaries and low-luminosity active galactic nuclei appear to scale in a particular way with accretion rate, irrespective of the orders-of-magnitude difference in black hole mass (chapter 2).

2. The physical basis for this power scaling can be directly tested, by modelling the simultaneous broadband spectra of accreting black holes that lie on the radio luminosity/X-ray luminosity/mass relation, i.e., the Fundamental Plane (chapter 2).

3. The fundamental difference between the concept of a 'corona' in the inner regions of an accretion flow and the outflowing jet, is the bulk motion (and directionality) of the radiating plasma. This distinction has not been properly tested until now, since most models are not global enough (chapter 4).

4. The broadband spectrum of GX 339-4, a low-mass X-ray binary, during the hard state, can be well-modelled as the superposition of a jet with relativistic electrons and a corona comprised of cooler plasma, where the distinction between the two regions is the temperature and optical depth of the plasma, and the seed photons for inverse Compton scattering (chapter 4).

5. The future of broadband spectral modelling of hard state X-ray binaries and low-luminosity active galactic nuclei (sources in which a compact radio jet is present) requires an improved treatment of the radiating plasma, particularly the particle distributions (chapter 4).

6. A full treatment of disc reflection requires proper testing of the effects of various geometries of the X-ray irradiating region on the reflection spectrum. Using physical models that are normalised according to the mass of the black hole can help us to start ruling out particular geometries and allow us to break degeneracies (chapter 5).

7. If primordial black holes contribute significantly to the dark matter in the universe, based on some conservative assumptions regarding the accretion of interstellar gas onto these black holes, radio and X-ray observations of our own Galactic centre should have already led to their detection (chapter 6).

8. For me, doing a PhD is like going 12 rounds with Mike Tyson whilst in a straitjacket. You start by taking a lot of punishment, but over time the binds loosen. Eventually you can begin to punch back, and you hope you learned something before that happens, because time is running out.

9. Nothing is ever gained by silencing the people you disagree with, and as scientists we should understand this better than anyone: any call to ban speech is a show of force against the right to free expression, and we all lose when this happens.

10. I recommend the Dutch astronomy community changes its outlook on the requirements of a PhD thesis; the magic number four is not as magic as everyone likes to pretend.

Riley Michael Thomas Connors, Amsterdam, November 2017