A Statement of Purpose in line with Oxford Graduate Admissions instructions and those set forth by the DPhil in Astrophysics.

During a 2017 conference hosted by the ARC Centre of Excellence for All-Sky Astrophysics (CAASTRO), I sat and watched as speaker after speaker presented their work. Part way through that week, one man stood at the front and single-handedly brought into question a concept that I had previously accepted at face value. It placed my previous astrophysics research experience in a new context, and since that time, it has remained at the forefront of my mind.

The research experience I reference extends back to 2015 with an undergraduate project undertaken at the University of Tasmania with Dr. Stanislav Shabala and Dr. Ross Turner. This project investigated the impact of the nearby environment on the length and luminosity of radio jets of Active Galactic Nuclei (AGN), with a key focus on classical double sources. Using classification data from citizen science project Radio Galaxy Zoo and additional radio images from large-scale surveys, I measured properties of radio jets and the number density of nearby galaxies. After 8 weeks of resolute learning and of numerous hurdles, I found evidence that denser environments host a disproportionate number of shorter and brighter radio lobes. As of September 2018, a paper detailing these findings is currently under review for publication with MNRAS. In addition to presenting this work at department meetings, I have also presented posters at two international conferences: one hosted by CAASTRO in Canberra, ACT, and the other by the Australian Institute of Physics (AIP) in Sydney, NSW, which I attended independently. I have additionally travelled around the state to present to the general public, reaching people from all walks of life.

During the summer of 2016, I undertook another research project at the CSIRO Astronomy and Space Science (CASS) centre in Perth, WA under the supervision of Dr. Cormac Reynolds. This project involved a study of intra-day variability amongst a sample of compact radio sources across an 8GHz frequency band, in addition to testing a new method of detection for Extreme Scattering Events. Outside of my main projects, I was also tasked with planning and leading observations of an intra-day variable source PKS-1257 to be undertaken at the Australia Telescope Compact Array (ATCA) in Narrabri, NSW in January of 2017. During this time I gained new skills and a new understanding in the area of experimental astrophysics, especially in the difficulties in planning observations, reducing data, and handling Radio Frequency Interference – even in such a remote location as the Narrabri Shire.

At the end of 2017 I graduated with a Bachelor of Science in Physics and Applied Mathematics, achieving a perfect Grade Point Average. I have since started my Honours degree in Astrophysics under Dr. Stanislav Shabala and Dr. Ross Turner modelling how Faraday Rotation signatures from black hole jets may be used to determine properties of galaxy clusters. Much of the work in determining cluster properties currently falls to X-ray surveys, however with the advent of large-scale radio telescope projects such as the Square Kilometre Array, X-ray and optical observations are unlikely to keep up with the prodigious flow of data. The emission from radio jets has an intrinsic degree of linear polarisation, and its subsequent depolarisation as it passes through the intervening media towards our telescopes can be used to constrain the properties of that media, all whilst taking advantage of the same flow of radio data. Over this year, I have not only improved my programming skills but also my organisation; when the majority of your time is not spent in class or in working towards a class, it is all too easy to lose sight of the finish line. My success this year in juggling my thesis, a number of classes, and many outreach events has hinged on my ability to plan ahead and keep copious notes on my progress.

However, what I had thought I knew about AGN and their environments was re-framed during the 2017 CAASTRO conference by Dr. Sugata Kaviraj when he denounced the use of the 1952 Bondi accretion model. In the same breath, this brought to mind many of the challenges that we face in astrophysics, a field where theory and observation are inextricably linked to both their benefit and detriment. The Bondi model assumes perfectly spherical, radiatively efficient accretion of a perfectly uniform gas cloud onto a black hole, none of which are reasonably expected to hold for a physical system. Using this model in analysis of real data or in simulations can act to obscure or totally destroy real correlations that are present, however more realistic transient and unstable behaviours in black hole accretion disks are poorly understood on a broad level and are further complicated by interactions with magnetic fields, leaving no clear, simple alternative. In order to better understand black hole growth and galaxy evolution, these details must be investigated with a mix of analytical and numerical methods, including magnetohydrodynamical (MHD) simulations and so-called "ray-tracing" codes. Whether I investigate such details as the dissipation of energy through ionised intracluster gas, variable black hole growth rates, or mechanisms which may affect the appearance of black holes over time, I intend for my future work to lead back to AGN and galaxy evolution in the space of the next 10 years.

With this goal in mind, Oxford University offers the world-renowned researchers and state-of-the-art computing facilities that I need. Supported by the knowledge and expertise from such theorists as Prof Steven Balbus and Prof Alexander Schekochihin, I believe that I can make significant progress in understanding some of the broad issues faced in plasma astrophysics as they relate to galaxies and their residing black holes. I have also contacted Prof Balbus who has expressed that he is able and willing to supervise me for a topic in this area, subject to available funding. With a background involving theory, computation, data analysis, and observation, I hope to take a phenomenological approach to theory and to explore its implications for the next generation of telescopes, a process made easier by the presence of a strong instrumentation research group. By paying consideration to a wide range of techniques, I plan to deliver robust science that can be further built upon in this age of collaborative multi-messenger astronomy.