Preface

The discovery of black holes in space represents one of the great scientific advancements of the twentieth century, and continues to this day to stimulate the imaginations of scientists and science-fiction writers alike. The influence of these extraordinary objects upon their environments—effected through the processes of accretion and, perhaps less intuitively, the ejection of matter back out into space—has come to be understood as fundamental in the formation and evolution of the Universe. Furthermore, the extreme gravitational forces that act within the vicinity of each black hole provide a wonderful opportunity for us to refine our understanding of the laws of nature by examining their action under conditions that would simply be impossible to reproduce in a laboratory here on Earth. Therefore, black holes are, and will continue to be, some of the most important and popular targets for scientific study across a wide range of research disciplines.

This thesis was written during my time studying as a Ph.D. student at the Astronomy Group of the University of Southampton, and utilizes X-ray spectral analysis to investigate the properties of accreting black holes that extend over several orders of magnitude in accretion rate ($\dot{m}_{\mathrm{E}}$) and black hole mass (M_{BH}), from the stellar mass black holes in X-ray binary systems (XRBs) to the supermassive black holes in active galactic nuclei (AGN). In general, high energy photons from accreting black holes are believed to originate from regions close to the event horizon where most of the gravitational potential energy is liberated, and emission in the X-ray band therefore provides the perfect probe for testing the geometry, behaviour and conditions present in the innermost regions of the accretion flow.

First, through a survey of X-ray emission in the nuclei of nearby galaxies I examine the usefulness of the X-ray to optical line ratios as identifiers of Compton-thick sources (i.e., sources with absorbing column densities greater than $\sim 10^{24}$atoms cm^{-2}) amongst low-luminosity AGN, and consider whether these ratios may have more practical use in distinguishing between AGN and non-AGN emission processes. Such line ratios are commonly used to identify Compton-thick sources amongst highly luminous AGN, but little is known about the extent to which this diagnostic applies to low-luminosity sources; the contribution to the optical line strengths from stellar processes in the latter may well be sufficient to affect the X-ray to optical line ratios, and therefore result in many sources being incorrectly classified as Compton thick.

Second, and more importantly, the main focus of this thesis is upon the variability of the Comptonised power-law X-ray spectral component, and more specifically an examination of how the photon index (Γ) varies with accretion rate. By cross-correlating the count rate from an XRB source with the fitted Γ on time-scales as short as 16 ms I search for the presence of separate components which could be associated with Comptonisation of disc seed photons and Comptonisation of cyclo-synchrotron seed photons in the hot inner accretion flow.

I would like to express my sincere gratitude to my Ph.D. supervisor, Prof. Ian McHardy, for his infectious enthusiasm and limitless knowledge of all things in astrophysics, and for the many interesting chats over the years. I would also like to extend, thanks to the rest of the staff of the astronomy group (past and present), and especially Tom Maccarone and Phil Uttley, for their help and support.

My thanks also go to the Science and Technology Facilities Council (STFC) for financially supporting my research.

Finally, my deepest thanks go to my family, and this thesis would not have been written without their constant support and encouragement.

http://www.springer.com/978-3-319-09586-8

Fast Spectral Variability in the X-ray Emission of Accreting Black Holes
Skipper, C.
2015, XXXIII, 150 p. 79 illus., 64 illus. in color., Hardcover
ISBN: 978-3-319-09586-8