

Preface

Just over a century has passed since the first observations of active galactic nuclei (AGN) were recorded. These objects, at the centre of galaxies, turned out to be the sites of growing super massive black holes. It has become clear that these AGN are among the most powerful energy sources in the Universe and are extremely luminous over the whole electromagnetic spectrum. For many decades these energetic phenomena were largely considered rare, yet fascinating objects to study in their own right. However, over the last quarter of a century or so, high-quality observations and theoretical work have moved AGN to the forefront of extragalactic astronomy research. Observations have now shown us that all massive galaxies are likely to have hosted AGN activity during their lifetimes. Furthermore, theoretical work now suggests that AGN activity has a profound influence on the evolution of its host galaxy and the larger scale environment that it resides in. These galaxy evolution models invoke AGN-driven galaxy-wide “feedback” processes (e.g., the expulsion of gas through outflows) in order to reproduce many of the fundamental properties of galaxies and the intergalactic medium. However, placing *observational constraints* on the influence of AGN on the evolution of galaxies remains an open area of research, with many outstanding questions. The motivation of this thesis was to use a variety of observational techniques to address this limitation and to test theoretical predictions.

In this thesis I use a technique called spatially-resolved spectroscopy (described in Chap. 2), to observe how the ionized gas in AGN-host galaxies is behaving and to search for evidence that gas is being expelled from these galaxies. I observed galaxies over a wide range of cosmic epochs; from those relatively close by to our own Milky Way, right out to the distant Universe where the galaxies are being observed as they were roughly 12 billion years ago (Chaps. 3–5). A key focus of the work in this thesis is to carefully select objects to observe those that are more typical of the overall galaxy population than previous work. An extra emphasis is placed on asking what my observations of some objects tell us about galaxies *as a whole*. The model predictions that AGN expel gas from galaxies, appears to be holding up reasonably well. However, some of the other results presented in this

thesis challenge key model predictions on the *impact* that these outflows are expected to have on the formation of stars inside these galaxies. Using far-infrared data from the *Herschel* space telescope, I measured the rate at which stars are forming in the host galaxies of some of the most powerful AGN in the Universe (Chap. 6). The simple picture that AGN suppress the formation of stars in their host galaxies, turns out to not be so simple. Towards the end of this thesis I discuss the implication of my work (Chap. 7) and the outstanding questions that are being addressed with ongoing observational projects (Chap. 8). The study of growing supermassive black holes, and their role in the formation of galaxies, continues to be an exciting and hugely active area of research.

There are many people to thank who have helped, in a variety of ways, to get my thesis to this finished state. I consider myself extremely lucky to have had Dave Alexander as my supervisor, with his infectious enthusiasm for extragalactic astronomy. Throughout the four years of my Ph.D. he provided me with excellent advice and created a number of fantastic opportunities for me to progress as a researcher. I am very appreciative of his supervising style that has allowed me to explore my own ideas, whilst drawing upon his own experience and expertise to guide me in the right direction.

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