Contents

1 Introduction ................................................................. 1
  1.1 A Brief History of the Discovery of Galaxies and AGN ........... 1
    1.1.1 Galaxies ...................................................... 1
    1.1.2 Active Galactic Nuclei ..................................... 2
  1.2 AGN Structure and Multi-wavelength Emission ....................... 4
    1.2.1 The Growing BH ............................................ 5
    1.2.2 AGN Standard Model and Broad-Band Continuum SEDs .......... 6
    1.2.3 AGN Standard Model and the Emission-Line Regions ......... 8
    1.2.4 Bolometric Luminosities ................................... 10
  1.3 The Census of AGN Activity ....................................... 10
    1.3.1 Optical/UV Surveys .......................................... 10
    1.3.2 X-Ray Surveys .............................................. 11
    1.3.3 Infrared Surveys ............................................ 12
    1.3.4 Radio Surveys ............................................... 13
    1.3.5 The AGN Demography ....................................... 13
  1.4 The Co-evolution of BH and Galaxy Growth ......................... 14
    1.4.1 The Cosmic Space Density of BH Growth and Star Formation Are Similar ........................................... 15
    1.4.2 Most BH Growth Occurs in Star-Forming Galaxies ........... 16
    1.4.3 BH Masses Are Related to Galaxy Bulge Properties ......... 18
  1.5 The Influence of AGN on the Evolution of Galaxies ............... 19
    1.5.1 Matching Models to Observations: AGN to the Rescue ......... 20
    1.5.2 Outflows ..................................................... 23
    1.5.3 The SFRs of Luminous AGN .................................. 26
  1.6 Thesis Outline ..................................................... 26
References ................................................................. 28
2 Integral Field Spectroscopy and Spectral Energy Distributions
  2.1 Integral Field Spectroscopy
    2.1.1 Introduction
    2.1.2 Integral Field Spectroscopy
    2.1.3 The Instruments Used in This Thesis
    2.1.4 Data Reduction
  2.2 Spectral Energy Distributions
  2.3 Calculation of SFRs and AGN Luminosities
  References

3 Energetic Galaxy-Wide Outflows in High-z ULIRGs Hosting AGN Activity
  3.1 Motivation
  3.2 Introduction
  3.3 Observations and Data Reduction
    3.3.1 Target Selection
    3.3.2 IFU Observations
    3.3.3 Flux Calibration and Stacking
  3.4 Star-Formation Rates and AGN Luminosities
  3.5 Analysis and Results
    3.5.1 Galaxy-Integrated Spectra
    3.5.2 Surface Brightness, Velocity and FWHM Maps
    3.5.3 Regions Dominated by Narrow and Broad Emission Lines
    3.5.4 Velocity Profiles
  3.6 Discussion
    3.6.1 Tracing Galaxy Dynamics, Mergers and Outflows
    3.6.2 Outflow Properties
  3.7 Conclusions
  References

4 Kiloparsec Scale Outflows Are Prevalent in Luminous AGN: Outflows and Feedback in the Context of the Overall AGN Population
  4.1 Motivation
  4.2 Introduction
  4.3 Targets, Observations and Data Reduction
    4.3.1 Target Selection
    4.3.2 Gemini-South GMOS Observations and Data Reduction
    4.3.3 SFRs, AGN Luminosities and the Origin of the Radio Emission
  References
4.4 Velocity Definitions and Spatially Resolved Kinematics 94
   4.4.1 Non-parametric Velocity Definitions 94
   4.4.2 Emission-Line Profile Fitting Procedure 96
   4.4.3 Velocity Maps and Velocity-Distance Profiles 99
4.5 Results 100
   4.5.1 Extended Emission-Line Regions: Sizes and Morphologies 102
   4.5.2 Spatially-Resolved Ionised Gas Kinematics 103
   4.5.3 Outflow Properties: Estimates of Mass, Energy and Momentum 108
4.6 Discussion 110
   4.6.1 What Drives the Outflows? 110
   4.6.2 What Role Do These Outflows Play in Galaxy Evolution? 117
4.7 Conclusions 118
References 121

5 Storm in a “Teacup”: A Radio-Quiet Quasar with \( \approx 10 \) kpc Radio-Emitting Bubbles and Extreme Gas Kinematics 125
   5.1 Motivation 125
   5.2 Introduction 126
   5.3 Data Acquisition, Reduction and Analysis.
      5.3.1 VLA Radio Data 128
      5.3.2 VIMOS IFU Data 131
      5.3.3 HST Imaging 133
   5.4 Results and Discussion 134
      5.4.1 Summary of Source Structure 134
      5.4.2 What Powers the Core Radio Emission and Outflow? 135
      5.4.3 What Powers the \( \approx 10 \) kpc Radio Bubbles? 138
   5.5 Conclusions 139
References 139

6 No Submillimetre Signature of Star Formation Suppression Among X-Ray Luminous AGN 143
   6.1 Motivation 143
   6.2 Introduction 144
   6.3 Catalogues and Data
      6.3.1 X-Ray Data 145
      6.3.2 IR Data 146
   6.4 Measuring Average Star Formation Rates 147
   6.5 Results
      6.5.1 Discussion 151
References 153
# 7 Conclusions

7.1 The Identification and Characterisation of Galaxy-Wide Outflows in ULIRGs Hosting AGN Activity ........................................ 155

7.2 Galaxy-Wide Outflows in the Context of the Overall AGN Population ................................................................. 156

7.3 Observations to Understand the Relationship Between Radio Emission and Outflows ........................................................... 157

7.4 Searching for Observational Evidence That Luminous AGN Suppress Star Formation .......................................................... 157

7.5 Overall Summary and Outstanding Issues ......................................................... 158

Reference ......................................................................................................................................................... 158

# 8 Ongoing and Future Work

8.1 What Physical Processes Drive the Outflows in AGN? ........................................ 159

8.2 What Are the Multi Gas-Phase Properties of Galaxy-Wide Outflows? .................. 163

8.3 What Is the Prevalence of Ionised Outflows in Galaxies Across Cosmic Time? .... 166

8.4 What Impact Do Outflows Have on Galaxy Evolution? ........................................ 169

8.5 Final Remarks ...................................................................................................................... 173

References ......................................................................................................................................................... 174

Appendix A: AGN Emission Lines: Some Relevant Information and Applications .............................................................................. 175

Appendix B: Assumed Cosmology ......................................................................................................................... 183

Appendix C: Acronyms ........................................................................................................................................ 187

Index .................................................................................................................................................................. 191
Observational Constraints on the Influence of Active Galactic Nuclei on the Evolution of Galaxies

Harrison, C.M.
2016, XXIII, 193 p. 57 illus., 17 illus. in color., Hardcover
ISBN: 978-3-319-28453-8