Abstract

In this thesis, we report on the properties of a new selection of active galaxies found using long-term NIR variability. Data from the United Kingdom Infrared Deep Sky Survey Ultra Deep Survey (UKIDSS UDS) is used, which is the deepest near-infrared (NIR) survey over $\sim$1deg^2 and has an 8 year baseline for IR imaging. Here we select 601 AGN based on their (long-term) NIR variability in the J (1.2μm) and K (2.2μm) photometric bands. We also make use of X-ray imaging from the X-UDS survey, a *Chandra* space telescope based X-ray survey of a sub-region of the wider UDS field, to detect 710 X-ray bright AGN. We first begin by investigating how the properties of active galaxies change depending on the detection method used to select them. A comparison of the AGN identified by near-infrared variability to those selected by X-ray detection find only modest overlap in the galaxies detected. Only 37 per cent of galaxies are found to be both X-ray bright and IR variable for the same imaging area. We find that NIR variability is able to detect AGN activity in galaxies with a range of stellar masses, which is in contrast to X-ray detection, which preferentially selects AGN in massive galaxies (M_* $10^{10}M_\odot$). From these findings, we conclude that a range of selection methods is required for a complete census of active galaxies to be obtained.

Having established that NIR variability as a relatively new way of finding AGN, we explore how the properties of these variable galaxies differ depending on the band in which the AGN is found to be significantly variable. Dividing variability detected AGN based on their detection band, we find that K (2.2μm) and J-band (1.2μm) variable AGN show opposite trends in their chromatic nature, with K-band correlating and J-band anti-correlating variability amplitude with wavelength. K-band variable AGN are preferentially observed at rest-frame infrared wavelengths whereas J-band variable AGN show no obvious preference for the rest-frame of detection. Inspecting the SED of the galaxies, AGN variable in the K-band have significantly redder UV colours compared to AGN variable in the J-band, with similar results being found between X-ray hard and X-ray soft active galaxies respectively, where the hardness ratio is used as an alternative measure of obscuration. AGN variable in the K-band also show lower variability amplitudes and variability that skews towards longer timescales compared to their J-band variable counterparts. The properties of AGN variable in different bands suggests that the IR spectrum of K-band variable AGN is dominated by thermal emission from hot dust, whereas J-band variable AGN show features consistent with thermal emission from accretion disk processes. These differences identify the rest-frame J to rest-frame K-band as a possible turnover in dominant IR emission processes

in AGN and we suggest K-band variability detecting AGN emission in dusty galaxies as a possible explanation for the properties found in these galaxies.

Finally, we examine the environment, observed colours and host galaxies to explore possible reasons for the differences seen in X-ray and variability detected active galaxies and their subgroups. X-ray and variability detected AGN are found in different environments compared to each other as well as when comparing to corresponding sets of control galaxies matched in stellar mass, redshift and effective radius. X-ray bright active galaxies are preferentially found in overdense environments whereas variability detected active galaxies do not show any obvious trends with environment. Optical (V - I) and infrared (J - H) colour comparisons over time find X-ray bright active galaxies to appear redder than variability detected samples at the 4000Å break, a feature that is typical of high mass galaxies with larger passive fractions. In preliminary work, X-ray to IR luminosity comparisons provide evidence that two component Sérsic + point source models are able to effectively decompose AGN from host galaxy emission. Inspecting the host galaxies of X-ray bright AGN finds significantly redder optical colours than control galaxies, but infrared colours are generally indistinguishable over time. Colour evolutions change when grouping galaxies by morphological type, with disk-type X-ray AGN hosts appearing redder both in the optical and infrared colours, but spheroidal hosts showing no clear trend in the optical colour but appearing much bluer than controls in the infrared colour. This preliminary work illustrates the need for AGN-host galaxy decomposition in determining intrinsic host properties in future wide-field studies.