

The Search for the Highest Redshift Quasars Using the Dark Energy Survey

Research Summary - Sophie Reed

Quasars are amongst the most luminous objects known in the Universe and thus can be observed out to large distances and correspondingly early times in the history of the Universe. Luminous quasars are powered by accretion of matter onto supermassive black holes ($10^6 - 10^{10} M_{\odot}$) and are situated in the centre of some of the most massive galaxies and are a crucial test of massive galaxy and supermassive black hole assembly and evolution models - proving hard to recreate using simulations. As well as being of intrinsic interest, the spectra of quasars contain information about the state of the intergalactic medium (IGM) in the vicinity of the quasar, and also cosmologically distributed material in the foreground, via absorption lines due to the intervening material. This allows studies of the IGM at high redshift along different sight lines, providing insight into the metallicity, temperature and homogeneity of the Universe.

This thesis discusses a new method of finding high redshift quasars using new multi wavelength data from the Dark Energy Survey, the VISTA Hemisphere Survey and Wide-Field Infrared Survey Explorer. The beginning of the thesis focusses on developing an automated selection code for $z > 6$ quasars, including the automatic rejection of foreground contaminating sources such as instrumental artefacts, asteroids, galactic stars and lower redshift quasars and galaxies. Following on from my first discovery of a $z = 6.1$ quasar in the DES and VHS data, I have developed a robust selection method that allows me to go straight from candidates to spectroscopy without needing additional photometric follow up. The method uses a grid of quasar models with a range of reddening and a series of brown dwarf spectral energy distribution models to derive a χ^2 statistical likelihood of an object being a quasar and an associated photometric redshift. This differs from previous methods in that it allows for automatic rejection of brown dwarf stars without requiring further data. My selection delivers a ranked candidate list which down weights astrophysical contaminants and imaging artefacts.

The thesis then discusses extending this method to higher redshift and the discovery of two quasars at $z = 6.75$ and $z = 6.9$. Included with this is a discussion about spectroscopic reduction of near IR data and the properties which can be derived from it.

The final part of the thesis uses the quasars I have found to study their environment such as the IGM which they are embedded in, I have been developing a robust method for measuring their hydrogen near zone sizes that can be compared to simulations.