RADIO SOURCE ENVIRONMENTS AT REDSHIFTS > 0.5

M. LACY[1], S. RAWLINGS[1], M. WOLD[2], A. BUNKER[1],
K.M. BLUNDELL[1], S.A. EALES[3], P.B. AND LILJE[2]

[1] *Astrophysics, Keble Road, Oxford OX1 3RH*
[2] *Institute of Theoretical Astrophysics, University of Oslo*
[3] *Physics & Astronomy, University of Wales, Cardiff*

1. Introduction

The most powerful radio sources in the local Universe are found in giant elliptical galaxies. Looking back to a redshift of 0.5 ($\approx$ half the age of the Universe for $\Omega = 1$), we see that these host galaxies are increasingly found in moderately rich clusters [1,2]. This fact gives us hope that radio sources can be used as tracers of high density environments at high redshift. By exploiting radio source samples selected over a wide range in luminosity (Blundell et al., these proceedings), we will also be able to test whether the luminosities of radio sources are correlated with their environments.

2. Methods of studying environments at high redshifts

For redshifts $0.5 < z \lesssim 0.8$, methods based on measuring the excess number of galaxies in a CCD frame relative to a comparison frame seem to still be viable, despite contamination by foreground and background galaxies. In an on-going project using the NOT on La Palma, we have imaged the fields of seven radio-loud quasars in this redshift range through either R and I or R and V filters so as to straddle the 4000Å break in the rest-frame of the companions. Three of our seven frames show an excess of galaxies relative to the comparisons significant at $> 3\sigma$.

Radio techniques based on depolarisation/rotation measure studies may prove useful for studying the gaseous environments of objects at redshifts higher than those accessible to current X-ray studies. Correlation with the richness of the optical environments is expected if indeed Faraday rotation arises in an external halo.

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Redshifts $\gtrsim 1$ require multicolour or narrow-band imaging to find companions in all but the very richest fields. Companions at $z > 2$ are of great interest as they are "normal" galaxies at high redshift, very few of which are currently known. Although ≈ 100 radio galaxies are now known above $z = 2$, their use in studying galaxy evolution is limited as high-redshift galaxies are known to have their optical light contaminated by contributions from the active nucleus, including reddened quasar light (e.g. [3]), emission lines [4], jet-induced star formation (e.g. [5]) and possibly others. Companions should be relatively unaffected by such processes and thus are of much more value for studying galaxy evolution. We have used narrow-band imaging in the near infrared around either the redshifted Hα or [OIII]4959/5007 lines in four fields at $2.1 < z < 2.7$. We typically find 2-3 objects per $\approx 1\,\mathrm{arcmin}^2$ field with significant excesses in the narrow band, which we now need to follow-up spectroscopically.

A further technique which becomes viable at $z > 3.4$ is that of imaging across the Lyman continuum break, which is redshifted beyond the band-pass of the U filter in the optical. This is potentially a very robust way of finding high-z galaxies as *almost no* flux shortward of the redshifted Lyman limit is able to penetrate the clouds of intervening Lyman limit absorption systems. A pilot study of the field of 4C41.17 ($z = 3.8$) has revealed three potential companions [6].

Our discovery of two radio galaxies at $z > 4.2$, 8C1435+635 ($z = 4.25$; [7]) and 6C0140+326 ($z = 4.41$; Rawlings et al., in preparation) allow us to use B-band to sample below the redshifted Lyman limit, a much more attractive option given the far higher observing efficiency in this band. We also hope that Lyα imaging, unsuccessful at $z \sim 2$, might be more successful at such high redshifts. Lyα photons are destroyed by resonant scattering from HI followed by absorption onto dust grains. By catching galaxies early enough, before they form dust, we might hope to detect Lyα emission. We have one Lyα emission-line candidate in the field of 6C0140+326, which again requires spectroscopic confirmation.

References

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