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Host Galaxies of $z \approx 4.7$ QSOs

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Abstract

The host galaxies of five z$\sim$4.7 QSOs are resolved in continuum and [O II] line emission, in 2μ broad- and narrow-band imaging from the Gemini-N telescope. The host galaxy magnitudes follow the K-z relationship for high redshift active galaxies, although the morphologies are irregular and knotty. The [O II] images are suggestive of jets and tidal tails, and indicate line fluxes of levels similar to the continuum. Two of the QSOs are in a local excess of faint galaxies similar to the host, and some have companions with narrow-band excess similar to the host.

1.1 Observations and Data Processing

The QSOs were chosen only by redshift, to include the [O II] 3727Å line in a narrow-band filter near to 2 microns. Observations were made during the first half of 2002, with total exposures of 40 minutes in both broad- and narrow-band filters. The details are given in the Table, along with properties of the QSOs and some measured quantities. As the observations were carried out by service observing over a number of nights, the conditions varied somewhat between them. The FWHM and limiting surface brightness are shown for all objects, and lie in reasonably compact ranges of values.

The analysed images were derived from dithered exposures, processed using standard techniques. The field size is approximately 2 arcmin, which included suitable PSF stars in all cases, and enabled some analysis of the QSO faint galaxy counts in the QSO neighbourhood. PSFs were subtracted from the QSO images for both sets of filters, and the line emission was isolated from the continuum by subtraction of the continuum images from the narrow-band images. Broad- and narrow- band image fluxes were measured and compared for the QSOs, as well as stars and other galaxies in the field, to assess the extra line flux in the NB images. PSF subtraction was scaled to match the nuclear flux levels with adjustment for different FWHM as necessary. The resolved flux estimates by PSF subtraction, NB/BB signal ratios, and integration of the luminosity profiles were all in good agreement with each other. Mean (magnitude) values are shown in the table.

Figure 1.1 shows the azimuthally averaged profile of the mean image of all 5 QSOs. The broad-band images in general show irregular and filamentary structure, which is azimuthally smoothed in the plot. The narrow-band images all have extra flux, both resolved and unresolved, presumably from [O II] line emission in the host galaxy. The narrow-band images

Table 1.1. *QSO properties*

Name	z	FWHM(")	K_{QSO}	NB%[a]	K_{host}
1321+0038	4.67	0.73-0.77	18.3	<10	20.5
1415+3408	4.60	0.89-0.94	18.4	10	19.8
1428-4217	4.72	0.68-0.72	17.4	15	20.2
1451-0104	4.67	0.56-0.89	18.4	16	19.8
1532-0039	4.62	0.53-0.73	17.3	23	19.3

[a] Percentage extra signal in [O II] image

generally show bright knots of emission near the QSO nucleus and some correspond with the continuum structures seen.

Figure 1.2 plots the best estimates of the host galaxy magnitudes in the K-z plot for radio galaxies. This suggests that the QSO hosts are similar, and evolve into massive large galaxies in the present universe.

There are several faint galaxy companions that have similar narrow-band excess and are candidates for companions to the QSO. The faint galaxy counts around the QSOs were compared with the corners of the field to look for other evidence for companions.

1.2 Results

1. Host galaxies at z=4.7 are resolved as irregular and filamentary, but fit the K-z relationship for active galaxies which follow a passive evolution path following an initial starburst at high redshift.

2. [O II] line emission is resolved in the same host galaxies and suggest knotty morphologies of star-forming regions, with the brightest regions near the nucleus.

3. Several of the QSOs live in crowded regions of faint galaxies, some of which appear to be in active star-formation if at the QSO redshift.

4. The general indication is that the hosts are massive galaxies in formation, and that massive black holes have formed within them by redshift 4.7.

This work will be published in full elsewhere. I thank Carlos de Breuck and Wil van Breugel for the set of K-z data points shown.

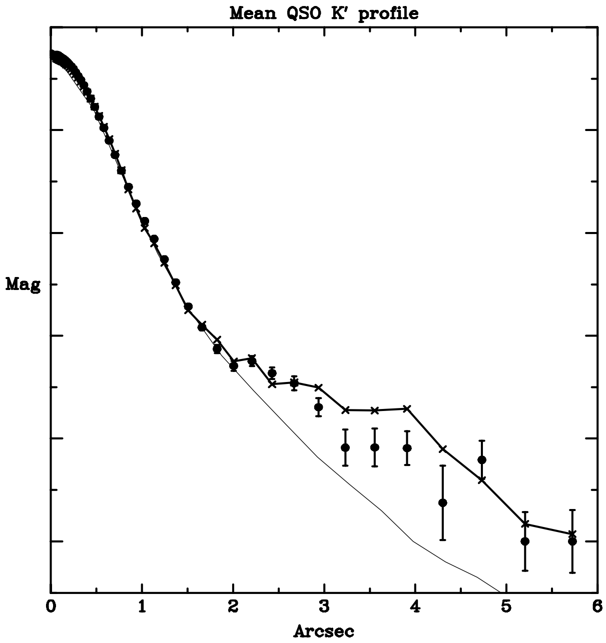

Fig. 1.1. Radial plot of mean of 5 QSO broad-band images, with mean PSF shown as a line. The x-points are the profile of the median QSO image.

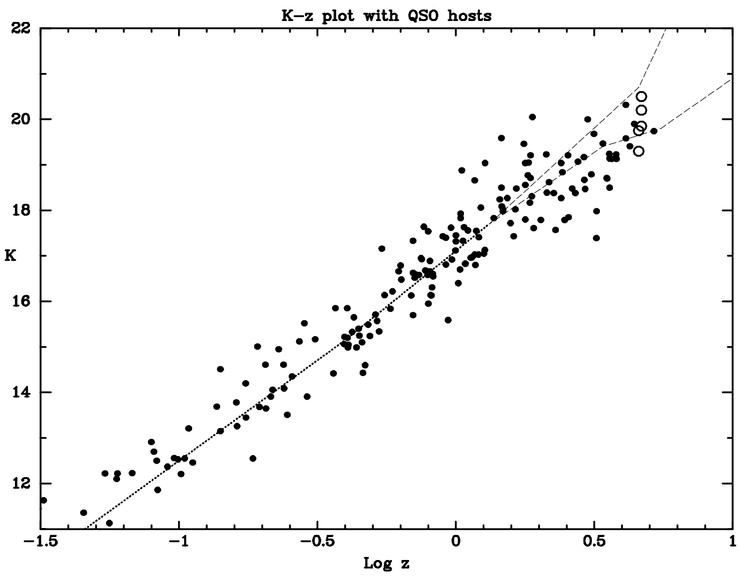

Fig. 1.2. Host galaxy K' magnitudes for z=4.7 QSOs (open cicles), and radio galaxies over all redshifts. Lines indicate passive evolution of a galaxy with 1.0 and 0.1 Gyr starbursts at z=20