The Host Galaxy of Q0151+048A

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Abstract

We report the detection of the host Galaxy of the radio quiet QSO Q0151+048A at z=1.922. Deep U, B and I imaging of the QSO pair Q0151+048A+B obtained at the Nordic Optical Telescope in good seeing has revealed a very luminous host ($M^{obs} \approx$ -24 in all three bands assuming Ω_m=1) centred on the position of Q0151+048A. The colours and extreme brightness of this host galaxy resembles the ones reported for high redshift radio galaxies.

The host galaxy of the 3.2 magnitudes fainter z=1.937 Q0151+048B is marginally detected in our deepest image, which is in the B-band. This host galaxy is about 3 magnitudes fainter than the host galaxy of Q0151+048A consistent with a strong correlation between QSO and host galaxy brightness.

1 Introduction

There is increasing evidence that luminous QSOs at redshifts z≈2 are embedded in extended emission that comprises from a few to ~20% of the total emission from the QSO. In the case of radio loud QSOs host galaxies have been detected both in the optical and in the infrared by Lehnert et al., 1992 and Carballo et al., 1998, and in the case of radio quiet QSOs host galaxies have been detected also both in the optical and in the infrared by Aretxaga et al., 1998a, 1998b. So far there has been found no evidence for systematic differences between the host galaxies of radio loud and radio quiet QSOs at high redshifts. Both populations of host galaxies are extremely bright, R≈21–22 (which to a

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large extend can be a selection effect), and have optical-to-infrared colours in the range R-K≈3–5. The colours of the host are consistent with stellar light, but measured polarisation of the light from some radio galaxies show that scattered QSO light can also contribute significantly to the observed extended emission (e.g. Cimatti et al., 1998).

In this paper we report on the detection of the host galaxy of the radio quiet QSO Q0151+048A. Q0151+048 is one of the very few known physical QSO pairs (i.e. not a gravitationally lensed system). The brightest component Q0151+048A at z_{em}=1.922 has a ≈3.2 mag fainter z_{em}=1.937 companion Q0151+048B at an angular separation of 3.25 arcsec (Williams and Weyman, 1976; Møller, Warren and Fynbo, 1998; Fynbo, Møller and Warren, 1999).

2 Observations and Data reduction

The observations were carried out with the High Resolution Adaptive Camera (HIRAC) instrument at the 2.56m Nordic Optical Telescope (NOT) in September and October 1998. A detailed description of the observations and the data reduction can be found in Fynbo, Burud and Møller, 1999. We obtained 3.5, 6.8 and 3.3 hours of data in U, B and I respectively. The combined seeings (fwhm) were 0.96, 0.84 and 0.67 arcsec in U, B and I. The 5σ detection limits for point sources in the field were U(AB)=25.6, B(AB)=27.4 and I(AB)=25.6.

3 Analysis

We have analysed the vicinity of the two QSOs with two independent methods, namely image deconvolution and Point Spread Function (PSF) subtraction. Both methods rely on a well determined PSF which we obtain from a bright, but unsaturated star in the field. The PSF is very stable across the 3.7×3.7 arcmin^2 field of HIRAC, hence we can exclude large systematical errors from the PSF-modelling.

First the region around the two QSOs was deconvolved using the code by Magain, Courbin and Sohy. The key element in this code is to obtain the optimally improved resolution of the image allowed by the sampling theorem (for the details of this code see Magain, Courbin and Sohy, 1998). In all three filters (U, B, I) we recovered bright, extended emission surrounding Q0151+048A. We will refer to this extended emission as the host galaxy in the following. In the B-band there was also a tentative detection of extended emission associated with Q0151+048B with a brightness about three magnitudes fainter than

Table 1
Photometry of qA, qB and the host of Q0151+048A (called H). The magnitudes given for the extended source from the deconvolution are measured in a circular aperture with radius 3.5 arcsec.

	u(AB)	B(AB)	I(AB)
qA	17.81±0.02	17.83±0.02	17.46±0.02
qB	21.00±0.02	21.18±0.02	20.69±0.02
H	21.6±0.3	21.0±0.3	21.5±0.3
gA	23.85±0.09	23.15±0.02	21.77±0.02
gB	24.02±0.09	24.06±0.02	23.18±0.03

the host of Q0151+048A. The data were also analysed using PSF-subtraction. The results of this analysis were consistent with the results derived from deconvolution. We find that the profile of the host of Q0151+048A is best fit by a de Vaucouleurs profile. Also with this technique we find evidence for faint extended emission around Q0151+048B in the B-band.

The photometry of the two QSOs, the host of Q0151+048A and two galaxies gA and gB near to the line of sight is given in Table 1. In Fig. 1 is shown a 14×14 arcsec^2 field from the B-band image containing the two QSOs. The left frame shows the the two QSOs, a faint star and the two faint galaxies gA anf gB. The right frame shows the field after PSF-subtraction of two QSOs. Contour plots of the same field in all three filters can be found in Fynbo, Burud and Møller (1999).

4 Discussion

The properties of the host galaxy of Q0151+048A are well constrained. The distance modulus assuming Ω_m=1.0, Ω_Λ =0 and a Hubble constant of H=50 km s^{-1} Mpc^{-1} is 45.8. Assuming Ω_m=0.2 and Ω_Λ =0.8 it is 46.8. Hence, the absolute AB magnitudes of the galaxy are <-24.0(-25.0) in U (rest frame 1100–1300Å), <-24.5(-25.5) in B (rest frame 1300–1500Å) and <-24.0(-25.0) in I (rest frame 2300–3400Å). Similar bright magnitudes are at low redshifts only found for first rank elliptical galaxies and at high redshifts similar to the magnitudes of radio galaxies.

The host galaxy of Q0151+048B is about three magnitudes fainter than the host galaxy of Q0151+048A. Hence, these observations suggest a strong correlation between the brightnesses of QSOs and the brightnesses of the surrounding extended emission of QSOs. Such a correlation would be expected if the extended emission is due to QSO light scattered on dust and electrons in its

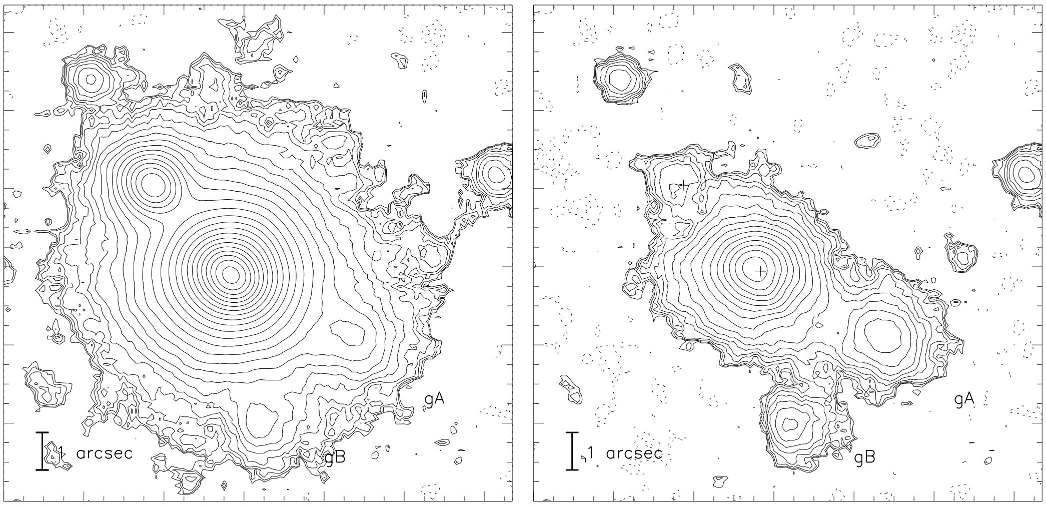

Fig. 1. *Left*: A contour plot of 14×14 arcsec^2 surrounding the two QSOs from the combined B-band image. North is up and East is to the left. Seen is Q0151+048A (the central bright source), Q0151+048B (3.25 arcsec north east of Q0151+048A), a faint star in the upper left corner and two faint galaxies, gA and gB, south west of Q0151+048A. *Right*: The same field after PSF-subtraction. Seen is extended emission around the positions (marked by crosses) of both QSOs.

host galaxy. However, it could also be explained by a correlation between the mass of the black hole giving rise to the QSO and the mass of the bulge of the host galaxy. Multi-wavelength and polarimetric observations are necessary to further constrain the nature of the host galaxies.

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