2QZJ 215454.3−305654: a radio-quiet BL Lacertae object or lineless quasi-stellar object?

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ABSTRACT
High signal-to-noise ratio spectroscopy has established a redshift of \(z = 0.494\) for the source 2QZJ 215454.3−305654, originally selected from the 2dF/6dF QSO Redshift Surveys as one of 45 candidate BL Lacertae (BL Lac) objects displaying a featureless continuum at optical wavelengths. Radio observations using the Australia Telescope Compact Array at 1.4 GHz place a 3 \(\sigma\) upper limit on the radio flux density of the object of \(\sim 0.14\) mJy. The radio-to-optical flux ratio of this object is thus more than seven times lower than the lowest such ratio observed in BL Lac objects. While the optical properties of 2QZJ 215454.3−305654 are consistent with a BL Lac identification, the lack of radio and/or X-ray emission is not. It is uncertain whether this object is an active galactic nucleus dominated by optical continuum emission from an accretion disc, or is similar to a BL Lac object with optical non-thermal emission from a relativistic jet.

Key words: galaxies: active – BL Lacertae objects: individual: 2QZJ 215454.3−305654 – quasars: general.

1 BACKGROUND

The candidate BL Lacertae (BL Lac) object 2QZJ 215454.3−305654 was observed in 2003 August using the VLT.1 It was previously observed as a colour-selected point source in 2000 June as part of the 2dF QSO Redshift Survey (2QZ, Croom et al. 2001, 2004). By examining spectra of point sources from both the 2dF and 6dF Redshift Surveys (2QZ/6QZ), Londish et al. (2002) began a campaign to identify the first optically selected BL Lac sample, the 2BL, unbiased with respect to the objects’ radio and X-ray flux densities. 2QZJ 215454.3−305654 was identified as one of 45 such featureless continuum objects.

Subsequent cross-correlation of these 45 candidate BL Lacs with the NVSS/FIRST radio catalogues2 produced matches for nine sources only; five of these objects are also detected in the RASS catalogue.3 No detection was found in either NVSS or RASS at the coordinates of 2QZJ 215454.3−305654. The optical apparent magnitudes of the 2BL cover the range 18.25 < \(b_J\) < 19.97, equating to \(\sim 0.2–0.04\) mJy; radio flux densities > 1 mJy would thus be expected for at least 50 per cent of the sample if these objects are similar to hitherto detected BL Lacs (i.e. radio loud with a ratio of radio-to-optical flux > 10).

The average signal-to-noise ratio (S/N) of the 2dF/6dF spectra in the 2BL is low (10–15). To eliminate contamination of the sample by objects such as featureless Galactic white dwarfs (WDs), we carried out proper-motion studies based on data from the updated (2003 June) SuperCOSMOS Sky Survey.4 We also investigated the spectral energy distribution (SED) of 2BL objects from the 2dF equatorial strip5 at optical and infrared wavelengths using data from the Sloan Digital Sky Survey (SDSS, Early Data Release, Stoughton 2002) as well as our own \(J-, H-\) and \(K-\) band observations using the 2.1-m telescope at Kitt Peak (Londish 2003; Londish et al., in preparation). We also examined the 2dF/6dF spectra for evidence of intervening absorbers (Outram et al. 2001) as a further means of

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1 VLT-UT4 on Cerro Paranal (Chile) operated by the European Southern Observatory in the course of the observing proposal 71.A-0174.
2 NRAO/VLA Sky Survey (Condon et al. 1998) and Faint Images of the Radio Sky at 20 cm (White et al. 1997).
3 ROSAT Bright and Faint All Sky Survey X-ray catalogues (Voges et al. 1999).
4 SuperCOSMOS Sky Survey at http://www-wfau.roe.ac.uk/sss, maintained by the Institute for Astronomy, Royal Observatory, Edinburgh.
5 The 2QZ survey covers \(\sim 740\) deg2 of sky, comprising two \(75 \times 5\) deg2 strips, one centred on \(\delta = 0^\circ\) with RA range from 9h50m to 14h50m (equatorial strip) and the other on \(\delta = -30^\circ\) with RA range from 21h40m to 3h15m (southern strip).
distinguishing between a Galactic WD and an extragalactic object; no intervening systems were found for 2QZJ 215454.3–305654.

In this paper we report in Section 2 on follow-up observations of 2QZJ 215454.3–305654 and discuss in Section 3 the implications of our findings with respect to the identity of this object. Throughout the paper we use $\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$, $H_0 = 70$ km s$^{-1}$ Mpc$^{-1}$, and define spectral index as $f_\nu \propto \nu^{-\alpha}$.

2 OBSERVATIONS OF 2QZJ 215454.3–305654

2.1 Proper-motion studies

Originally 78 objects were selected from the 2QZ/6QZ surveys as being featureless continuum objects. Inspecting the SEDs of 24 objects found in the SDSS and our own infrared observations at Kitt Peak, we determined that a proper-motion cut at 2.5$\sigma$ (where $1\sigma \approx 15$ mas yr$^{-1}$) provided an effective discrimination between objects likely to be Galactic WDs (characterized by high proper motion and thermal SEDs in the optical/infrared bands) and potential extragalactic objects (non-thermal SEDs and no detectable proper motion). Removing objects with high proper motion resulted in the final sample of 45 candidate BL Lac objects, including 2QZJ 215454.3–305654 with a measured proper motion of 7.5 $\pm$ 16.3 mas yr$^{-1}$. The $u' - b_1$ and $b_1 - r$ colours of this object in the 2QZ system (Smith et al. 2004) are $-0.78$ and $0.66$, respectively.

2.2 Variability studies

2QZJ 215454.3–305654 was observed in $B$ band using the MSSSO 74-inch telescope at Mt Stromlo, ACT, Australia, between 2002 August and October as part of a year-long campaign to look for evidence of variability in the 45 2BL objects. In analysing the data, instrumental magnitudes of the candidate BL Lac objects were compared to those of five other stars in the same field. Conditions were not photometric and no attempt was made to convert from instrumental magnitudes to apparent magnitudes. Instead, magnitude differences between the first and subsequent observations of the non-varying stars were calculated, and an average shift between images computed. This correction was subsequently applied to all objects in the image so that instrumental magnitudes to apparent magnitudes. Instead, magnitude differences between the first and subsequent observations of the non-varying stars were calculated, and an average shift between images computed. This correction was subsequently applied to all objects in the image so that instrumental magnitudes to apparent magnitudes. Instead, magnitude differences between the first and subsequent observations of the non-varying stars were calculated, and an average shift between images computed. This correction was subsequently applied to all objects in the image so that instrumental magnitudes to apparent magnitudes. Instead, magnitude differences between the first and subsequent observations of the non-varying stars were calculated, and an average shift between images computed. This correction was subsequently applied to all objects in the image so that instrumental magnitudes to apparent magnitudes.

2.3 Spectroscopy

A low-resolution spectrum of 2QZJ 215454.3–305654 was recorded on the night of 2003 August 26–27 with FORS2 at the ESO 8-m VLT-UT4, Paranal, Chile. We used grism 150i, which gave us a spectral scale of $\sim$6.9 Å pixel$^{-1}$. The slit width was set to 1 arcsec and integration time was 900 s. The effective wavelength range covered was $\sim$4000–7800 Å (longward of 7800 Å the spectrum is heavily contaminated by night-sky emission and second-order overlap). During the night the spectrophotometric standard LTT 7379 from Oke (1990) was observed.

The data reduction of the spectrum (bias subtraction, flat-fielding, cosmic ray removal, sky subtraction, wavelength and flux calibration, etc.) was performed using standard IRAF routines. The full width at half-maximum (FWHM) spectral resolution measured from strong night-sky emission lines is $\sim$25 Å. The spectrum is shown in Fig. 2; several features – Ca ii H-, K- and G-band absorption features and [O iii] $\lambda$5007 emission at $z = 0.494$. Telluric absorption features at 6540, 6860–6920 and 7585–7655 Å have been removed. The inset shows the SED with upper limits for X-ray and radio flux (x-axis is observed frequency).

From the slope in Fig. 2, the optical spectral index (4500–7500 Å) is calculated to be $f_\nu \propto \nu^{-0.36}$, typical of blue Type I active galactic nuclei (AGNs) (e.g. quasi-stellar objects, QSOs). The Ca ii ‘break contrast’, defined as the relative depression of the continuum

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Table 1. Measured wavelengths and deduced redshifts.

|          | Rest \( \lambda \) (Å) | Measured \( \lambda \) (±4 Å) | \( z \) |
|----------|-------------------------|-------------------------------|-------|
| Ca II K  | 3933                    | 5877                          | 0.4943|
| Ca II H  | 3968                    | 5929                          | 0.4942|
| G band   | 4303                    | 6430                          | 0.4943|
| [O III]  | 5007                    | 7475                          | 0.4929|
| Hβ       | 4861                    | 7254                          | 0.4923|

Figure 3. Upper panel: spectrum of 2QZJ 215454.3–305654 (solid line) compared to an elliptical (solid line) and starburst template (dotted line), scaled to the same flux as 2QZJ 215454.3–305654 at 5960 Å. Lower panel: spectrum of 2QZJ 215454.3–305654 (solid line) compared to a composite starburst plus elliptical plus flat-spectrum power law (dotted line) in the ratio 0.015 : 0.045 : 0.94.

Figure 4. VLT acquisition image of 2QZJ 215454.3–305654 (centre); grey-scale is logarithmic and shows a slight east–west elongation of the source, compared to a star to the north-west.

The blueward of the Ca II H and K absorption lines [namely \( Br_{\text{H}} = (f^+ - f^-)/f^+ \), where \( f^+ \) is the average flux at 4050–4250 Å and \( f^- \) is the average flux at 3750–3950 Å], is \( 0.02 \), indicative of a strong non-stellar continuum. Inspection of galaxy templates in the online Kinney–Calzetti Spectral Atlas of Galaxies⁶ (Calzetti, Kinney & Storchi-Bergmann 1994) shows the spectrum of 2QZJ 215454.3–305654 to be inconsistent with that of either a starburst or a bulge/elliptical (Fig. 3, upper panel). However, a composite using a contribution of 1.5 per cent starburst and 4.5 per cent elliptical gives a good approximation of emission-line strength and the rise in flux at the 4000-Å break seen in the spectrum of 2QZJ 215454.3–305654. Using starburst and elliptical spectral templates plus a flat-spectrum power law in the ratio 0.015 : 0.045 : 0.94 (at 5960 Å) also reproduces the blue continuum longward of 3500 Å rest frame (Fig. 3, lower panel). This provides evidence for a non-stellar origin to the blue component, i.e., either thermal emission from an accretion disc or synchrotron emission from a jet.

Unfortunately no infrared photometry is available for 2BL objects in the southern strip of the 2QZ. Non-detection of the source by RASS places an upper limit on the X-ray emission of \( 8 \times 10^{-14} \text{ erg s}^{-1} \text{ cm}^{-2} \) (2.36 \( \times 10^{-5} \) mJy). The overall SED of 2QZJ 215454.3–305654 is shown in the inset of Fig. 2 using upper limits from RASS and our own observations at 1.4 GHz for the radio.

2.4 Morphological analysis

To study the morphology of our target, we used two VLT \( I \)-band images of 2QZJ 215454.3–305654 lasting 15 s each. These were taken as acquisition for the spectroscopy, and not specifically for host galaxy studies. After standard data reduction, the two images were aligned and summed (Fig. 4). Photometric calibration was performed using Landolt standard stars (Landolt 1992).

Although the ‘break contrast’ observed at \( 6000 \) Å is virtually zero, and results of template fitting described in Section 2.3 suggest a dominant core, the combined 30 s \( I \)-band image of 2QZJ 215454.3–305654 shows evidence of a host galaxy in the slightly elongated shape of the target source. A similar absence of a detectable break contrast is observed in the BL Lac 1ES 1853+671 (Perlman et al. 1996) even though the host galaxy is resolved (Heidt et al. 1999). We therefore proceeded with a fully two-dimensional decomposition of this source using the routines described in Nilsson et al. (1999). We fitted five different models to 2QZJ 215454.3–305654 – one representing an AGN (scaled point spread function, PSF), two representing a galaxy (elliptical or disc-type galaxy) and two representing an AGN plus galaxy (scaled PSF plus elliptical/disc-type galaxy). The core is described by three parameters \( (x_c, y_c, m_c) \), while the galaxy is described by seven parameters \( (x_g, y_g, m_g, r_g, \epsilon, \text{PA}) \) and shape parameter \( \beta = 0.25 \) for an elliptical and \( \beta = 1 \) for a disc-type galaxy). For the AGN plus galaxy fits, we did not allow for an offset between the centres of the AGN and galaxy. The galaxy models were convolved with the PSF. To extract the PSF, several non-saturated stars in the field brighter than 2QZJ 215454.3–305654 itself were combined.

The results of our fits are summarized in Table 2. The \( k \)-corrections were derived from Fukugita, Shimasaku & Ichikawa (1995). We used \( K(I) = 0.45 \) mag for the elliptical galaxy and 0.25 mag for the disc-type galaxy (Sbc). No \( k \)-corrections were applied to the AGN (we assumed a power-law spectrum of the form

![Image](ftp://ftp.stsci.edu/cdbs/cdbs2/grid/)

[⁶ Available at: ftp://ftp.stsci.edu/cdbs/cdbs2/grid/](ftp://ftp.stsci.edu/cdbs/cdbs2/grid/)
I_ν \propto \nu^{-1}$. Extinction (0.05 mag) was taken from NED.² To make the half-light radius derived for 2QZJ 215454.3–305654 comparable to the ones derived for the $ε = 0$ fits in other studies, we multiplied the half-light radius in arcseconds by $\sqrt{(1 - ε)}$ when converting to kiloparsecs.

As can be seen from Table 2, neither a pure core fit nor a pure galaxy fit gave good results. The best fit was obtained by a combination of a core point source plus a galaxy. We note that the host galaxy and core are of similar brightness according to our 2D fitting, contrary to what might be expected from the spectrum of 2QZJ 215454.3. The luminosity of the active nucleus and of the host galaxy are both in the lower range found for BL Lac objects at high velocities (Heidt et al. 1994). The luminosity of the active nucleus and of the host galaxy and core are of similar brightness according to our 2D fitting, contrary to what might be expected from the spectrum of 2QZJ 215454.3.

In the fitting, the host galaxy profile is much more extended and flatter with respect to the central point source. Simulations reveal that slit loss for the core is about 0.25 mag, whereas for a bulge galaxy it would be 0.9 mag. This factor of 2 (∼0.75 mag) is nevertheless insufficient to explain fully the observed difference between the imaging and spectroscopic results regarding the relative contribution between the host and core. Any remaining discrepancy, however, is consistent with the errors in the fitting procedures (both imaging and spectroscopic).

In the image fitting no one host galaxy type is preferred over the other; however, the integration time for the acquisition image was very short ($2 \times 15$ s). Almost all known BL Lacs have been found to reside in an elliptical host, with the notable exception of PKS 1413+135, which appears to reside in an edge-on spiral (McHardy et al. 1998). The luminosity of the active nucleus and of the host galaxy are both in the lower range found for BL Lac objects at $z ∼ 0.5$ (see Heidt et al. 2004).

### 2.5 Polarization studies

Polarization studies of a subsample of the featureless continuum objects selected from the 2QZ were conducted in 2003 April using the VLT FORS1 in service observing mode (see Kedziora-Chudczer et al., in preparation). Data reduction was carried out using software developed by Jeremy Bailey based on the Starlink POLPACK package.

All BL Lacs discovered to date have detectable optical polarization, typically 2–15 per cent for low-luminosity, X-ray-selected BL Lacs (Jannuzi, Smith & Elston 1994). For 2QZJ 215454.3–305654 only 0.5 ± 0.2 per cent linear polarization was measured in the $R$ band. These measurements may have been made during the minimum polarization state of this source, given that polarization of BL Lacs is known to be variable and can at times be too low to be detectable (Fan & Lin 2000; Fan, Cheng & Zheng 2001). Deep radio observations at 8.4 GHz were conducted of a subsample of 2BL objects using the Very Large Array (VLA) radio telescope, Socorro, New Mexico, USA. 2QZJ 215454.3–305654 was observed in 2001 January using the VLA in a hybrid Bn–A configuration with 25 antennas operating. Two 20-min observations were taken using a single frequency channel. Flux densities were bootstrapped from the calibrator 3C 286; however, the maximum elevation of the secondary calibrator (2151–304) was 24°, compared to 65° for the primary.

Data were reduced using the Australia Telescope National Facility’s MIRIAD software package (Sault, Teuben & Wright 1995), following standard procedures from the MIRIAD User’s Manual (Sault & Killeen 1999). The rms noise in the cleaned image is ∼100 $\mu$Jy; there is no detectable 8.4-GHz flux at the coordinates of our candidate BL Lac.

Observations of 2QZJ 215454.3–305654 at 1.432 and 1.344 GHz (2 × 128 MHz bandwidth) were carried out in 2003 November using the Australia Telescope Compact Array (ATCA). The array was in the 1.5D configuration with baselines ranging from 107 to 4439 m; however, the six shortest baselines suffered from solar contamination, thus only the nine longest baselines (>1 km) were used in creating the radio map. The source was observed for 22 × 40 min over two days. Flux densities were bootstrapped from the primary calibrator PKSB 1934–683. Data reduction was again performed using MIRIAD. There is no detectable radio emission at the coordinates of our source above the rms noise of ∼45 $\mu$Jy (see Fig. 5). This places a 3σ upper limit of 135 $\mu$Jy on the 1.4-GHz radio emission of this source, equating to $P_{1.4\,GHz} < 8.5 \times 10^{21}$ W Hz⁻¹ (using a radio spectral index $α = 0.5$). Note that this upper limit applies to the combined galaxy plus core, not just the central AGN.

### 3 DISCUSSION

The optical spectrum of 2QZJ 215454.3–305654 is inconsistent with that of a pure elliptical galaxy, while the lack of strong emission lines excludes it from being a nuclear starburst or a Type I QSO; no combination of elliptical and starburst alone can reproduce the strong blue continuum of our source. Neither is this source likely to be a dust-obscured Type II AGN, as the spectrum is blue rather than red. Galaxy fits using a ‘diluted’ (1.5 per cent) starburst plus elliptical (4.5 per cent) plus power law (94 per cent) resulted in a spectrum similar to that of 2QZJ 215454.3–305654. The puzzle therefore is whether this object is a virtually lineless AGN with the optical continuum emission emanating from an accretion
optical variability (0.5 mag) on these time-scales (see Fig. 1).

Figure 5. The 1.4-GHz ATCA radio map; the ATCA field centre was offset 15 arcsec from the optical position of 2QZJ 215454.3–305654, which is marked with a cross.

disc, or instead a radio-quiet/radio-weak object with optical synchrotron emission from a relativistic jet viewed at a small angle to the line of sight, i.e. a radio-quiet BL Lac object. Similar radio-quiet, X-ray weak, lineless QSOs have been found in the Sloan Digital Sky Survey (Fan et al. 1999; Leighly, Halpern & Jenkins 2004). Leighly et al. suggest that high-z lineless QSOs might be early Universe counterparts of luminous narrow-line type 1 Seyfert galaxies.

To establish the extent to which the lack of radio emission is unusual in an object that otherwise displays many characteristics of a BL Lac,\(^3\) we compare its radio-to-optical flux ratio (\(\alpha_{\text{ro}}\)) with that of an unbiased sample of X-ray-selected BL Lacs from the HRX\(^2\) BL Lac survey (Beckmann et al. 2003). In our calculations of \(\alpha_{\text{ro}}\) values, we use flux densities in the observed frame to maintain consistency with values derived for the HRX BL Lacs.

Care needs to be taken in the calculation of \(\alpha_{\text{ro}}\) for a variable object, where

\[
\alpha_{\text{ro}} = -\frac{\log(f_{\lambda}/f_{\nu_0})}{\log(\nu/\nu_0)} ,
\]

particularly when the radio and optical measurements are non-contemporaneous. We therefore use the optical/radio measurements separated by the smallest time interval; the I-band magnitude derived from the ESO CCD observations (2003 August) and the 1.4-GHz 3\(\sigma\) upper flux limit from the ATCA observations (2003 November). These observations also provide the most accurate limits on the flux of the object in both regimes. However, we note that 2QZJ 215454.3–305654 has been observed to exhibit significant optical variability (0.5 mag) on these time-scales (see Fig. 1).

We calculate \(\alpha_{\text{ro}}\) values based on both the total I-band magnitude of the object (\(m_I = 18.83\)) and that of the AGN (core) component in the case of the fainter elliptical galaxy fit (\(m_{\text{core}} = 19.29\)). This should bracket the likely range of \(I\)-band magnitudes for the AGN component. Indeed, we choose not to use the ratios derived from the spectroscopic fitting, in order to avoid slit loss corrections and to obtain a firm lower limit of the I-band magnitude of the core component.

For \(I_{\text{total}}\) (0.076 mJy) and \(I_{\text{core}}\) (0.050 mJy) we obtain a 3\(\sigma\) upper limit of \(\alpha_{\text{ro}} < 0.047\) and \(\alpha_{\text{ro}} < 0.082\) respectively. We note however that the image fitting is likely to have significant errors; from spectral fitting in Section 2 we would expect a more dominant core component, thus computed optical core luminosities can be treated as lower limits, resulting in an even more stringent upper limit on the calculated \(\alpha_{\text{ro}}\) value.

The distribution of \(\alpha_{\text{ro}}\) values for the HBX BL Lac sample (redshift range 0.030 < \(z\) < 0.89) is shown in Fig. 6. The mean (\(\langle \alpha_{\text{ro}} \rangle\)) is 0.37, with a lowest computed value of \(\alpha_{\text{ro}} = 0.13\). We note that the 1.4-GHz and \(B\)-band measurements were not taken contemporaneously and that none of the \(B\)-band fluxes in the HRX BL Lac sample have been corrected for host galaxy contribution (Beckmann, private communication).

Comparing first \(\alpha_{\text{ro}}\) values uncorrected for host galaxy contamination, we find that 2QZJ 215454.3–305654 exhibits a radio-to-optical flux ratio that is more than 60 times lower than the mean value for the HRX sample (\(\alpha_{\text{ro}}\) of 0.05 compared to (\(\alpha_{\text{ro}}\) = 0.37). The uncorrected \(\alpha_{\text{ro}}\) values also imply that 2QZJ 215454.3–305654 has a total radio-to-optical flux ratio at least three times lower than that of IES 1255+244, the HRX BL Lac with the lowest \(\alpha_{\text{ro}}\) value (\(f_{1.4\text{GHz}} = 14.7\) mJy and \(m_B = 15.4\)). However, in the case of IES 1255+244 (\(z = 0.141\)), there is a clearly extended host galaxy on the \(B\)-band image; indeed Heidt et al. (1999) measured the core \(R\)-band (650-nm) flux of this object to be \(m_R = 17.9\) (\(m_B \sim 18.37\), giving \(\alpha_{\text{ro}} = 0.34\) for this object. Similar removal of host galaxy flux for another technically radio-quiet HRX object (Beckmann, private communication) raises the minimum observed \(\alpha_{\text{ro}}\) value for the HBX to >0.23. With the galaxy-corrected \(\alpha_{\text{ro}}\) upper limit for 2QZJ 215454.3–305654 of 0.08, this translates to a 3\(\sigma\) upper limit for the radio-to-optical flux ratio that is at least 6–7 times lower than the lowest observed value in the HBX sample. The radio properties of this optically featureless, variable source are thus likely to be

\(^3\) Defined in Maran (1991) as ‘... point-like sources of optical radiation that show little or no line emission, and strong and variable brightness and polarization’.

\(^2\) Hamburg–RASS X-ray-selected sample of BL Lacs.

Figure 6. Histogram of \(\alpha_{\text{ro}}\) values for the 103 X-ray-selected BL Lac objects from the HRX BL Lac survey (Beckmann et al. 2003). One object has a value of 0.13 (subsequently revised to 0.34, see text for details), while the remaining 102 have \(\alpha_{\text{ro}} > 0.2\).
significantly different from those of BL Lac objects discovered to date. 2QZJ 215454.3−305654 is clearly not a ‘traditional’ BL Lac, but may instead belong to a hitherto unrecognized population of radio-quiet continuum objects. Whether optical appearance alone is sufficient to classify an object as a BL Lac is a moot point. The optical continuum emission from such an object could be radiation from the accretion disc – thus we are seeing a radio-quiet AGN. The absence of clear emission lines in the spectrum may result from a lack of gas clouds illuminated by the source, or the ionizing radiation from the source may have been absorbed or scattered by dust. This object might be similar to objects in an X-ray-selected sample of type 2 Seyfert galaxies studied by Nicastro, Martocchia & Matt (2003) in which instability patterns in the accretion disc (rather than dust obscuration) result in the lack of a broad-line region, although not of emission lines from the narrow-line region. Alternatively Leighly et al. (2004) suggest that lineless QSOs result from a very high accretion rate and a strong ultraviolet-peaked continuum. If, however, the optical emission of 2QZJ 215454.3−305654 is beamed synchrotron radiation, then the absence of photons at radio energies needs to be explained. Velocity structures in the jet (proposed by Chiaberge et al. 2000), resulting in higher kinematic Doppler factors for optical photons in the spine of the jet, might be one such explanation. Deep X-ray observations of 2QZJ 215454.3−305654 would provide further clues as to the identity of this object.

2QZJ 215454.3−305654 is only one of ∼30 objects, first identified in the 2QZ/6QZ surveys, that display similar featureless ‘non-thermal’ optical spectra with no associated radio emission. On-going detailed observations of these objects may demonstrate that 2QZJ 215454.3−305654 is not alone, and that a population of hitherto unrecognized radio-weak ‘BL Lacs’ makes up yet another exhibit in the AGN zoo.

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