Do galaxy interactions trigger radio quiet quasars?

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We present deep GMOS-S/Gemini optical broad band images of a sub-sample of 18 type II quasars taken from the Zakamska et al. (2003) sample. The complete sub-sample comprises 20 quasars in the redshift range 0.3 < z < 0.41 and [OIII] emission line luminosities L[OIII] > 10^{35} W. The images were taken with the aim of investigating the interaction status of the host galaxies in an attempt to determine the significance of interactions in triggering nuclear activity. This study was motivated by the work of Ramos Almeida et al. (2011), in which a similar study was made for powerful radio galaxies (PRG). We wish to compare the interaction status of these two types of AGN to determine in what way they are related. We find that 15 of the 19 objects that we have images for (~80%), show evidence for interaction in the form of tails, shells, fans, irregular features, amorphous halos and double nuclei. The median surface brightness of the features in the r' band, corrected for extinction, surface brightness dimming and k-corrected is μ =23.51 mag arcsec $^{-2}$ and the range is $\Delta\mu \simeq$ [23,27] mag arcsec $^{-2}$. The wide variety of features suggests that AGN activity can be triggered before, during or after the coalescence of the black holes with 5 of the 19 objects (~26%) having double nuclei. These results are comparable to those obtained for the PRG, which have similar rates of interactions and observed features. This leads us to conclude that it is possible that type II quasars and PRG may be triggered in the same manner.

Sample Selection

Our sample of 20 objects is selected from the Zakamska et al (2003) catalogue of candidate Type II quasars. The objects have RAs in the range 23 < RA < 10 hr, declinations <+20 degrees, redshifts in the range 0.3<z<0.41 and [OIII] emission line luminosities L> 10^{35} W (see Table 1). These limits were imposed to keep the sample size manageable. The redshift limit also ensures that the objects are sufficiently close and bright enough for the detection of faint and diffuse features to be possible. The [OIII] luminosity limit was decided on to ensure that the objects were indeed true quasars. The full sample of 20 objects is 95% complete and is unbiased in terms of host galaxy and AGN properties.

The Gemini Detector

Deep optical imaging data of 18 objects from the sample was obtained using the Gemini Multi-Object Spectrograph (GMOS-S) mounted on the 8.1m Gemini South telescope at Cerro Pachon, Chile. As our objects fell in the redshift range 0.3 <z < 0.41, we employed the r' band filter for all observations. This allowed us to observe in the rest frame optical.
The Gemini/GMOS -S detector has a field of view of 5x5 arcmins and 0.146 arcsec/pixel. To allow us to detect the faint extended features, we required reasonable seeing. The average FWHM = 0.8 arcsec and the value ranged between 0.5 and 1.1 arc sec.

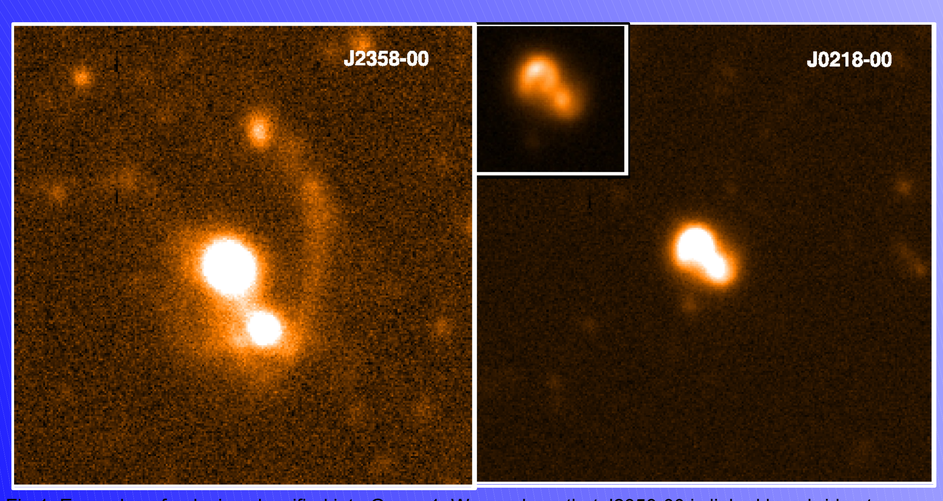

Fig 1. Examples of galaxies classified into Group 1. We see here that J2358-00 is linked by a bridge to its companion whilst J0218-00 appears to be in a galaxy pair.

Name	Abbreviated name	z	Scale	$\log(L_{[OIII]}/L_{\odot})$	Morphology	Group
J002531-104022	J0025-10	0.303	4.326	8.73	2N, 2T	2,3
J011429+000037	J0114+00	0.389	5.102	8.66	2N, S	2,3
J012341+004435	J0123+00	0.399	5.184	9.13	2N, T, [A]	2,3
J014237+144117	J0142+14	0.389	5.103	8.76	...	4
J015911+143922	J0159+14	0.319	4.478	8.56	NI	...
J021757-011324	J0217-01	0.375	4.987	8.55	...	4
J021758-001302	J0217-00	0.344	4.711	8.75	S, I, [T]	2
J021834-004610	J0218-00	0.372	4.962	8.85	A	1,2
J022701+010712	J0227+01	0.363	4.884	8.90	A, 3S, T	2
J023411-074538	J0234-07	0.310	4.392	8.77	...	4
J024946+001003	J0249+00	0.408	5.259	8.63	S	2
J032029+003153	J0320+00	0.384	5.061	8.52	I	2
J033248-001012	J0332-00	0.310	4.394	8.50	2N, S, [B]	2,3
J033435+003724	J0334+00	0.407	5.252	8.61	S	2
J084856-013647	J0848-01	0.350	4.784	8.56	2S	2
J090414-002144	J0904-00	0.353	4.813	8.93	T, S	2
J092318+010144	J0923+01	0.386	5.099	8.94	S, F, T	2
J092356+012002	J0924+01	0.380	5.046	8.59	T	2
J094836+002104	J0948+00	0.324	4.548	8.52	...	4
J235818-000919	J2358-00	0.402	5.208	9.32	T, B, F	1,2

Table 1: A full classification of the type II quasar host galaxies giving the detected morphological features. We also give the group classification determined by their apparent interaction status.

Group	Type II Quasars	SLRG
1 – Galaxies in pairs or tidal interactions.	11%	20%
2 – Signs of morphological disturbance	79%	54%
3 – Double nuclei	21%	17%
4 – Isolated galaxies with no sign of morphological disturbance.	21%	6%
Any sign of interaction or merger	79%	94%

Table 2 The percentage of type II quasars in each of the groups compared to that of the strong line radio galaxies from the sample of Ramos Almeida et al(2011).

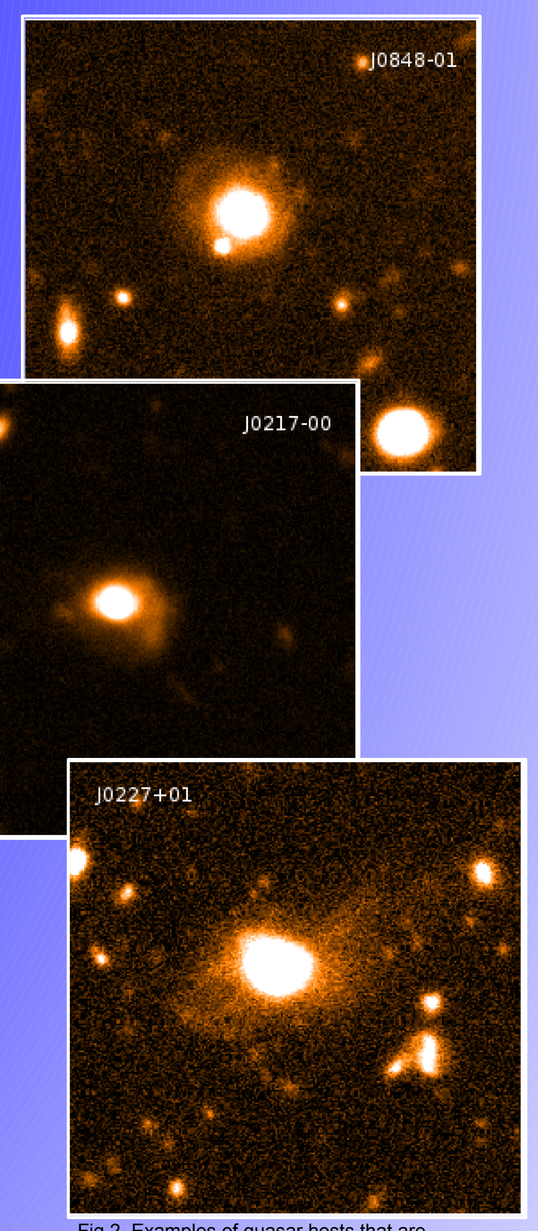

Fig 2. Examples of quasar hosts that are categorised into Group 2. These three galaxies show signs of morphological disturbance which are likely to be caused by interactions or mergers. J0848-01 shows a spectacular example of shells whilst J0227+01 has an amorphous halo and tail. J0217-00 is an example of irregular features with its clumpy knots at both ends of the galaxy.

Conclusions

We find that of the 19 objects in our sample for which we have images, 79% appear to be involved in a merger or interaction event. Of these, 21% have double nuclei and 11% are in either a galaxy pair or involved in a tidal interaction. A further 47% show morphological signatures of mergers in the form of shells, fans and tails. This demonstrates that AGN activity can be triggered at any point during a merger event. These results are similar to those of the study of powerful radio galaxies by Ramos Almeida et al. (2011), demonstrating that both forms of AGN may be triggered in the same way.

Fig 3. Examples of quasar hosts with double nuclei. Both J0123+00 and J0332-00 appear to be in the pre coalescence phase of a merger.

References

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