RESOLVED IMAGING AND SPECTROSCOPY OF QSOs

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ABSTRACT: We have obtained direct images and off-nuclear spectra for five QSOs having a wide range of radio, optical and X-ray luminosity. Four objects show absorption features identified with stars in a host galaxy, and off-nuclear changes in emission line wavelengths. All objects show off-nuclear changes in continuum coulour, and in emission line intensities and ratios. The radio loud objects have more luminous galaxies, strong and extended [OII] and [OIII], and UV-bright nuclei. They tend to have luminous nuclei, high nuclear to galaxy luminosity ratio, and blue host galaxies. This paper is a brief summary of results that will appear in more detail elsewhere.

1. OBSERVATIONS

The objects were observed in June 1985 at the prime focus of the Canada-France-Hawaii Telescope (CFHT) using FOCAS-II, a holographic grating spectrograph/imager (Hickson 1986a). The spectroscopic detector was a photon counting CCD camera (Hickson 1986b) and The CFHT RCA CCD camera was used as the imaging detector. The spectra have a spatial resolution of 0.8 arcsec and a spectral resolution of 30Å. Exposures used a long slit 3 arcsec wide and ranged from 2.5 to 4 hours per object. The direct images have 0.4 arcsec pixels. They were used to position objects on the slit, and were later analysed to study the host galaxy morphology, the luminosities of the galaxies and nuclei, and to determine the seeing which was uniformly close to 1 arcsec FWHM.

The observational results and data for individual objects are summarized in Table I.

2. DISCUSSION

Host galaxy spectra are clearly seen in the two objects of lowest Lnuc/Lgal ratio. The galaxies are marginally seen in the next two and are not seen at all in the last (which has the highest Lnuc/Lgal of any so far imaged). The host absorption spectra have the same redshift as the nuclei. Where there is extended emission, usually several

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TABLE I

	1512+370	1700+518	1701+610	2130+099	2135-145
z	0.37	0.29	0.16	0.06	0.29
V	15.5	15.2	17.0	14.9	15.4
Lnuc/Lgal	10.0	40.0	0.35	2.6	4.0
Mnuc	-25.0	-24.9	-20.1	-21.5	-23.5
Mgal	-23.0	-21.2	-21.5	-20.6	-22.2
log L6cm (W Hz^{-1})	25.7	22.1	-	<20.0	24.7
log Lx (erg s^{-1})	-	-	43.7	-	45.3
B-V:					
nucl	(-0.3)	0.0	0.3	0.1	0.6
nuc2	-	-	0.5	-	0.2
off-nuc	(0.0)	-0.1	0.7	0.5	0.1
companion	(0.3)	-	0.1	-	0.2
[OII],[OIII]	Strong	Very weak	Strong	Weak	Strong
[O] extended?	Yes	No	Slightly	No	Yes
Host Abs	(Mg b)	-	Mg b,G,CaII	Mg b,CaII	(Mg b)
Other lines	-	H-beta abs	-	4600Å emis	-
Interacting?	Yes	No	Yes	No	Yes
Other morph	OIII clouds	BAL	Tidal tail	Spiral gal	Twin nuc

Lnuc/Lgal corrected for z, sky,seeing as in Hutchings et al. 1984
H = 100 for all luminosities and absolute magnitudes
Off-nuclear spectra are not corrected for nuclear contamination

components are seen spatially, with velocities up to 1000 km s^{-1}. Some off-nuclear areas have blue spectra, suggesting hot stellar populations.

As can be seen from the table, the radio-loud objects have more luminous galaxies, and have strong and extended [OII] and [OIII]. They tend to have luminous nuclei, high nuclear to galaxy luminosity ratio, and blue host galaxies. All three objects which are interacting have strong nuclear (or near nuclear) [OIII]. Two of our objects have been studied (without spatial resolution) by Boroson and Oke (1984). Our results are in agreement with theirs, and are consistent with the connections that they make between radio and optical properties.

3. REFERENCES

Boroson, T. A., and Oke, J. B. 1984, Ap.J. 535, 68.
Hickson, P. 1986a, submitted to Pub. A. S. P.
Hickson, P. 1986b, submitted to Pub. A. S. P.
Hutchings, J. B., Crampton, D., Campbell, B. 1984, Ap.J. 280, 41.

DISCUSSION

Bregman : How are you able to distinguish whether the galaxy underlying a quasar is a spiral or an elliptical galaxy ?

Hutchings : Not by the luminosity-radius relation. The uncertainity in the central intensity of the point spread function allows you to fit exponential or $R^{1/4}$ laws equally well in most cases. Spirals can be recognised by structure, but ellipticals can be disguised by tidal effects or starbursts if an encounter has occurred. While many host galaxies may be ellipticals there are few positive indicators. Some off-nuclear spectra show late type populations which may be the best evidence.

Alighieri : What is the object to the North of the quasar 4C37.43 in your last slide ? Is it a galaxy ?

Hutchings : It is a galaxy. We have a redshift, and it is the same as the quasar (0.37).

Chatterjee : What, if any, are the essential differences between quasars which seem to be associated with interacting galaxies and quasars which seem to be isolated ?

Hutchings : I do not know of any differences in the central QSO. The host galaxies however are frequently tidally distorted and contain hot stars or ionised gas. However, the data are fully consistent with all quasars being ignited by a collision, if their lifetimes are 10^7 or 10^8 years.

Alighieri : Concerning the discussion on whether extended line emission means that galaxies underlying quasars are spirals rather than ellipticals, it is known now that several radio galaxies, classified as ellipticals from broad band imaging have extended ionised gas surrounding them at distances of several tens of kpc.

Hutchings : This tends to support my claim. Ellipticals which have been violently activated bear these other signs. Normal ellipticals do not. When they are very distant and have a quasar core, it is difficult to say definitely that they are ellipticals.

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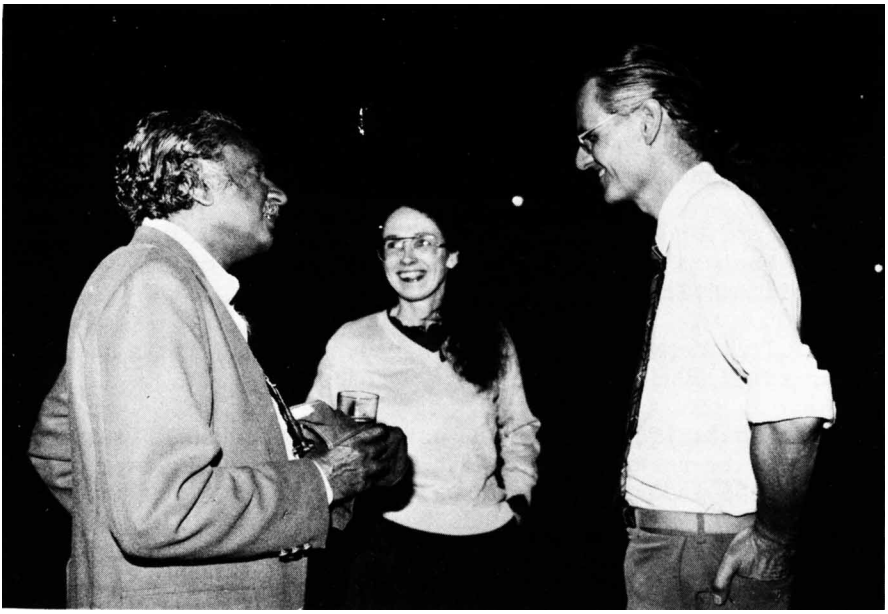

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