the fact that the ionizing spectrum of a star as hot as that invoked in the planetary nebula does closely mimic an active nucleus (thus at least providing support for photoionization rather than collisional excitation in active nuclei). The more difficult problem is accounting for the similarity whith novae if collisional excitation really does play an important role in these objects.

As the other galaxies mentioned above which show the [SiVI] line have not been observed around [SiVII], the constancy of this ratio in galaxies cannot yet be tested. These and other galaxies for which [SiVI] upper limits have been obtained do, however, appear to exhibit lower [SiVI]/Br_γ ratios (≤ 2) except perhaps for the Seyfert 1 galaxy IC4329A (≥ 1.7). The [SiVI]/[FeVII] line ratio in this galaxy is also larger than in NGC1068 – consistent with higher excitation conditions as already indicated by its larger [FeX]/[FeVII] ratio. Further tests of the correlation between [Si] and [Fe] lines are of interest but presently limited by the small sample of galaxies observed to date and uncertainties in the extinction corrections to be applied to the visible lines.

Following the planned upgrade of IRSPEC with a 2D array detector, it is now hoped in the near future to be able to extend our observations of the [Si] lines to a larger sample of galaxies; to utilize the new long-slit capability to measure their spatial distribution and to search for coronal emission from other species in order to investigate further the location and excitation of these lines.

Acknowledgement

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New NTT Discoveries on Distant Galaxies and Gravitational Lensing

F. HAMMER, DAEC, Observatoire de Paris-Meudon, France
O. LE FÈVRE, Canada-France-Hawaii Telescope Corp., Hawaii, USA

Since the discovery of the double lensed QSO 0957+561 by Walsh et al. (1979), gravitational lensing effects are being identified in a steadily increasing number of sources. Indeed, detector improvements in the 1980s have led to the detection of features as faint as a few thousandths of the sky signal. This has resulted in the identification of radio galaxies at high-z, which are much more numerous than QSOs and also potentially affected by gravitational lensing.

We know today about 50 radio galaxies at z>1, and these sources are likely to be affected by gravitational lensing, because they lie at the bright end of the Radio Luminosity Function (RLF). This is the steepest part of the RLF – the slope is equal to –3.5 – and hence is strongly subjected to statistical gravitational lensing. Let us recall that the latter influences much more steeper luminosity functions than the normal galaxy luminosity function which, with a slope equal to –1, cannot be statistically affected by lensing. We have predicted (Hammer and Le Fèvre, 1990; Hammer and Wu, in preparation) that there should be 5 to 10 times more bright radio sources behind rich lensing clusters of galaxies than in the rest of the sky and therefore, maybe that all 30 known high-z galaxies are part of the 3CR catalog because their radio luminosity has been sufficiently mag-

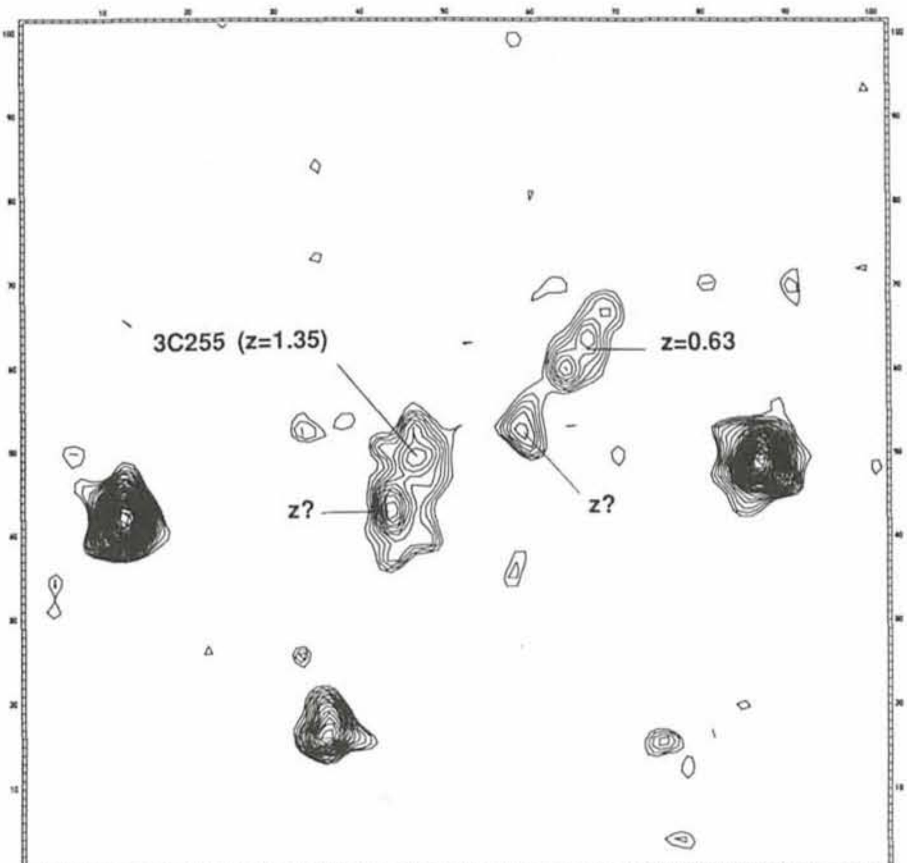

Figure 1: *3C255 (z=1.35), R, FWHM=0.″9, CFHT prime focus. The field is 20 × 20 arcsec, North is up and East to the left.*

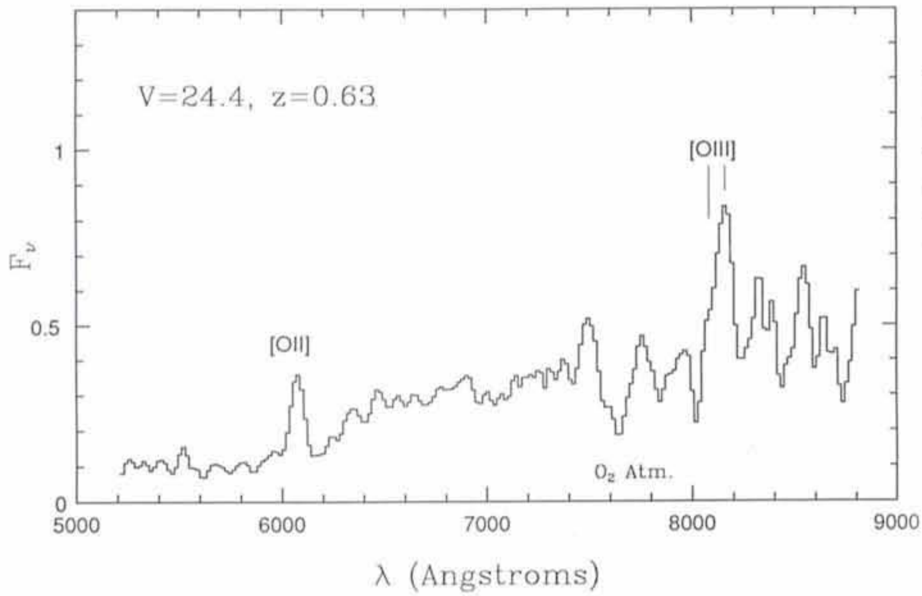

Figure 2: *ESO/NTT spectrum of a B=25 (V=24.4) galaxy identified at z=0.63 from [O II] 3727 Å and [O III] at 4959 and 5007 Å. It is only 4″.5 away from the radio galaxy 3C255 (z=1.35).*

nified by foreground deflecting matter. Identification of foreground matter and search for possible gravitational mirages among these sources are part of an ESO Key Programme (Surdej et al., 1989) jointly with similar searches for bright multiple lensed optical QSOs and additional observational studies of known lenses.

There are few doubts that gravitational lensing greatly helps us in detecting the most distant galaxies. Discoveries and studies of giant luminous arcs (Soucail et al., 1987; Lynds and Petrosian, 1987; Hammer and Rigaut, 1989) have led to a new sample of galaxies which would have B=24–25 if they were not lensed and which probably lie at relatively moderate z (<z>=0.8 for 6 sources. Radio rings are the result of gravitational lensing of a distant radio lobe or jet by a massive foreground galaxy (Hewitt et al., 1988). They also potentially allow studies of distant galaxies which are much more "normal" than the extremely peculiar radio galaxies in the 3C and 4C surveys which are dominated by radio emission.

In the following sections, we present several results obtained during five very good nights at the NTT in February 1990. Weather conditions were good (seeing <FWHM>=0″.9 and stable, best seeing 0″.7 FWHM, photometric sky) while the telescope, the EFOSC2 instrument and the Thomson 1024^2 CCD performed almost flawlessly. This combination has provided us with very good data. There was no instrumental failure, which is remarkable since it was only the 2nd month of official use of the NTT. We first report on the spectroscopic discovery of foreground galaxies close to the 3CR 255 line of sight including the record spectroscopic identification of a B ~ 25 galaxy. Another high z 3CR galaxy, 3CR 297, is found to be a good gravitational mirage candidate from its spectroscopy. Deep spectroscopy of the well-known high-z galaxy, 3CR368 (z=1.13) reveals that the brightest and central component is a Galactic M star, and elucidates the nature of this source. Finally, direct imaging in several broad-band filters of M1131+0456 identifies the lens and the lensed/distorted optical counterpart of the radio ring, while the physical nature of the lens and a possible redshift are tentatively derived from the spectroscopy. These results emphasize the importance of gravitational lensing in our understanding of the distant Universe.

Contaminating Foreground Galaxies in the Field of 3CR255

3CR255 was identified with an extremely complex optical system including at least five components (Fig. 1). The redshift was previously obtained by Giraud (1989) and we confirm its value of z=1.35 from our detection of the strong [O II] 3727 emission line and [Ne III] 3869 which are to be added to the previously detected C III, C II and Mg II. However, only one component, indicated on Figure 1, shows emission lines at this redshift.

Four arcseconds away there is a B=25 (V=24.4) galaxy for which we have derived a redshift z=0.63 (5.5 hours of total integration time) from the observed [O II] 3727 and [O III] 5007 and 4959 emission lines (Fig. 2). Apart from

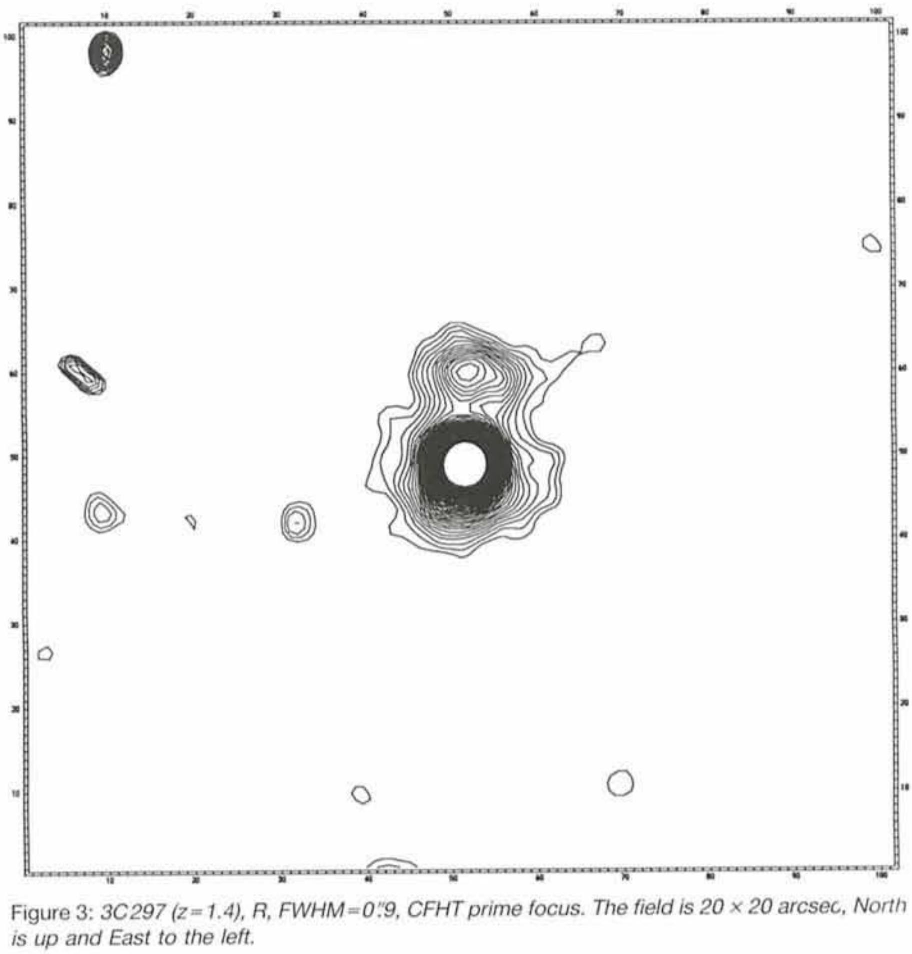

Figure 3: *3C297 (z=1.4), R, FWHM=0″.9, CFHT prime focus. The field is 20 × 20 arcsec, North is up and East to the left.*

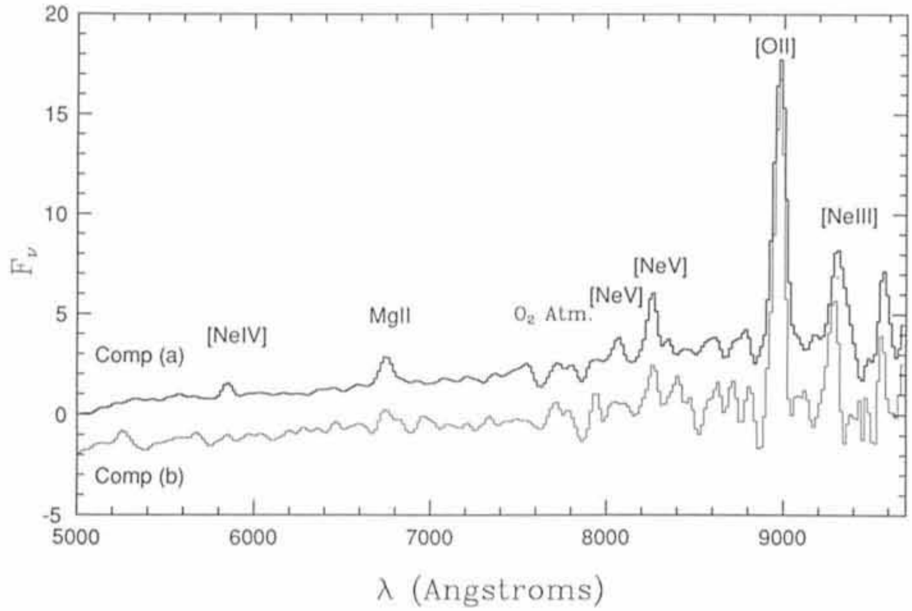

Figure 4: *ESO/NTT spectra of the 2 components of 3C297. The emission lines show the same velocity at less than 100 km/s difference.*

the detection record in faint object spectroscopy, this is a field galaxy selected at random which should be compared with similar detections up to B=24 (Cowie, Ellis and Koo, in a workshop on galaxies at high z, Oxford, July – August 1990) and to the B=24-25 sources forming the giant luminous arcs. Our B=25 galaxy is also intrinsically faint – several tenths of L* (see e.g. Efstathiou et al., 1988) – similar to galaxies belonging to the main population of the B=22.5 redshift survey (Colless et al., 1990) with <z>=0.32. Taken together, these results indicate that no luminosity evolution is required for galaxies up to z ~ 0.8, and that counts up to B=27 (Tyson, 1988; Lilly et al., 1990) might be dominated by galaxies at moderate z. There are also indications that component (c) is a foreground object, and possibly again at z=0.63.

The 3CR 255 optical counterpart is probably gravitationally magnified by this foreground matter, and its complexity and intrinsic luminosity would be largely decreased by removing the foreground objects. A more detailed analysis of these data will be reported elsewhere.

A New Gravitational Lens Candidate: 3CR 297

The optical counterpart of 3CR 297 (z=1.4) is dominated by two components (Fig. 3). Spectroscopy with EFOSC at the 3.6-m and EFOSC2 at the NTT have provided the spectra shown in Figure 4. The two components have the same emission lines [NeIV], MgII, [NeV], [OII], [NeIII] and there is no velocity discrepancy between them down to our measurement accuracy of 100 km/s. Moreover, [OII] 3727, the strongest emission line, has a blueshifted wing in both spectra. The continuum of the faintest component however is bluer than the brightest one, which could be due to the presence of the deflecting object. New radio data (van Breugel, private communication) show very distorted structures but do not confirm or infirm at this stage the lensing hypothesis.

3CR 368: a Well-Known High-z Galaxy Dominated by a Galactic M Star!

This source has been considered by several authors as a prototype of the high-z radio galaxies from its luminosity, its colour, its morphology (Fig. 5 (a)) and the alignment between radio and optical axis. It has been the source of a large

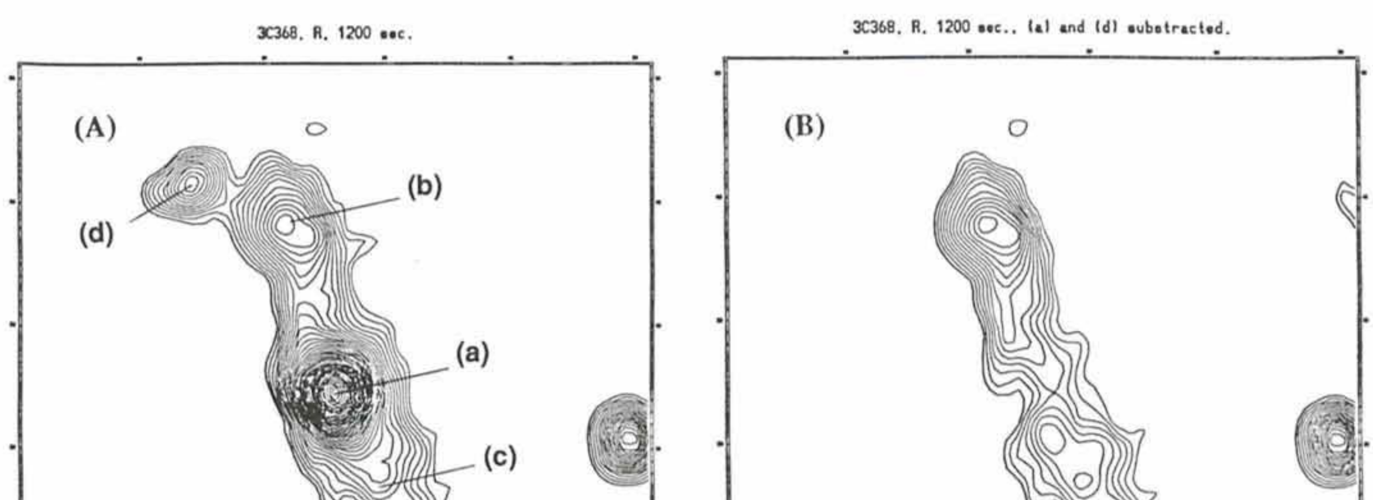

Figure 5: *3C368, R image, FWHM=0.″8, CFHT prime focus: (a) before "decontamination", (b) after "decontamination" by a foreground Galactic M star. The fields are 10 × 10 arcsec, North is up and East to the left.*

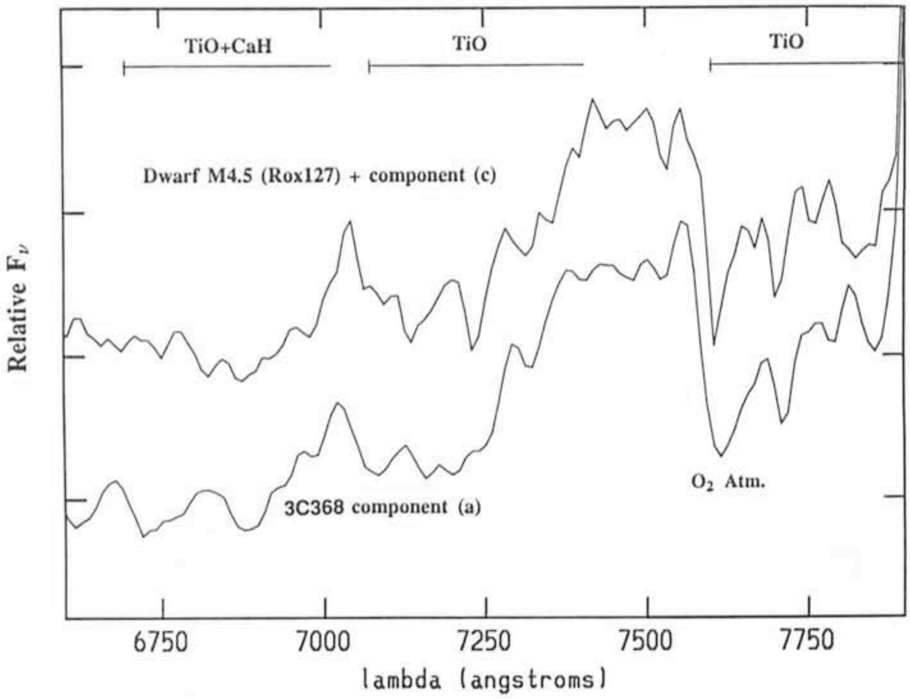

Figure 6: *ESO/NTT spectrum of component (a) of 3C368, sum of 3 spectra 45 min each. It shows the TiO and CaH bands typical of M5 stars.*

number of studies at all wavelength (Djorgovski et al., 1987; Chambers et al., 1988; di Seregho Alighieri et al., 1989; Chambers and Charlot, 1990; Scarrott et al., 1990, etc . . .). Our new spectroscopic measurements obtained with the CFHT and the NTT have revealed that the brightest and reddest central component is a Galactic star – probably an M5 dwarf – rather than a foreground galaxy as we first believed or a z=1.13 source as stated prior to our measurements (Fig. 6 and Hammer, Le Fèvre and Proust, 1990). Removing the foreground object decreases the 3CR368 luminosity several times, especially at red and infrared wavelength (up to 1.4 mag in the K band). We believe that the superposition of the M star may also alter the radio properties and the previously reported optical polarization. The residual 3CR368 at z=1.13 (Fig. 5 (b)) actually shows an almost flat continuum associated with very strong and somewhat broad emission lines. Its appearance is therefore strongly modified and it could be an AGN associated with an extended emission line region rather than a distant galaxy dominated by stellar emission. Similar results on other distant radio galaxies, namely 3CR 238 and 3CR 297, have also been found from the same run at the NTT (Hammer and Le Fèvre, in preparation). We emphasize again the danger of interpreting such peculiar and rare distant radio sources as multiple-component galaxies without paying attention to the possible contamination by foreground objects, such as Galactic stars or faint galaxies.

MG 1131+0456: Discovery of the Optical Lensed Source and Spectroscopy of the Lens

This radio source has been discovered by Hewitt et al. (1988) in the frame of a large radio survey with the VLA. Its radio morphology consists of an almost complete ring accompanied by a pair of compact sources nearly diametrically opposed. This is probably the result of a radio jet well aligned with a foreground massive galaxy and then highly lensed, while the associated radio core is gravitationally multiplied.

We have obtained deep broad band images in the B, V, R and I bands. Nothing has been detected in B, while we have measured the optical object at other wavelengths, with V=23.4,

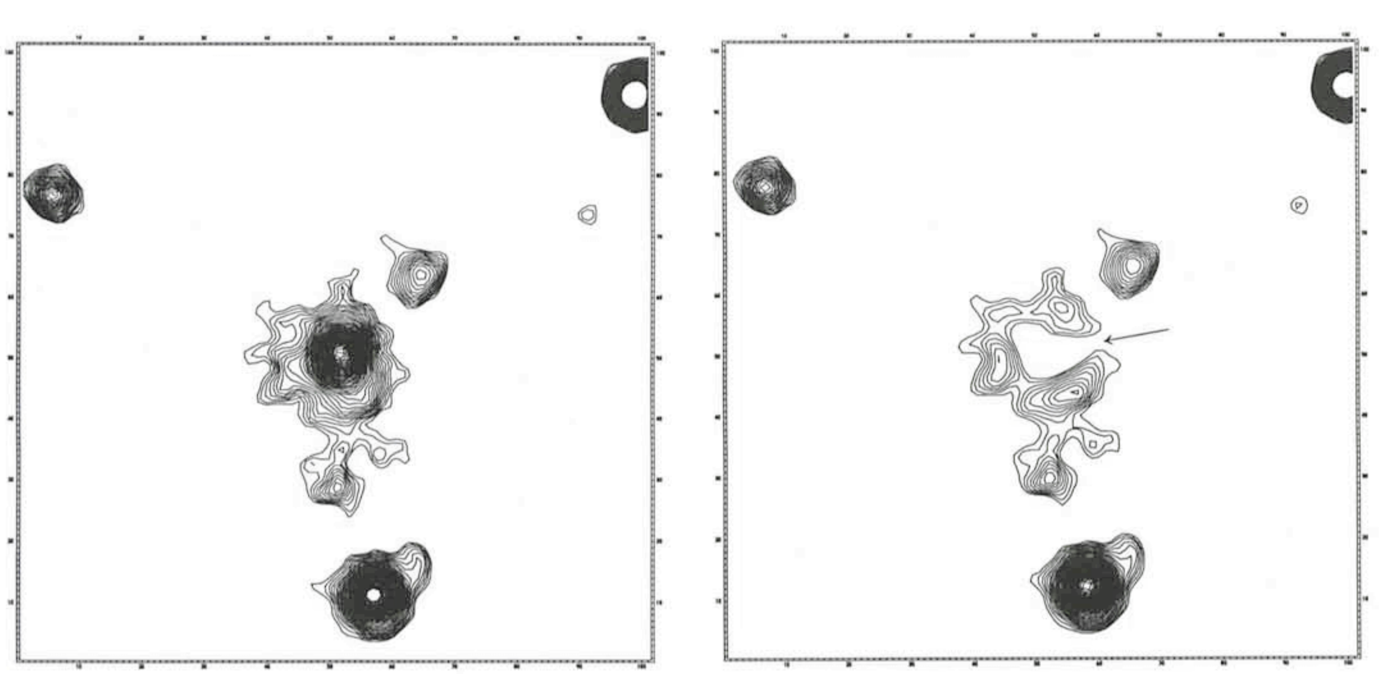

Figure 7: *(a) NTT image of the optical object detected at the radio location of the M1131+0456 Einstein ring (2 h 30 total integration R+I bands, seing 0."9 FWHM); (b) same after removal of a L_{eff}=5 kpr $r^{1/4}$ profile. The residual is believed to be the optical emission associated with the lensed object and radio ring (see text). The field is 16 × 16 arcsec, North is up and East to the left.*

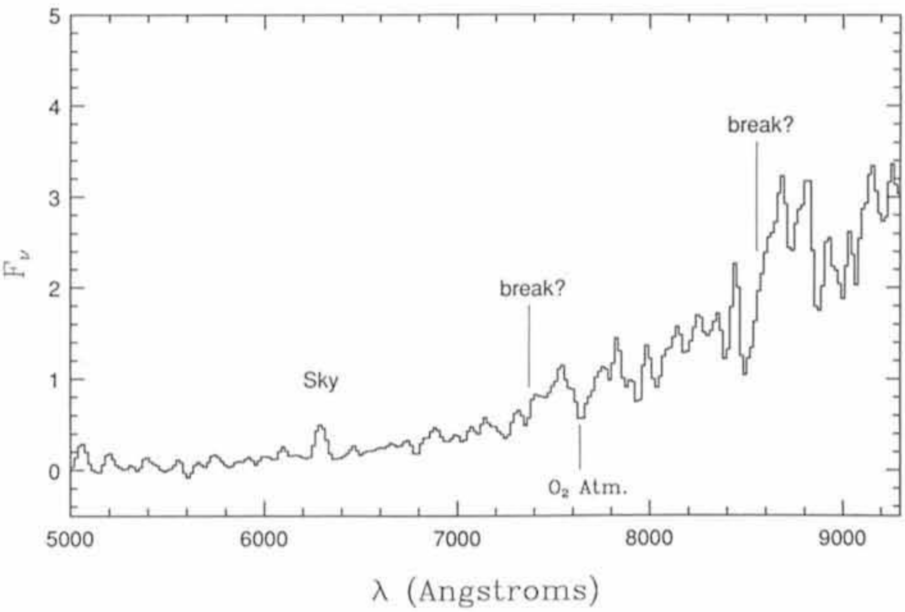

Figure 8: *ESO/NTT spectrum of M 1131+0456 (R=22.15), note the very red continuum and two possible breaks at 7400Å and 8550Å.*

R=22.15 and I=20.67. It is located just at the centre of the radio ring and constitutes most probably the lens (Fig. 7 (a)). The red colours deduced have led us to the hypothesis of a 4000Å break between V and R or between R and I. Moreover, the I image looks more extended than that of an elliptical galaxy. Indeed, if we assume that the lens is an elliptical galaxy, the R and I images cannot be fitted by any reasonable $r^{1/4}$ profile, which indicates an additional source of light. After removal of a $r_{eff}=5$ kpc $r^{1/4}$ profile, one can see a residual ring-like emission that follows the radio ring fairly closely (Fig. 7 (b)); note the gap indicated by the arrow in both the optical and radio images); profiles with r_{eff} up to 15 kpc have also been tried but none was successful in removing this extra emission. It is therefore likely to be the optical counterpart of the background radio source, i.e. the first example of an optical ring.

We have then obtained spectra of the optical object and Figure 8 reveals a featureless spectrum without any emission line. This is however extremely red with two breaks (S/N ~ 2), one located at 7400Å and the other at 8550Å. There are at this stage two alternatives: either we have spectroscopically detected the lens alone which has a spectrum very similar to the one of an elliptical redshifted at z=1.13 or we have found the blend of the lens at z=0.85 with the source at z=1.13. In both cases the lens is identified with a rather unevolved elliptical galaxy for which the absence of [O II] 3727 emission indicates no strong star-formation activity. The source is the counterpart of a radio emission at mJy level, far below the radio luminosity of the 3CR high-z galaxies. It is likely to be an elliptical galaxy gravitationally distorted by the foreground lens, and if it lies at z=1.13 it should also be a non evolved elliptical at least 3 magnitudes fainter than the powerful radio galaxies (Hammer et al., in preparation).

Conclusions

The NTT has convincingly shown us its outstanding capabilities in terms of the detection of very faint objects and features in crowded environments, in both imaging and spectroscopy.

The results presented above should be interpreted in the frame of extragalactic research and more especially in the sampling of the high-z Universe by distant galaxies. A key problem was open by deep counts of galaxies up to B=27: if they were dominated by high-z sources (z=1.4), this would favour strong luminosity evolution and a low value for the baryonic density, while a major contribution by small and dwarf galaxies at moderate z (z=0.6–1.2) implies no or small luminosity evolution plus a number density evolution and then a higher value for the baryonic.

Spectroscopic results on distant 3CR galaxies show them to be extremely peculiar and without evidence to be dominated by stellar content. Indeed, most of their properties seem to be closely linked with their active nucleus (Hammer, Le Fèvre and Sol, in preparation). Interpretations of these sources should be made carefully, also because they are expected and found as being affected by contamination due to foreground matter and/or resulting gravitational lensing (Hammer and Le Fèvre, 1990). The use of these extremely peculiar sources to test galaxy evolution is therefore particularly dangerous. Moreover, we know now some massive and high-z ellipticals considerably fainter than the high-z radio galaxies and rather non evolved. These are for instance the lens of QSO 2016+112 identified at z=1.01 by Schneider et al. (1986) or the lens and/or the source of the system M 1131+0456 detected by us. On the other side, there are the spectroscopic identifications of very faint sources found at moderate z, such as sources associated with the giant luminous arcs or the B = 25 galaxy presented here. Again they show no or little luminosity evolution. Strong luminosity evolution seems to be rejected both for intrinsically bright and faint galaxies.

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