WR Stars

There are two WR stars in our material. One of these, PK 309 −4°1 (= He 2–99) was previously classified as a planetary nebula with a WC9 star as central star (Jones, 1969). Our observations confirm this. The other example is PK 337 +1°1, which appears as No. 67 in the list of misclassified or doubtfully classified planetary nebulae by Sanduleak (1976). The reason for this was the finding by Webster (1969), who from photometric observations concluded that the normally strong [O III] line at 500.7 nm seemed to be absent in PK 337 +1°1. A spectrogram of this object is shown in Fig. 2 (upper). The strongest lines are Hα and the [N II] doublet at 654.8 and 658.4 nm. Hβ and [N II] at 575.5 nm are also narrow and relatively strong. The [N II] line is surrounded with broader features, which also can be found near 465 nm and in the red end of the spectrum.

A so-called "high-cut" version of the spectrum (Fig. 2) reveals that these features are due to lines typical for a Wolf-Rayet star of type WC9. In fact the object is very similar to PK 309 −4°1, which also has very weak [O III] lines, a property that is normal for planetary nebulae with late WC type central stars. The most natural interpretation is to regard also PK 337 +1°1 as a planetary nebula with a WC9 type central star.

However, the line widths of the emission lines are normally smaller for planetary nuclei of WR type than for "classical" WR stars of the same type (Smith and Aller, 1971). A comparison with the classical WC9 star, WR103, which was observed during the same observing run, did not show any significant differences in line widths or line intensities between the two stars. One must therefore also consider the possibility that PK 337 +1°1 might be a normal WC9 star surrounded with a compact H II region. Hopefully, the finally reduced data will permit a more unambiguous interpretation of this object.

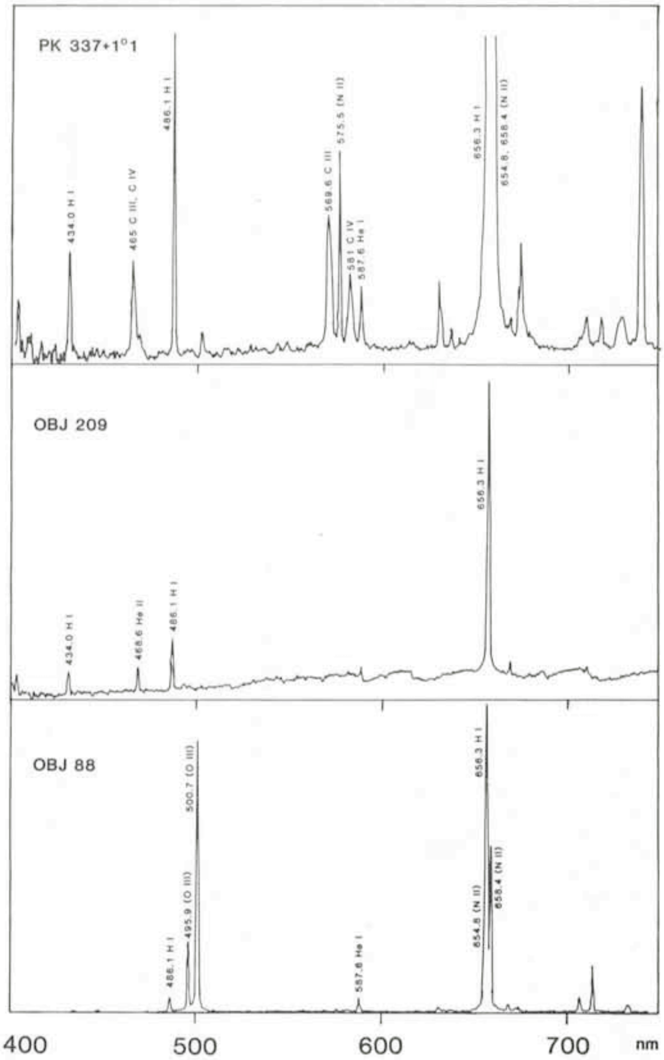

Fig. 2: *Spectral signatures of three objects mentioned in the text. Not finally reduced, no calibration of the ordinate is done.*

Symbiotic Stars

Fig. 2 (middle) shows a spectrum of our object 209, also known as No. 324 in the list of Hα emission objects by Stephenson and Sanduleak (1977). The true nature of this object was previously unknown, but our spectrogram clearly shows a symbiotic object, with a high excitation line spectrum superposed on a late-type stellar spectrum.

Planetary Nebulae

Our final example is a spectrogram of our object 88 ($\alpha = 18^h46^m\!.11$, $\delta = -5°59'\!.8$). This object does not, as far as we know, appear in any other list of emission line objects. The spectrum (Fig. 2, lower) is typical of a planetary nebula of medium excitation.

There are of course several other interesting objects in our material, but since almost no reductions have yet been made, we feel that a discussion of these must be postponed to a later occasion. Let us only once more emphasize that the IDS is an excellent tool for studying faint emission-line objects and that we certainly intend to make use of this fine equipment for future investigations of similar kind. For example, with the experience hitherto gained, we are now designing a programme for ESO in which we will investigate all known or suspected planetary nebulae in the southern sky. This project, which will not require very much telescope time, will go into a planned catalogue of planetary nebulae as proposed by Agnès Acker at the Strasbourg Observatory.

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Colour Gradients in Elliptical Galaxies – Some Results from CCD Photometry

E. Sadler, ESO

The use of charge-coupled device (CCD) cameras in galaxy photometry offers a number of significant advantages over traditional photoelectric and photographic techniques. CCDs have a high quantum efficiency compared to photographic

Fig. 1: *B–R colour map of the dust-lane galaxy NGC 1947.*

plates, and their response is linear over a large range of brightness. Since they are two-dimensional detectors, the centring problems of photoelectric photometers are avoided, and object and sky can be observed simultaneously. Of course, there are also some disadvantages; the CCD is much smaller in area than a photographic plate, and the read-out noise is a limiting factor for short exposures. However, one area in which CCD detectors are particularly valuable is in studying the inner regions of nearby galaxies, and in particular the colours and colour gradients in galactic nuclei. Here, the smaller size of the CCD is no disadvantage as we are studying objects 1–2 arc minutes in angular size. Since the luminosity profile of a galaxy rises sharply towards the centre, saturation effects and the non-linear response of the emulsion present problems for photographic work, while it is extremely hard to obtain photoelectric aperture photometry with diaphragms smaller than 10–15″ because of the difficulty in centring the galaxy accurately. The resolution of the CCD image, on the other hand, is limited only by the pixel size (0″.47 at the Danish 1.5 m telescope) and the seeing (usually 1–2″ at La Silla). This allows us a fascinating glimpse into the innermost regions of many nearby galaxies, and may provide new insight into the mechanisms responsible for "active" nuclei in galaxies.

The existence of colour gradients in the outer parts of some elliptical galaxies is well known (e.g. Strom and Strom 1978 *A.J.* **83,** 73), although the number of galaxies for which detailed information is available is still small. Generally, the galaxy becomes bluer in colour further out from the centre, and this is generally explained as being due to a gradient in the abundance of heavy elements. However, it is also very interesting to know how the colour of the galaxy nucleus compares with that in the outer parts, because several phenomena which are believed to take place in the central 1 kpc of the galaxy may have an observable effect on the colour of the central region. Despite the classical picture of elliptical galaxies as essentially gas-free systems of old stars, there is mounting evidence that modest ($\sim 10^6\ M_\odot$) amounts of ionized gas are a normal feature of these galaxies. A group of us (L. Binette and

E. Sadler at ESO, together with M. Dopita, M. Phillips and C. Jenkins) have found weak Hα and [N II] emission lines in more than half of a sample of 200 elliptical and S0 galaxies. A similar result for emission lines of [O II] has been reported by Caldwell (1982 Ph.D. Thesis, Yale University), who also argues that recent bursts of star formation have occurred in some ellipticals. If this is the case, the young stars should be concentrated in the nucleus of the galaxy where most of the gas resides, and their effect will be to change the colour of the central region relative to the galaxy background.

In March 1984, I spent three nights observing with the CCD camera at the Danish 1.5 m telescope at La Silla. A description of the CCD was given in a previous issue of the *Messenger* (Pedersen and Cullum, December 1982). The weather during this run was very good, with excellent seeing (often better than 1"). Images were obtained with B, V and R broad-band filters for 15 galaxies as part of a project to study the relationship between gas, radio emission and the stellar population in elliptical galaxies. A number of standard stars were observed each night, and were used to transform the observations to the standard Cousins BVR system after flat-fielding and dark subtraction had been done. Although only 5–6 stars were observed each night, the transformation was accurate to about 0.02 mag. in V and 0.01 mag. in B–V and V–R. This is encouraging since it shows that, at least for bright objects, the CCD can produce results comparable in accuracy with photoelectric photometry.

At this stage, we can derive the brightness distribution in each galaxy out to about 25 mag./(arcsec^2) in B (i.e. at least 2 magnitudes fainter than the La Silla night sky) and corresponding levels in V and R. However, some further processing is necessary to obtain the B–V and B–R colour maps. It is important that the point spread function have exactly the same width and shape in each frame before they are subtracted. If, for example, the seeing is better in the red frame than the blue, then subtraction of the two frames will produce an artificially "red" nucleus because the red profile is narrower and so the central few pixels contain proportionally more light. Other effects, such as guiding errors (which are very small at the Danish telescope thanks to the autoguider) or focus drift can produce an asymmetric image. Each frame must therefore be broadened to the same "seeing" profile with a two-dimensional gaussian function and aligned exactly with the others before subtraction. This is done by measuring the position and half-width in X and Y directions of 6–10 stellar images in each frame. The stellar images also provide a check on the final colour map – they should be circular in shape and of uniform colour if the subtraction has been done correctly.

Fig. 1 shows a B–R map of the dust-lane S0 galaxy NGC 1947. North is at the top, east to the right, and darker and lighter areas represent bluer and redder colours respectively. The area to the top and left of the picture shows only noise since it lies outside the galaxy image. The reddening due to the dust-lanes on the NE side of the galaxy is clearly seen, and the structure of the dust itself is reminiscent of that in Centaurus A (see e.g. Ebneter and Balick 1983 *PASP* **95,** 675 for a recent photograph) although NGC 1947 is somewhat more distant and intrinsically fainter. Fig. 2 shows the blue luminosity profile and B–R colour gradient for a region perpendicular to the dust-lane. The dust manifests itself both as absorption in B and as a sharp reddening in B–R. The colour gradient in the underlying galaxy is very small (≤0.1 mag. in B–R over 70" on the SW (dust-free) side).

What is interesting is that this "dust-lane signature" is also seen in the inner regions of a number of apparently "normal" elliptical galaxies. Figs. 3 and 4 show the E2 galaxy IC 3370 in which the B–R map reveals a small (~10" long) dust lane which is clearly seen in the B–R profile even though it is barely visible as an absorption kink in the luminosity gradient and certainly cannot be detected on photographic plates. This dust-lane has a diameter of about 1.3/h kpc (H_0 = 100 h km/s/Mpc), compared to 3–4/h kpc for the NGC 1947 dust-lane and 10–15 kpc for the dust lane in Centaurus A. CCD surface photometry

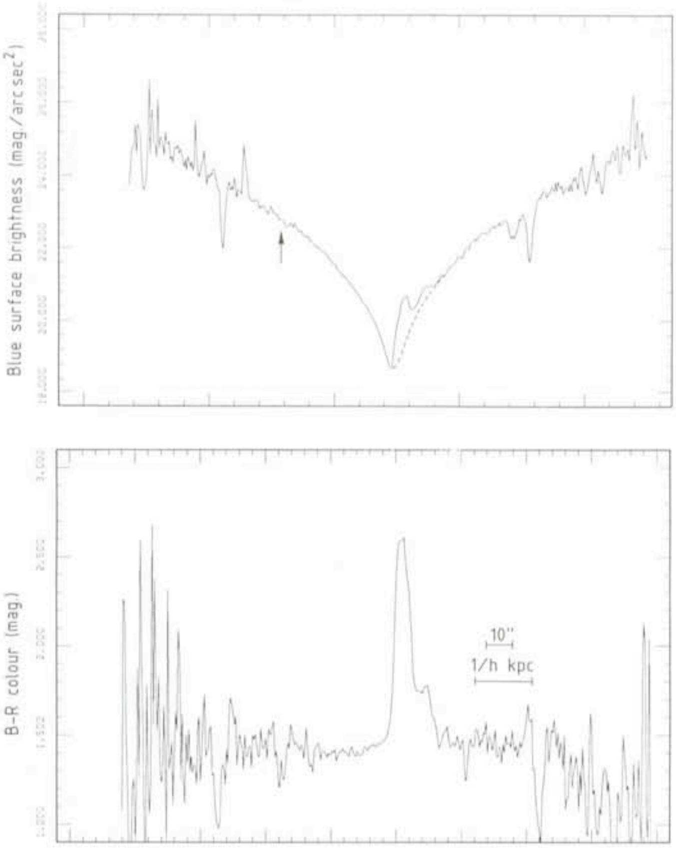

Fig. 2: *Profiles in blue luminosity and B–R colour along a line perpendicular to the dust-lane of NGC 1947 and passing through the nucleus. An arrow indicates the brightness of the night sky at La Silla at the time of observation, while the dotted line is the reflection of the (dust-free) south-west side about the nucleus. The bright "spikes" far from the nucleus are due to foreground stars.*

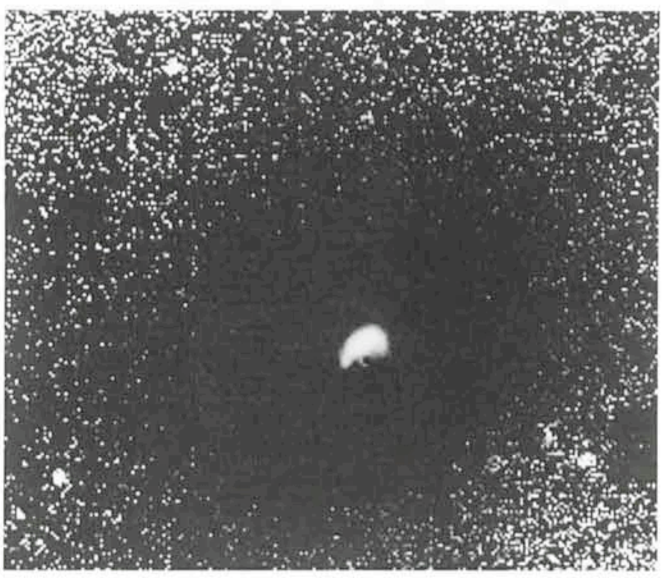

Fig. 3: *B–R colour map of the elliptical galaxy IC 3370, revealing a small dust-lane in the nucleus.*

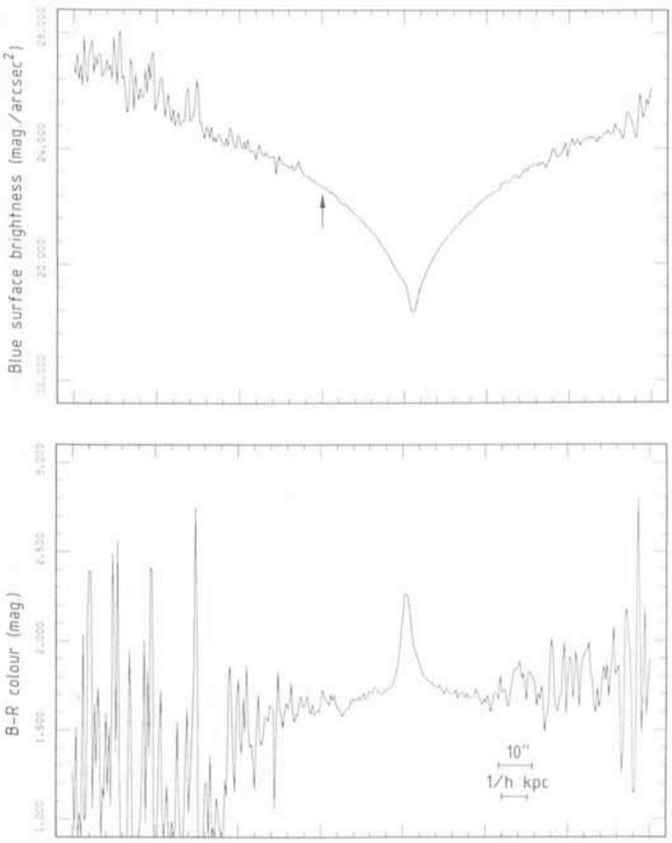

Fig. 4: *As Fig. 2, for IC 3370. Note the similarity to Fig. 2 despite the smaller size of the absorbing region.*

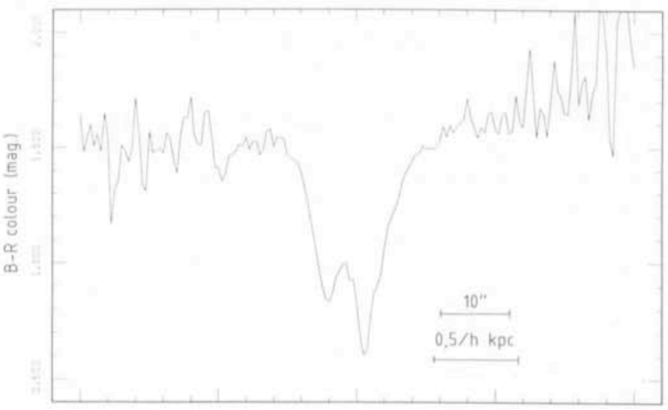

Fig. 5: *B–R profile of the star-forming elliptical galaxy NGC 2328. The blue nucleus is clearly seen.*

seems to be a powerful method of revealing "hidden" dust in the nuclei of elliptical galaxies because at least three other galaxies in the small sample so far observed show resolved red nuclei similar to that in IC 3370. All these galaxies show weak emission lines in their nuclei and also contain small radio sources, suggesting that all these factors may be linked.

NGC 2328 is an example of an early-type galaxy currently undergoing a strong burst of star formation. It is very blue in colour, and has an emission-line spectrum characteristic of H II regions. The two-dimensional B–R map shows a ring of blue regions which encircle the centre of the galaxy, and several of them can be resolved. Fig. 5 shows a profile through the nucleus.

These preliminary results from a project which is still in progress show the power of CCD photometry in the study of galactic nuclei and reveal once again that elliptical galaxies are by no means the "simple" systems they were once believed to be.

I should like to thank Holger Pedersen and H. Jørgensen for their advice and help during the CCD observing run, and Preben Grosbøl for guiding me during several stages of the photometric reduction.

PERSONNEL MOVEMENTS

STAFF

Arrivals

Europe

DEIRIES, Sebastian (D), Technician, 1.9.1984
MAASWINKEL, Alphonsus (NL), Project Engineer in Astronomical Instrumentation, 1.10.1984

Chile

JUTZI, Christian (CH), Administrator, 1.9.1984
LE BERTRE, Thibaut (F), Astronomer, 6.9.1984
MERTL, Wenzel (CH), Electronics Engineer, 1.10.1984

Departures

Chile

MEINEN, Inge (D), Administrator, 31.8.1984

ASSOCIATES

Departures

Europe

KRAUTTER, Joachim (D), 30.11.1984

ALGUNOS RESUMENES

Un telescopio submilimétrico de 15 m en La Silla

En su última reunión del 7 de junio de 1984 el Consejo de la ESO aprobó el acuerdo entre el Consejo Sueco de Investigaciones de Ciencias Naturales y la ESO por la instalación y operación en La Silla de un telescopio submilimétrico de 15 m y el acuerdo entre IRAM y ESO por el cual IRAM proporcionará el telescopio.

El tiempo de observación será compartido en períodos iguales entre Suecia y ESO. Gran parte de la responsabilidad técnica para el proyecto quedaría a cargo del Observatorio Espacial de Onsala que ya opera un telescopio submilimétrico de 20 m en Onsala. Está programado que el telescopio submilimétrico Sueco-ESO (SEST) opere a partir de 1987.

El Señor Profesor L. Woltjer fue nombrado nuevamente como Director General por el Consejo de la ESO para el período del 1° de enero de 1985 al 31 de diciembre de 1989.