is considerably more metal-rich than 47 Tuc, part of this "reddening" should be due to an opacity difference: adopting the usual value of E(B-V) = 0.8 for NGC 6553 (Webbink, 1985), an opacity difference of 0.2 magnitudes is found.

For estimating the age, the magnitude difference between the turn-off and the HB is used (see Buonnano et al., 1989). NGC 6553 seems to be slightly younger than the classical globular clusters (see Ortolani et al., 1989), which would have important implications for the epoch of the inner bulge formation.

5. Impact of the CMDs of NGC 6553

The colour-magnitude diagrams of NGC 6553 are very important for the study of super-metallic populations: in particular those present in bulges of elliptical galaxies. Indeed a major difficulty of population syntheses using stellar libraries is the adoption of isochrones for a super-metal-rich population; theoretical computations of such isochrones are not available, and the CMDs of NGC 6553 provide, for the first time, information on the CMD morphology for such systems.

References

Armandroff, T.E. 1988, *Astron. J.* **96,** 588.
Aurière, M., Ortolani, S. 1988, *Astron. Astrophys.* **204,** 106.
Bica, E., Pastoriza, M. 1983, *Astrophys. Spa. Sci.* **91,** 99.
Buonnano, R., Corsi, C.E., Fusi Pecci, F. 1989, *Astron. Astrophys.,* in press.
Fusi Pecci, F. 1989, in "Astrophysical Ages and Dating Methods", 5th IAP Workshop, eds. E. Vangioni-Flam, M. Casse, J. Audouze, Ed. Frontières, to appear.
Gratton, R., Ortolani, S. 1988, *Astron. Astrophys. Suppl.* **73,** 137.
Morgan, W.W. 1959, *Astron. J.* **64,** 432.
Ortolani, S. 1988, Space Telescope Technical Report, ST-ECF-ESO, Garching.
Ortolani, S., Barbuy, B., Bica, E. 1989, in "Astrophysical Ages and Dating Methods", 5th IAP Workshop, eds. E. Vangioni-Flam, M. Casse, J. Audouze, Ed. Frontières, to appear.
van den Bergh, S. 1967, *Astron. J.* **72,** 70.
Webbink, R.F. 1985, in "Dynamics of Star Clusters", eds. J. Good, P. Hut, Reidel, p. 541.
Zinn, R., West, M.J. 1984, *Astrophys. J. Suppl.* **55,** 45.

On the Theoretical Ratio of Some Nebular Lines

A. ACKER, "Equipe Populations Stellaires", Observatoire de Strasbourg, France
J. KÖPPEN, M. SAMLAND, Institut für Theoretische Astrophysik, Heidelberg, F. R. Germany, and
B. STENHOLM, Lund Observatory, Sweden

1. Introduction

As pointed out by Rosa (1985) and Wampler (1985), the response of the IDS system seems to show a dependence on the value of the input intensity. Peimbert and Torrès-Peimbert (1987) give a review of different determinations of the factor K in the relation between the flux F and the instrumental signal $S = F^{(1+K)}$. The value of K seems to be small (0.03) if the emission lines appear over a strong continuum – which is rare for planetary nebulae –, and K is higher (0.08) for lines over a weak continuum. The value adopted by Peimbert and Torrès-Peimbert is 0.07.

These corrections must be taken into account, as systematic errors will affect the determination of physical parameters. In particular, if line intensities are uncorrected, then:
- the extinction factor c (Hβ) is too high, by about 0.15;
- the electron temperature is too low;
- the He/H abundance is underestimated and the heavy element abundance is too high, if the determination is based on collisionally excited emission lines.

2. ESO Observations of Planetary Nebulae

Since 1984, two of us (A.A. and B.S.) have conducted a spectroscopic survey of the planetary nebulae of our Galaxy, in the spectral range 400 to 740 nm and with a low resolution of about 1 nm (see Acker and Stenholm, 1987). We have used first the IDS system, and since July 1987, a CCD detector, both mounted on the Boller & Chivens Cassegrain Spectrograph at the 1.5-m telescope at La Silla. We have obtained spectra of more than 1000 planetary nebulae: about 400 spectra taken with the IDS and 120 with the CCD are measured.

2.1 The [O III] doublet

Here we compare theoretical predictions with observed values for the emission lines ratio [O III]r 500.7 nm versus [O III] at 495.9 nm, taking into account the interstellar extinction c.

Figure 1a presents the raw data for IDS spectra. For the 342 spectra measured, we found:
I (500.7)/ I (495.9) = 3.01 ± 0.23.

On Figure 1a we see that, for faint lines (I (495.9) $< 10^3$), the ratio of the [O III] doublet shows highly dispersed values. For very strong lines (I (495.9) $> 10^5$), the ratio becomes too faint, due to saturation effects. The central part of the relation shows clearly that the observed ratio is higher than the theoretical one. Figure 2a shows that the relation I (500.7)/I (495.9) versus I (495.9) has the same appearance for the CCD data as for the IDS data.

The coefficient β′ is calculated as follows, assuming a theoretical value of 2.88 for the [O III] doublet as proposed by Mendoza (1983), and the value of the extinction c derived from our data through the Balmer decrement (see Acker et al., 1989) using the "HOPPLA" code written by J. Köppen:
(I (500.7)/I (495.9) obs =
$(2.88 \times 10^{0.013\,c})^{\beta'}$

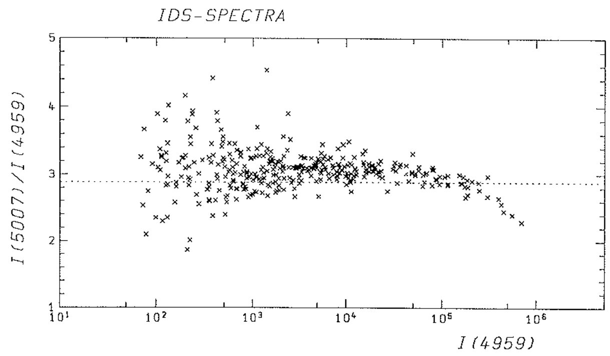
By selecting the lines with intensities in the range 10^3–10^5 we found:
β′ = 1.0316 ± 0.0478 (CCD)
β′ = 1.0317 ± 0.0403 (IDS)

These values lead to the following values of the "Rosa-coefficient" β = 1/β′:
β = 0.969 ± 0.047 (CCD)
β = 0.969 ± 0.038 (IDS)

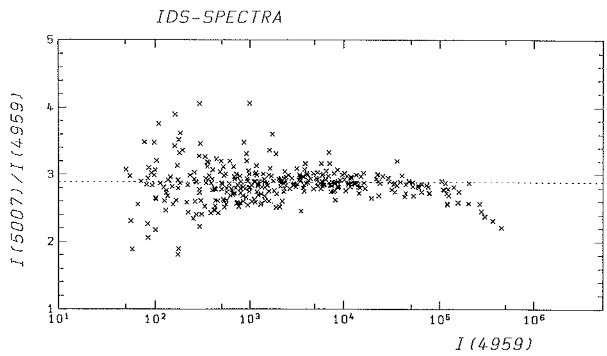
These values are similar to the value given by Rosa (1985): β = 0.96 ± 0.02.

On Figures 1b and 2b, we report the corrected IDS (1b) and CCD (2b) intensities, using the "Rosa-coefficient" β = 0.969. Figure 1c gives the mean relations calculated for the IDS data.

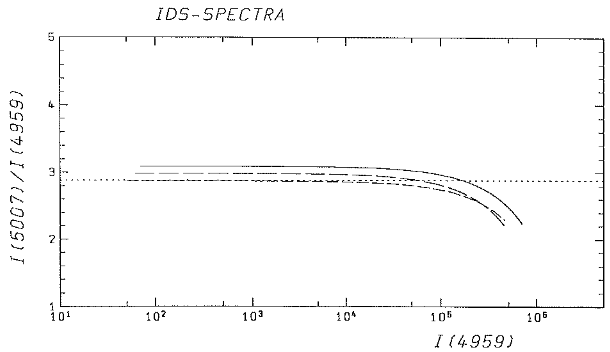
The excellent agreement we found between the IDS and the CCD data suggests that the discordance with the theoretical predictions cannot be due to instrumental effects only. To check this assumption, we study now the possible non-linearity shown by the [N II] red lines.



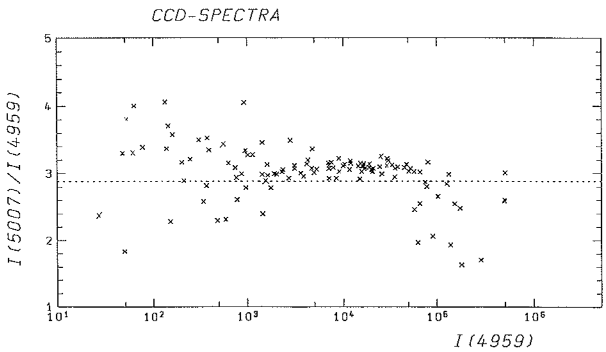
1a - NO DE-REDDENING
- ROSA-COEFFICIENT K = 1.000
- THEOR. VALUE (2.88) : ------



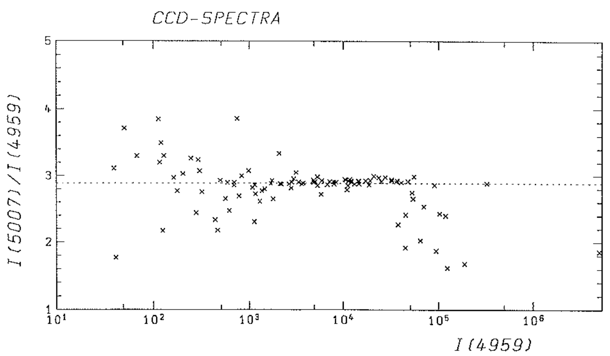
1b - DE-REDDENED
- ROSA-COEFFICIENT K = 0.969
- THEOR. VALUE (2.88) : ------



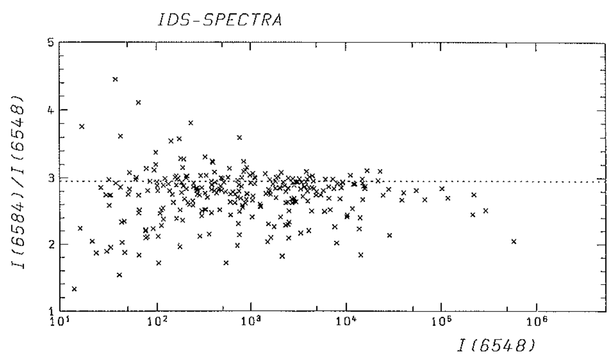
1c DATA : ———
DATA + ROSA-CORR. (K=0.969) : — —
DATA + ROSA-CORR. + DE-REDD. : _ _ _
THEOR. VALUE (2.88) : ......



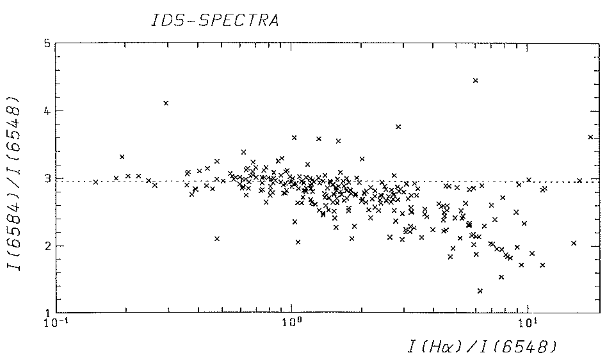
2a - NO DE-REDDENING
- ROSA-COEFFICIENT K = 1.000
- THEOR. VALUE (2.88) : ------



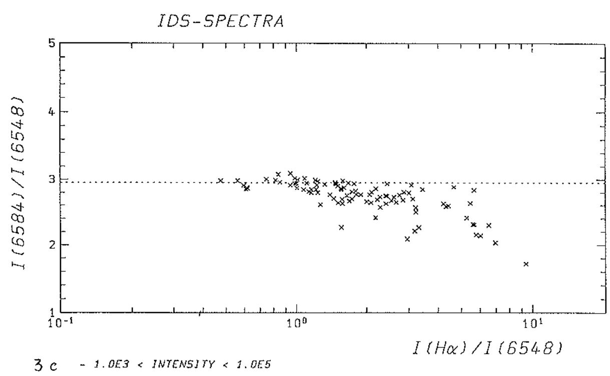
2b - DE-REDDENED
- ROSA-COEFFICIENT K = 0.969
- THEOR. VALUE (2.88) : ------



3a - DE-REDDENED
- ROSA-COEFFICIENT K = 0.969
- THEOR. VALUE (2.95) : ------



3b - DE-REDDENED
- ROSA-COEFFICIENT K = 0.969
- THEOR. VALUE (2.95) : ------



3c - 1.0E3 < INTENSITY < 1.0E5
- DE-REDDENED
- ROSA-COEFFICIENT K = 0.969
- THEOR. VALUE (2.95) : ------

2.2 The [N II] doublet

On our IDS spectra, we could measure the [N II] doublet for 267 nebulae. We found: I (658.3)/I (654.8) = 2.92 ± 0.32, comparable to the theoretical value of 2.95. On figure 3a, we show the observed intensities corrected of the interstellar reddening and of the "Rosa effect". The average behaviour of the I (658)/I (655) line ratio versus the I (655) value is comparable to the correlation found for the [O III] lines shown on Figure 1a, but it appears that the "Rosa-correction" has perhaps not to be applied here.

The measure of the [N II] doublet is affected by the proximity of the Hα line, implying for all [N II] doublets the use of the "Multiple-Gaussian-Fit" procedure of the IHAP programme. The deconvolution of the (Hα, [N II]) blend becomes measurable if I (Hα)/I(655) > 0.2, as shown by the Figure 3b. On this figure, the value of the [N II] lines ratio decreases with an increasing ratio R = I (Hα/I (655): if R < 1, the intensity of the 655 line seems underestimated. If 1 < R < 4, the I (658)/I (655) ratio is near to the theoretical value of 2.95. For higher values of the [N II] lines, saturation would decrease the observed line ratio. This effect is clearly visible for the strongest lines (Figure 3c).

The number of CCD spectra measured up to now is not sufficient to allow any conclusion concerning the [N II] lines ratio.

3. Conclusions

From the analysis of our IDS and CCD spectra of planetary nebulae, we have shown that a nonlinearity proposed for the IDS receptors cannot be made responsible for the apparent discrepancy between the observed [O III] line ratio and the predicted one expected to lie around 2.9. It seems possible that the true intensity ratio of these forbidden lines is likely to be around 3.0 – as proposed by Rosa (1985). Further observational and theoretical work is needed.

References

Acker, A., Köppen, J., Stenholm, B., Jasniewicz, G.: 1989, *Astron. Astrophys. Suppl.* in press.

Acker, A., Stenholm, B.: 1987, *The Messenger* **48,** p. 16.

Peimbert, M., Torrès-Peimbert, S.: 1987, *Rev. Mex. Astron.* **14,** 540.

Rosa, M.: 1985, *The Messenger,* **38,** p. 15.

Wampler, E.J.: 1985, *The Messenger,* **41,** p. 11.

EFOSC Observations of the Inner Echo Around SN 1987 A

F. PARESCE, W. B. SPARKS and F. MACCHETTO,

Space Telescope Science Institute, Baltimore, Maryland, USA, and

Astrophysics Division, Space Science Department of ESA

Time varying light echoes around bright supernovae have been known since their first detailed observation in 1901–1902 by Ritchey, Kapteyn and Perrine around Nova Persei 1901 (GK Per) and the first comprehensive theoretical model put forth by Couderc in 1939.

In this framework, they are understood as due to the delayed reflection (echo) of the supernova light pulse from nearby interstellar or circumstellar dust clouds. The temporal variability, of course, is a consequence of the sweeping action of the pulse through an anisotropic and inhomogeneous reflecting medium.

The recent SN 1987A has not disappointed observers of this phenomenon due to its relative vicinity and complexity of the surrounding material. The overriding scientific importance of the detailed study of the SN light echoes resides in their ability to shed light on its past evolutionary history (the SN in search of its past as it has been aptly put recently) by progressively illuminating the circumstellar region into which objects as massive as the SN 1987A progenitor are expected to deposit a very significant fraction (up to 1/2) of its mass. The two key observational as-

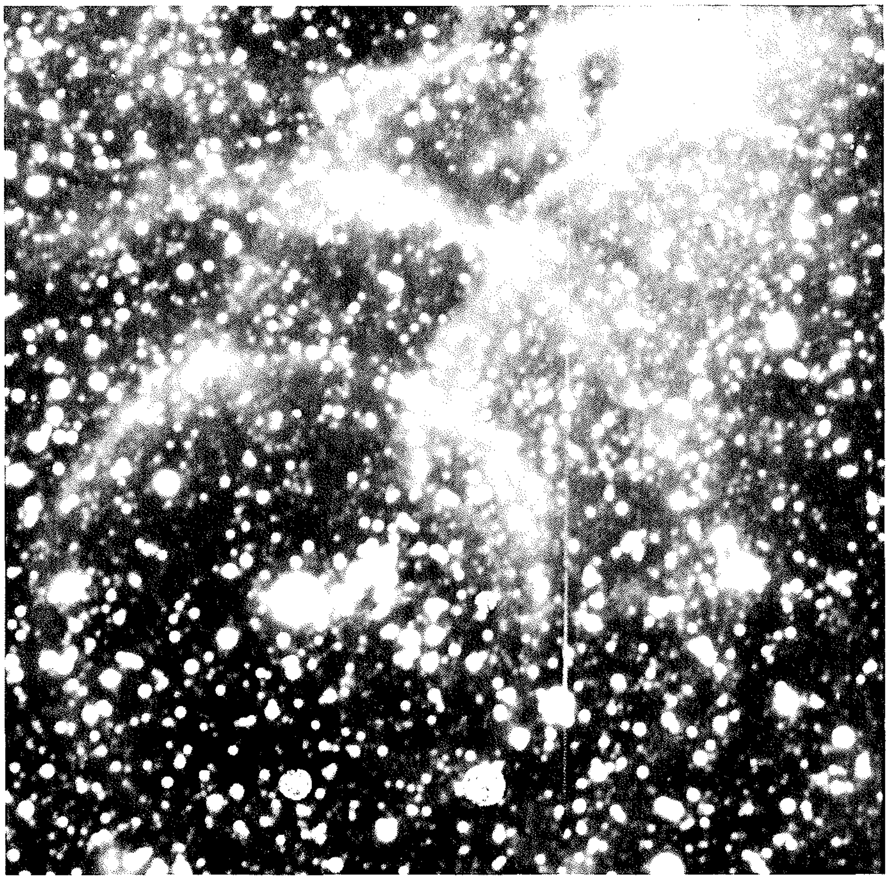


Figure 1.