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PHOTOGRAPHIC AND SPECTROSCOPIC OBSERVATIONS OF SOUTHERN PLANETARY NEBULAE

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RESUMEN. Se presentan observaciones fotográficas y espectroscópicas de un grupo de nebulosas planetarias y estrellas simbióticas australes. Las fotografías se han tomado en la región visual del espectro y en las líneas [OIII] λ5007 y Hα. Los espectros cubren, en general, la región λλ3400 - 8600 Å. Se presentan algunos ejemplos de estas observaciones.

ABSTRACT. Photographic and spectroscopic observations of a group of southern planetary nebulae and symbiotic stars are presented. The photographs have been taken in the visual region of the spectrum and in the lines [OIII] λ5007 and Hα. The spectra cover, in general, the region λλ3400 - 8600 Å. Some examples of this work are presented.

Key words: DIRECT IMAGES — NEBULAE-PLANETARY — SPECTROSCOPY

I. INTRODUCTION

Planetary nebulae are important tools for the study of different problems of astrophysical interest, including the physical characteristics and evolution of the nebulae themselves and of their central stars. For these reasons we have started a program of studies of southern planetary nebulae. In the first part of this work we have made spectrophotometric observations of some bright objects (Gutiérrez-Moreno et al. 1985, 1986). Now we are studying some faint planetary nebulae by means of photographic and spectroscopic observations.

II. OBSERVATIONS

To study faint planetary nebulae, particularly in the vicinity of the galactic center, it is necessary to obtain adequate finding charts. With this purpose, 52 centers in galactic center fields (Kinman and Lasker 1981) have been photographed. As an independent program, other 52 centers taken from Perek and Kohoutek (1967), mainly in the zone $11h \leq \alpha \leq 18h$, $-40° \geq \delta \geq -70°$, have been observed. Here we will refer only to this last program.

The aim of the program is manifold. Some plates were taken for identification purposes; others to discern the stellar aspect of some certain or suspected symbiotic stars; some plates will help ascertain if some objects are most probably planetary nebulae or just stars with Hα in emission. Finally, a few were taken to show the difference in morphology presented by photographs taken in different regions of the spectrum.

The photographs were obtained in 1981-1984 with the Image Tube Camera attached to the 1.0-m telescope of CTIO. This equipment is used for direct photography with filter. A Carnegie RCA 33011 image tube system is used at the f/10 Ritchey-Chretien focus of the telescope. This camera uses plate holders for 50.8 mm (2-in) square plates and special filters (wide-band, narrow-band or interference filters) of the same size. Unfiltered dark-sky background is reach-

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ed in exposures of about five minutes. The field covered is 13 arcmin in diameter and the sc is about 19.5 arcsec/mm.

For every center of interest a minimum of three plates has been taken, using a V wide-band filter and two interference filters centered at [OIII] λ5007 and Hα, with pass-bands of 14 and 17 Å, respectively. The exposure times were 50 sec for the V filter, 12 min for the [OIII] λ5007 filter and 20 min for the Hα filter. Baked IIIaJ plates were used and developed with D19. Even though many of the observed planetary nebulae have stellar appearance in the visual, the photographs taken with the interference filters allow an inmediate and secure identification of the doubtful or difficult objects. Normally the images present a larger diameter and/or some peculiarities or structure.

The spectra were obtained with CTIO 1.5-m telescope with a Cassegrain spectrograph and a SIT Vidicon. The regions between λλ3400 and 6000 Å, and between λλ4300 and 7000 Å were served with the 16mm UV SIT-Vidicon, with about 20 Å resolution. The region between λλ5600 and 8600 Å was covered with the 16mm Red SIT-Vidicon, with 10 Å resolution. A total of 25 objects was observed with the UV SIT-Vidicon, and 15 of these objects were also observed with the Red SIT-Vidicon. The objects studied include: typical planetary nebulae; very low excitation planetary nebulae in which the spectrum of the star is clearly visible; symbiotic stars with the characteristic TiO bands; suspected symbiotic stars that must be studied, and other objects classified as no planetaries.

Table 1 lists the objects observed in the photographic program, including some remarks with the corresponding references and showing which objects have also spectroscopic observations (Sp column).

TABLE 1. Observed objects

PK	Name	Rem	Ref	Sp	PK	Name	Rem	Ref	Sp	PK	Name	Rem	Ref	Sp
291 -4°1	IC2621			x	310 - 2°1	He2-103				333 + 1°1	He2-152			x
288 +5°1	He2-61	not PN	1	x	308 -12°1	He2-105				331 - 2°1	He2-157			
292 +1°2	He2-67			x	312 - 2°1	He2-106	SS	2	x	327 - 6°1	He2-158			x
298 -1°1	He2-79	p.not PN	1	x	312 - 1°1	He2-107			x	330 - 3°1	He2-159			x
299 -0°1	He2-80	p.not PN	1	x	315 - 0°1	He2-111	Bp,I	3	x	331 - 3°1	He2-162			x
299 +2°1	He2-82				318 - 2°1	He2-114	Bp,I	3		327 - 7°1	He2-163			x
300 +0°1	He2-83				318 - 2°2	He2-116				332 - 4°1	He2-170			
302 -0°1	He2-87	SS	2		317 - 5°1	He2-119				331 - 5°1	PC11	p.y. PN	5	
304 +5°1	He2-88				331 +16°1	NGC5873				326 -10°1	Cn1-2	SS	2	x
304 -4°1	IC4191				322 - 2°1	Mz1				325 -12°1	He2-182			
305 +1°1	He2-90				315 -13°1	He2-131	vℓe	4	x	321 -16°1	He2-185			x
305 -0°1	He2-91	p.not PN	1		319 - 9°1	He2-134	SS	2	x	344 - 8°1	PC18	SS	2	x
306 -0°1	Th2-A				330 + 4°1	Cn1-1	sSS	2	x	345 - 8°1	Tc1	vℓe	4	x
307 -1°1	Th2-B				322 - 6°1	He2-136			x	348 - 4°1	He2-306			
307 -4°1	MyCn 18				320 - 9°1	He2-138	vℓe	4	x	342 -14°1	Sp3			
309 -4°1	He2-99				331 + 0°1	He2-145			x	320 -28°1	He2-434			
311 +3°1	He2-101	sSS	2	x	326 - 6°1	He2-151			x	2 -52°1	IC5148-50			
311 +2°1	He2-102													

Remarks: - Bp : bipolar
I : Peimbert type I
not PN : it is not a PN
p. not PN : probably not a PN
p.y. PN : probably a young PN
sSS : suspected Symbiotic Star
SS : Symbiotic Star
vℓe : very low excitation

References: 1) Webster 1986
2) Allen 1984
3) Peimbert and Torres-Peimbert 1983
4) Adams and Barlow 1983
5) Gutiérrez-Moreno et al. 1987

III. PRELIMINARY RESULTS

The spectra have already been calibrated in wavelength and flux and though the fluxes have not yet been measured, some comments may already be made. First of all, we must remark that there are some spurious features, as the "line" near λ6000 Å, and those at the beginning and end of each region of the spectrum. Besides, both ends of each spectral region are noisy.

We will analyze briefly the photographs and spectra of a few of the objects observed The estimates of relative intensities and reddenings have been obtained only from peak intensities.

a) He2-111. This is an extended planetary nebula. The visual plate shows a faint nebulosity, not very well defined, while the [OIII] and Hα images look very dense, with a rather elliptical form suggesting bipolarity. Jets of nebulosity, quite noticeable in [OIII], seem to emerge from the main body of the source (Fig. 1a).

Two sets of spectra were taken, one in the northern part and the other one in the south. We present here only the spectra of the southern part. The [NII] lines are very intense (λ6583/Hα ≳ 5.5), and [NI] λ5200 is clearly visible. He is present as HeI and HeII. The intensity of HeII λ4686 (∿ 0.77 Hβ) implies an excitation class of the order of 8. O is present as OI, OII and OIII. [OI] λ6300 is clearly visible in the spectrum of the region λλ4300-7000 Å (not shown in Fig. 1); [OIII] λ5007 is very intense (≳ 20 Hβ), which also corresponds to an excitation class about 8. [SII] nebular lines are distinguished, with I(λ6717) < I(λ6731) (Fig. 1b and c). An estimate of the reddening gives C ≳ 1.3. Peimbert and Torres-Peimbert (1983) propose He2-111 as a PN of type I candidate, N and He rich.

b) He2-138. This is a very low excitation planetary. The [OIII] image is less intense than the visual image and much less intense than that in Hα (Fig. 2a).

The spectrum of the central star is prominent. The most important lines are the Balmer series and the [OII] and [NII] lines. The [SII] doublet is well separated, with I(λ6717) < I(λ6731). The line at λ7452 could be [FeII] (Fig. 2b and c). An estimate of the reddening, using Hγ/Hβ, gives C ≳ 0.3, close to the value given by Kaler (1976).

c) He2-80. This object has been labelled by Webster (1966) as "probably not PN", since it has no emission lines in the blue. The images are stellar, being the most intense that in Hα (Fig. 3a).

The spectrum shows the lines Hα and Hβ in emission with Hα/Hβ ≳ 30. [NII] λ6583 seems to be present as a faint emission in the wing of Hα. [OI] λλ6300 and 6363 are easily seen. We must point out that in this case, due to the width of the lines, all identifications, except for the lines shown in Fig. 3b and c, are tentative. Some features may be absorption lines. This object deserves further studies.

d) He2-134. This is a recognized symbiotic star. It has stellar aspect being very faint in [O III] and brighter in Hα (Fig. 4a).

The spectrum shows very high excitation, with HeII λ4686/Hβ > 1. HeI λ5876 is also intense. Several lines of [Fe VII] are visible, [Ca VII] λ5615 is detected. [OIII] λ5007 is faint. The unidentified feature at λ6830 is clearly seen. TiO bands are conspicuous at λλ > 6500 Å.

We have presented here a sample of the photographic and spectroscopic observations we have made. We hope that the complete analysis of this material will contribute to the knowledge of planetary nebulae and symbiotic stars.

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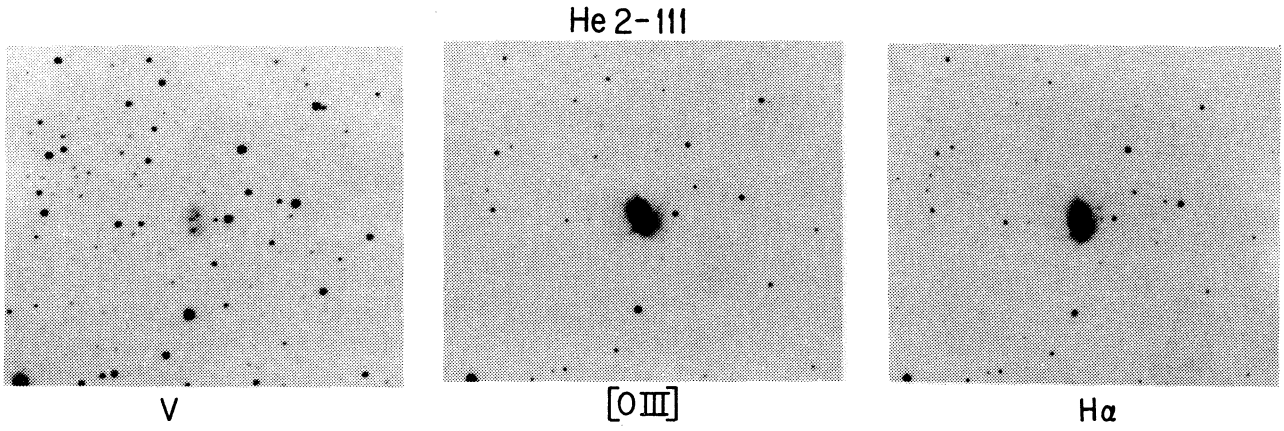
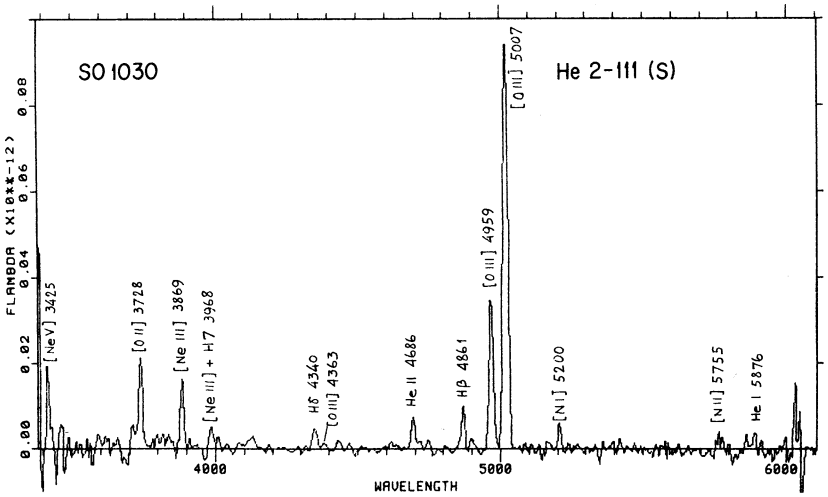




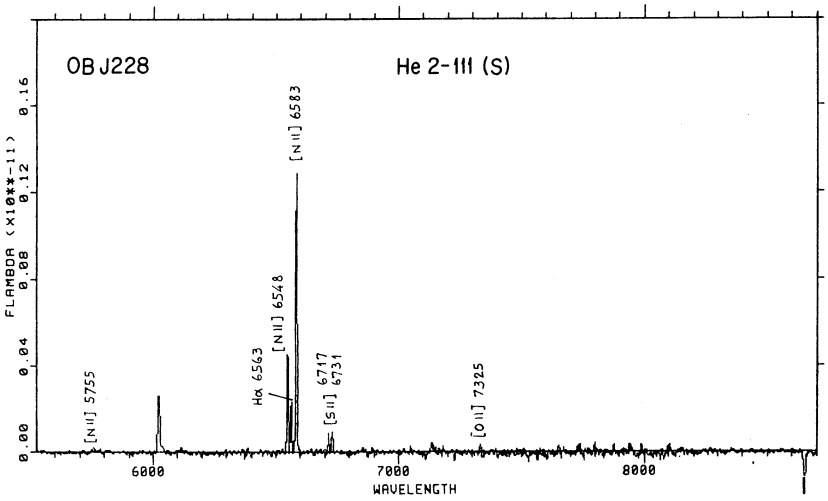
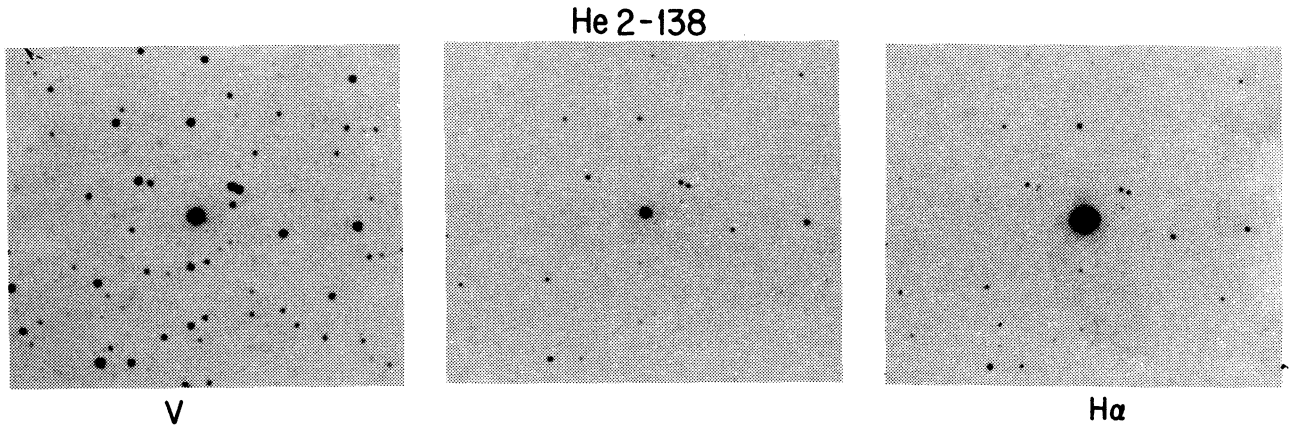
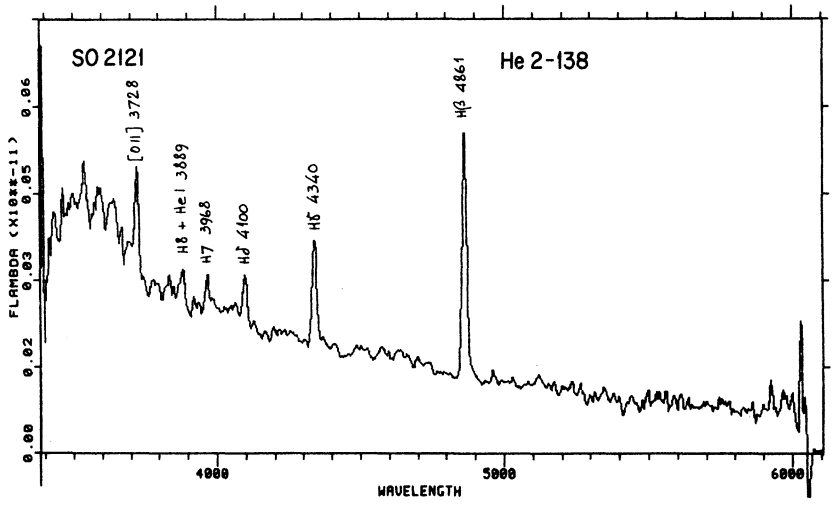


Fig. 1. a) Photographs of the bipolar planetary nebula He2-111, taken in visual light, in [O III] λ5007 and Hα. Notice the different orientation of the images in [O III] and Hα with respect to the background stars. b) Spectrum of the southern part of He2-111, in the region λλ3400-6000 A. c) Spectrum of the southern part of He2-111, in the region λλ5600-8600 A.





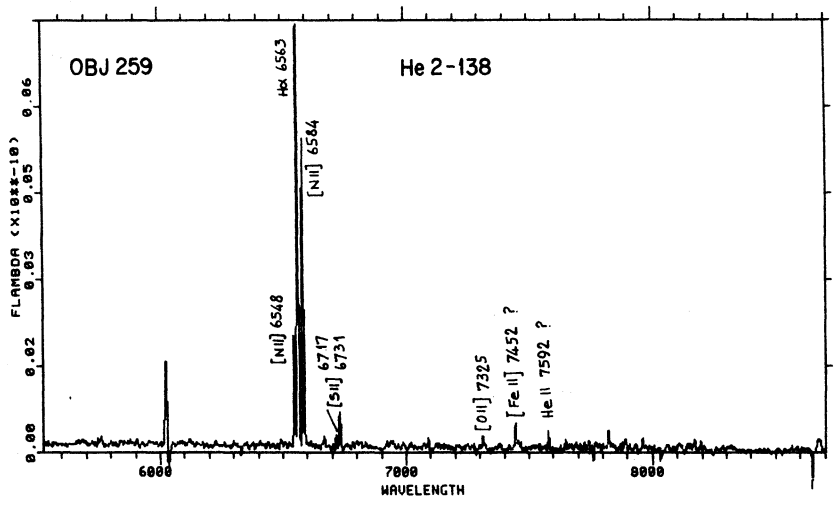
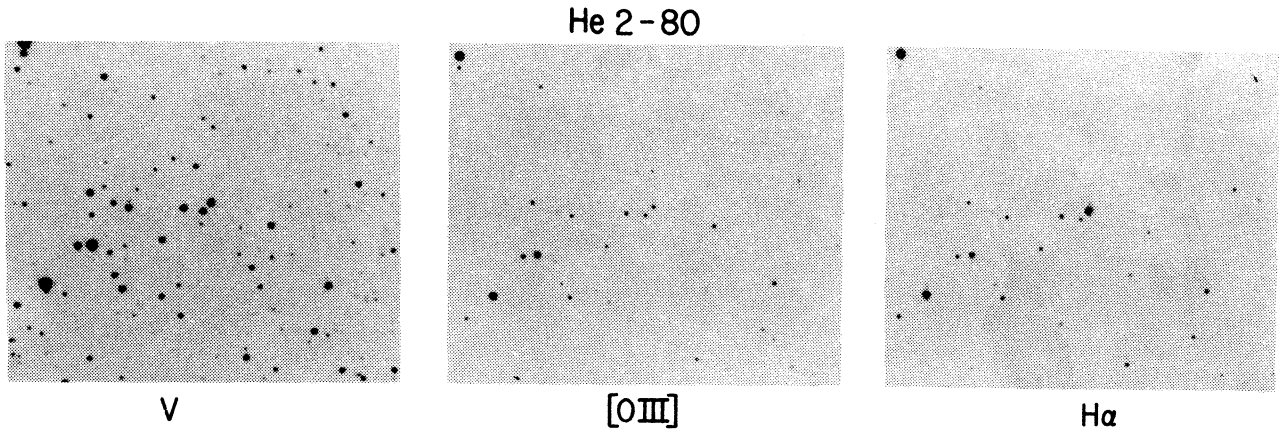
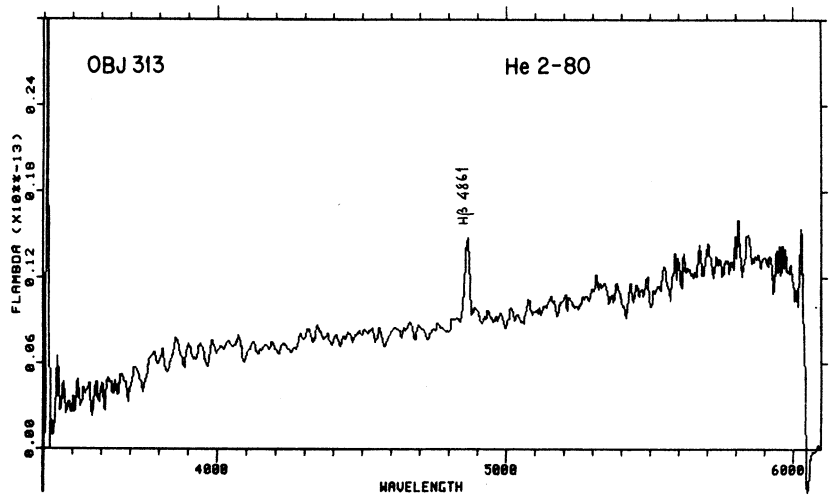


Fig. 2. The same as Figure 1 for the low excitation PN He2-138. The spectra correspond to the whole nebula.





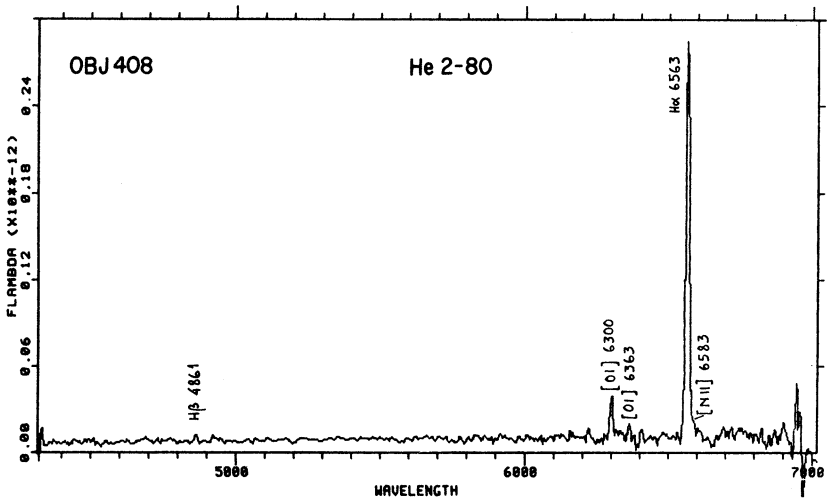
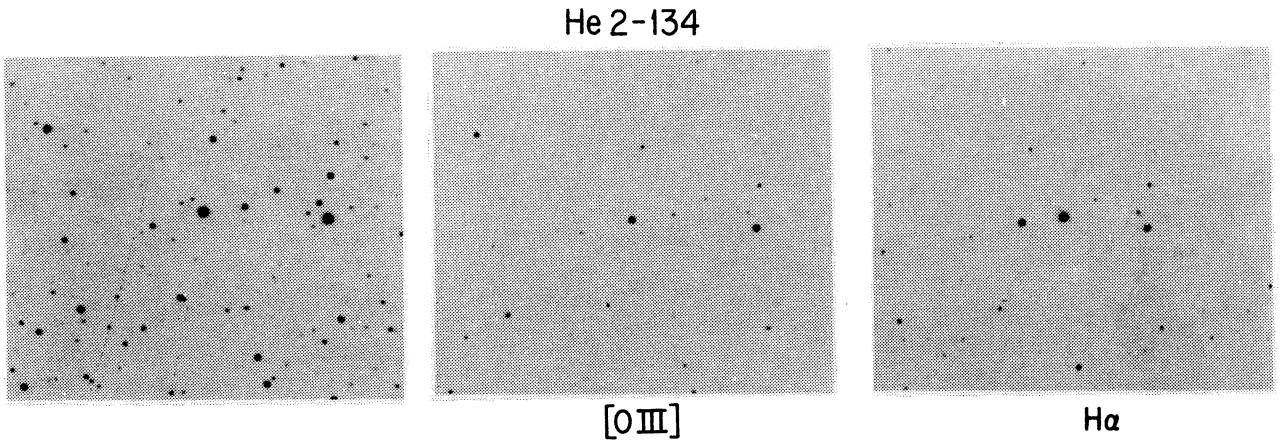
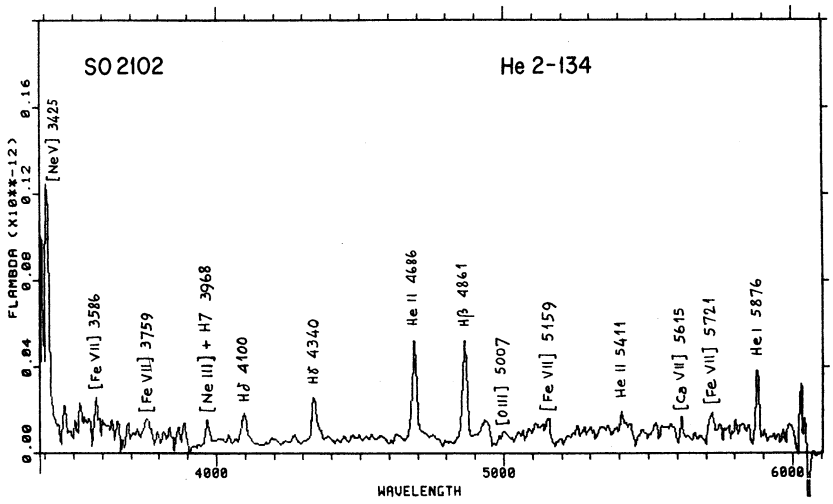


Fig. 3. The same as Figure 2 for the object He2-80, probably not a PN according to Webster (1966). The spectral ranges covered in this case are λλ3400-6000 A and λλ4300-7000 A.





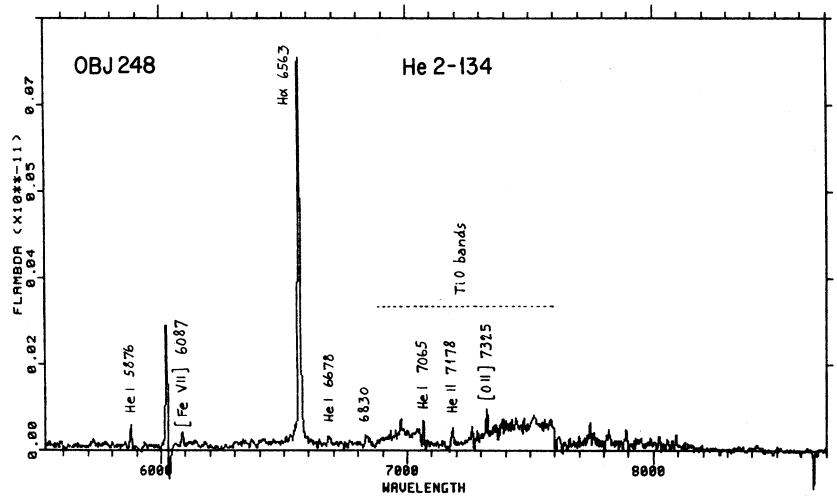


Fig. 4. The same as Figure 2 for the symbiotic star He2-134.

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