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PL 1547.3−5612: A PURE NITROGEN RING NEBULA

MARÍA TERESA RUIZ[1]
Departamento de Astronomía, Universidad de Chile
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ABSTRACT

A ring nebula of pure nitrogen has been found with a radius of 0.6 pc and at about 4 kpc from the Sun.

The emission from the region inside the ring is of more normal composition, containing lines of H, O, S, and N. No obvious central star is seen.

Subject headings: nebulae: abundances — nebulae: individual

I. INTRODUCTION

In 1979 van den Bergh published the optical identification of the peculiar supernova remnant G326.3−1.8. Optical filaments were visible in a 2 hour Hα plate obtained with the Cerro Tololo Inter-American Observatory (CTIO) 4 m telescope. At the edge of the radio source G326.3−1.8, he found two objects identified as planetary nebulae, one of which is PL 1547.3−5612.

In a radio survey by Milne *et al.* (1979) at 1415 MHz with the Fleurs synthesis telescope, no radio emission from PL 1547.3−5612 was detected with their sensitivity.

The appearance of PL 1547.3−5612 on the Hα plate published by van den Bergh is that of a closed ring about 1′ in diameter with no obvious central star. Some structure can be seen in the NE and SW edge of the ring, suggesting two incomplete rings crossing at those points. A reproduction of the plate taken by van den Bergh is shown in Figure 1; the arrow indicates the position of a star of about 21st magnitude that could be the central star.

II. OBSERVATIONS

The spectra were obtained in 1982 April–May with the CTIO 4 m and 1.5 m telescopes with a Cassegrain spectrograph and a SIT vidicon. The spectral region between 5000 Å and 6800 Å was observed with the 4 m telescope and the 40 mm vidicon tube with a resolution of about 6 Å. With the 1.5 m telescope and the 16 mm vidicon tube, we covered the region between 4300 Å and 6800 Å with a resolution of 15 Å and the region from 6200 Å to 7300 Å with 10 Å resolution. For estimating the strength of the [O II] λλ3727, 3729 lines relative to the [N II] λ6584 line, we used a lower quality spectrum taken at position D (see Fig. 1) obtained in 1981 with the CTIO 4 m telescope and the 16 mm tube with about 20 Å resolution.

The observed positions are indicated in Figure 1. The slit was kept E-W; its full length was 4′ and its width, 1″.8. The length of the spectra at positions A, B, and C is 20″ and at position D is 32″.

Positions A and B correspond to opposite sides of the emission ring, position C is the central part between A and B, and position D is nearly tangential to the ring.

The contribution from the sky was subtracted using parts of the slit where no emission from the object is visible. Data reductions were performed at the CTIO Computer Center at La Serena.

III. RESULTS

From Figure 2 one can see that the distribution of gas emitting in the [O III] λ5007 line is quite different from that of gas emitting in [N II] λ6584. The distribution of the [N II] emission is concentrated toward a ring while O, H, and S emission seems to fill the region inside the ring. The spectra obtained at position A are presented in Figures 3*a* and 3*b*; by far the most prominent lines [N II] λλ6548, 6584. The same is true for positions B and D. At C (Figs. 3*c* and 3*d*), the lines of [O I], [O III], Hβ, Hα, and [S II] are stronger, although the [N II] lines are still quite strong.

Inspired by what we saw in Figure 2, and without any geometrical consideration, we have made the exercise of assuming that the lines of oxygen, hydrogen, and sulfur we see in the ring (positions A and B) are produced by the diffuse matter of more normal composition seen at the center (C), mixed with a pure nitrogen ring. If we subtract what we see in C from the spectra at A and B, we get spectra containing only [N II] lines (see Figs. 3*e* and 3*f*). During two consecutive nights we took spectra with the slit at the same position containing A, B, and C. The data from the first night were reduced such that

[1]Visiting Astronomer, Cerro Tololo Inter-American Observatory, operated by AURA, Inc., under contract to the NSF AST 74-04128.

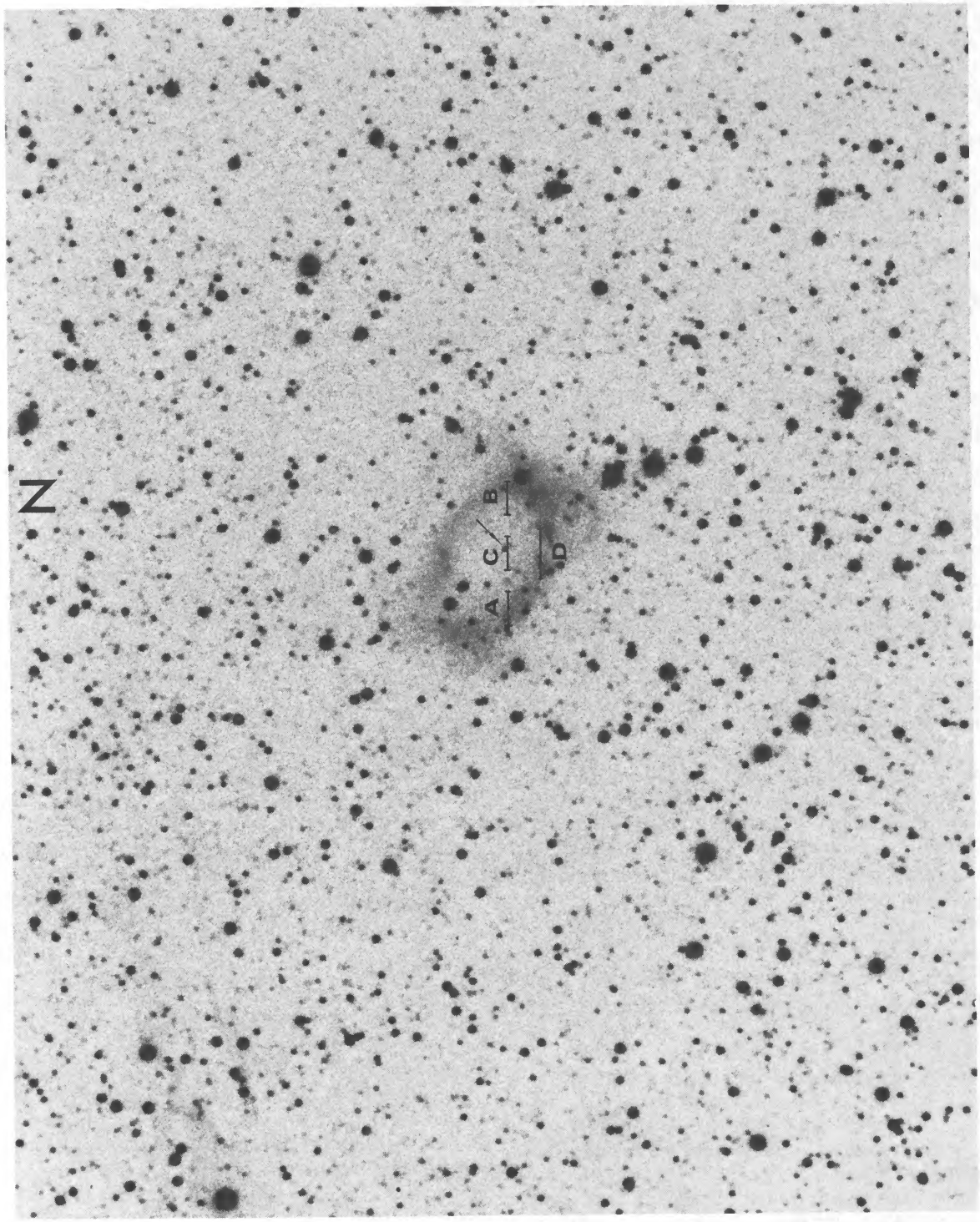

FIG 1.—The positions of the slit are indicated over a 2 hour Hα plate obtained by S. van den Bergh (1979) at the prime focus of the CTIO 4 m telescope

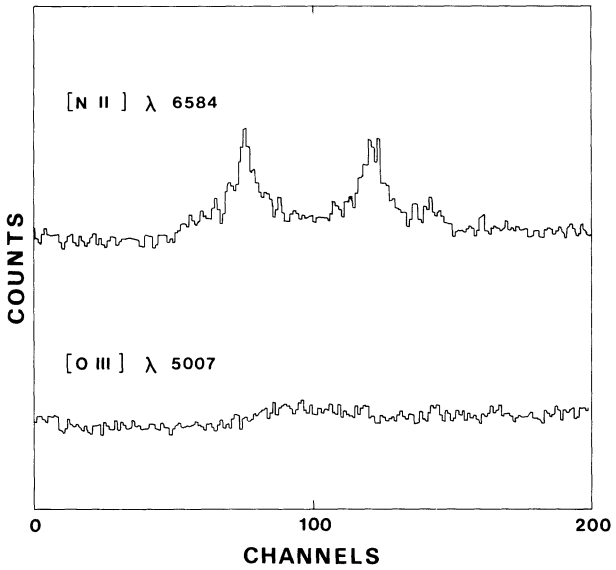

FIG. 2.—Distribution of emission along the slit at the wavelengths of [N II] λ6584 and [O III] λ5007

only the spectra from A and B were extracted. The data from the second night were reduced differently, taking the spectrum at C and subtracting it from those at A and B. These results are also given in Table 1 (A − C and B − C), where the intensity of the [N II] λ6584 line is normalized to 100 and no reddening correction has been applied.

Table 1 also contains the line intensities obtained at positions A, B, D, and C normalized to $H\beta = 100$. A value of A_v of 1.8 mag was found at positions D and C assuming a theoretical $H\alpha/H\beta$ ratio of 3 and a normal reddening law.

The value of $A_v = 1.8$ mag was assumed to be the same for positions A and B where no $H\beta$ line was detected. The reddening corrected line strengths, $I(\lambda)$, are given in Table 1.

The intensities of the [S II] λλ6717, 6731 lines are inaccurate because they are located near one end of the spectra where the noise is very bad. This excludes the [S II] lines at position D where the only red spectrum was taken (from 6200 Å to 7300 Å) with the [S II] λλ6717, 6731 lines near the center of the spectrum.

IV. CONCLUSIONS

According to Lucke (1978), the average absorption toward the galactic position of PL 1547.3−5612 and within 2 kpc from the Sun is 1 magnitude. We found a visual absorption at PL 1547.3−5612 of 1.8 mag, suggesting a distance of about 4 kpc.

The supernova remnant near PL 1547.3− 5612 has been found to have 5.1 mag of visual absorption (Dennefeld 1980), so it probably has no physical relation to the ring.

At a distance of 4 kpc, the 21st magnitude star, indicated in Figure 1, would have an absolute magnitude, considering absorption, of about 6, a reasonable value for the central star of a normal planetary nebula. Visual inspection of a blue and red plate of the region shows that the red image of the star is at least 2 mag brighter than the blue one, making it too red to be a planetary nucleus.

From Table 1 one can calculate the densities using the [S II] lines. The density obtained for position D, where the [S II] λλ6717, 6731 lines were measured with more precision, is about 100 cm^{-3}. For positions A and B we found densities of about 500 cm^{-3}. If we take a mean density of 300 cm^{-3} and consider the ring to be a shell of 0.6 pc radius and a thickness of 0.2 pc, then the mass contained in the ring turns out to be over 4 $M_\odot$, a value well over those of normal planetary nebulae. Ring nebulae around Wolf-Rayet stars can contain a few solar masses, but Wolf-Rayet stars are very luminous and in this case we do not see any such star inside the ring.

The nature of PL 1547.3−5612 is not clear. A study of the dynamics of the gas in the ring and at the center, together with a survey of the stellar candidates that could be responsible for the ejection of the gas would give important clues.

Thanks are due to Jorge Melnick for helpful discussions and to S. van den Bergh for a print of his original

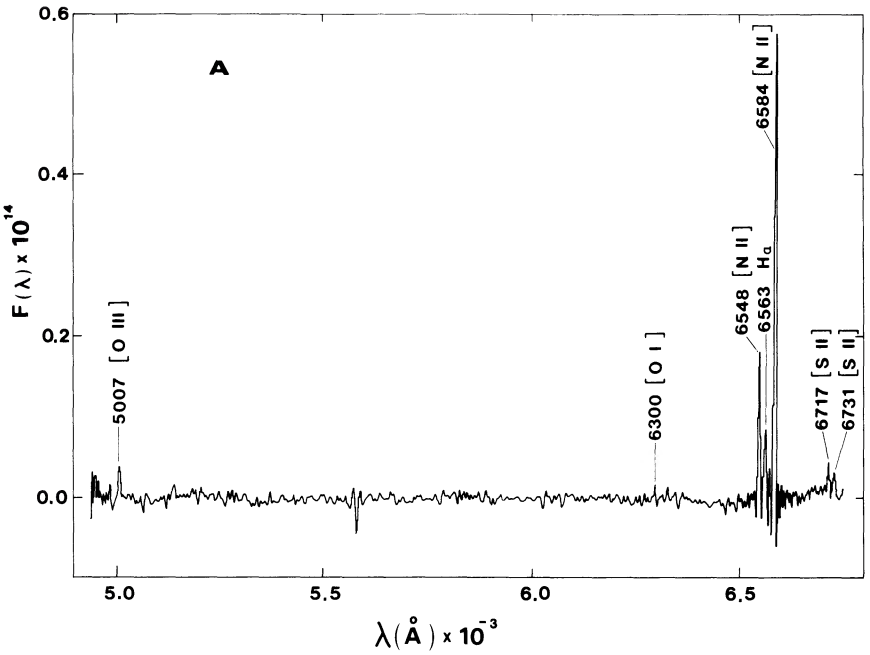

FIG. 3*a*.—Spectra at position A with 6 Å resolution

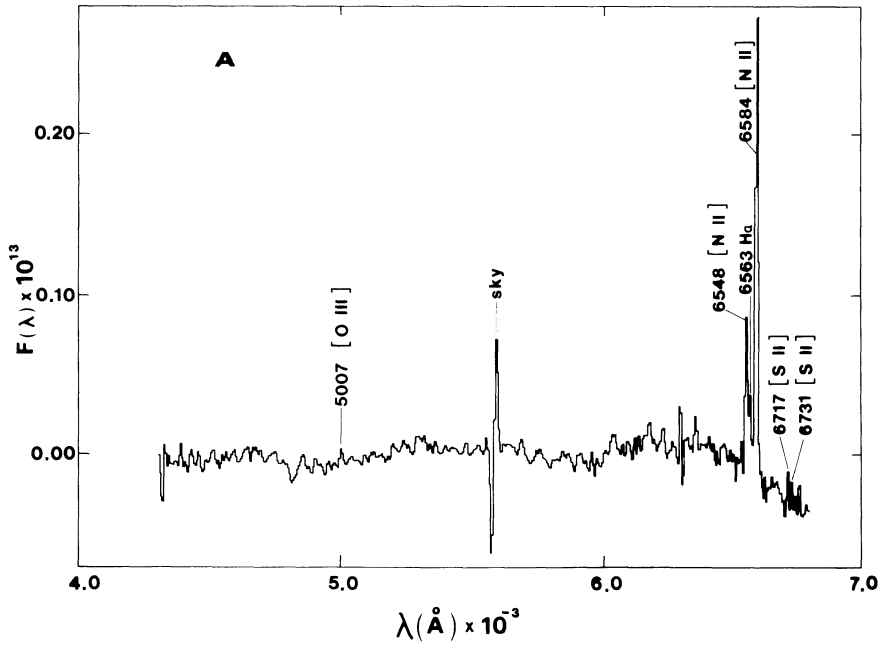

FIG. 3*b*.—Spectra at position A with 15 Å resolution

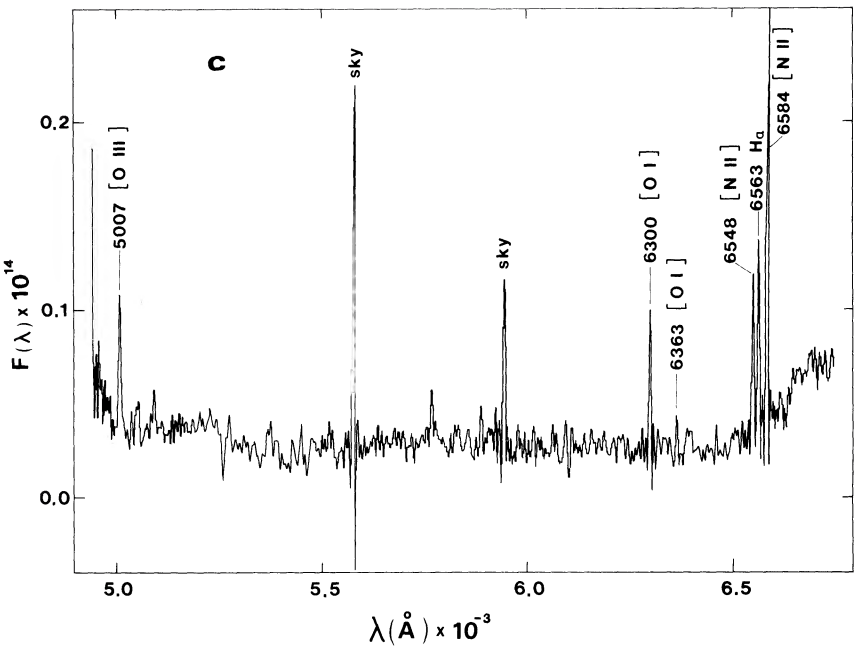

FIG. 3*c*.—Spectra at position C with 6 Å resolution

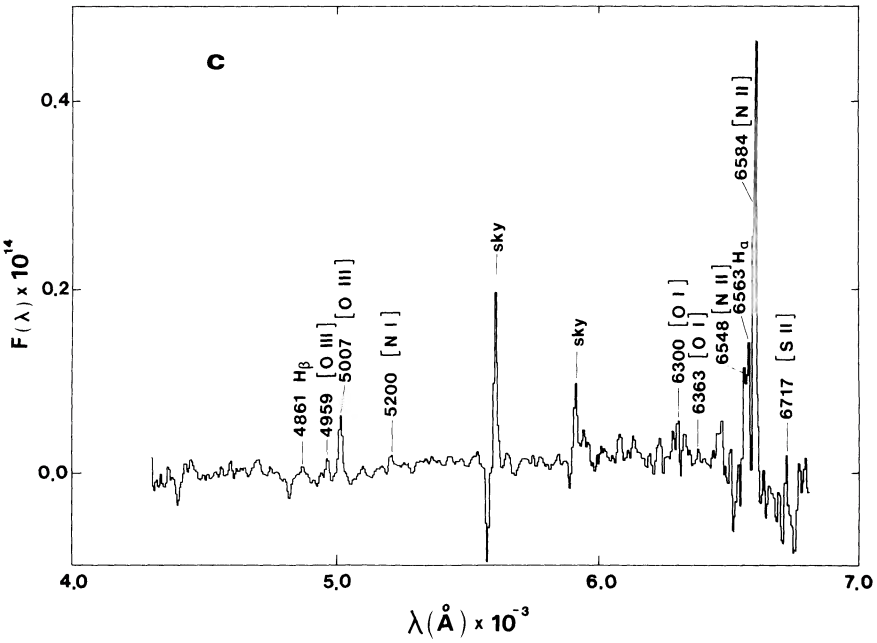

FIG. 3*d*.—Spectra at position C with 15 Å resolution

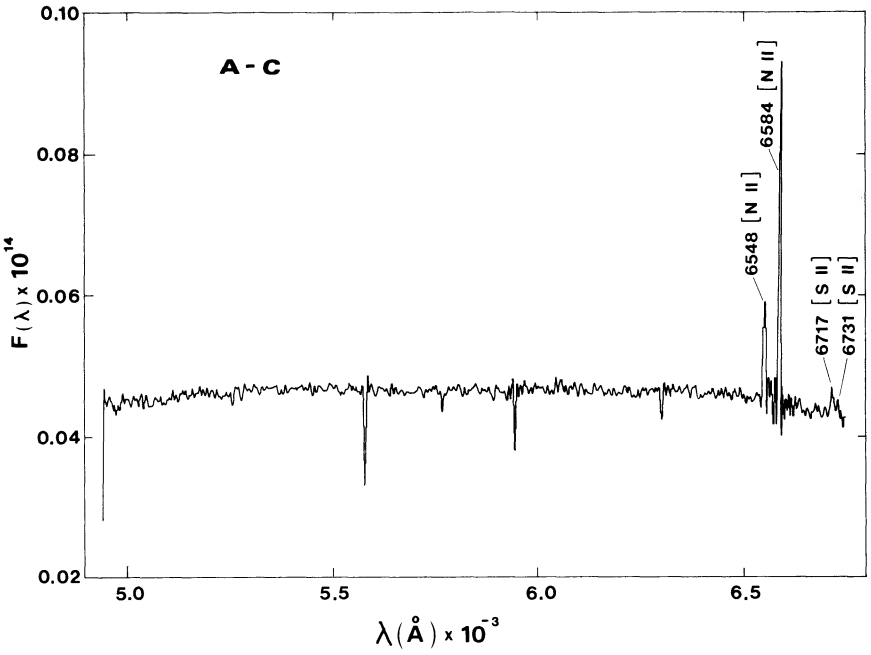

FIG. 3*e*.—Spectra at A minus spectra at C with 6 Å resolution

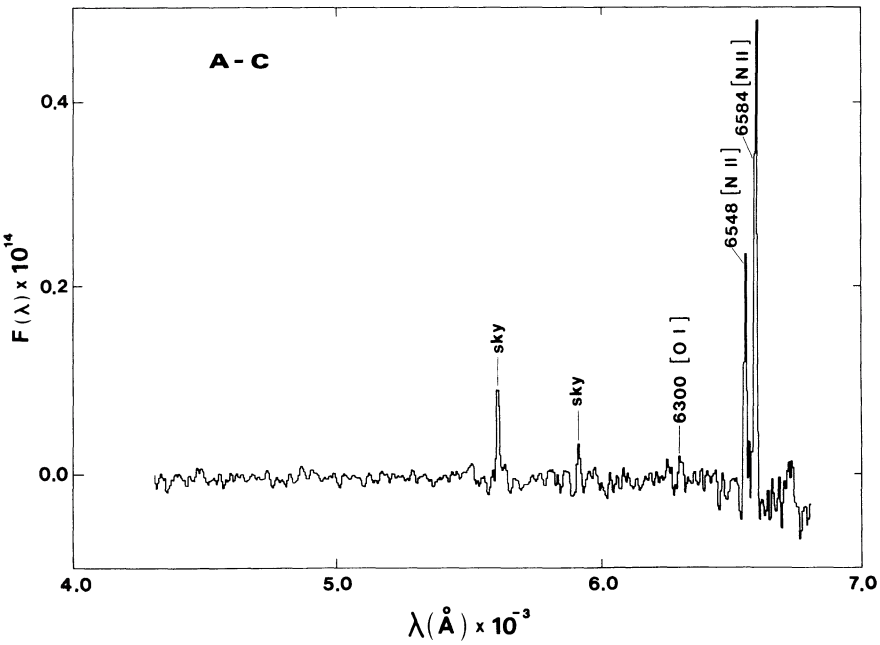

FIG. 3*f*.—Spectra at A minus spectra at C with 15 Å resolution

TABLE 1

LINE INTENSITIES IN PL 1547.3−5612

LINE	A[a]		B[a]		D[a]		C[a]		A − C[b]	B − C[b]
	$F(\lambda)$	$I(\lambda)$	$F(\lambda)$	$I(\lambda)$	$F(\lambda)$	$I(\lambda)$	$F(\lambda)$	$I(\lambda)$	$F(\lambda)$	$F(\lambda)$
[O II] 3727+3729	...	...	...	...	572:	1012:	...	...	...	...
Hβ 4861	...	...	...	...	100	100	100	100	7:	...
[O III] 4959	...	...	...	...	133:	129:	135	130	...	...
[O III] 5007	137	129	122	115	290	275	458	433	...	...
[N I] 5200	...	...	...	...	...	...	117:	102	...	...
[O I] 6300	86	50	78	45	...	...	265	154	10	...
[O I] 6363	...	...	49	28	...	...	97	55	...	...
[N II] 6548.....	884	477	667	360	897	484	512	276	38	37
Hα 6563	560	300	560	300	570	305	560	300	7	9
[N II] 6584.....	2557	1367	1938	1036	2859	1528	1575	839	100	100
[S II] 6717	156	79	122	62	135	68	321:	163:	26:	20:
[S II] 6731	128	65	117	59	98	50	161:	81:	...	...

[a]Normalized to Hβ = 100 and reddening corrected using A_v = 1.8 mag.
[b]Normalized to [N II] λ6584 = 100.
NOTE.—A colon following a number indicates a very imprecise value.

plate containing PL 1547.3−5612. I am also grateful to the referee for interesting suggestions.

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MARÍA TERESA RUIZ: Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile