HST Spectrophotometric Data of the Central Star of the Planetary Nebula LMC-N66

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Introduction

N66 (WS 35, SMP 83) is a Type I (He-N rich) PN in the LMC with a high ionization degree. It shows a bipolar morphology with a filamentary structure (Dopita et al. 1993). Its central star has shown very impressive changes, in short time scale, that have been investigated. Here we describe the history of these changes:

1.- In 1987, as derived from nebular parameters (Peña & Ruiz 1987), the central star had a weak continuum with $T_* \sim 120\,000$ K and $L_* \sim 25\,000\ L_\odot$. From evolutionary tracks, a stellar mass of $\sim 1 M_\odot$ was obtained, which is one of the highest of those that have been determined with reasonable accuracy.

2.- In 1990 the star began a spectacular mass-loss event. Its UV and optical continua increased by factors ranging from 2 to 4 magnitudes and it developed WR features resembling a Population I WN4.5 (or earlier) star (Peña et al. 1995).

3.- The strong wind has persisted for more than 5 years, showing some variations in the emission line ionization degree and a sudden disappearance of the WR features which lasted some weeks in August-September, 1995. From ground-based telescopes and the IUE satellite we have followed the central star evolution; the changes in the stellar fluxes are presented in Table 1.

4.- N66 central star is the only nucleus of a PN showing a WN type spectrum. All the other CSPNe with WR features (in the Galaxy and the Magellanic Clouds) are of WC type.

5.- These spectacular changes have no theoretical explanation at present. The possibilities that the star is undergoing a late thermal pulse or suffering a violent instability due to its high luminosity are being explored.

This work

HST FOS spectroscopic data of the central star in the UV ($\lambda\lambda$1150-2320) and optical ($\lambda\lambda$3250-4800) spectral ranges, were obtained in December 1995. The use of the 0.3″ slit allowed us to isolate the central star emission from the intense nebular emission. These data have been analyzed together with an optical spectrum obtained with the CTIO 4-m telescope in January, 1996. These observations were carried out shortly after the August-September 1995 minimum of the wind.

Expanding atmosphere models, that include H, He, C, N and O, have been constructed to fit the stellar features and continuum, by using the code developed by the "Potsdam group" (Hamann 1996). Preliminary results from the best-fit models show that:

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1.- The stellar atmosphere is extremely H-deficient with $X/Y < 0.1$.
2.- N abundance by mass is $\sim 0.8\%$ while C and O are considerably depleted ($\leq 0.02\%$ by mass). The chemical composition of the stellar atmosphere is consistent with a complete conversion of C and O into N through the CN- and ON-cycles.
3.- The stellar luminosity is 3.2×10^4 $L_\odot$ and the present effective temperature, $T_* \sim$ 100 000 K, is much higher than what was claimed by Peña et al. (1995). However, the H I and He II Zanstra temperatures derived from models, are much lower than T_* and it is predicted that, if the present atmosphere conditions persist, the high ionization degree of the nebula should decrease in about 20 years due to the lack of UV photons able to ionize He^+.
4.- The star is ejecting a massive stellar wind with a mass-loss rate of 1.5×10^{-6} $M_\odot$/yr, at a velocity of about 2 000 km/s. Fast variations observed in the ionization degree of the stellar emission lines could be explained with small changes in T_* and/or the mass-loss rate.

TABLE 1. EVOLUTION OF THE STELLAR CONTINUUM FLUX[a]

	1987	Mar94	Sep94	Jan95	Apr95	Sep95	Dec95[b]	Apr96
m_V^*	19.7	16.2	16.1	15.9	16.2	17.7	17.0	17.0
$F_\lambda(1300)$	7.3:	30.3	54.5	19.5	28.0	7.9:	19.5	20.0
$F_\lambda(1850)$	3.7:	11.0	20.5	10.5	13.3	4.5:	12.0	...
$F_\lambda(3000)$	...	2.6	3.3	3.0	...	1.3:	4.0	...
$F_\lambda(4000)$	0.14:	2.0	2.3	2.2	...	0.6:	1.2	1.5
$F_\lambda(5500)$	0.08:	0.9	1.1	1.3	...	0.3:	...	1.3

[a] Stellar fluxes not corrected for reddening, in units of 10^{-15} erg cm^{-2} s^{-1} $\AA^{-1}$
[b] HST FOS observations

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