CARBON TO HELIUM RATIO IN THE WIND OF CENTRAL STARS OF PLANETARY NEBULAE WITH WC SPECTRUM

J.A. DE FREITAS PACHECO and R.D.D. COSTA
Instituto Astronômico e Geofísico, Universidade de São Paulo, Brazil
F.X. DE ARAÚJO
Observatório Nacional - CNPq, Rio de Janeiro, Brazil
and
D. PETRINI
Observatoire de la Côte D'Azur, Nice, France

Abstract. We present $\frac{C}{He}$ ratios in the wind of a sample of 5 central stars of planetary nebulae having WC spectrum. The resulting values are comparable to those observed in population I WR stars.

Key words: Planetary nebulae, Wolf-Rayet stars, Chemical abundances

1. Introduction

UV spectra of the central stars of planetary nebulae (CS) indicate that most of these objects have a fast wind. The study by Cerruti-Sola and Perinotto (1985) led to the conclusion that CS's with a Wolf-Rayet spectrum (WC type) have a detected wind in the UV range. CS's are believed to be remnants of red giants which have thrown off their outer envelope. In this work we give a preliminary estimate of the $\frac{C}{He}$ in the wind of 5 CS's having a WC spectrum. Our analysis supports the view that the $\frac{C}{He}$ ratios in the wind and in the nebula are different, indicating that mass loss rates estimated with the usual assumption of equal chemical composition are incorrect.

2. Observations and Data

The data were obtained using the facilities of the National Laboratory for Astrophysics (Brazopolis - Brazil). Cassegrain+Reticon and Coudé+CCD observations were performed for all the stars of our sample.

Most of the lines in the wind of the observed objects display PCyg profiles, indicating that the medium is not transparent to the considered photons. Optical depth effects in an expanding envelope can be treated using the "first moment" of the line (Castor, Lutz and Seaton 1981). A detailed calculation based on such an approach will be presented elsewhere (de Freitas Pacheco et al. 1991). Here we give only a first estimate of the $\frac{C}{He}$ ratio, neglecting self-absorption effects and assuming that the lines are formed by recombination processes.

The table below gives the measured equivalent widths (in Å) of lines formed in the wind, which were used in our analysis. These lines were selected because they are probably formed mainly by recombination processes (Clegg 1989).

P. D. Singh (ed.), Astrochemistry of Cosmic Phenomena, 359–360.

	BD+30	SwSt-1	N5315	Hen 2-99	Hen 2-113
*HeI*λ5876	21.0[a]	nebular	nebular	33.0	9.7[a]
*HeII*λ4686	7.8[b]	5.0[a]	70	4.0[a]	-
*CII*λ4267	12.4[c]	0.95[c]	-	21.3[c]	11.6[d]
*CIII*λ4650	49.0[a]				
		} 22.1[a]	280.0	49.0[a]	3.5[a]
*CIV*λ4659	32.3[b]				
*CIV*λ5806	29.7[a]	4.9[a]	672.0	73.9	0.4[a]

Notes:(a)line displaying a PCyg profile. Data refer to the emission component only; (b)line with probably a PCyg profile; (c)from Cassegrain observations; (d)data from Kaler et al. (1989)

3. Carbon-to-Helium Ratio

Under the discussed conditions, we found the following results for the relative $\frac{C}{He}$ ratios:

	BD+30	SwSt-1	N5315	Hen 2-99	Hen 2-113
$\frac{C}{He}$	0.33	0.67	$\geq$1.4	0.37	0.48

4. Conclusions

In spite of the simplicity of our analysis, the conclusion that the $\frac{C}{He}$ ratio in the wind of CS's with WC spectrum differs from that in the surrouding nebula cannot be avoided. Our procedure, similar to that used by Torres (1988) and by Kaler et al. (1989) gave a $\frac{C}{He}$ ratio for Hen 2-99 in agreement with the latter authors. These $\frac{C}{He}$ ratios, comparable to those found in the wind of population I WC stars (de Freitas Pacheco and Machado 1988), indicate contamination of the expanding stellar envelope by the core material. Another open possibility is to consider that CS's having WC type are post-AGB helium-burning objects.

References

Castor,J., Lutz,J.H., Seaton,M.J. 1981, Mon. Not. R. astr. Soc. **194**,547
Cerruti-Sola,M., Perinotto,M. 1985, Ap.J. **291**, 237
Clegg,R.E.S. 1989 in *Planetary Nebulae* ed. S. Torres-Peimbert - Reidel, Dordrecht, pg. 139
De Freitas Pacheco,J.A., Araujo,F.X., Costa,R.D.D.,Petrini,D. 1991 - in preparation
De Freitas Pacheco,J.A., Machado, M.A.D. 1988, Astron.J. **96**, 365
Kaler,J.B., Shaw,R.A., Feibelmann,W.A., Lutz,J.H. 1989, Ap.J.Supp. **70**,213
Torres,A.V. 1988, Ap.J. **325**,759