PLANETARY NEBULAE: THEIR EVOLUTION AND ROLE IN THE UNIVERSE
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The Weak Emission Line Stars

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Abstract. In this paper, we study the evolution of the weak emission line central stars of planetary nebula (WELS), which are similar to the H-deficient Wolf-Rayet central stars except for systematically weaker emission lines. Our attempts at finding an evolutionary sequence for the WELS similar to what was established for Wolf-Rayet central stars, were unsuccessful. No correlation was found between any of the analysed quantities: emission and absorption line fluxes or stellar and nebular parameters from the literature. It does appear, however, that WELS have intermediate stellar temperatures (30-80 kK), and do not reside in the middle of Type I planetary nebulae, possibly indicating lower mass precursors.

Wolf-Rayet central stars ([WC] CSs) are classified in order of increasing ionization, which is the direction of their evolution (Crowther, De Marco & Barlow 1998). We tried to find a similar sequence for the weak emission lines stars (WELS; Tylenda, Acker & Stenholm 1993), but no clear correlations were found in the data that we looked at. Emission lines of C II (λ4267), C III ($\lambda\lambda$4647,5696), C IV ($\lambda\lambda$4658,5801), N III ($\lambda\lambda$4634,40), N V (λ4603), He I ($\lambda\lambda$4471,5876) and He II (λ4876) were measured for the WELS M2-31, NGC6567, NGC6572 and NGC6803, while for the WELS M1-46, Cn3-1, IRAS21282+5050 and A78 we measured mostly absorption lines (all measurements were carried out on 1-Å resolution spectroscopy, obtained at the 2m INT and 2.1m KPNO telescopes in 1996 and 1998, respectively, and were corrected for nebular contribution).

Type I PN have a N/O ratio greater than 0.8 and are thought to derive from a more massive stellar population (Kingsburgh & Barlow 1994). As can be seen from Fig. 1, none of the PNe around WELS are Type I, with only 3 out of the 42 objects for which we found literature values, having unsure results. For the [WC] CSs, on the other hand, 9 out of 49 objects were Type I, with 4 having unsure results. A KS test on these two samples, shows that there is a 97% probability that the two populations are distinct. This may indicate that WELS are preferentially a lower mass population when compared with the [WC] stars. This could be in line with the fact that WELS have weaker emission lines,

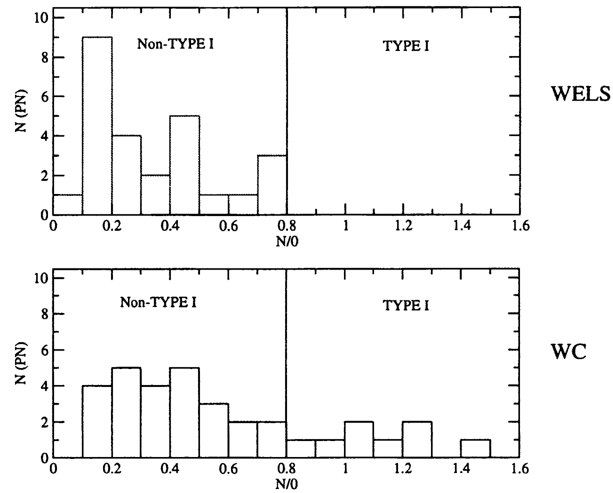

Figure 1. Histogram of the N/O values for WELS and [WC] central stars, revealing that no WELS reside in the middle of Type I PNe.

deriving from a lower mass-loss. A lower mass-loss could be the result of an overall lower luminosity. Last, it was noted (Barlow, priv. comm.) that WELS seem to have intermediate stellar temperatures, with no objects in the very hot domain (T_{eff}>80 kK), which characterizes most of the [WC] CSs. Type I PNe, on the other hand, are mostly found around very hot CSs, since their more massive precursors evolve more rapidly. However the very fact that WELS seem to have intermediate stellar temperatures could be confirming a slower evolution, and hence a lower precursor mass.

It has to be pointed out, that some WELS are actually H-rich (e.g. NGC6543, NGC6891 [Mendez et al. 1988] and NGC6543 [Mendez et al. 1990], all classified as WELS by Parthasarathy et al. [1998]). This goes to show that the WELS sample might contain more objects which are not *bona fide* H-deficient CSs. A lower mass-loss could also be promoted by a lower opacity (when compared to the [WC] CSs). This would be the case if WELS contained some hydrogen. Establishing the exact hydrogen content for these stars would therefore contribute to positioning them in relation to the [WC] CSs. This is no easy task, since the stellar lines are contaminated by line emission from the PN.

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