[WOLF-RAYET]-TYPE CENTRAL STARS OF PLANETARY NEBULAE

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Abstract. A number of central stars of planetary nebulae (CSPN) show emission lines in their spectra. Among them about 50 have been classified as [Wolf-Rayet] type (Tylenda *et al.* 1993). In spite of the fact that these stars probably have masses below 1 $M_\odot$ and luminosities $< 10^4$ $L_\odot$ their spectra show emission bands very similar to those of much more massive and luminous Population I Wolf-Rayet stars. We present some preliminary results of an extensive investigation of the [WR]-type CSPN based on the spectroscopic survey described in the Strasbourg-*ESO* Catalogue of Galactic Planetary Nebulae (Acker *et al.* 1992).

Key words: stars: [Wolf-Rayet] – planetary nebulae: central stars

1. Classification and main characteristics

Comparing the results of our classification of the [WR]-type CSPN to those of the population I WR stars one immediately finds two important differences (Tylenda *et al.* 1993). First, almost all the known [WR] CSPN are of [WC] type whereas the massive WR stars show similar proportions of WC and WN types. The second difference concerns the distribution among WC subclasses. [WR] CSPN mostly populate subclasses [WC3]–[WC4] and [WC9]–[WC11], whereas Population I WR stars are of WC4–WC9 subclasses. However one object has been recently observed by us and reclassified as [WC6].

Observations of planetary nebula can give some clues on the evolutionary status of their central stars. Using the Zanstra and Stoy methods we have derived temperatures for the [WR] type CSPN. We found a correlation between the CSPN temperature and the [WC] subclass in the sense that the temperature rises from later to earlier subclasses. We have also noticed that planetary nebulae with [WR]-type central stars of earlier subclasses have lower electron densities. This can be attributed to the nebular expansion and means that the [WR] CSPN evolve from later to earlier subclasses, or in other words, from lower to higher effective temperatures. A similar conclusion can be drawn from the fact that we find higher nebular expansion velocities for earlier [WC] subtypes if we assume that the expansion velocity rises in the course of time.

K. A. van der Hucht and P. M. Williams (eds.), Wolf-Rayet Stars: Binaries, Colliding Winds, Evolution, 85–86.

2. Number of objects and galactic distribution

An important question is how common is the Wolf-Rayet phenomenon among the CSPN. From the spectroscopic survey of Acker and Stenholm we have selected 281 objects for which a stellar component is seen in the spectra. Among them we found 24 to be of [WR]-type. This gives 8.5% but we expect that the proportion of the CSPN passing through the [WR] phase is higher. The reason is that in our sample we may have a number of CSPN which have already passed through the [WR] phase and are now, for instance, cooling down after having ceased nuclear burning. A more detailed consideration would require an estimate of the life-time of the [WR] phenomenon.

It is interesting to ask if the [WR] CSPN compose any specific subsystem in the Galaxy when compared to other planetary nebulae. We have investigated distributions of the objects in the l and b galactic coordinates. Tests show that the positions of both groups in the plane of the sky do not differ statistically. We find that 14.3% of [WR] type CSPN are in the direction of galactic center ($|l| < 7°$, $|b| < 7°$) and 63.3% close to the galactic disk in other directions ($|l| > 7°$, $|b| < 7°$). The corresponding numbers for the rest of planetary nebulae are 22.0% and 52.1%. The observed similarities do not argue in favour of theories claiming that the [WR] CSPN come from stars originally more massive, as we would expect to find them closer to the disk.

3. Conclusions

From our investigation we find that planetary nebulae with [WR]-type central stars do not differ in spatial distribution from other galactic planetary nebulae. We also find that about 8.5% of central stars are in the [WR] phase. This phase, which occurs in most cases directly after having left the AGB (Tylenda & Górny 1993), is characterised by an evolution from lower to higher temperatures similarly as for other CSPN. A more elaborate discussion will appear in *Astronomy & Astrophysics.*

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