

CENTRAL STARS OF OLD PLANETARY NEBULAE

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During a program for the observation of central stars of old planetary nebulae 29 stars are classified until now. Most of them (22) are belonging to the hydrogen-rich sequence and resemble either high-gravity sdO stars or white dwarfs (14 DAOs, 3 DAs). 3 are hydrogen-deficient PG 1159 stars, and also 3 are hybrid type stars. Further 3 CPN are close binaries, whose evolution has been certainly influenced by this circumstance. A complete list of so far observed objects is given in Napiwotzki (1992).

For the analysis we used model atmospheres containing H and He calculated with the sophisticated NLTE code of Werner (1986). We tried to determine temperature and gravity of the observed central stars in the usual way by fitting the Balmer lines. A consistent fit of the Balmer lines was not possible for a number of objects. Examples are S 216 and NGC 7293. In the case of S 216 we derived $T_{\text{eff}} = 50,000$ K from H_{α} and $T_{\text{eff}} = 90,000$ K from H_{δ} , for NGC 7293 $T_{\text{eff}} = 55,000$ K (H_{β}) and 110,000 K (H_{δ}).

Possible reasons for the Balmer line discrepancy are (1) a change of the atmospheric structure caused by the line blanketing of iron and other metals, (2) possible errors in the line broadening theory (VCS) used for the Balmer lines, (3) the effect of a weak stellar wind, or (4) magnetic fields. From these points the iron line blanketing or the line broadening are the most likely reasons. Test calculations with D. Koesters LTE code showed that pressure ionization and quenching of atomic levels (Hummer & Mihalas 1988) is completely unimportant for the investigated Balmer lines (H_{α} to H_{δ}).

Independent temperature estimates are possible from the ionization balance of iron and helium, and from the modeling of the ionization structure of the surrounding nebula. A more detailed discussion can be found in Napiwotzki (1992) and will be published in the Proceedings of the White Dwarf Workshop 1992 in Leicester.

We can conclude that the DA/DAO central stars are the evolutionary link between the hydrogen-rich central stars and the DA white dwarf sequence. It is likely that the temperature scale of hot white dwarfs is in error. Independent temperature estimates are important to clarify this problem.

References

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