CHEMICAL COMPOSITION AND DISTRIBUTION OF WHITE DWARFS

VOLKER WEIDEMANN
(Universität Kiel, Germany)

This contribution makes a few points which are relevant to the question of the fraction of white dwarfs formed via the planetary-nebula phenomenon.

There is spectroscopic evidence for at least two kinds of white dwarfs which differ in atmospheric composition. Those belonging to spectral type DA (60–80%) having hydrogen-determined spectra, and those of spectral types DB, DC $\lambda 4670$, which are hydrogen-free. DA stars form a well-defined sequence in the two-color and HR diagrams, while the scatter for the other types seems to be larger. Masses for DA's are confined to $0{\cdot}6 \pm 0{\cdot}3$ solar masses. The average mass for hydrogen-free stars may be slightly higher, but this is not significant in view of the uncertainty in parallaxes as well as in blanketing and bolometric corrections. In particular, there is no evidence for the existence of two separate white-dwarf sequences of smaller and larger mass.

Evolutionary considerations imply that the interiors of white dwarfs should be H- and He-free, i.e. consist of C, O or heavier elements. Exceptions are white dwarfs formed by mass exchange in binaries according to Kippenhahn *et al.* (1967).

Since white dwarfs follow closely the theoretical luminosity function derived from the cooling law of Mestel and Ruderman (1967), an estimate can be given of the total number of white dwarfs as a function of age or lower limit of luminosity (Weidemann, 1967). By fitting the luminosity function to empirical data (from Luyten, Eggen, Greenstein and Sandage) and extrapolation to $M_{bol} = 15{\cdot}5$, corresponding to a cooling time of $5 \times 10^9 a$, the space density of white dwarfs younger than $5 \times 10^9 a$ turns out to be most probably 1×10^{-2} pc^{-3}, corresponding to a birth rate of $\chi_{WD} = 2 \times 10^{-12}$ pc$^{-3} a^{-1}$. Comparison with corresponding figures for planetary nebulae, $\chi_{PN} = 1 \times 10^{-13}$ or 11×10^{-13} pc$^{-3} a^{-1}$ for Seaton's or Abell's distance scales respectively, show that 5–50% of all white dwarfs should be formed via planetary nebulae. These are expected to be of type DA since planetary nebulae are not hydrogen-deficient.

Extension of the luminosity function to higher temperatures gives no indication of a 'gap' at $0 < \log L/L_\odot < 2$ that could be taken as evidence for neutrino cooling.

Although the majority of white dwarfs have moderate space velocities (< 100 km sec^{-1}) there are some, at first thought to be pygmies, which have velocities up to 250 km sec^{-1} and thus show extreme population-II characteristics (Eggen and Sandage, 1967).

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