THE ATMOSPHERE OF SUBLUMINOUS B STARS

U. Heber[1], K. Hunger[1], G. Jonas[1], R.P. Kudritzki[2]

1) Institut f. theoretische Physik und Sternwarte, Kiel
2) Institut f. Astronomie und Astrophysik, München

8 sdB stars have been analyzed for effective temperatures, gravity and helium content by means of LTE and NLTE model atmospheres (Heber et al., 1983). The analyses are based on the following observations:

1.) B&C IDS spectrograms obtained with ESO's 3.6m and 1.5m telescopes (4250-4800Å at 29 Å/mm, or, 4000-5000Å at 59 Å/mm).
2.) IUE spectra in low resolution (6Å) through the large aperture.
3.) Johnson and Strömgren colours, which are taken from the literature.

Effective temperatures are obtained via their definition from the integrated fluxes. Surface gravities then follow from the line profiles of $H\gamma$ and (when available) $H\beta$. The helium abundances are derived from the equivalent widths of He I, λ4471Å.
The results are summarized in Table 1. The majority of the program stars (6 out of 8) have effective temperatures around 26000K. SB 707 and LB 3241 are distinctly hotter and thus belong to the sdOB subgroup. Helium is depleted in all program stars, the depletion varying by large factors. In SB 707 and LB 3241 no He I, λ4471Å or He II, λ4686Å are seen and hence upper limits are derived. The helium content of SB 707 is the lowest known in any subdwarf. These low helium abundances (far below primordial) cannot be explained by canonical stellar evolution. It is brought about by diffusion (gravitational settling of helium).

Table 1: Atmospheric parameters of sdB stars

star	T_{eff}/K	log g	n_{He}/n_H
SB 459	25000	5.3	0.0016
LB 1559	25200	5.2	0.0150
SB 410	26700	5.1	< 0.0012
SB 485	27100	5.0	0.0040
SB 290	28200	5.5	0.0044
SB 815	28800	5.4	0.0035
SB 707	34000	6.0	< 0.0007
LB 3241	41000	5.7	< 0.0050

A. Maeder and A. Renzini (eds.), Observational Tests of the Stellar Evolution Theory, 223–224.

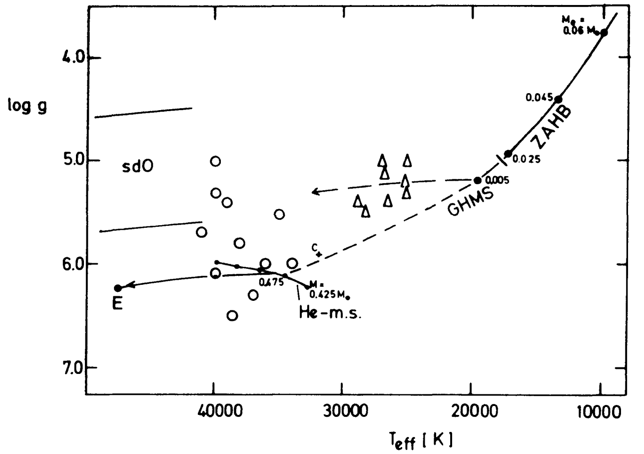

Fig. 1: Position of analyzed sdB (Δ) and sdOB (o) stars in the (log g, T_{eff})-plane. See text.

The Evolutionary Status of the sdB Stars

In Fig. 1 the position of all sdB's and sdOB's sofar analyzed are shown in the (log g, T_{eff})-plane. Also shown are Zero Age Horizontal Branch models (ZAHB, Gross, 1973) with core masses M_C=0.475 $M_\odot$, helium mass fraction Y=.25 and metallicity Z=0.01. The models are labelled with their envelope masses (in solar units). The model from Caloi (1972) labelled with an C in Fig. 1 has a very low envelope mass M_e=0.0005 $M_\odot$. When the core mass fraction q exceeds 0.95, hydrogen burning in the envelope is negligible ($L_H/L_{He} \leq 0.2$): a helium main sequence is reached which has an inert hydrogen rich envelope (henceforth called generalized helium main sequence GHMS). The true helium main sequence is also plotted in Fig. 1. The dashed line is an interpolated GHMS line for envelope masses less than M_e=0.005 $M_\odot$. The position of q=0.95 which separates hydrogen shell burning models (ZAHB) from GHMS models is indicated by a tick mark. The observed sdB's and sdOB's (except two objects) lie to the left and above the GHMS. Evolutionary tracks for GHMS models are not yet available. Since the envelope is inert the evolution proceeds presumably similar to that of a pure helium star. In Fig. 1 the evolutionary track of a pure helium star of 0.5 $M_\odot$ (Paczynski, 1971) until helium core exhaustion (point E) is shown. If we apply the same (horizontal) evolutionary vector to the GHMS stars we reach the domain of the observed subdwarfs. This implies that the sdB's are slightly evolved GHMS stars and have very low envelope masses ($M_e \lesssim 0.02$ $M_\odot$). The envelope masses of the majority of the sdOB's are further reduced to almost nothing ($M_e \leq 10^{-3}$ $M_\odot$).

References:

Caloi, V.: 1972, Astron. Astrophys. 62, 411
Gross, P.G.: 1973, Monthly Notices Roy. Astron. Soc. 164, 65
Heber, U., Hunger, K., Jonas, G., Kudritzki, R.P.: 1983, Astron. Astrophys., in press
Paczynski, B.: 1971, Acta Astron. 21, 1

https://doi.org/10.1017/S007418090003093X Published online by Cambridge University Press