

# Analysis of Hydrogen Rich PG 1159 Central Stars of Planetary Nebulae

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The PG 1159 stars represent the hottest stage of post-AGB evolution. Quantitative spectral analyses of most known PG 1159 stars have been carried out by us from optical, UV and EUV observations (see Dreizler et al 1995 for a review). It has been shown that these stars have atmospheres dominated by C and He with a significant admixture of O. These abundances reveal the inter-shell matter of a former AGB star. The four stars, HS 2324+3944, NGC 7094, Abell 43, and Sh 2-68, define a small group of peculiar PG 1159 stars (termed hybrid PG 1159). Unlike all other PG 1159 stars hydrogen is detected in their spectra. Three of them are CSPNe. Our Non-LTE analyses (Dreizler et al 1995; Dreizler et al 1996) show that these stars have typical PG 1159  $T_{\text{eff}}$ ,  $\log g$  as well as C and He abundances (Table 1). In contrast, the O abundance is lower than in PG 1159 stars. N is probably present but near the detection limit of the currently available spectra. Hybrid PG 1159 stars tend to have lower masses/luminosities than ordinary PG 1159 stars. A reduced mass-loss in their post-AGB evolution might be responsible for the incomplete removal of the H rich envelope. However, peeling of a post-AGB star alone can not produce the observed abundance pattern. In addition, mixing is required. A first evolution calculation with time dependent mixing of Iben & MacDonald (1995) shows some qualitative agreement in the abundance pattern like the C/He ratio it is, however, not able to explain the overall abundances.

Non-radial  $g$ -mode pulsations in HS 2324+3944 were detected recently by Silvotti (1996). A possible detection in Abell 43 was also reported by Ciardullo & Bond (1996). Since standard theory of pulsations in PG 1159 stars requires a hydrogen free envelope this is a challenge for the understanding of the GW Vir instability.

Table 1: Results of NLTE analyses of hybrid PG 1159 stars

Star	$T_{\text{eff}}$	$\log g$	He/H	C/H	$M/M_{\odot}$	$\log L/L_{\odot}$
HS 2324+3944	130000	6.2	0.5	0.15	0.59	3.4
NGC 7094	110000	5.7	0.3	0.05	0.59	3.6
Abell 43	110000	5.7	0.3	0.05	0.59	3.6

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