

Grids of Synthetic Spectra for H-poor Central Stars of Planetary Nebulae (CSPNe)

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Abstract. We present comprehensive grids of model spectra from far-UV to IR, covering the parameter space of [WC]-type CSPNe (Keller et al. 2011) and PG1159 stars. Models are calculated with CMFGEN (Hillier & Miller 1998) accounting for non-LTE, line blanketing, winds, clumping, and including ions previously neglected. The grids are available at <http://dolomiti.pha.jhu.edu/planetarynebulae.html>. We used them to analyse UV and far-UV spectra of the hot central stars of NGC 6905 and NGC 5189.

Keywords. stars: AGB and post-AGB, stars: atmospheres, stars: low-mass, brown dwarfs, stars: mass loss, stars: winds, outflows, stars: individual (NGC 6905, NGC 5189).

1. Grids of Synthetic Spectra

H-deficient CSPNe are commonly divided into: [WC] type, showing strong C and He emission lines; PG1159 type, occupying the region at the top of the WD cooling track and characterized by absorption lines of highly ionized He, C and O, besides weaker UV wind lines; and [WC]-PG1159, that are believed to be transition objects. They are thought to constitute an evolutionary sequence: [WC] stars would evolve from the AGB at an almost constant luminosity, towards higher temperatures, until nuclear burning ceases and the stars progress as PG1159 into the WD cooling track, while luminosity and mass-loss decrease and the wind reaches very high terminal velocities.

Our uniform model sets enable systematic analysis of observed spectra of PG1159 and [WC] type CSPNe to constrain stellar parameters. They also facilitate line identification, and illustrate spectral line changes across the CSPN evolutionary phase. The stellar parameters covered by both our grids of CMFGEN models can be seen in the left panel of Fig. 1. They follow, approximately, the tracks from Miller Bertolami & Althaus (2006) for H-deficient CSPNe. Each point corresponds to several models of different mass-loss rates and terminal velocities. On the right panel of Fig. 1, we show examples of models from the grid for PG1159-type CSPNe. Detailed discussion on the grid for [WC] type stars hotter than 50 kK can be found on Keller et al. (2011).

2. NGC 6905 and NGC 5189

We analysed UV and far-UV spectra of the central stars of NGC 6905 (Keller et al. 2011) and NGC 5189 using the [WC] grid to constrain their main physical parameters. We also explore additional parameters, such as less abundant ions not included in the wider grids, which affect almost exclusively the O V lines, and the iron abundance (Fig. 2). We find an upper limit to the iron abundance of 0.3 times solar in both [WCE] stars analysed here. Werner et al. (2011), however, finds solar iron abundance for a group of PG1159 stars. Table 1 summarizes our results and lists the spectra used in the analysis.

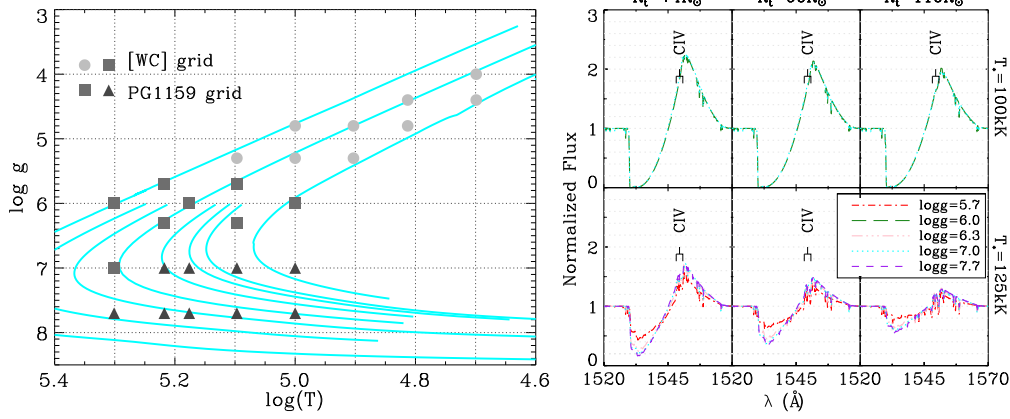


Figure 1. Left: stellar parameters covered by our grids of CMFGEN models. The lines correspond to evolutionary tracks from Miller Bertolami & Althaus (2006) for H-deficient CSPNe of different masses. Right: example of models from the grid covering the parameter space of PG1159-type CSPNe.

Table 1. Used spectra and derived parameters. T_* is the temperature at an optical depth of 20, R_t is the transformed radius, v_∞ is the wind's terminal velocity, X_{He} , X_C , and X_O are He, C and O mass fractions.

Object	Instrument	Data Set	Resolution [\AA]	Range [\AA]	T_* [kK]	R_t [R_\odot]	v_∞ [km/s]	X_{He}	X_C	X_O
NGC 6905	FUSE	A1490202000	~ 0.06	905-1187	150	10.7	2000	0.44	0.45	0.08
	STIS + G140L	O52R01020	~ 1.20	1150-1736						
	STIS + G230L	O52R01010	~ 3.15	1570-3180						
NGC 5189	FUSE	S6013001000	~ 0.06	905-1187	165	10.5	2500	0.58	0.25	0.12
	IUE	SWP08219	~ 6.0	1151-1979						
	IUE	LWR07171	~ 7.0	1851-3349						

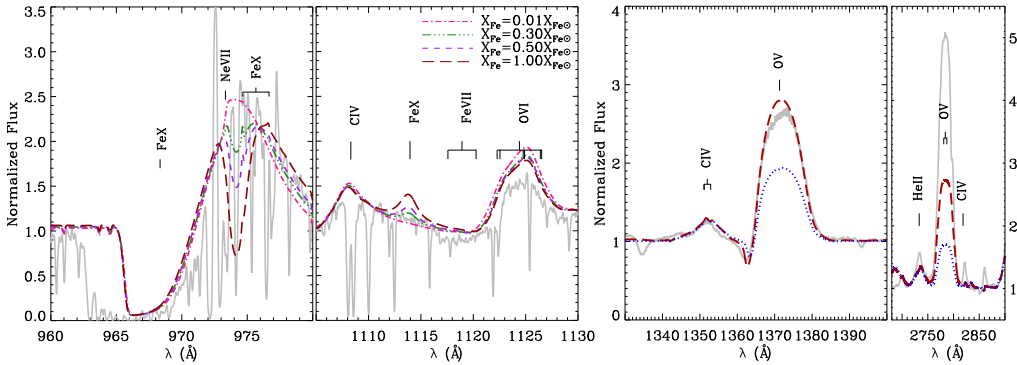


Figure 2. Left: observed spectra (light grey continuous line) of CSPN NGC 5189 is compared with models of different Fe content (dashed lines). The numerous narrow absorptions observed are from interstellar H_2 . Right: synthetic spectra of CSPN NGC 6905 with (dashed line) and without (dotted line) Mg, Na, Co, and Ni is compared with the observed one (light grey continuous line). The effect is seen only on the O V lines.

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References

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