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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] (Keller et al. 2011) and PG1159 stars. Models are calculated with the CMFGEN code, accounting for non-LTE, line blanketing, wind, 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 NGC6905's and NGC5189's central stars.

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

1. Introduction. Grids of Synthetic Spectra

H-poor CSPNe are commonly divided into: [WC], showing strong C and He emission lines; PG1159, positioned at the top of the WD cooling track and exhibiting 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 and then progress as PG1159 into the WD cooling track, while luminosity and mass-loss decrease and the wind reaches very high terminal velocities.

We computed, with the CMFGEN code (Hillier & Miller 1998), uniform model sets that enable systematic analysis of observed spectra of PG1159 and [WC] type CSPNe to constrain stellar parameters. They facilitate line identification and illustrate spectral line changes across the CSPN evolutionary phase. The parameter space covered by our model grids is shown on the left panel of Fig.1. It approximately follows the tracks from Miller Bertolami & Althaus (2006). For each [$\log g$,T_*] point, several models of different mass-loss rates and terminal velocities (v_∞) were calculated. The right panel of Fig. 1 shows examples of models from the grid of PG1159 type CSPNe, parametrized with $R_t = R_*[(v_\infty/2500 \text{ km s}^{-1})/(\dot{M}/10^{-4} \text{ M}_\odot\text{yr}^{-1})]^{2/3}$. 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 (Table 1). We also explored additional parameters, such as less abundant ions not included in the wider grids - affecting almost exclusively the O V lines - and the Fe content (Fig. 2), finding an upper limit of 0.3 times solar in both stars. Werner et al. (2011), however, finds solar iron abundance for a group of PG1159 stars.

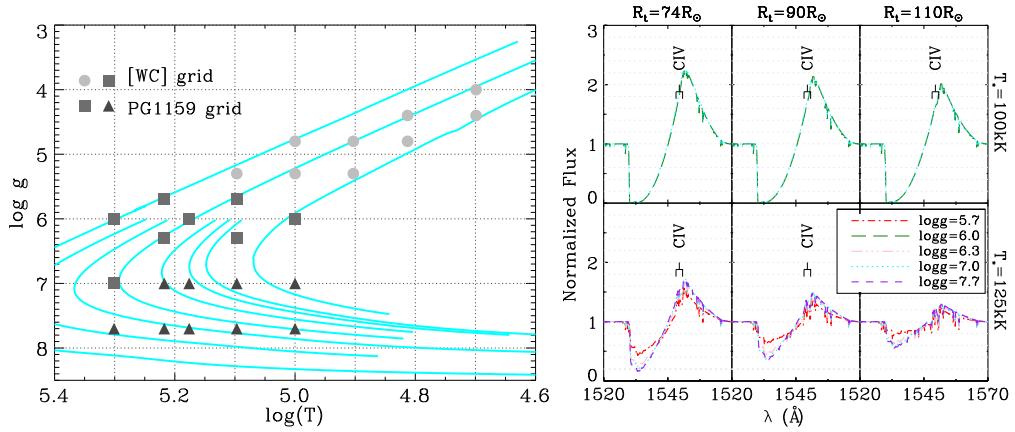

Figure 1. Left: stellar parameters covered by our grids of models and evolutionary tracks from Miller Bertolami & Althaus (2006) (lines). Right: example of models from the PG1159 grid.

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

Object	Instrument	Data Set	Resol.[Å]	Range[Å]	T_*[kK]	R_t[R$_\odot$]	v_∞[km/s]	X_{He}	X_C	X_O
NGC6905	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						
NGC5189	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						

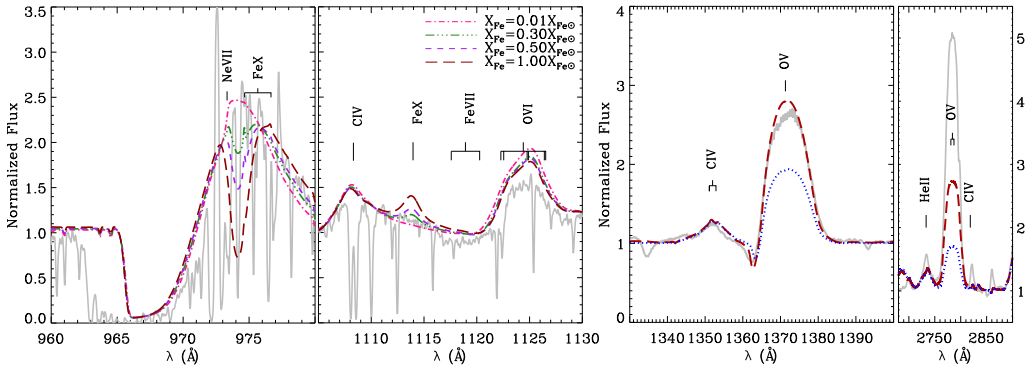

Figure 2. Left: observed spectra (continuous line) of NGC5189's CS and models of different Fe content (dashed lines). The numerous narrow absorptions are due to interstellar H_2, which also affects the blue edge of the Ne VII P-Cygni profile. Right: spectra of NGC6905's CS (continuous line) and models computed with (dashed line) and without (dotted line) Mg, Na, Co, and Ni.

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