TheoSSA

Synthetic Stellar Spectra on Demand
The Geier Grids

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Within the framework of the German Astrophysical Virtual Observatory (GAVO), the Tübingen project is closely related to spectral analysis and provides a number of tools and services that, e.g., allow the easy access of VO users to theoretical stellar spectral energy distributions (SEDs). One of the recent ingestions are extended grids of H+He+C composed models with solar and helium-rich abundances that were calculated on the initiative of Stephan Geier with the Tübingen non-local thermodynamical equilibrium (NLTE) model-atmosphere package (TMAP). It presently covers effective temperatures of 30 000 K $\leq T_{\rm eff} \leq$ 90 000 K and surface gravities $\log\,(g\,/\,{\rm cm/s^2})$ between 4 and 7.

The Grids

The spectral analysis of hot stars requires suitable model atmospheres that consider deviations from the local thermodynamical equilibrium (LTE). While for stars with spectral type B or later, LTE modeling may be adequate, one has to be aware that non-LTE (NLTE) effects are present in any star. These are important, at least if high-resolution and/or high-energy observations are analyzed. For most of the subdwarf stars of spectral types O and (!) B, NLTE spectral modeling is mandatory (Fig. 2).

Ion		Levels NLTE	Levels LTE	Lines
H	I	15	1	105
	II	1	—	—
He	I	71	32	282
	II	30	2	435
	III	1	—	—
C	II	16	30	37
	III	22	111	45
	IV	54	4	295
	V	1	0	0

Table 1: Statistics of the model ions used to calculate the Geier grid.

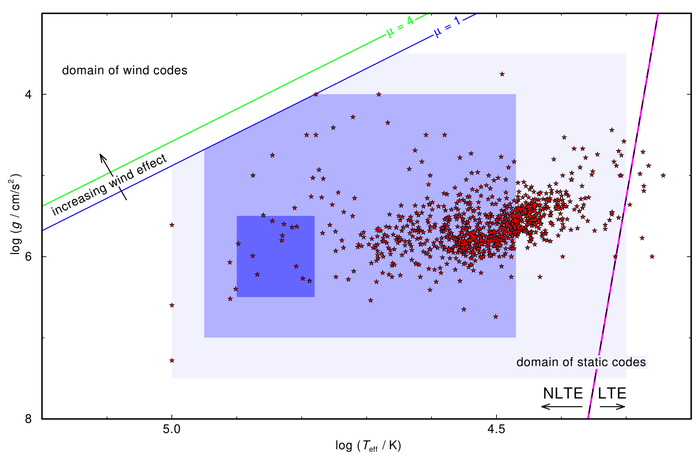

Figure 2: Location of 924 stars with given $T_{\rm eff}$ and $\log\,g$ from Geier's catalog of 5613 hot subdwarf stars (2017, A&A, 600, A50) in the reliability domains of LTE and NLTE models for static and expanding stellar atmospheres. The shaded regions indicate the regions of the Geier grids (dark blue: original He-rich Geier request, medium blue: already calculated solar grid, light blue: planned He-rich Geier grid). The $\mu = 1$ and $\mu = 4$ lines indicate the Eddington limits for pure H and He atmospheres, respectively.

In late 2016, Stephan Geier asked for a small grid of NLTE spectra that should consider the opacities of H, He, and C (Table 1 shows the statistics of the model ions) with mass ratios of 0.059 : 0.938 : 0.004 within

$$60\,000\,{\rm K} \leq T_{\rm eff} \leq 80\,000\,{\rm K} \quad (\Delta T_{\rm eff} = 1000\,{\rm K})$$
$$5.5 \leq \log g \leq 6.5 \quad (\Delta \log g = 0.05)$$

to analyze a hyper-velocity star. This initiated the calculation of two extended H, He, and C grids (one with solar abundances, one with those given above) within

$$30\,000\,{\rm K} \leq T_{\rm eff} \leq 90\,000\,{\rm K} \quad (\Delta T_{\rm eff} = 500\,{\rm K})$$
$$3.5 \leq \log g \leq 7.5 \quad (\Delta \log g = 0.01)$$

The solar grid is almost complete while the calculation of the He-rich grid is ongoing. Spectral energy distributions within the wavelengths ranges 910 Å$\leq \lambda \leq$ 1188 Å, 1150 Å$\leq \lambda \leq$ 1780 Å, 3000 Å$\leq \lambda \leq$ 55000 Å are now easily accessible via the German Astrophysical Virtual Observatory (GAVO, `http://g-vo.org`) service TheoSSA that is briefly described in the next section.

TheoSSA

GAVO developed the registered service TheoSSA (theoretical stellar spectra access, `https://dc.zah.uni-heidelberg.de/theossa`) and the supporting registered VO tool TMAW (Tübingen Model-Atmosphere WWW interface). These allow individual spectral analyses of hot, compact stars with state-of-the-art NLTE stellar-atmosphere models that presently consider opacities of the elements H, He, C, N, O, Ne, Na, and Mg, without requiring detailed knowledge about the involved background codes and procedures. Presently, TheoSSA provides easy access to about 225 000 pre-calculated stellar SEDs and is intended to ingest SEDs calculated by any model-atmosphere code.

Figure 3 shows the TheoSSA WWW page with the input to request the Geier grid.

Figure 3: TheoSSA request for the original Geier grid.

Figure 4 shows a part of the large TheoSSA results page. To download, use the Product-key buttons on its left side. With "[...a Teff-log g-grid for this chemistry and wavelength range]", you may download a complete grid – at least all SEDs that match the parameters of the selected SED.

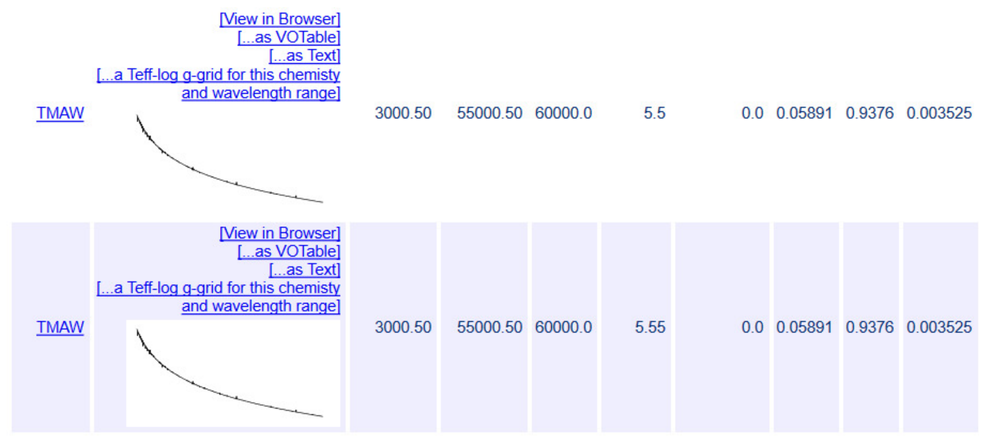

Figure 4: Part of the TheoSSA result WWW page for the request of Fig. 3.

Those users who are interested to calculate individual model atmospheres as well as SEDs may contact the authors or use the GAVO tool TMAW (`http://astro.uni-tuebingen.de/~TMAW`).

Rauch et al. (2018, MNRAS, 475, 3896) give an example for a spectral analysis using TheoSSA and TMAW SEDs.

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