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X-ray Model-Atmosphere Spectra for Extremely Hot, Compact White Dwarfs – Access via the Virtual Observatory Service *TheoSSA*

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The German Astrophysical Virtual Observatory (*GAVO*) provides the registered Virtual Observatory (VO) service *TheoSSA* (Theoretical Stellar Spectra Access). It is dedicated to the easy access of VO users to theoretical stellar spectral-energy distributions, calculated with any model-atmosphere code. In a pilot phase, *TheoSSA* is based on the well established Tübingen NLTE Model-Atmosphere Package (*TMAP*) for hot, compact stars. This includes e.g. spectra of objects with effective temperatures far in excess of 200 000 K, e.g. novae in outbursts during their so-called supersoft source (SSS) phase.

TMAP

TMAP (http://astro.uni-tuebingen.de/~TMAP) was created in the 1980s and is continuously developed since then. With *TMAP,* model atmospheres for hot, compact objects like e.g. central stars of planetary nebulae (CSPN), PG 1159 stars, and white dwarfs in novae can be calculated. Effective temperatures between 20 kK and more than 200kK, surface gravities between log $g = 4$ and 9 can be chosen and elements from hydrogen to nickel can be included into the calculations. *TMAP* considers:

- hydrostatic and radiative equilibrium
- plane-parallel or spherical geometry
- about 1500 atomic levels in NLTE
- H - K: about 4000 lines
- Ca - Ni (iron-group elements): 200 millions of lines

TheoSSA

TheoSSA uses the IVOA standard SSA. It is currently based on *TMAP* and provides

- SEDs (http://dc.g-vo.de/theossa)
- Simulation Software (*TMAW*, http://astro.uni-tuebingen.de/~TMAW)
- Atomic Data (*TMAD*, http://astro.uni-tuebingen.de/~TMAD)

Fig. 1: Web interface of *TheoSSA*.

TheoSSA is controlled via a web interface where fundamental parameters like $T_{\rm eff}$ or log g are entered (Fig. 1). A table of available SEDs is given as a result. Selected SEDs can be downloaded then. Newly calculated SEDs (*TMAW*) are automatically ingested. With this service, spectral analyses can be done the easy way.

TMAW

If a requested SED is not available, it can be calculated via *TMAW*. *TMAW* is the web interface of *TMAP*. Without detailed knowledge of the code, individual SEDs considering opacities of the elements H+He+C+N+O can be calculated. The requested parameters and the email address have to be entered in the web interface and the result is sent to this address within one day. It is also possible to calculate grids of SEDs on compute resources of AstroGrid-D (http://www.gac-grid.net/).

TMAD

The model-atom database *TMAD* provides ready-to-use model atoms including level energies and radiative and collisional transition data. Presently, it includes the elements H, He, C, N, O, F, Ne, Na, Mg, Si, S, Ar, and Ca. Complete model atoms are available for model-atmosphere and for SED calculations (incl. fine-structure splitting).

Application to SSS

TheoSSA contains several grids suitable for the analysis of SSS (Rauch & Werner 2010). Such SEDs were already used to successfully model the flux of e.g. V4743 Sgr (Rauch et al. 2010, Fig. 2). If SEDs with different parameters are needed, they can be requested via *TMAW*.

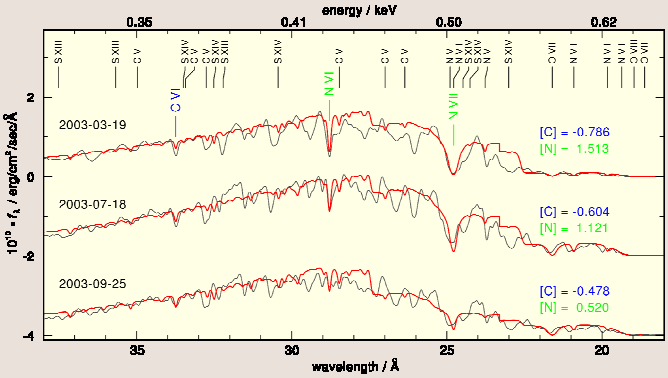

Fig. 2: The SSS phase of V4743 Sgr at three different phases..The model matches the changing N and C abundances.

Recent Improvements

After a first benchmark test that compared *TMAW* with *TMAP* models with the same parameters, we decided to further improve *TMAW* SEDs. E.g. we included a better temperature correction. A line-formation step with far more detailed model atoms is performed at the end of the calculation. These additional iterations improve the accuracy further, but the calculation time increases only slightly.

References:

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Acknowledgements

ER is supported by the Federal Ministry of Education and Research (BMBF) under grant 05A11VTB.
TR is supported by the German Aerospace Center (DLR) under grant 05 OR 0806.

Poster presented at The First eROSITA International Conference, Garmisch-Partenkirchen, Germany, October 17-20, 2011