The Milky Way and the Local Group – Now and in the Gaia Era
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Gaia Stellar Library

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Data Processing & Analysis Consortium

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Aim of this talk

- ★ inform the wider community about the efforts under way within DPAC to construct the **GSL**
- ★ the role of **GSL** within DPAC
- ★ what can/cannot be expected from **GSL**
- ★ the usefulness of **GSL** outside of DPAC
- ★ remaining challenges (calibration)

"*Ask not what GSL can do for you.*
Ask what you can do for GSL."

What is GSL?

A collection of **synthetic stellar fluxes and spectra** for objects **across the HR diagram** showing variance in dominant input parameters:
$T_{\rm eff}$, log g, [Fe/H], [α/Fe], [X/Fe], $\upsilon_{\rm rot}$, ...

300 – 1100 nm	**$\delta\lambda$ = 0.1 nm**	**BPRP spectrophotometry**
840 – 890 nm	**$\delta\lambda$ = 0.001 nm**	**RVS spectroscopy**

The **resolving power** of these spectra is significantly higher than what Gaia's instruments will provide, as these spectra are used to simulate what Gaia will see (PSF convolution, instrument sensitivity etc.).

Main role of GSL: **train the algorithms** extracting radial-velocity and astrophysical information from the Gaia observations.

My role: coordinator of the 'Synthetic Stellar Spectra' work package (within CU8 'Training Data', led by Frédéric Thévenin)

The GSL who's who?

Status of the grids

Table 1: Sub-packages within WP 811-10000 "Synthetic Stellar Spectra" as defined in Korn & Thévenin (2006). The various sub-grids cover stars from $T_{\rm eff} = 2{,}000 - 100{,}000$ K, $\log g = -0.5 - 9$ and [Fe/H] $= -5 - +1$. Abbreviations used: WD – white-dwarf; AA – abundance-anomalous; CA – chromospherically-active; UC – ultra-cool.

WP	type of stars	$T_{\rm eff}$ [K]	$\log g$ [cgs]	[Fe/H]	provider/code
10100	WD stars	6,000 – 90,000	7 – 9	%	Koester/TMAP
	sdO	26,000 – 100,000	4.8 – 6.4	0	Heber
10200/300	OBA	8,000 – 50 000	1 – 5	−5 – +1	GHOST team/TLUSTY
	BAF	6,000 – 16,000	2.5 – 4.5	−1.5 – +0.5	Kochukhov/LL
10400	AA stars	6,500 – 18000	1 – 5	%	Kochukhov/LL
10500/700	FGKM	2,500 – 8,000	−0.5 – 5.5	−5.0 – +1	Gustafsson/MARCS
	AFGKM	3,000 – 10,000	−0.5 – 5.5	−3.5 – +0.5	Hauschildt/PHOENIX
10600	CA stars	4,000 – 6,000	4.5 – 5.5	0	Korn/MARCS+MULTI
10800	C stars	4,000 – 8,000	0 – 5	−5 – 0	Plez/MARCS
10900	UC stars	2,000 – 3,000	2.5 – 5.5	0	Allard/PHOENIX

A natural emphasis of the GSL efforts is on stars with SP F and later, as these constitute 95 % of all stars Gaia will observe.

How *good* is the GSL?

Hard to evaluate!

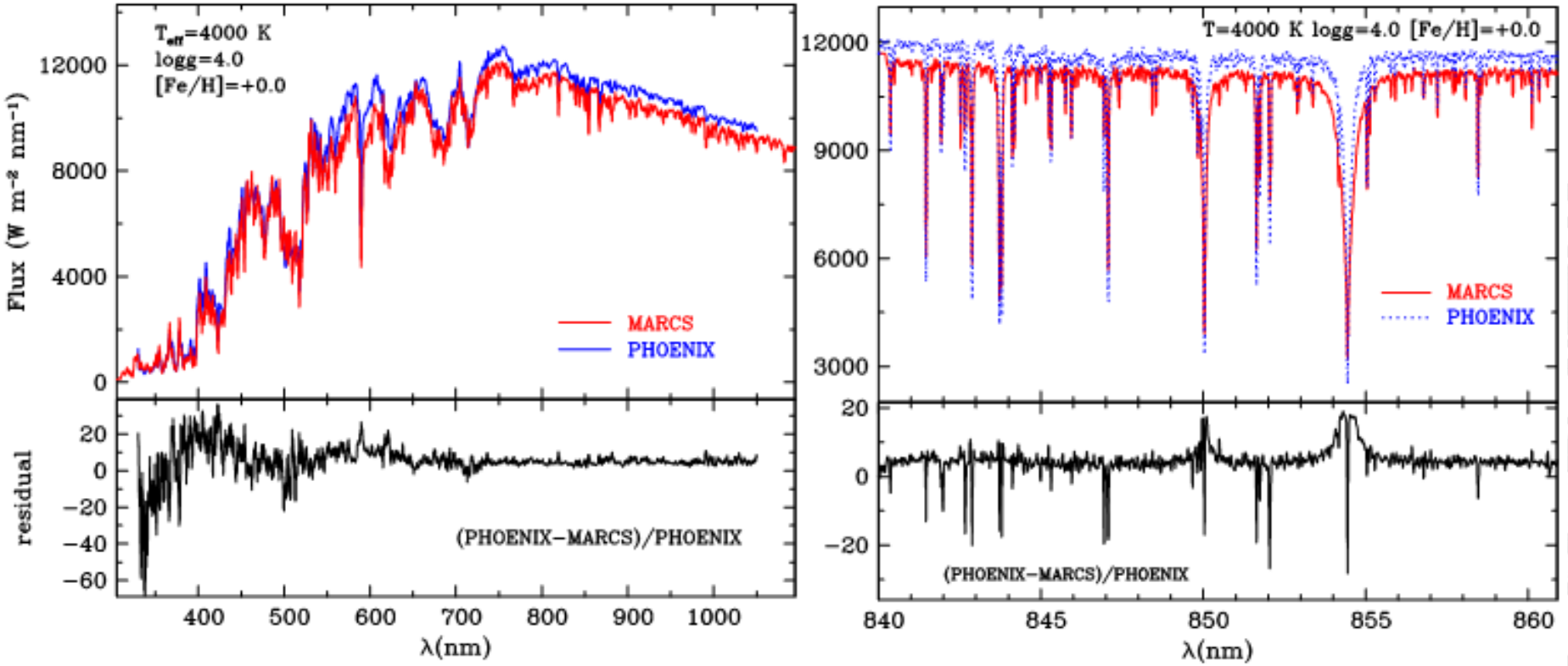
The **grids reflect the current knowledge** about the dominant physical effects in certain groups of stars: e.g. NLTE+rotation in early-type stars, atomic diffusion in late-B/A/early-F-type stars, molecular opacity in stars with SP later than G.

But the grids are in some cases not state-of-the-art: e.g. the construction of 1000s of 3D-HD models for late-type stars is not computationally feasible at present.

Main goal: **provide** (local) **accuracy** with precision provided by means of calibrations (see Ulrike Heiter's talk).

How *good* is the GSL?

Hard to evaluate!

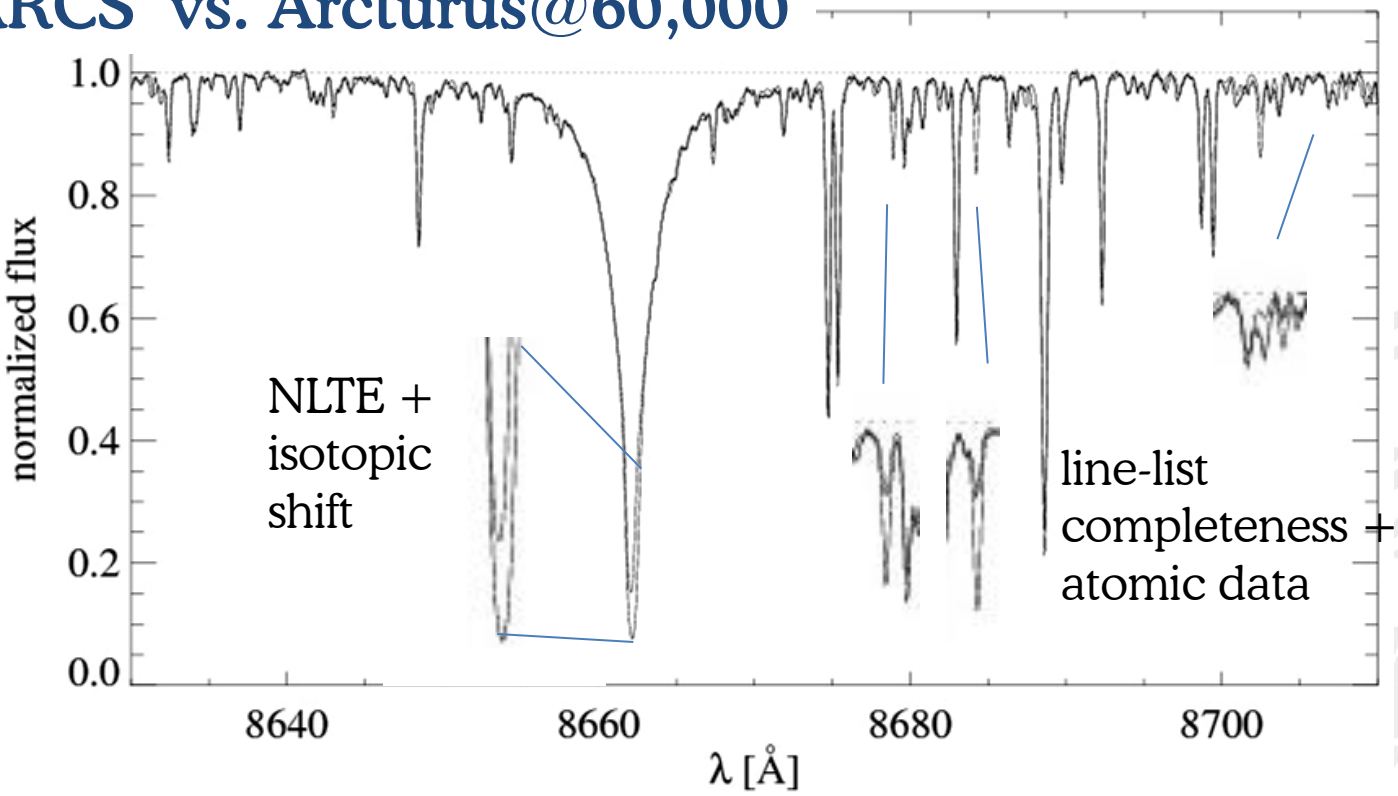


Sordo *et al.* 2009, MSAI 80, 103 (astro-ph/0812.0297)

How *good* is the GSL? (cont'd)

Check against observations of stars we think we know. Example:

MARCS vs. Arcturus@60,000



A systematic approach covering late-type stars is taken by the GBOG/SAM efforts (see talk by Ulrike Heiter).

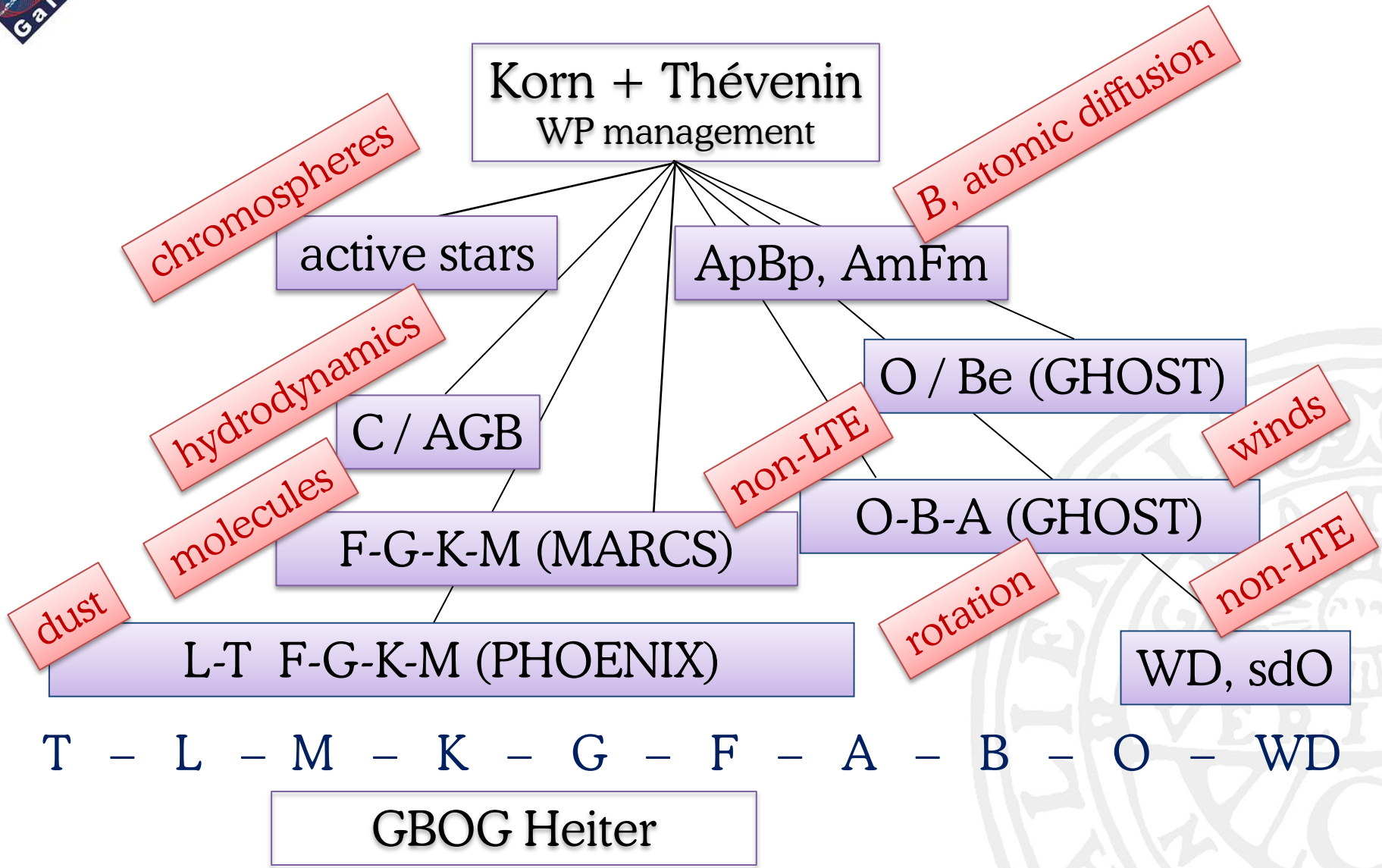
What will not be achieved

Due to the specifications Gaia's instruments have, most of **GSL** has been/is custom-produced. For the providers, this is a **long-term investment** with little immediate science return.

To make providers volunteer to perform these computations nonetheless, some compromises have been made: providers are free to use their codes and are asked to make informed decisions regarding atomic input data and other (tuneable) parameters (e.g. composition, the efficiency parameter α of local MLT).

This means that there are **some inherent inconsistencies** in the grid which we will have to deal with (somehow). **Full consistency in** thus **not possible** across different sub-grids.

GSL Challenges



GSL summary

The **Gaia Stellar Library** constitutes a major step forward in collecting **homogeneous synthetic stellar fluxes** and near-IR high-resolution spectra **across the HR diagram**. The pre-launch GSL will be made publicly available in late-2010.

In particular for the fluxes, scientific spin-offs outside of Gaia are obvious ~~(see talk by Antonella Vallenari)~~.

The GSL (and GBOG) efforts will continue throughout Gaia's mission phase with a final grid to be ready for the post-mission data analysis in 2018. **Your input is welcome at any time, whatever you can contribute with!**

Last but not least: **thanks to all those who have already contributed to this long-term effort!**