StePar/SteParSyn:

Two automatic codes to infer stellar atmospheric parameters

https://github.com/hmtabernero/

instituto de astrofísica e ciências do espaço

Hugo Tabernero
htabernero@astro.up.pt

Team

David Montes (UCM)
Emilio G. Marfil (UCM)
Jonay I. González Hernández (IAC)
José A. Caballero (CAB)
Hugo M. Tabernero (IA-Porto)

Methods

a. StePar → *EW*-method (**Tabernero et al. 2019**)

   https://github.com/hmtabernero/StePar

b. SteParSyn → Spectral synthesis (**Tabernero et al. 2018**)

StePar/SteParSyn science cases

a. Characterization of exoplanet hosts
   - CARMENES → **See Emilio's talk**
   - ESPRESSO

b. Gaia-ESO survey stellar parameters (WG11, WG12)

c. In general terms → Any FGKM star.

Input data

Atoms: VALD3/Gaia-ESO linelist

Molecules: B. Plez, ExoMol, and Kurucz

TiO SiH MgH CaH CrH FeH C_2 ZrO H_2O OH CN CO VO

Atmospheric models

Model	Effective temperature	Surface gravity	Metallicity
PHOENIX	2600 K < T_{eff} < 7500 K	-0.5 < log g < 6	-4 < [M/H] < 0.5
KURUCZ	3500 K < T_{eff} < 7500 K	0.0 < log g < 5.0	-4 < [M/H] < 1
MARCS	2500 K < T_{eff} < 7500 K	-0.5 < log g < 5.5	-4 < [M/H] < 1

Radiative transfer codes

Turbospectrum (**Álvarez and Plez 1998**)
Spectrum (**Gray and Corbally 1994**)
MOOG (**Sneden 1973**)

These are stellar atmospheric models
They are NOT synthetic spectra

We can generate *almost* anything at any wavelength and model (just ask)

The grids are appropriate for Milky Way stars
[α/Fe] enhanced models

We can calculate irradiated models (transmission spectroscopy)

StePar (Tabernero et al. 2019)

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Astronomy & Astrophysics

StePar: an automatic code to infer stellar atmospheric parameters

H. M. Tabernero[1,2], E. Marfil[3], D. Montes[3], and J. I. González Hernández[4,5]

4 different Fe I-II line lists

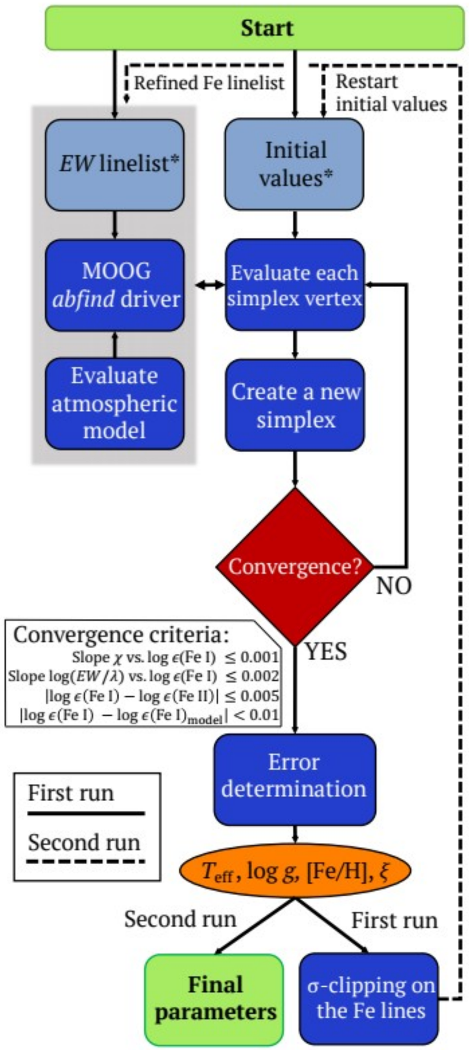
MARCS models (**Gustafsson et al. 2008**)

MOOG code (**Sneden 1973**)

Nelder-mead optimization (**Press et al. 2002**)

https://github.com/hmtabernero/StePar

StePar (Tabernero et al. 2019)



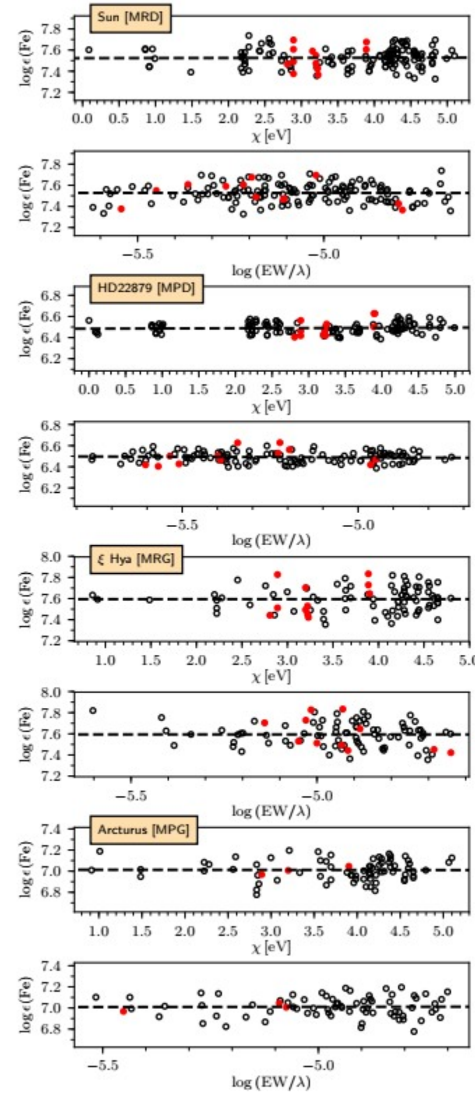
Gaia-Benchmark stars

Jofré et al. 2014, 2018; Heiter et al. 2015b

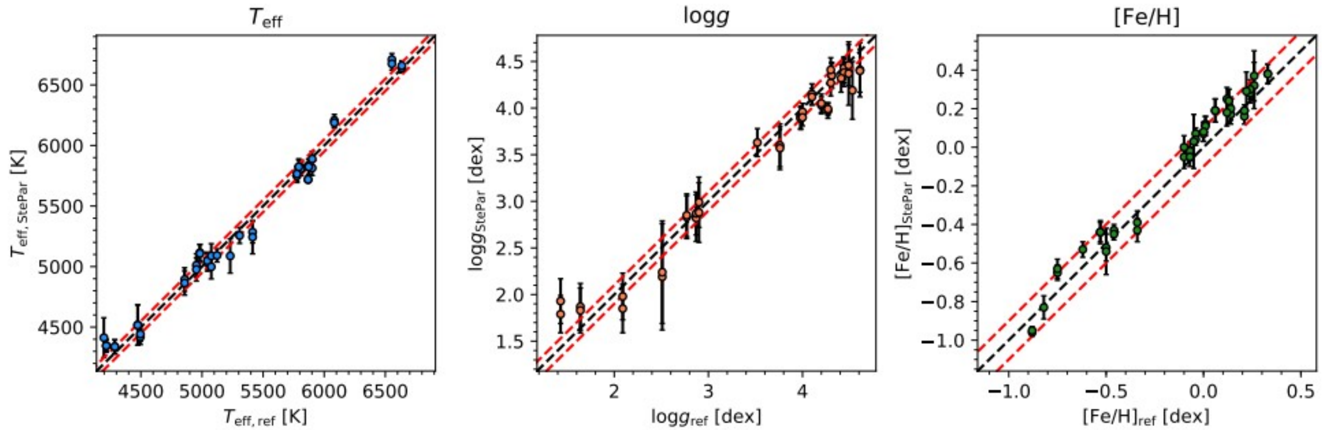
Table 2. Number of Fe I and Fe II in each of the four linelists used in this work.

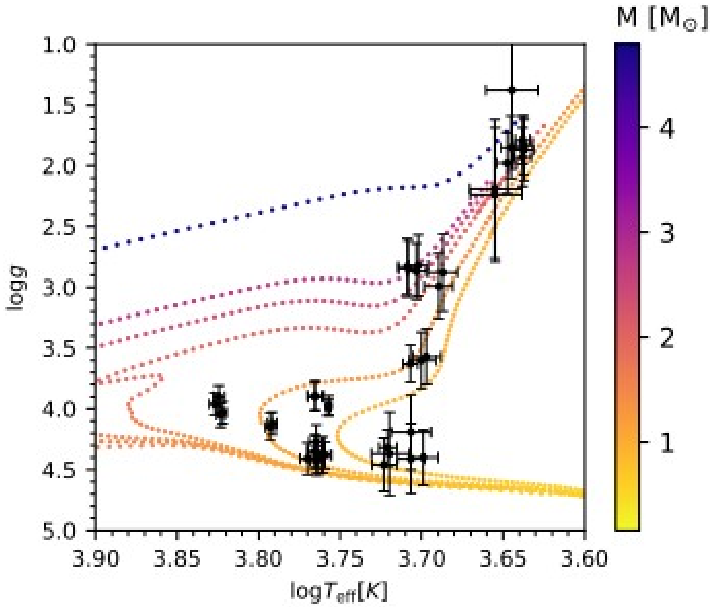
Element	MRD	MPD	MRG	MPG
Fe I	146	127	113	115
Fe II	12	13	11	6
#stars	8	4	7	4

Star	List	T_{eff} [K]	$\log g$ [dex]	[Fe/H] [dex]
Sun	MRD	5777 ± 1	4.44 ± 0.01	0.03 ± 0.01
HD 22879	MPD	5868 ± 89	4.27 ± 0.03	-0.86 ± 0.05
ξ Hya	MRG	5044 ± 40	2.87 ± 0.02	0.16 ± 0.20
Arcturus	MPG	4286 ± 35	1.60 ± 0.20	-0.52 ± 0.08



StePar (Tabernero et al. 2019)





We find a small internal scatter for the Gaia benchmark stars of:

9 ± 32 K in Teff
0.00 ± 0.07 dex in log g
0.00 ± 0.03 dex in [Fe/H]

SteParSyn (Tabernero et al. 2018)

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MNRAS **476**, 3106–3123 (2018) doi:10.1093/mnras/sty399
Advance Access publication 2018 February 15

An LTE effective temperature scale for red supergiants in the Magellanic clouds

H. M. Tabernero,[1★] R. Dorda,[1] I. Negueruela[1] and C. González-Fernández[1,2]

AAOmega spectra (R=10,000)

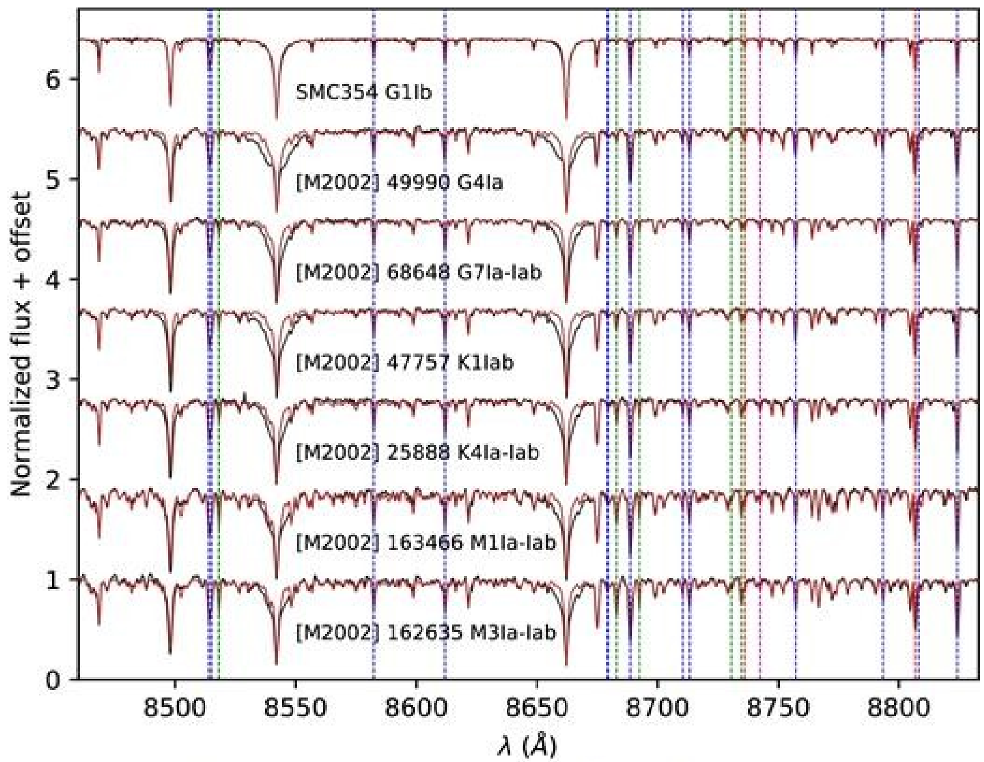
Fe I +Mg I +Si I+ Ti I lines between 8500-8900 A.

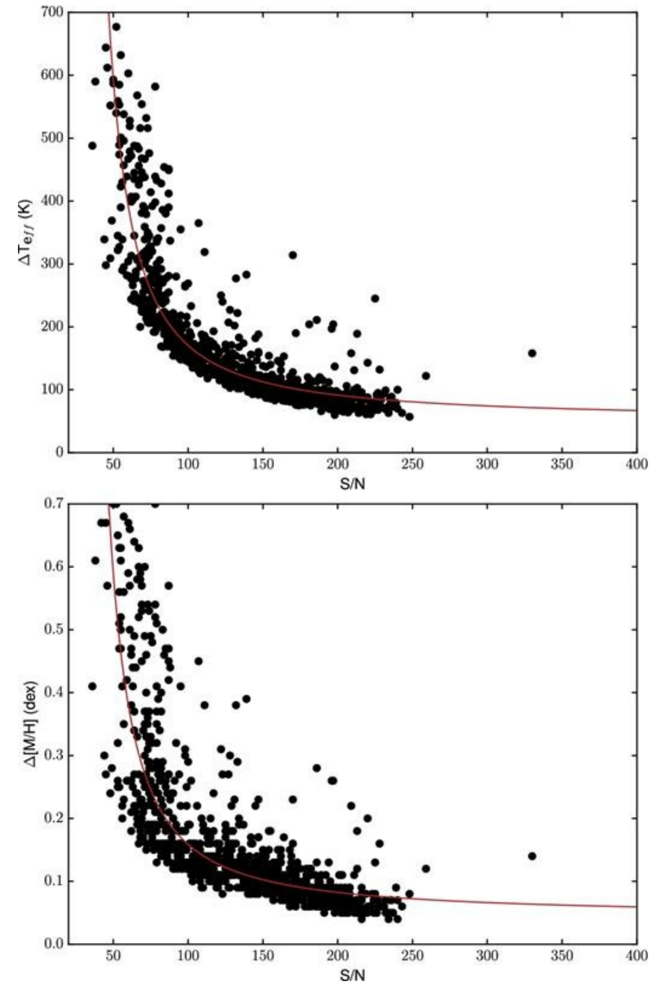
MCMC method

Spectrum (**Gray and Corbally 1994**)

MARCS/KURUCZ

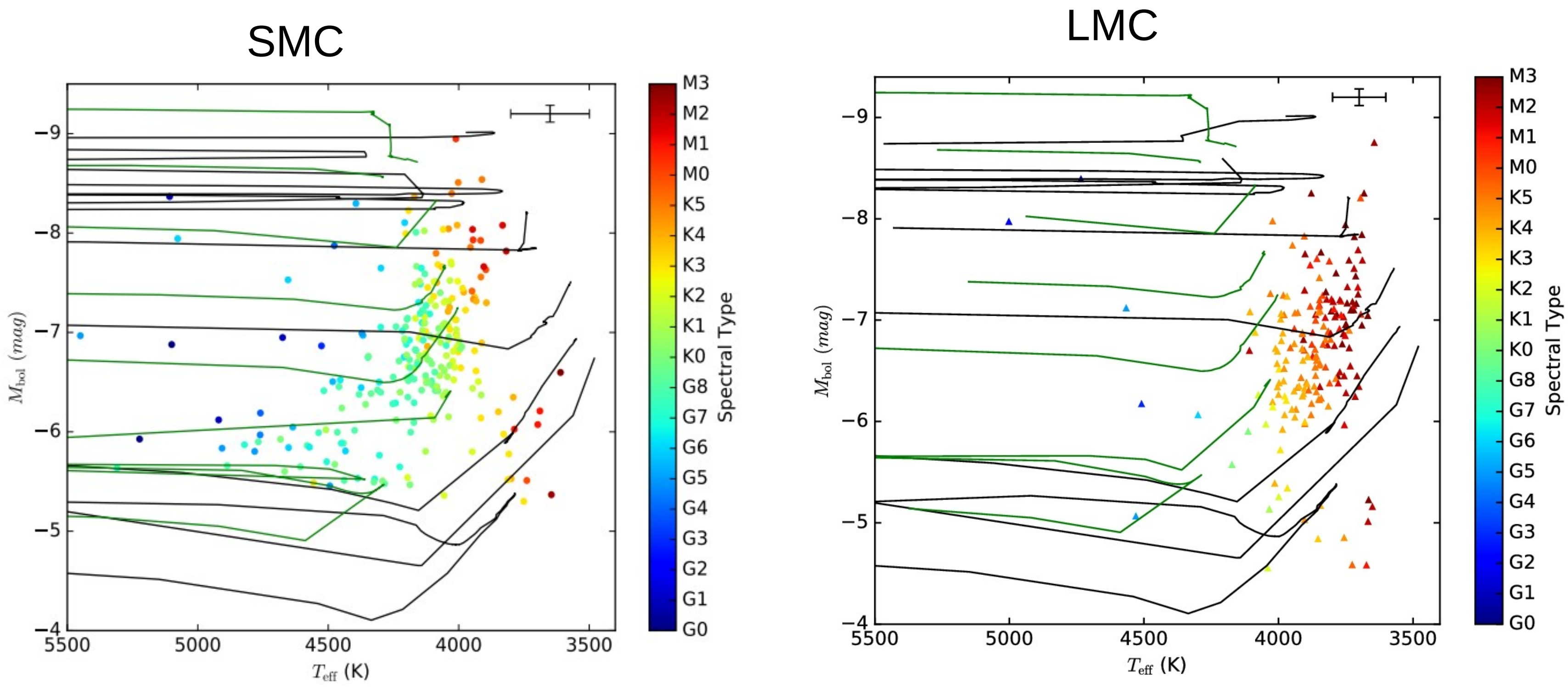
StePar Syn (Tabernero et al. 2018)





Mg I (Red), Si I (Magenta), Ti I (green), Fe I(blue)

SteParSyn (Tabernero et al. 2018)



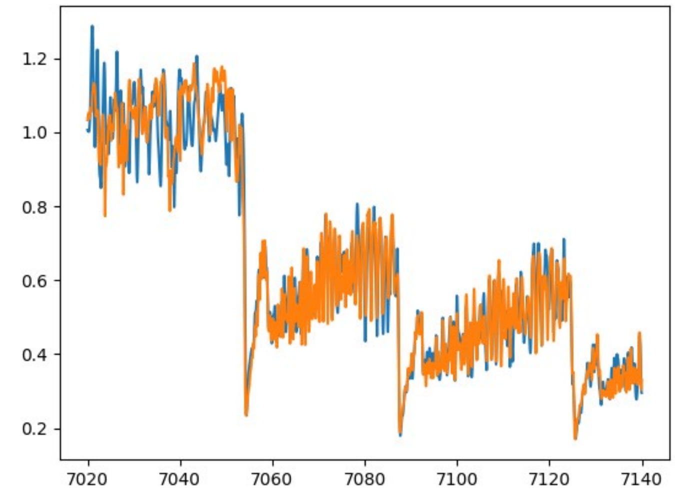
Green tracks SMC (**Georgy et al. 2013**)

Black tracks are for Solar metallicity (**Ekstrom et al. 2012**)

All tracks: 9, 12, 15, 20, 25, and 32 solar Masses.

Mbol inferred according to **Bessell and Wood (1984)** using J-Ks.

SteParSyn (Tabernero et al. 2020, in prep)



Atomic lines + Bands

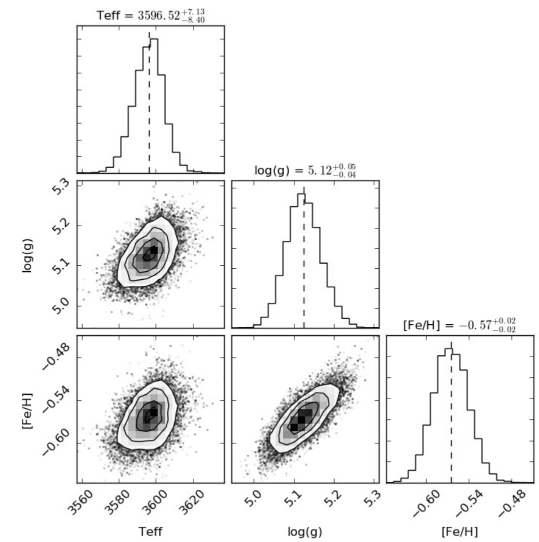
PHOENIX models (BT-Settl)

Turbospectrum (**Álvarez and Plez, 1998**)

MCMC + Gaussian processes + PCA grid

(**python packages: emcee, celerite,sklearn**)

See Emilio's Talk for CARMENES



Wrap-up

a. StePar → *EW*-method (**Tabernero et al. 2019**)

   https://github.com/hmtabernero/StePar

b. SteParSyn → Spectral synthesis (**Tabernero et al. 2018**)

c. Applicable to several science cases (FGKM stars):

- Planet hosts
- Low-mass stars
- Massive stars

Thank you

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e ciências do espaço

Hugo Tabernero
htabernero@astro.up.pt