

The CIFIST Legacy



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**Cosmological Impact of the First Stars
(CIFIST Marie Curie Team)**

Observatoire de Paris-Meudon (GEPI)



CIFIST



Team members:

Team Leader – Piercarlo Bonifacio

Experienced Researcher – Hans-G. Ludwig

Researcher – Luca Sbordone

Early Stage Researcher – Jonay Gonzalez-Hernandez

Early Stage Researcher – Natalie Behara

PhD Candidate – Elisabetta Caffau

Collaborators:

GEPI – M. Spite, F. Spite, R. Cayrel, V. Hill, P. François

Matthias Steffen (Postdam)



MARIE CURIE ACTIONS

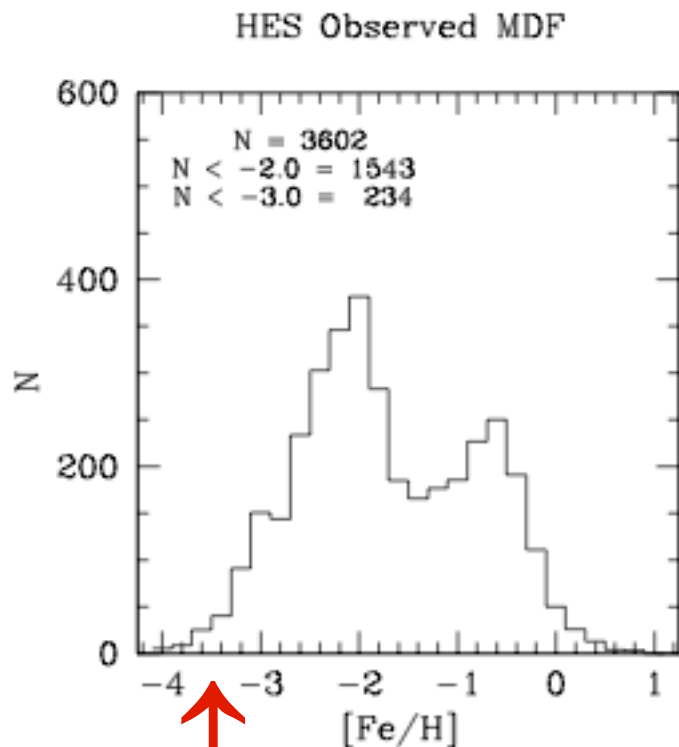




CIFIST - Cosmological Impact of the First STars

Main goals:

Measure the chemical composition of the lowest metallicity stars, descendants of the First Stars.



This implies:

- *Find the stars (not trivial)*
- *Acquired HR spectra*
- *Interpret the spectra with suitable theory*

$[X/Y] = \log(X/Y) - \log(X/Y)_{\odot}$



CIFIST Activities

Activities can be coarsely divided into two branches

- Observations & analysis of observational data
- Theory of stellar atmospheres, line formation etc..

CIFIST is computing the **largest available database of 3D hydrodynamical stellar atmosphere models**, as well as compiling a **significant database of science-ready, fully reduced spectra** of metal-poor stars, typically with very high S/N.



The CIFIST Legacy

The CIFIST team began activities in September 2005, and these are due to be completed by September 2009

One of our goals is that the CIFIST project must not dissolve into nothing, but leave a “legacy”. Something useful for the scientific community which remains after the project, as such is completed. This legacy project is officially supported by the GEPI.

Data available to the Team



- ★ First Stars LP legacy
- ★ TNG + SARG spectra EMP dwarfs (5 stars, 1 binary)
- ★ VLT+UVES spectra EMP dwarfs, HK/HE (10 stars)
- ★ VLT + UVES spectra EMP dwarfs SDSS (15 stars)
- ★ TNG+SARG spectra low S/N for RV r-rich stars (continue)
- ★ REM VRIK raw photometric data for 274 HK/HE stars
- ★ TNG+SARG MP K dwarfs Mg isotopic ratios
- ★ VLT+UVES MP K dwarfs Mg isotopic ratios
- ★ VLT+Giraffe TO+SG NGC 6397 for Li test
- ★ VLT+CRIFRES spectra of MP stars for SI Mult.3
- ★ VLT+UVES High S/N CS22876-32 for ${}^6\text{Li}$ (to be o
- ★ VLT+UVES spectra of r-l stars (to be obs.)
- ★ OHP1.93m+SOPHIE RV for r-rich EMPS (ongoing)



Observational Dataset

CIFIST observations + “First Stars” ESO LP data will cover about 100 objects: high quality, fully reduced spectra.

This significant database will be made available to the community for further research, teaching and comparison purposes.

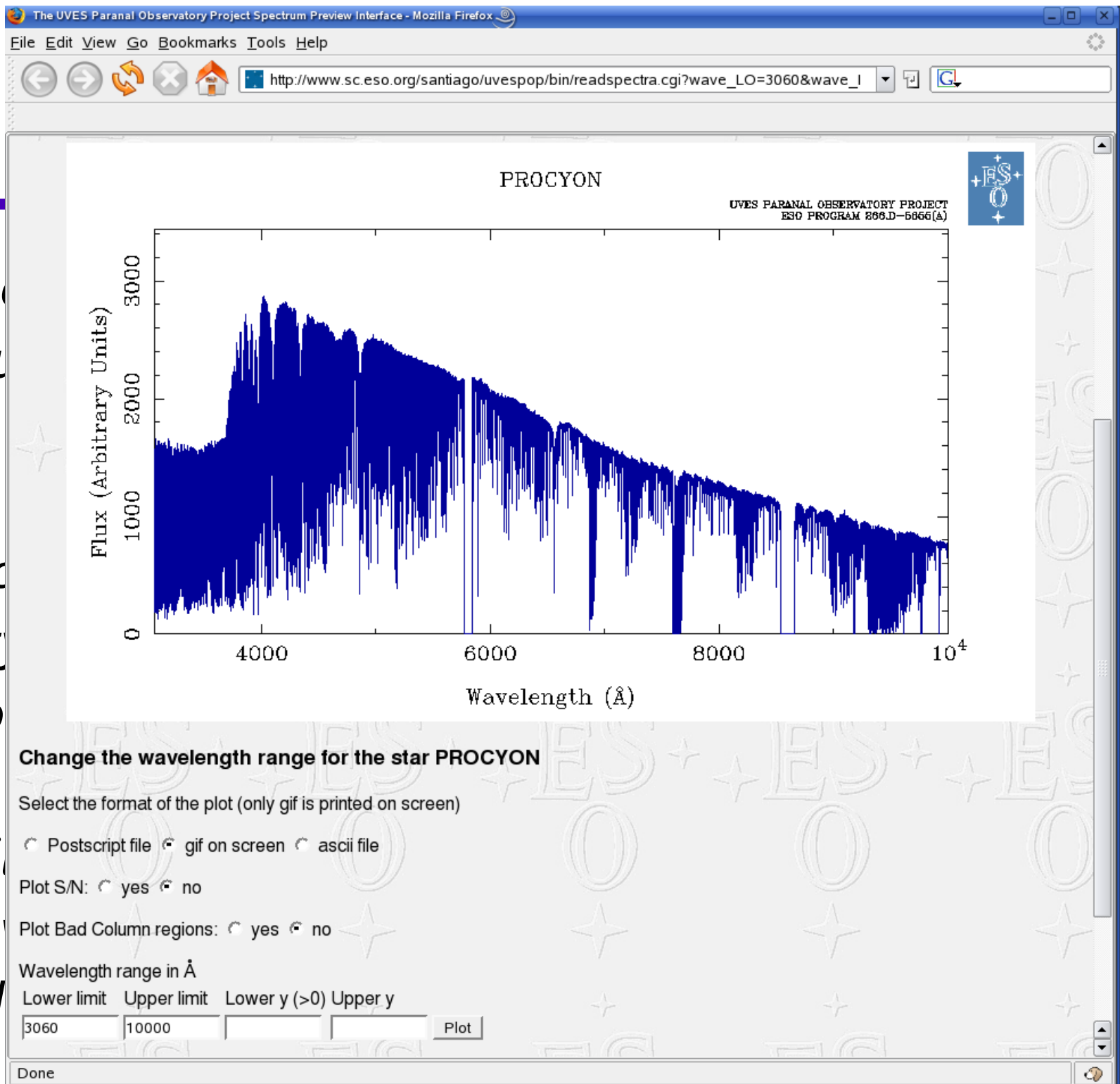
Archive will be easy to access and search. Links to published work will be provided. VO compatibility is envisioned for the observational database.

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Archive wi
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3D Model Atmospheres

Computed with CO⁵BOLD, a 3D radiation hydrodynamics code designed to model stellar atmospheres (Freytag et al. 2002).

Gas-dynamical effects can lead to dramatic deviations from radiative equilibrium conditions, especially in metal-poor stellar atmospheres. The aim of 3D models is to represent the detailed interplay of hydrodynamics and radiation.

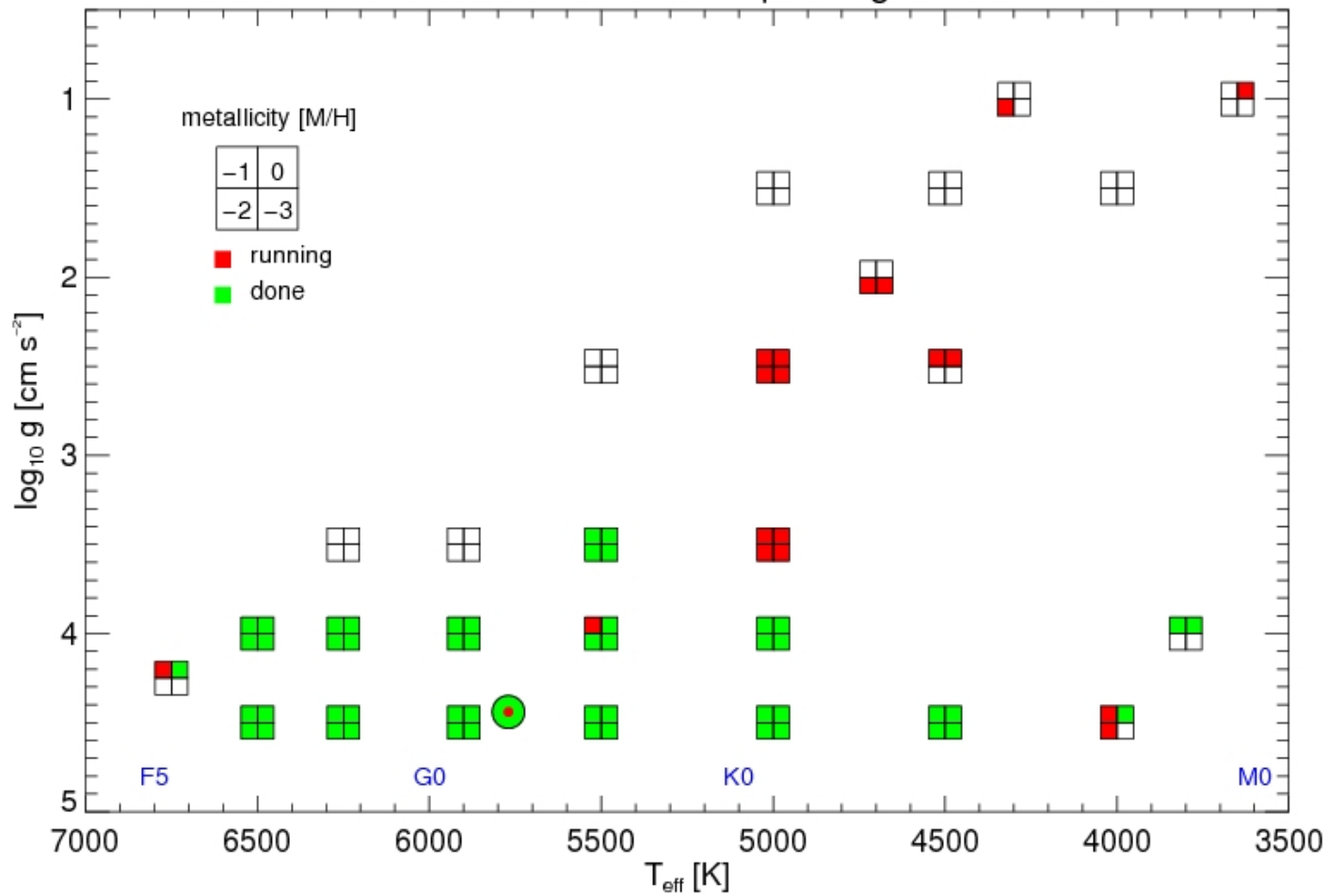
3D models are expensive to compute (CPU time, manpower, hardware) so every model is highly valuable.





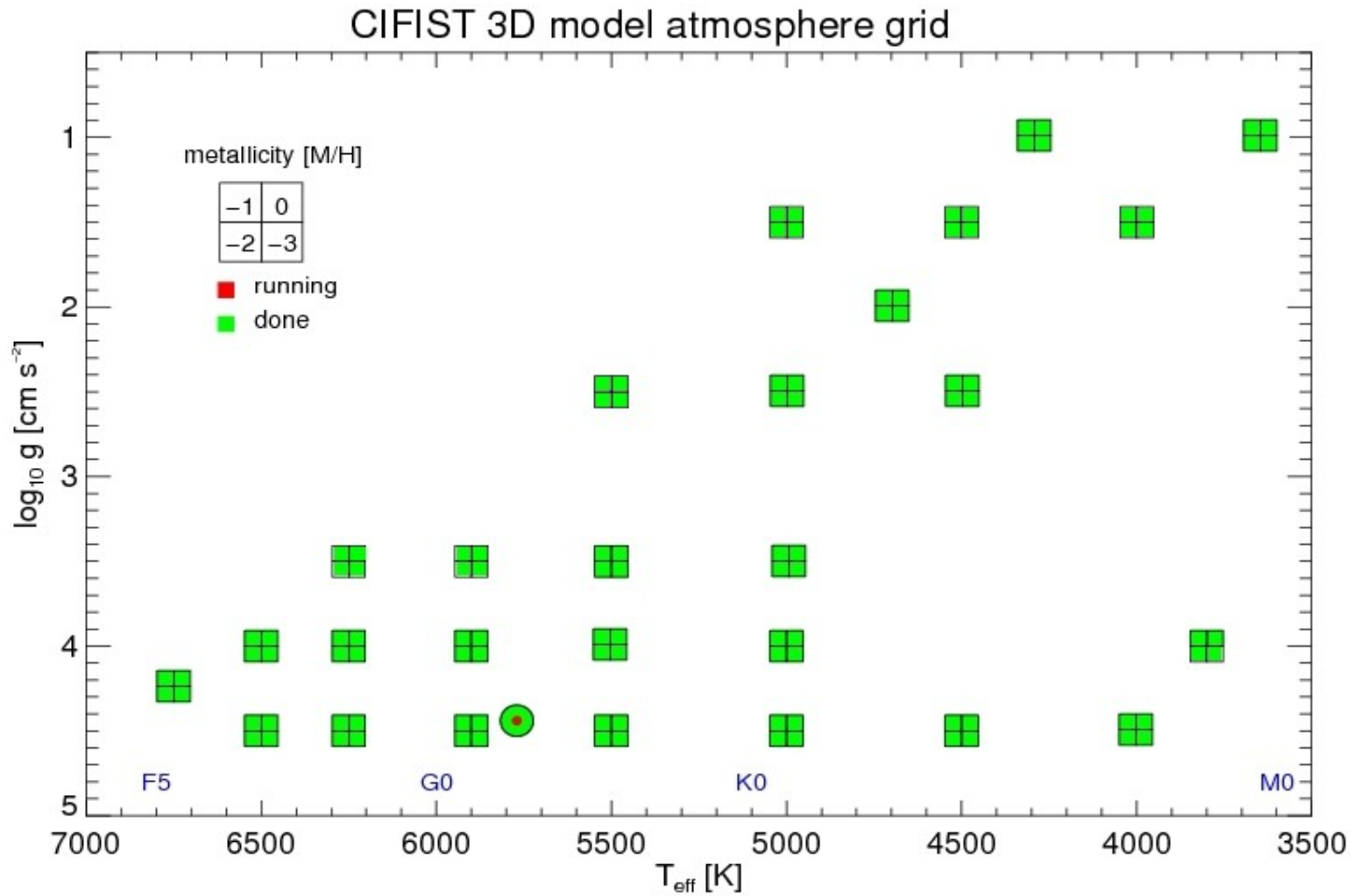
Models currently available

State of CIFIST 3D model atmosphere grid: 2008-02-17





Models available at the end of the project

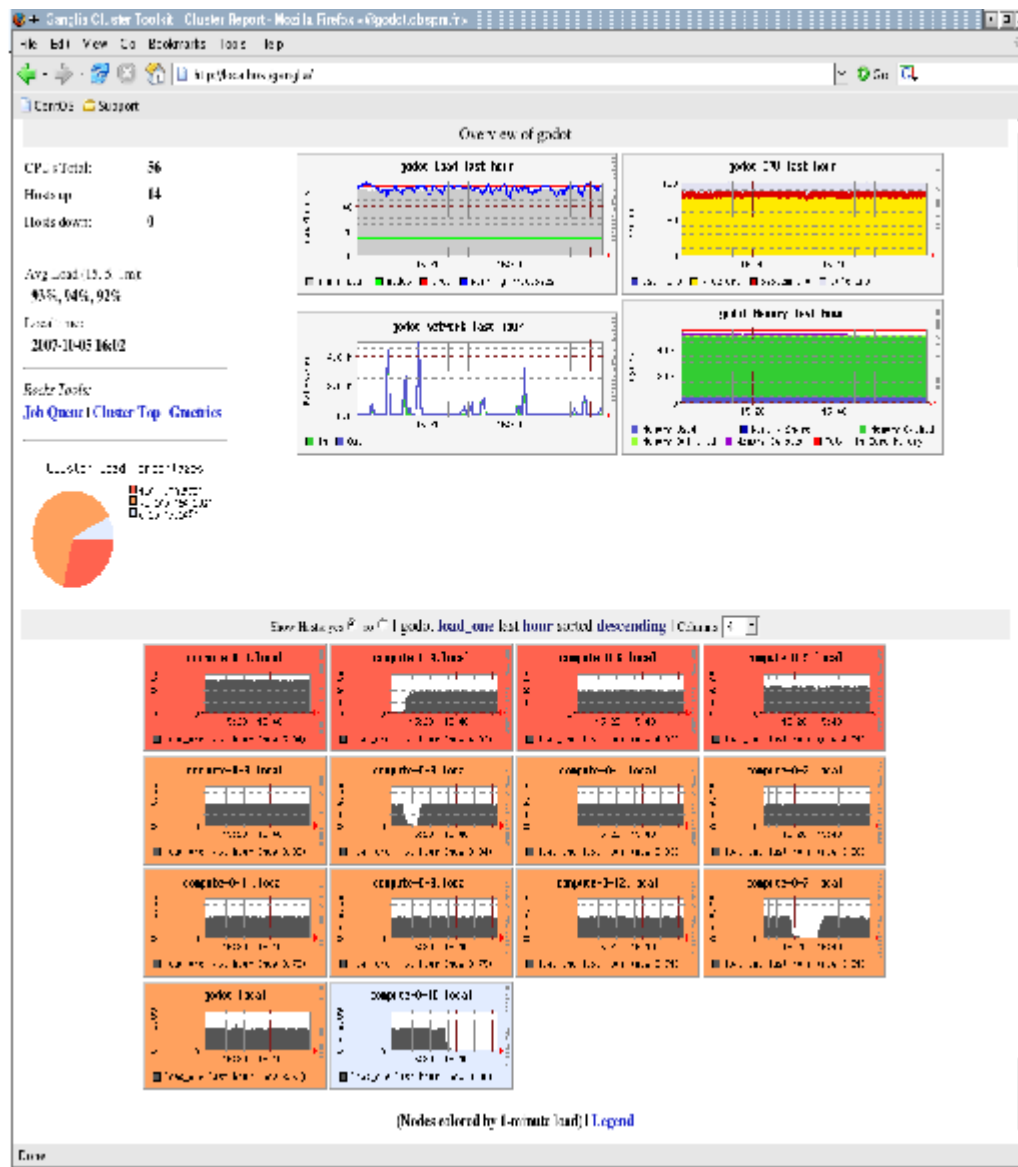


Compute Cluster GODOT - hardware

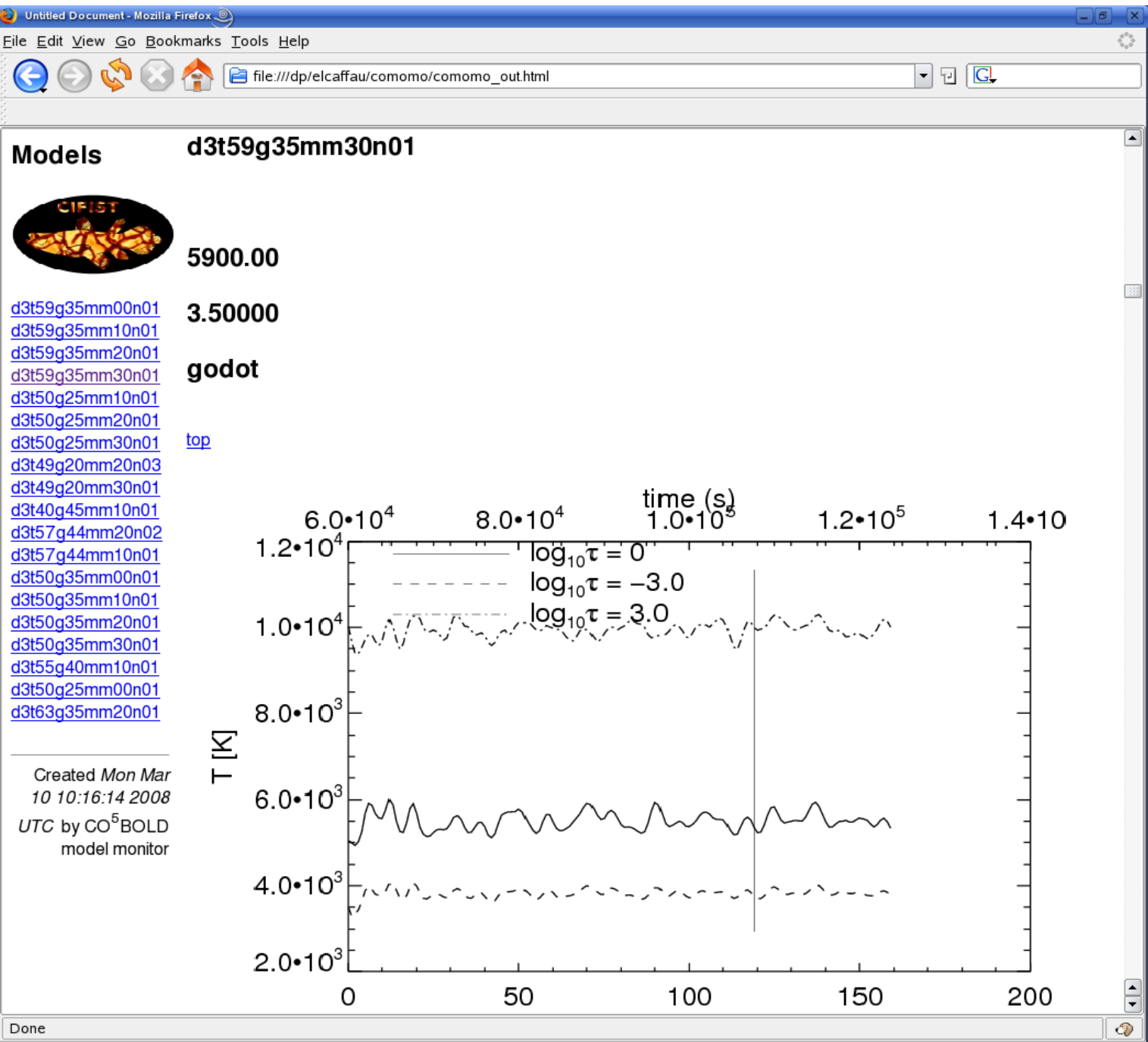


- *14 identical PCs, standard ethernet switch (1 Gb/s)*
- *2x dual core AMD Opteron processor 285, 2.6 Ghz, 4 Gb RAM, 120 Gb disk*

Compute Cluster GODOT - software



- *Rocks Cluster management system*
- *Centos Linux (free Red Hat Enterprise clone)*
- *inter-communication*
- *queuing system, load balancing*
- *job monitoring*
- *software maintenance across cluster nodes*



- *Allows users to check the availability or status of a 3D model*


- *Semi-automatic update*

Main page <http://www.galax.obspm.fr/CIFIST/>


CIFIST - Cosmological Impact of the First STars - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://dasgal.obspm.fr/CIFIST/cifist_home_page.html




CIFIST - Cosmological Impact of the First STars



Welcome to the CIFIST website

Latest CIFIST News

The Team is now complete! go to the [Team Members](#) page for more details.



The CIFIST project

CIFIST - standing for the Cosmological Impact of the First STars - is a research team financed by the European Commission through a Marie Curie Excellence grant (for more information see the [MC EXT Programme Handbook](#)) within the Sixth Framework Programme (FP6). The CIFIST Project's main objective is to study the properties of the first generation of stars which were an important source of metals and ionizing photons, these in turn, have important bearings on the subsequent galaxy formation and evolution. The CIFIST Team is hosted by the Observatoire de Paris-Meudon. Its five members work in close collaboration with the scientists of the Observatoire, and began their activities on September 1st 2005.

The method of choice to meet the objectives of the CIFIST project is to study the ancient stars in the Milky Way and galaxies of the Local Group. The chemical composition of such stars is the fossil record of the galaxy as it was forged by the first generation of stars. The chemical abundance patterns in these stars pose important constraints on the properties of the first generation of stars, noticeably on their masses.

If stars of primordial chemical composition and low mass ($M < M_{\text{Sun}}$) were formed, they should still shine on the Main Sequence today. Although no such star has been found today, there are still good motivations to push the search to the very limits of our own Galaxy, to see if there indeed exists a critical metallicity ($Z \sim 2.5 \times 10^{-4} Z_{\text{Sun}}$) for the formation of low mass stars, as has been suggested theoretically.

The fields in which the CIFIST Team expects to make substantial advances are:

- High resolution spectroscopy for detailed chemical analysis of the most metal poor stars
- Accurate physical modeling of stellar atmospheres taking into account their three dimensional nature
- Exploitation of existing or upcoming large spectroscopic Surveys (noticeably SDSS and SEGUE) and planning of new ones

CIFIST is associated with the First Stars Team at Paris Observatory (GEPI): R. Cayrel, P. Francois, V. Hill, B. Lemasle, F. Spite and M. Spite.

Done

Last updated: 30 August 2007



CIFIST - Cosmological Impact of the First STars



3D models status (last database update 2007 10 08 12:33:21)

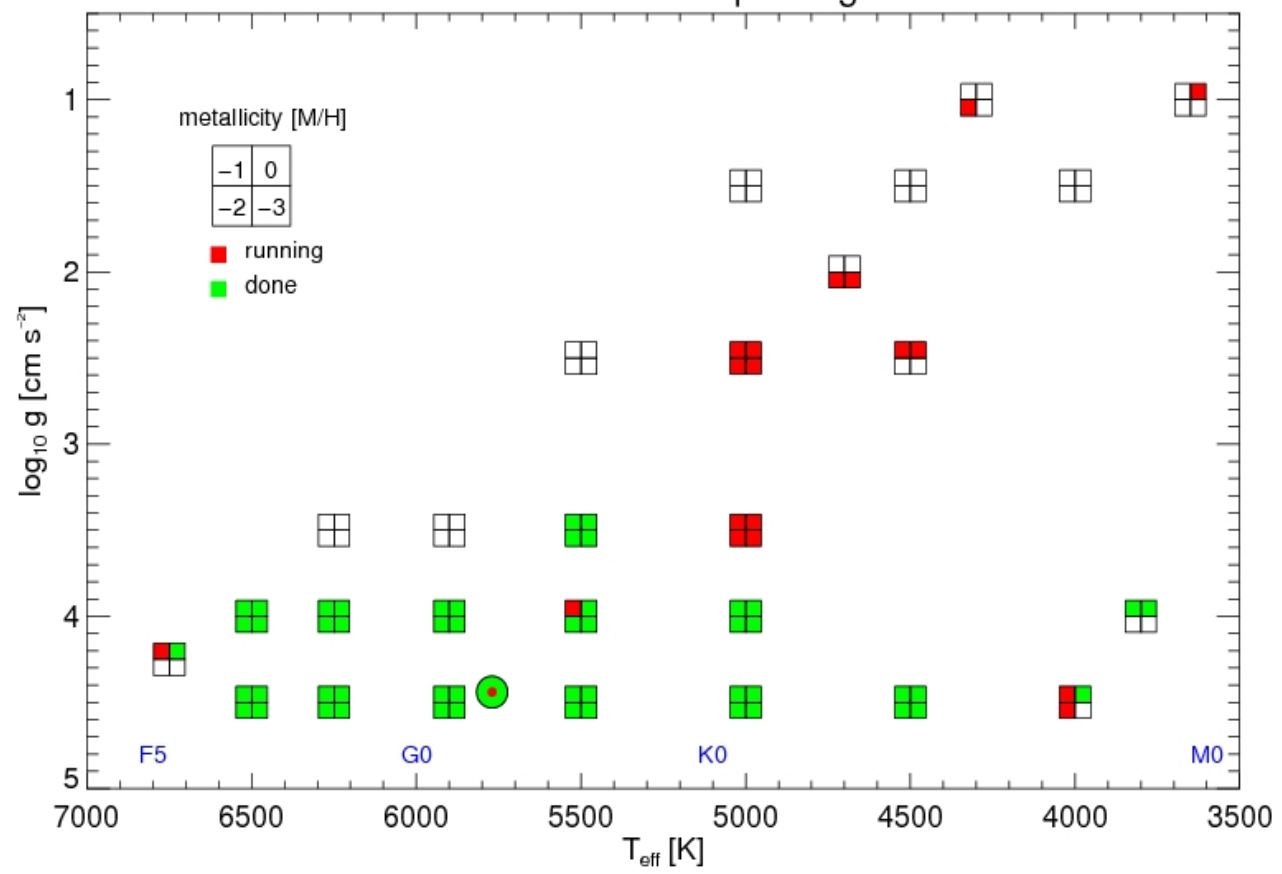
If it is your first time here see the page instructions!!!



Model status map (you can also go directly to the model list)

- Home
- Team Members
- Contact CIFIST
- Kick-Off Meeting
- Reports
- Publications
- Links
- Restricted Area

State of CIFIST 3D model atmosphere grid: 2008-02-17



Model list

Model name	T _{eff}	log g	[Fe/H]	Status	LHD	notes
d3t36g10m00	3600	1.0	00	SEL	no	8 snaps
d3t38g40mm00	3810	4.0	0.0	SEL	yes	20 snaps
d3t38g40mm10	3790	4.0	-1.0	SEL	no	20 snaps
d3t38g40mm00	3810	4.0	0.0	SEL	LHD	20 snaps
d3t40g45mm00	3960	4.5	0.0	SEL	yes	20 snaps
d3t45g45mm00	4510	4.5	0.0	SEL	no	21 snaps
d3t45g45mm10	4500	4.5	-1.0	SEL	no	20 snaps
d3t45g45mm20	4540	4.5	-2.0	SEL	no	20 snaps
d3t45g45mm30	4520	4.5	-3.0	SEL	no	20 snaps
d3t50g45mm00	4980	4.5	0.0	SEL	yes	20 snaps
d3t50g45mm10	5060	4.5	0.0	SEL	yes	19 snaps
d3t50g45mm20	5010	4.5	-2.0	SEL	no	20 snaps
d3t50g45mm30	4990	4.5	-3.0	SEL	no	20 snaps
d3t50g40mm00	4950	4.0	0.0	SEL	no	20 snaps
d3t50g40mm10	4980	4.0	-1.0	SEL	no	20 snaps
d3t50g40mm20	4960	4.0	-2.0	SEL	no	20 snaps
d3t50g40mm30	4990	4.0	-3.0	SEL	no	20 snaps
d3t50g35mm00	5000	3.5	0.0	RUN	-	-
d3t50g35mm10	5000	3.5	-1.0	RUN	-	-
d3t50g35mm20	5000	3.5	-2.0	RUN	-	-
d3t50g35mm30	5000	3.5	-3.0	RUN	-	-
d3t50g25mm00	5000	2.5	0.0	RUN	-	-
d3t50g25mm10	5000	2.5	-1.0	RUN	-	-
d3t50g25mm20	5000	2.5	-2.0	RUN	-	-
d3t50g25mm30	5000	2.5	-3.0	RUN	-	-
d3t55g45mm00	5490	4.5	0.0	SEL	no	20 snaps
d3t55g45mm10	5470	4.5	-1.0	SEL	no	20 snaps
d3t55g45mm20	5480	4.5	-2.0	SEL	no	20 snaps
d3t55g45mm30	5490	4.5	-3.0	SEL	no	20 snaps
d3t55g40mm00	5480	4.0	0.0	SEL	no	20 snaps



d3t50g45mm10n03

$T_{\text{eff}} = 5060 \text{ K}$
 $\text{Log } g = 4.50$
 $[\text{Fe}/\text{H}] = -1.00$
19 snapshots selected
 $\Delta t = 18.2\text{h}$
CIFIST abundances

Plots

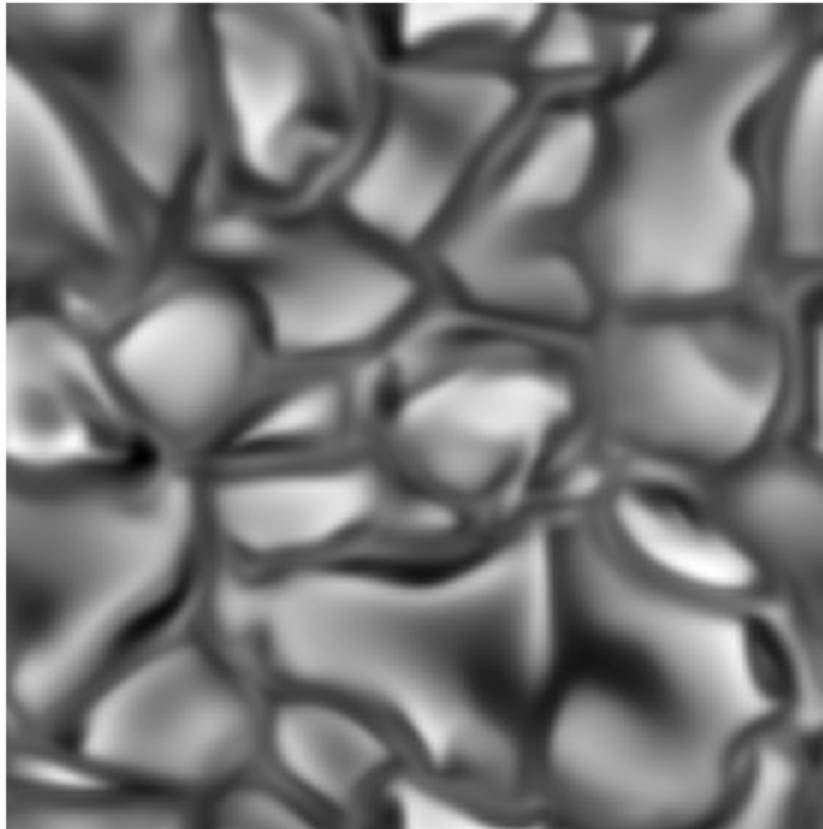
[1D LHD Models](#)

[Publications](#)

[Additional Material](#)

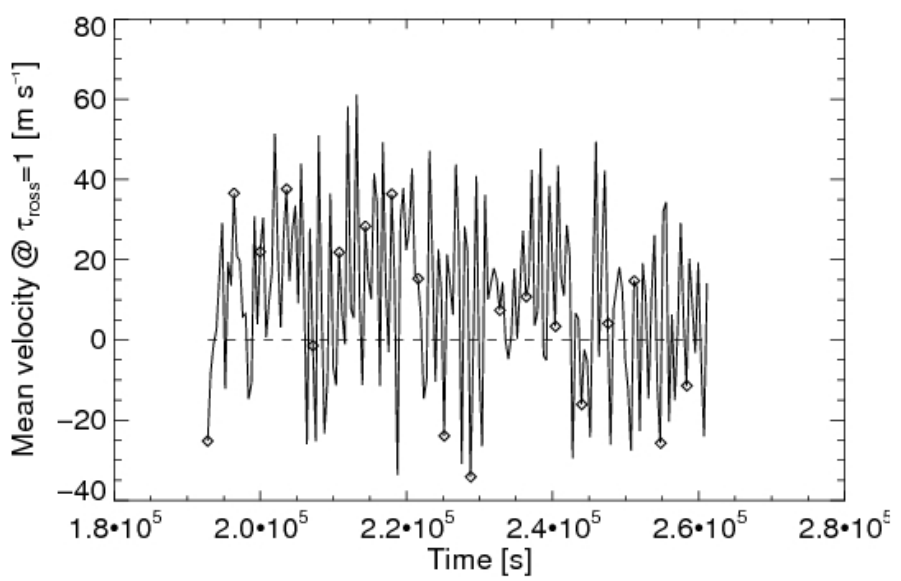
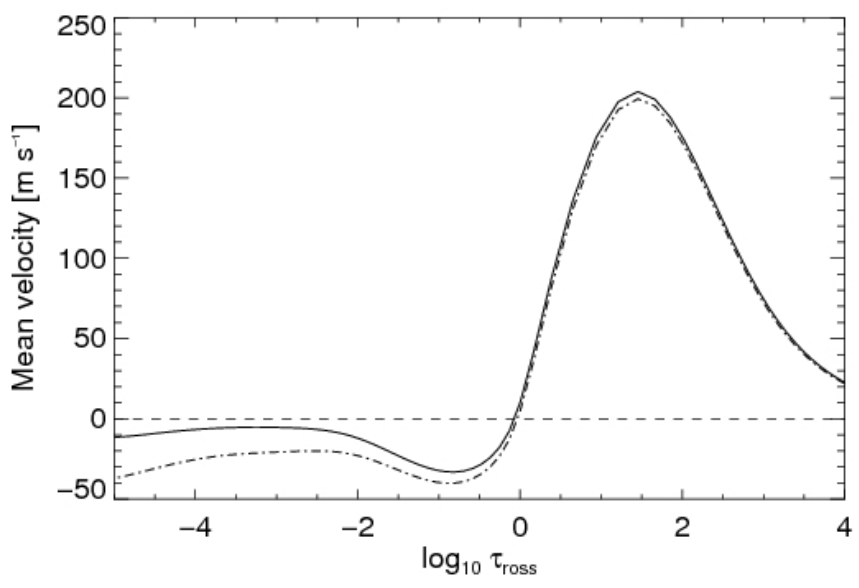
Full model parameters

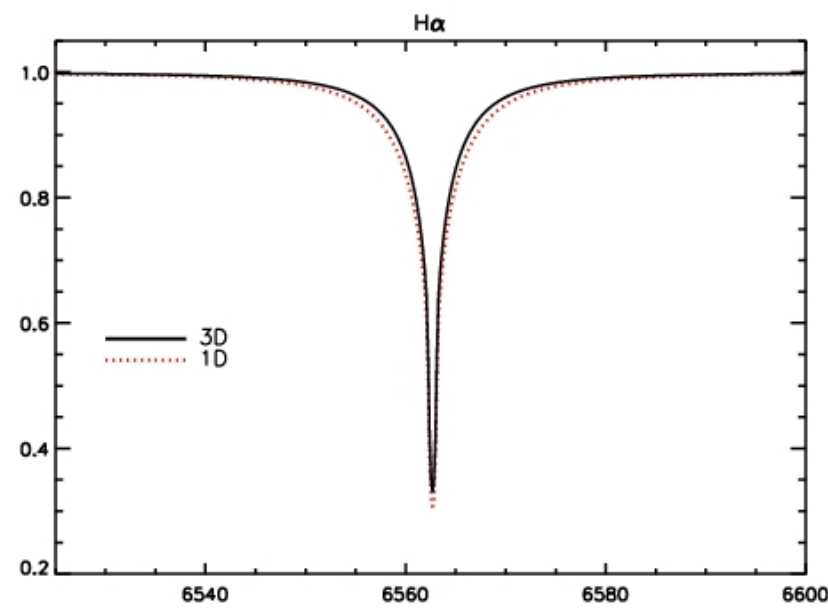
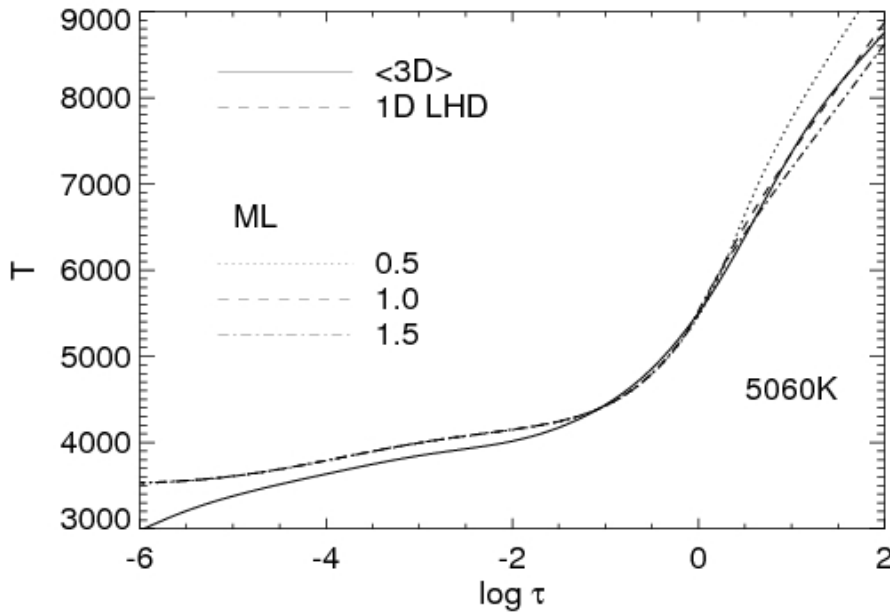
Box dimension: 5084.46 x 5084.46 x 2477.64 km
Grid resolution: 140 x 140 x 141
Typical size of granulation pattern: 726 km
Typical lifetime of granulation pattern: 15.1 s
RMS of the contrast: 0.0872575
Numbers of opacity bins used in the radiative transfer: 6

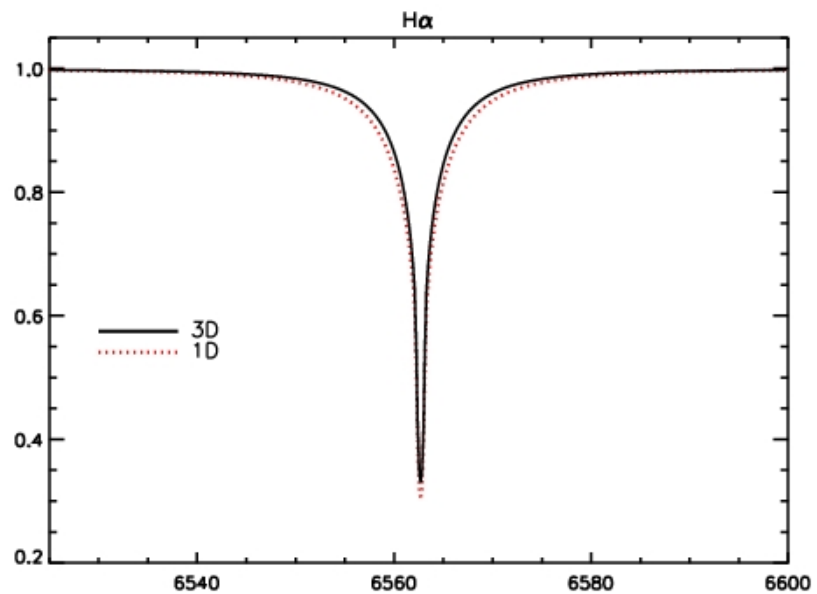


[top](#)

Plots







[top](#)

Associated LHD Models

Reference 1D LHD models. The parameter α refers to the mixing-length.

$\alpha = 0.5$	$\alpha = 1.0$	$\alpha = 1.5$	$\alpha = 2.0$
t5060g45mm10	t5060g45mm10	t5060g45mm10	t5060g45mm10

[top](#)

Related Publications

Caffau, Sbordone, Ludwig, Bonifacio, Steffen, Behara

The solar photospheric abundance of hafnium and thorium: Results from co5bold 3D model atmospheres
Astronomy and Astrophysics, 2008, submitted

Behara, Ludwig, Bonifacio et al.

Stellar effective temperatures derived from the analysis of balmer line profiles in 3D metal-poor stars
2008, in preparation