TOUCAN

A distributed framework for asteroseismology models

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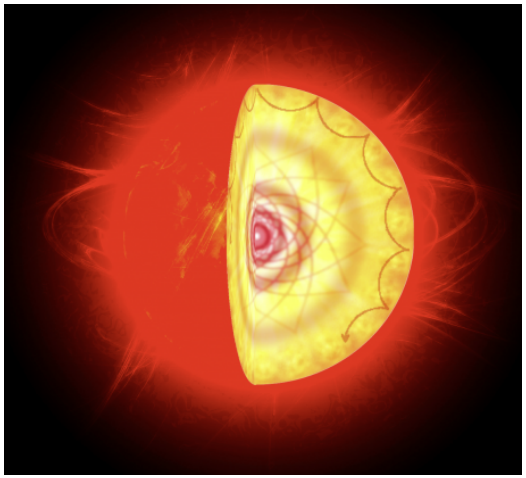
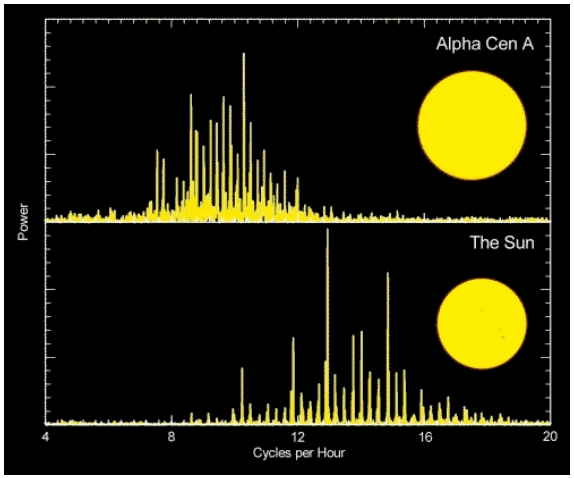
Introduction: Motivation

- Asteroseismology allows to infer stellar properties using their oscillation spectra.
- In the last decades space missions like SOHO, MOST, CoRoT, Kepler and SDO have caused a dramatic increase of the asteroseismic and related data.
- Future missions plan to increase in orders of magnitude the asteroseismic data to be analysed (like PLATO).



(http://irfu.cea.fr



(hao.ucar.edu)

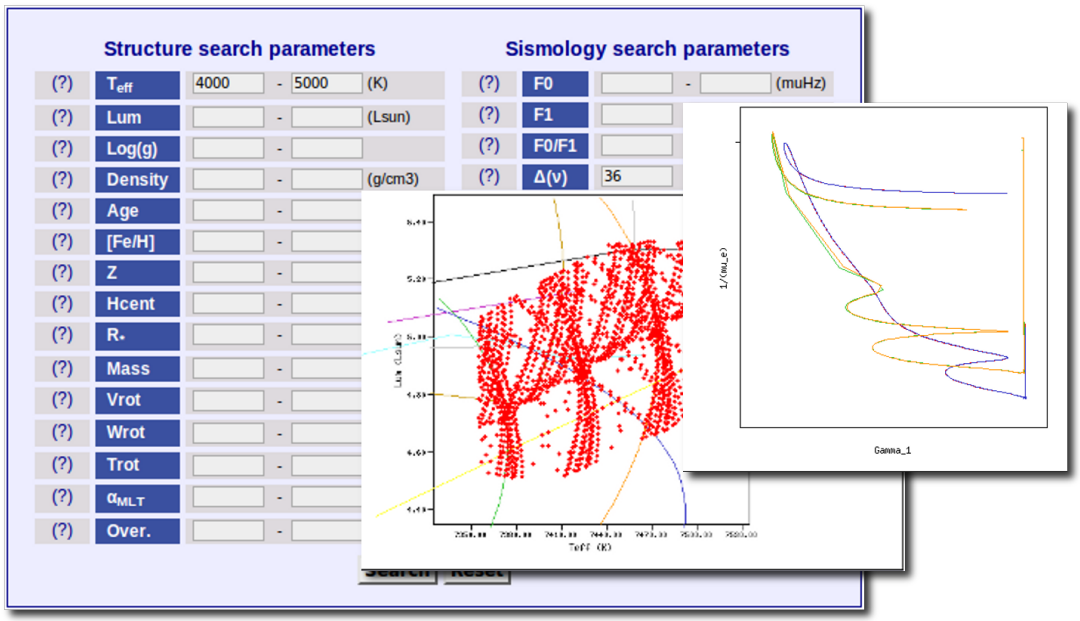
Introduction: Motivation

- Analysis of all space and ground-based associated data requires **theoretical models** developed by different groups,
  - with different codes,
  - different numerical approximations,
  - different physical definitions,
  - different output formats,
  - etc.
- This lack of homogeneity makes it difficult to design automatic tools to simultaneously work with different models and/or applications able to use the models on the fly.

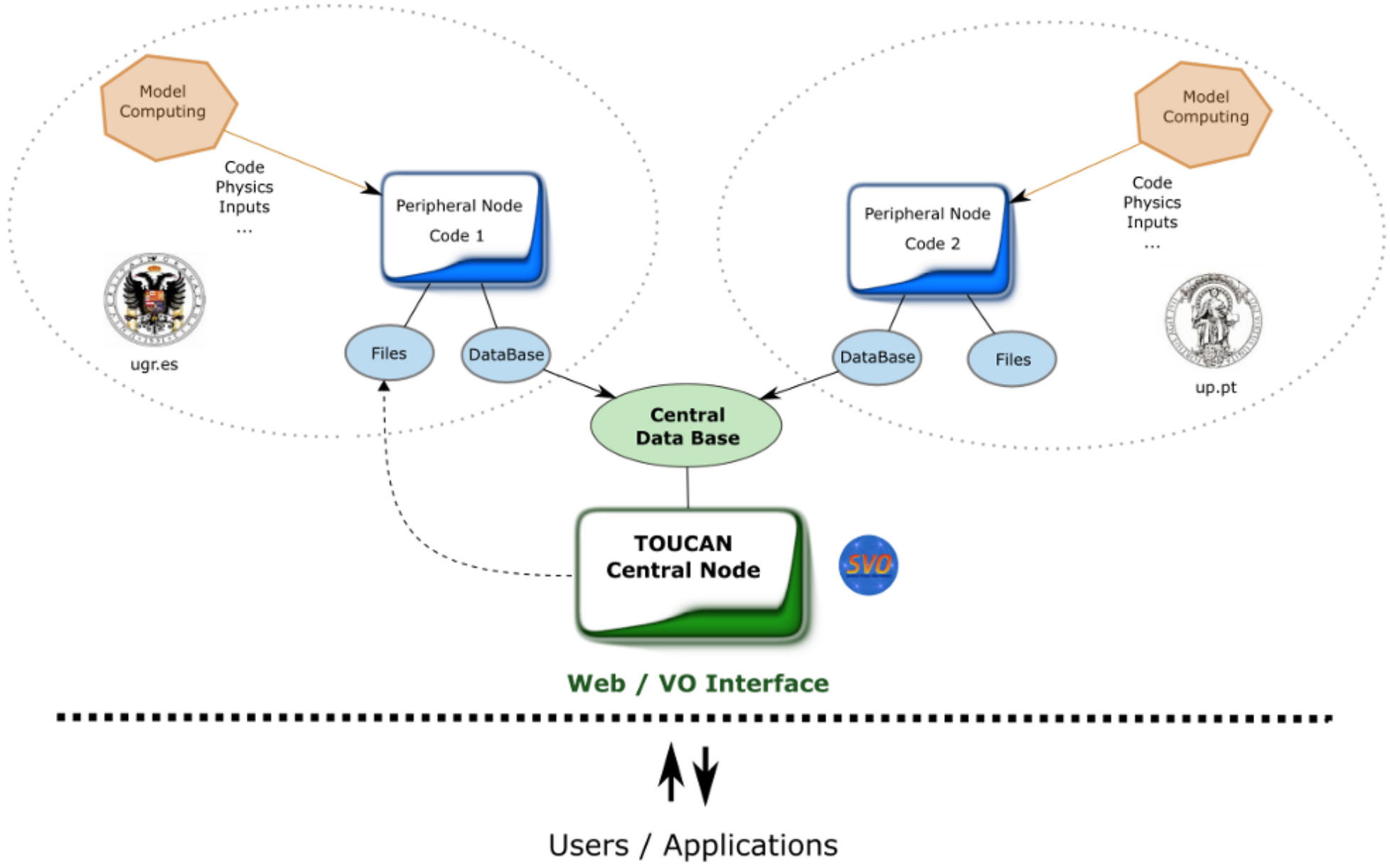
Introduction

- a distributed framework to handle asteroseismology simulations.
- Compare different models.
- Compare models with observations.
- Using VO approach.
- Testing Grid an Cloud technologies.

Introduction



Based on the previous work for VOTA (VO Tool for Asteroseismology).


Model Computing
Code Physics Inputs ...
Peripheral Node Code 1
ugr.es
Files
DataBase
Model Computing
Code Physics Inputs ...
Peripheral Node Code 2
DataBase
Files
up.pt
Central Data Base
TOUCAN Central Node
SVO
Web / VO Interface
Users / Applications

Each model/simulation/data collection:

- A different code, physics, algorithms...
- Contains $\sim 10^6$ results (*outputDataSets*).

Each result:

- Global metadata
  - Stellar metadata
  - Oscillations metadata
- A stellar structure file.
- A oscillation spectrum.

Global metadata:

- Stellar global properties/metadata:
  - Teff, Luminosity, Log(g), Density, Age, FeH, Z, Hcent, Radius, Mass, Vrot, Wrot, Trot, Alpha, Overshooting
- Seismology global properties/metadata:
  - F0, F1, F0/F1,
  - $\Delta\nu$ (large separation), $\delta\nu$ (small separation)
- These metadata, for all models, are kept in Central Toucan Database.
- They are the relevant parameters for discovery queries.

CESAM2k evolutionary code + GraCo oscillation code

You can search the database in terms of several parameters (move your mouse over the (?) symbol to see a description and the available range of values for each one).

- Please, select a range for each parameter that you want to use in the search and then click the "Search" button to retrieve a list of the available files.
- Take into account that some combinations of values could correspond to no result.

Structure search parameters

(?)	T_{eff}	4000	5000	(K)	
(?)	Lum			(Lsun)	
(?)	Log(g)				
(?)	Density			(g/cm3)	
(?)	Age			(Myr)	
(?)	[Fe/H]				
(?)	Z				
(?)	Hcent				
(?)	R•			(Rsun)	
(?)	Mass			(Msun)	
(?)	Vrot			cm/s	
(?)	Wrot			rad/s	
(?)	Trot			sec	
(?)	α_{MLT}				
(?)	Over.				

Sismology search parameters

(?)	F0			(muHz)	
(?)	F1			(muHz)	
(?)	F0/F1				
(?)	Δ(v)	25	30	(muHz)	
(?)	δ(v)			(muHz)	
(?)	[v]			(muHz)	
(?)	[l]				
(?)	[n]				
(?)	Sta.	all modes			
(?)	v_{Sta}			(muHz)	

Search Reset

Results table

Summary | New Search | Restart

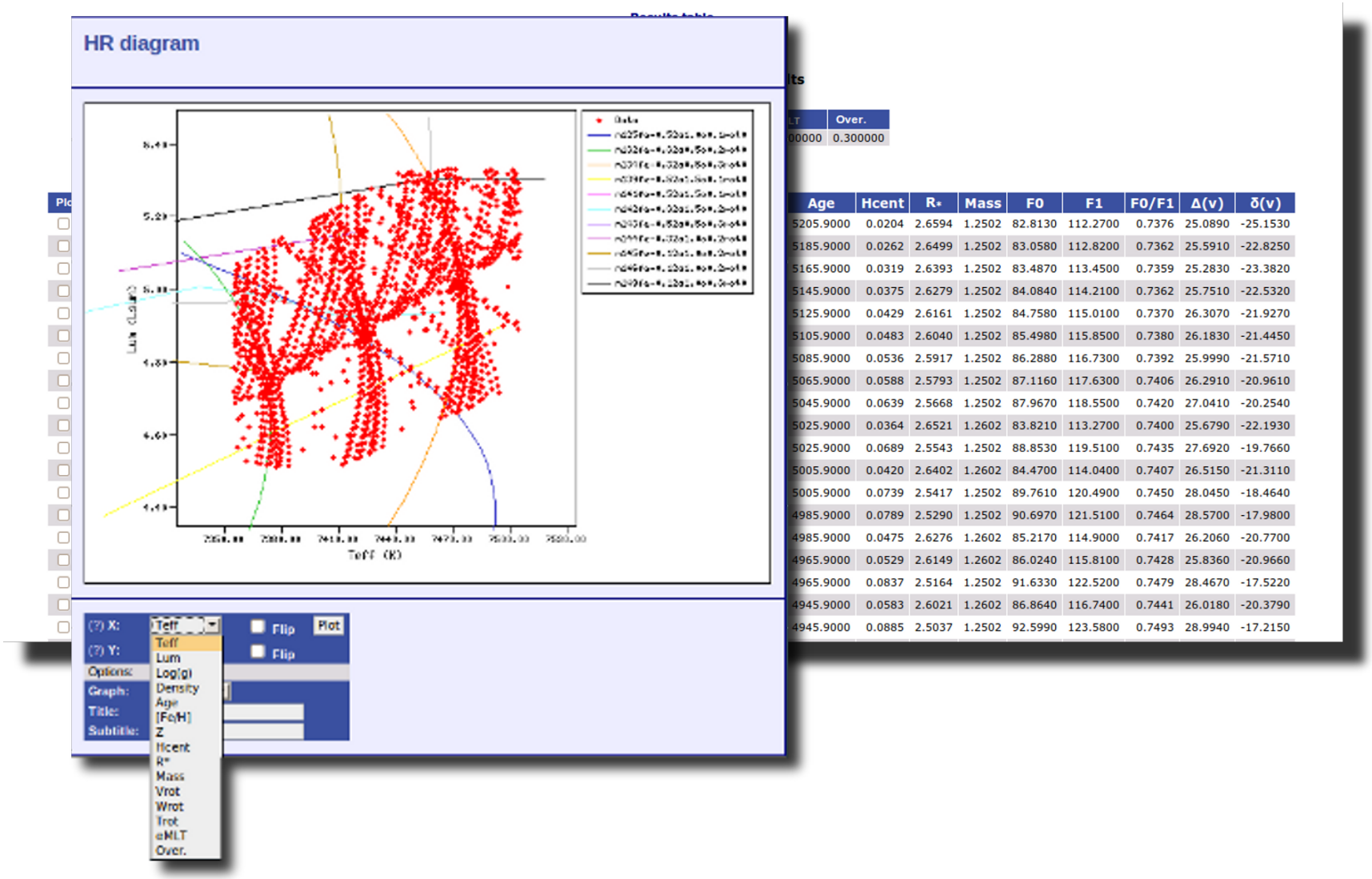
Values common to all shown results

[Fe/H]	Z	Vrot	Wrot	Trot	α_{MLT}	Over.
0.080000	0.020592	0.000000	0.000000	0.000000	0.500000	0.300000

Page: 1 2 Next Results

Mark All | Unmark All | Retrieve | Plot

Plot	VOT	Txt	VOT		Txt		Track	Fileid	T_{eff}	Lum	Log(g)	Density	Age	Hcent	R_*	Mass	F0	F1	F0/F1	Δ(v)	δ(v)
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0272	4813.3000	3.4078	3.6856	0.0938	5205.9000	0.0204	2.6594	1.2502	82.8130	112.2700	0.7376	25.0890	-25.1530
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0271	4806.2000	3.3639	3.6887	0.0948	5185.9000	0.0262	2.6499	1.2502	83.0580	112.8200	0.7362	25.5910	-22.8250
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0270	4805.4000	3.3348	3.6921	0.0960	5165.9000	0.0319	2.6393	1.2502	83.4870	113.4500	0.7359	25.2830	-23.3820
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0269	4808.4000	3.3144	3.6959	0.0972	5145.9000	0.0375	2.6279	1.2502	84.0840	114.2100	0.7362	25.7510	-22.5320
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0268	4814.0000	3.2998	3.6998	0.0986	5125.9000	0.0429	2.6161	1.2502	84.7580	115.0100	0.7370	26.3070	-21.9270
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0267	4821.3000	3.2892	3.7038	0.0999	5105.9000	0.0483	2.6040	1.2502	85.4980	115.8500	0.7380	26.1830	-21.4450
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0266	4829.8000	3.2814	3.7079	0.1014	5085.9000	0.0536	2.5917	1.2502	86.2880	116.7300	0.7392	25.9990	-21.5710
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0265	4839.3000	3.2757	3.7121	0.1028	5065.9000	0.0588	2.5793	1.2502	87.1160	117.6300	0.7406	26.2910	-20.9610
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0264	4849.5000	3.2715	3.7163	0.1043	5045.9000	0.0639	2.5668	1.2502	87.9670	118.5500	0.7420	27.0410	-20.2540
☐	☐	☐	cesam2k	graco	cesam2k	graco	m126fe0.08a0.5o0.3rot0	0263	4827.1000	3.4284	3.6914	0.0953	5025.9000	0.0364	2.6521	1.2602	83.8210	113.2700	0.7400	25.6790	-22.1930
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0263	4860.3000	3.2685	3.7206	0.1059	5025.9000	0.0689	2.5543	1.2502	88.8530	119.5100	0.7435	27.6920	-19.7660
☐	☐	☐	cesam2k	graco	cesam2k	graco	m126fe0.08a0.5o0.3rot0	0262	4832.2000	3.4119	3.6953	0.0966	5005.9000	0.0420	2.6402	1.2602	84.4700	114.0400	0.7407	26.5150	-21.3110
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0262	4871.5000	3.2664	3.7249	0.1075	5005.9000	0.0739	2.5417	1.2502	89.7610	120.4900	0.7450	28.0450	-18.4640
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0261	4883.1000	3.2649	3.7292	0.1091	4985.9000	0.0789	2.5290	1.2502	90.6970	121.5100	0.7464	28.5700	-17.9800
☐	☐	☐	cesam2k	graco	cesam2k	graco	m126fe0.08a0.5o0.3rot0	0261	4839.4000	3.3999	3.6994	0.0980	4985.9000	0.0475	2.6276	1.2602	85.2170	114.9000	0.7417	26.2060	-20.7700
☐	☐	☐	cesam2k	graco	cesam2k	graco	m126fe0.08a0.5o0.3rot0	0260	4848.0000	3.3912	3.7037	0.0995	4965.9000	0.0529	2.6149	1.2602	86.0240	115.8100	0.7428	25.8360	-20.9660
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0260	4895.0000	3.2640	3.7336	0.1107	4965.9000	0.0837	2.5164	1.2502	91.6330	122.5200	0.7479	28.4670	-17.5220
☐	☐	☐	cesam2k	graco	cesam2k	graco	m126fe0.08a0.5o0.3rot0	0259	4857.7000	3.3848	3.7079	0.1010	4945.9000	0.0583	2.6021	1.2602	86.8640	116.7400	0.7441	26.0180	-20.3790
☐	☐	☐	cesam2k	graco	cesam2k	graco	m125fe0.08a0.5o0.3rot0	0259	4907.2000	3.2634	3.7379	0.1124	4945.9000	0.0885	2.5037	1.2502	92.5990	123.5800	0.7493	28.9940	-17.2150


HR diagram
Log (L/Lsun)
Teff (K)
(?) X:
Teff
Flip
Plot
(?) Y:
Flip
Options:
Graph:
Title:
Subtitle:
Teff
Lum
Log(g)
Density
Age
[Fe/H]
Z
Hcent
R*
Mass
Vrot
Wrot
Trot
eMLT
Over.
Over.
0.300000
Age Hcent R* Mass F0 F1 F0/F1 Δ(ν) δ(ν)
5205.9000 0.0204 2.6594 1.2502 82.8130 112.2700 0.7376 25.0890 -25.1530
5185.9000 0.0262 2.6499 1.2502 83.0580 112.8200 0.7362 25.5910 -22.8250
5165.9000 0.0319 2.6393 1.2502 83.4870 113.4500 0.7359 25.2830 -23.3820
5145.9000 0.0375 2.6279 1.2502 84.0840 114.2100 0.7362 25.7510 -22.5320
5125.9000 0.0429 2.6161 1.2502 84.7580 115.0100 0.7370 26.3070 -21.9270
5105.9000 0.0483 2.6040 1.2502 85.4980 115.8500 0.7380 26.1830 -21.4450
5085.9000 0.0536 2.5917 1.2502 86.2880 116.7300 0.7392 25.9990 -21.5710
5065.9000 0.0588 2.5793 1.2502 87.1160 117.6300 0.7406 26.2910 -20.9610
5045.9000 0.0639 2.5668 1.2502 87.9670 118.5500 0.7420 27.0410 -20.2540
5025.9000 0.0364 2.6521 1.2602 83.8210 113.2700 0.7400 25.6790 -22.1930
5025.9000 0.0689 2.5543 1.2502 88.8530 119.5100 0.7435 27.6920 -19.7660
5005.9000 0.0420 2.6402 1.2602 84.4700 114.0400 0.7407 26.5150 -21.3110
5005.9000 0.0739 2.5417 1.2502 89.7610 120.4900 0.7450 28.0450 -18.4640
4985.9000 0.0789 2.5290 1.2502 90.6970 121.5100 0.7464 28.5700 -17.9800
4985.9000 0.0475 2.6276 1.2602 85.2170 114.9000 0.7417 26.2060 -20.7700
4965.9000 0.0529 2.6149 1.2602 86.0240 115.8100 0.7428 25.8360 -20.9660
4965.9000 0.0837 2.5164 1.2502 91.6330 122.5200 0.7479 28.4670 -17.5220
4945.9000 0.0583 2.6021 1.2602 86.8640 116.7400 0.7441 26.0180 -20.3790
4945.9000 0.0885 2.5037 1.2502 92.5990 123.5800 0.7493 28.9940 -17.2150

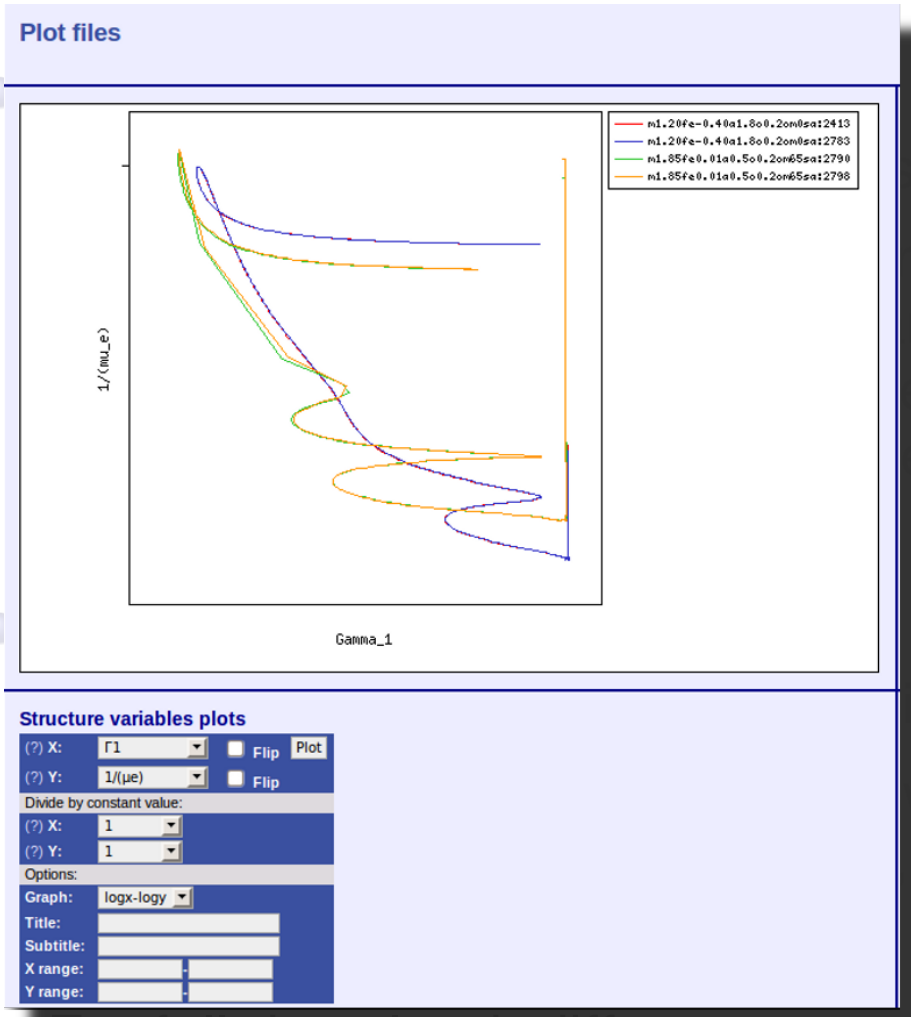
Data files:

- Structure file:
  - A lot of properties at different stellar shells:
  - radius, Log(Mass), Temperature, Pressure, Density, dlnT/dlnP, Luminosity, Rosseland opacity, Thermonuclear energy, Cp=Specific heat, 1/me, A Väisälä, Γ_1=dln(P)/dln(ρ), ∇ Adiabatic, etc..

- Oscillation spectrum:
  - Properties for the different oscillation modes:
  - n, l, m, ν (frequency), w0, w1, w2, wtot, I0, Period, Q, Kinetic Energy, Phase Lag, δT, δg, NP, NG, η, Stability...

- For full download, different cutouts or visualization.

Data files:


Plot files
m1.20fe-0.40a1.8o0.2om0sa:2413
m1.20fe-0.40a1.8o0.2om0sa:2783
m1.85fe0.01a0.5o0.2om65sa:2790
m1.85fe0.01a0.5o0.2om65sa:2798
1/(mu_e)
Gamma_1
Structure variables plots
(?) X: Γ1
Flip
Plot
(?) Y: 1/(μe)
Flip
Divide by constant value:
(?) X: 1
(?) Y: 1
Options:
Graph: logx-logy
Title:
Subtitle:
X range:
Y range:

Internal Data Model

Evolution model

Global variables

- T_{eff}
- Luminosity
- Log(g)
- Density
- Age
- FeH
- Z
- H_{cent}
- Radius
- Mass
- V_{cst}
- W_{cst}
- T_{rot}
- Alpha
- Overshooting

Shell properties (r)

- r
- Log(Mass)
- Temperature
- Pressure
- Density
- dlnT/dlnP
- Luminosity
- Rosseland opacity
- Thermonuclear energy
- Γ_1=dln(P)/dln(ρ)
- ∇ adiabatic
- δ=- dlnρ / dlnT
- C_p=Specific heat
- $1/\mu_e$
- A Vaissala
- Ω
- dln κ/dln T
- dln κ/dln ρ
- dln ε/dln T
- dln ε/dln ρ
- P_{rot}/P_{gas}
- ∇ radiative
- $d\Gamma_1/dlogP$
- $d\Gamma_1/dlogT$
- $d\Gamma_1/dY$
- dP/dρ
- dP/dT
- dP/dX
- du/dρ
- du/dT

Oscillation model

General properties

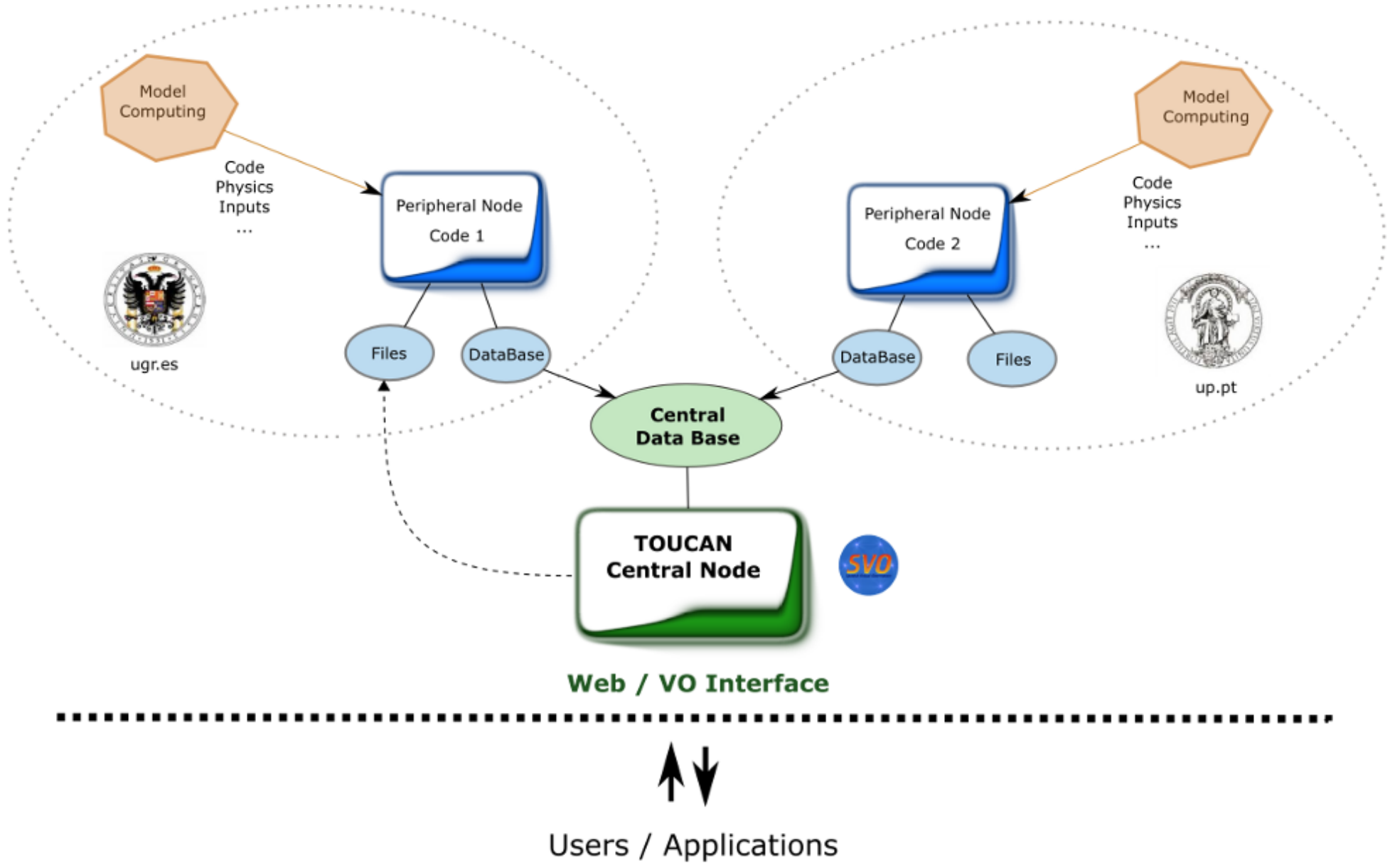
- F0
- F1
- F0/F1
- Δν=Large separation
- δν=Small separation

Conditions for the calculation of Δ(Δν) and Δ(δν)

- Mode ν range
- Mode l range
- Mode n range
- Mode stability

Mode properties (n,l,m)

- n
- l
- m
- ν (frequency)
- ω_0
- ω_1
- ω_2
- ω_{rot}
- I_0
- Period
- Q
- Kinetic Energy
- NP
- NG
- NP Shibahashi
- NG Shibahashi
- NG Shibahashi
- % G Energy
- Faselag
- δT
- δg
- Eta
- stability


Model Computing
Code Physics Inputs ...
Peripheral Node Code 1
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THANK YOU!