

# Methods for stellar parameter estimation

## Impact of asteroseismology

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# An estimation problem

## Stellar parameters

$$\boldsymbol{\theta} = (M, t_{\star}, Y_0, Z_0, \alpha, \alpha_{\text{OV}}^{(e,c)}, \dots)$$

- Stellar codes

## Data

$$\mathbf{X} = (T_{\text{eff}}, L, [\text{Fe}/\text{H}], R, (\nu)_{n,l}, \dots)$$

- Spectroscopy, Interferometry
- Asteroseismology

# Statistical methods

## Grid approaches

- CPU time

## Non-grid approaches

- More flexible
  
- Simple optimization
- Geneva, Padova, BaSTI, . . .

## Frequentist

- Maximum likelihood

## Bayesian

- Density estimation

# Statistical methods

## Grid approaches

- CPU time

## Non-grid approaches

- More flexible
  
- Integration over grid
- Geneva, Padova, BaSTI, . . .

## Frequentist

- Maximum likelihood

## Bayesian

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# Statistical methods

## Grid approaches

- CPU time

## Non-grid approaches

- More flexible

## Frequentist

- Maximum likelihood

## Bayesian

- Density estimation

- Levenberg-Marquardt, Genetic algorithms
- Miglio & Montalbán (2005), Metcalfe (2009)

# Statistical methods

## Grid approaches

- CPU time

## Non-grid approaches

- More flexible
  
- Markov chain Monte Carlo
- Bazot et al (2008, 2012)

## Frequentist

- Maximum likelihood

## Bayesian

- Density estimation

# Asteroseismology

How to use seismic data?

- Global constraint
- Detailed modelling

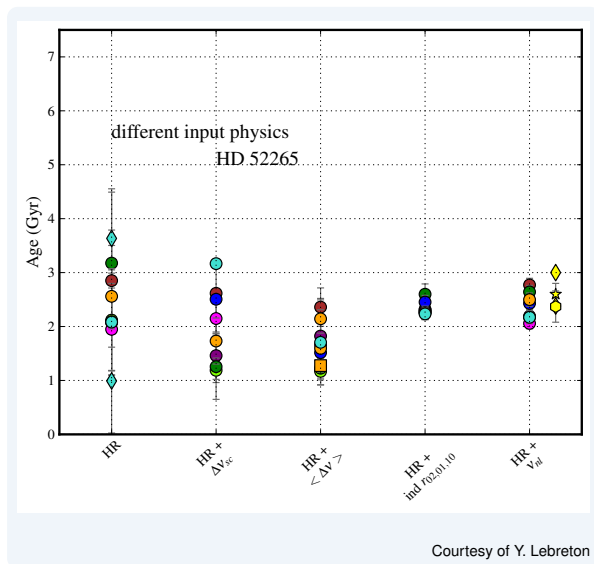
Possible discrepancies

- KIC 6106415 & KIC 12009504 (Silva Aguirre 2013)

Some estimates

- $\alpha$  Cen A (HARPS) :  $\Delta t_{\star}/t_{\star} = 10\%$  ( $\Delta M/M = 0.4\%$ )
- 16 Cyg (Kepler) :  $\Delta t_{\star}/t_{\star} \sim 5\%$ ,  $\Delta M/M \sim 0.6\%$
- HD 52265 (CoRoT)  $\Delta M/M \sim 1.5\%$

# An example : HD 52265





# Conclusion : rationale for PLATO

## Stellar physics/Asteroseismology

- Methodologies for stellar parameter estimation
- Precision on the parameters

## Stellar parameters for planetary systems

- Estimates of  $M_{\star} \rightarrow M_{\star}/M_p$
- Age estimates  $\rightarrow$  System dynamics
- Initial metallicity  $\rightarrow$  Planet formation