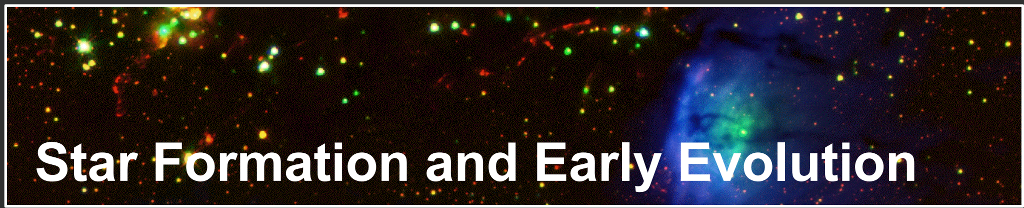
Origin and evolution of stars and planets



The Team is divided in 3 main lines of research.

CENTRO DE ASTROFÍSICA DA UNIVERSIDADE DO PORTO

www.astro.up.pt

Margarida Cunha

Team presentation

22 March 2013

Team

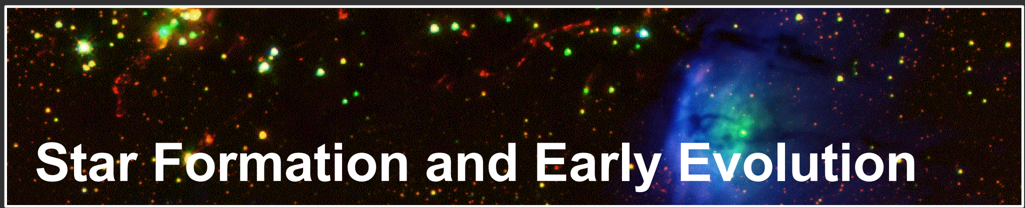
Members

- 23 Researchers
- 10 PhD students
- 7 Graduate (non-PhD) students

Important International collaborations

- ESO- GAIA Survey
- Planet search surveys (RV)
- CoRoT (Asteroseismology)
- Kepler Asteroseismic Science Consortium
- ESO-VISTA, Deep-GLIMPSE and UKIDS surveys
- Participation in planning / development of ground based instrumentation (ESPRESSO; HARPS-N; CODEX)
- Participation in consortia for planned space missions (PLATO; PlanetVision)

Origin and evolution of stars



Star Formation and Early Evolution

Case study

Formation of massive stars: observations confront theory

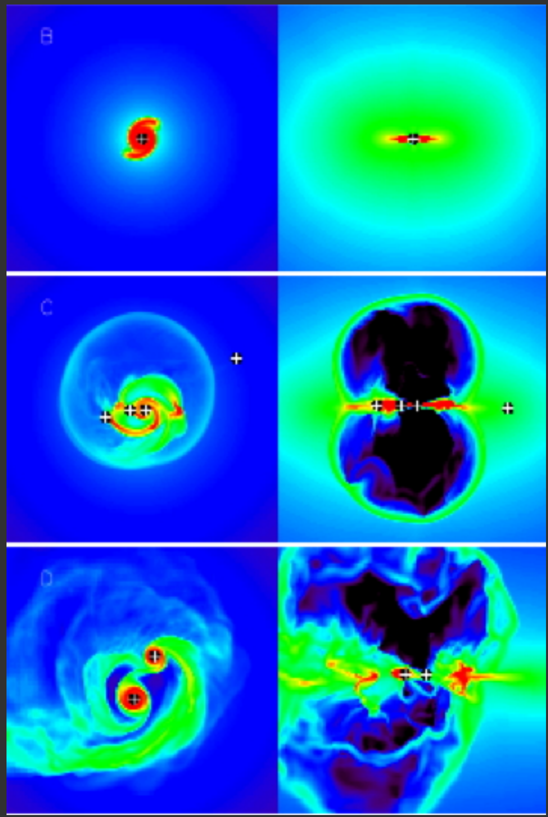
Case study

Formation of massive stars: observations confront theory

✧ Massive stars for rapidly in the densest cores and ignite hydrogen even as they are forming.

✧ Gravitational and Rayleigh-Taylor Instabilities set in leading to fragmentation and asymmetries in radiation-filled bubbles.

✧ Radiation can flow away while filaments of dense fluid continue to fall towards the star.



Krumholz et al., Science, 2009.

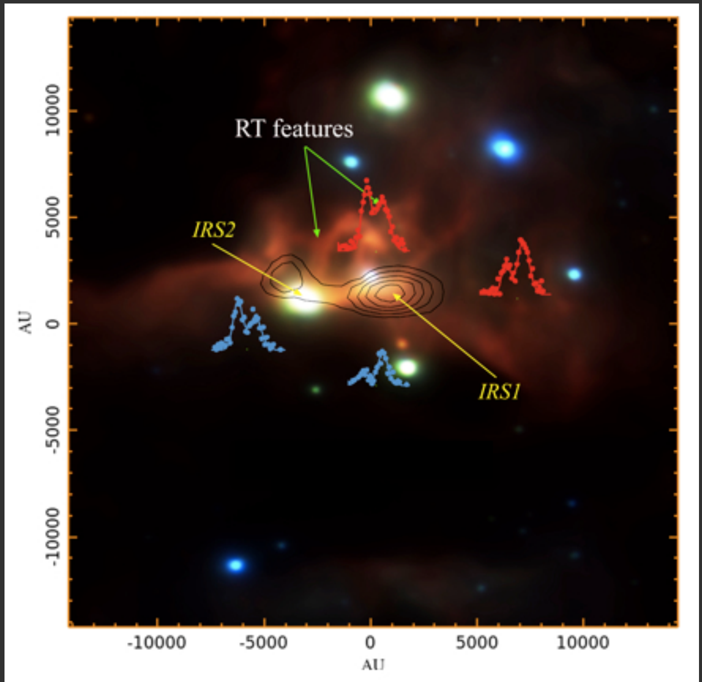
Case study

Formation of massive stars: observations confront theory

✧ Fragmentation and possible Rayleigh-Taylor instabilities are discovered with adaptive optics imaging at VLT (ESO).

✧ Temperatures of embedded objects (IRSI & IRS2) are high at 40000-50000 K.

✧ ALMA is now being used to study disks, kinematics, molecular emission.



Grave et al., submitted; Kumar et al., 2013

Asteroseismology:

Probing inside stars through the analysis of stellar oscillations

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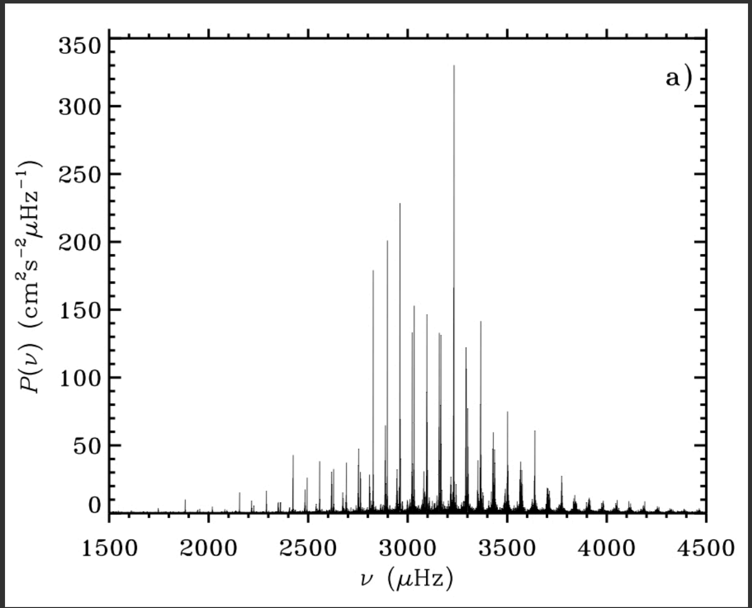
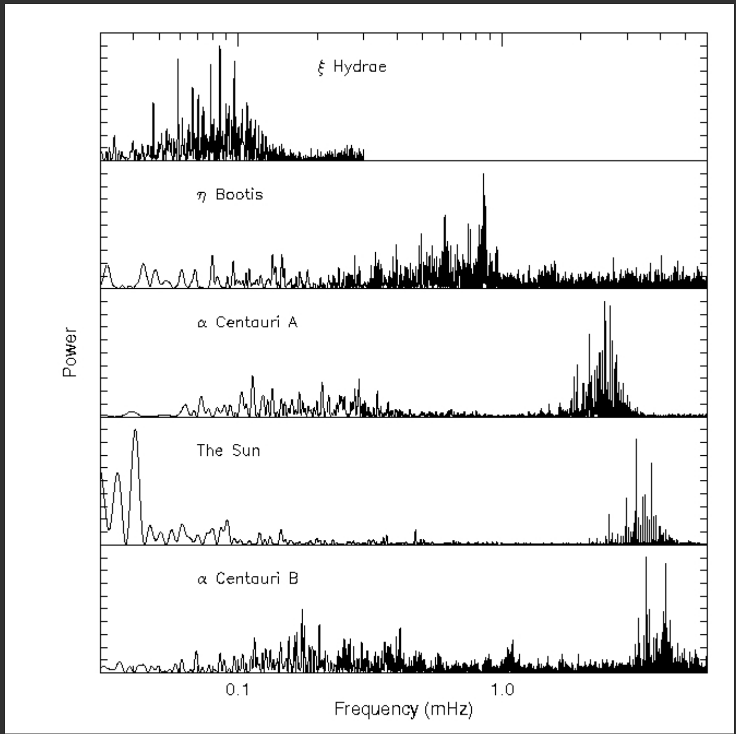
Probing inside stars through the analysis of stellar oscillations



BiSON solar data – Chaplin et al. 2007



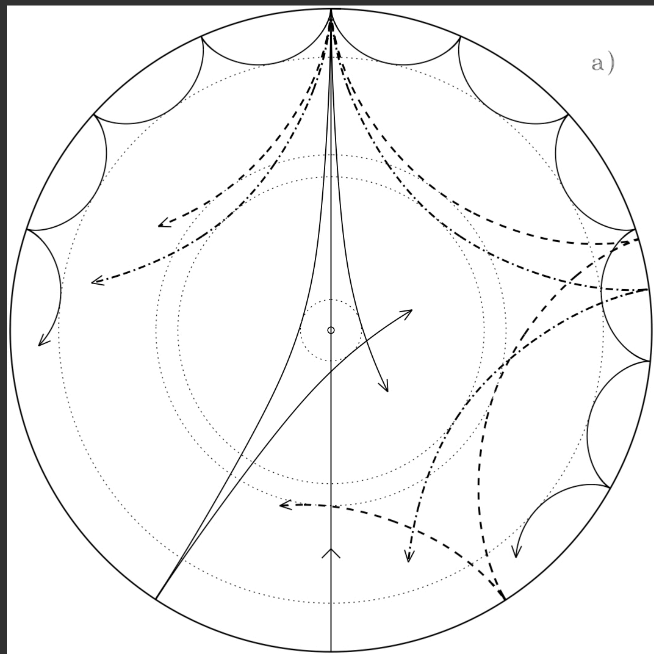
Cunha et al. 2007 with data collected from different authors

Asteroseismology:
Probing inside stars through the analysis of stellar oscillations

✧ Modes of different characteristic horizontal scale propagate in different cavities.

✧ Forward approach: universe of models within a given parameter space [*e.g.*, {M, X_0, Y_0, age, *etc.*}] and with a "given physics" [*e.g.*, κ, eq. of state, nuclear reaction rates, prescription for convection, *etc.*] => compare with observations

✧ Inverse approach: search for frequency combinations that provide localized averages of the structure.



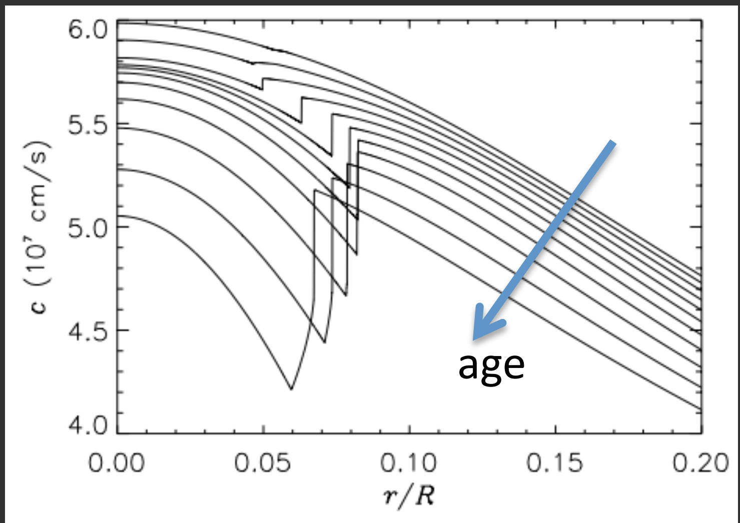
Acoustic ray paths – Cunha et al. 2007

Stellar Interiors and Atmospheres

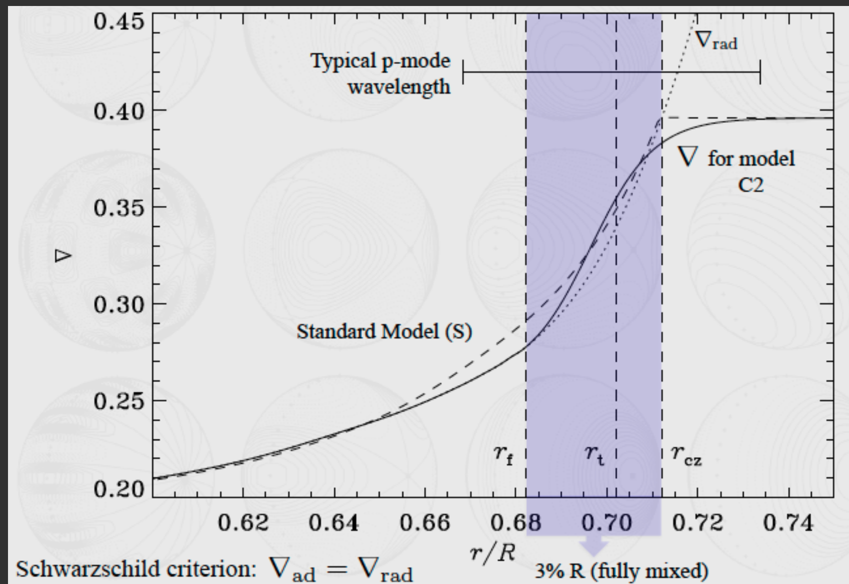
Asteroseismology:

Glitches: characterizing regions of rapid structural variation

1.3 Msun sequence



Convective core region – Cunha and Brandão, 2011



Base of convective envelope
Christensen-Dalsgaard, Monteiro et al., 2011

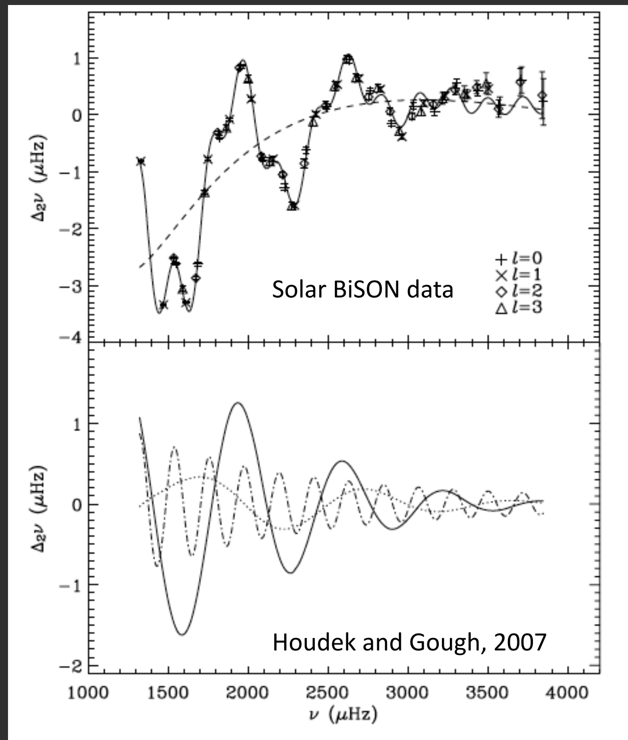
Asteroseismology:

Glitches: characterizing regions of rapid structural variation

$$\nu_{nl} = \nu^{s}_{nl} + \delta\nu^{env}_{nl} + \delta\nu^{c}_{nl}$$

$$\delta\nu^{env}_{nl} \sim A\cos\left[2\left(2\pi\nu_{nl}\tau_{d} + \varphi\right)\right]$$

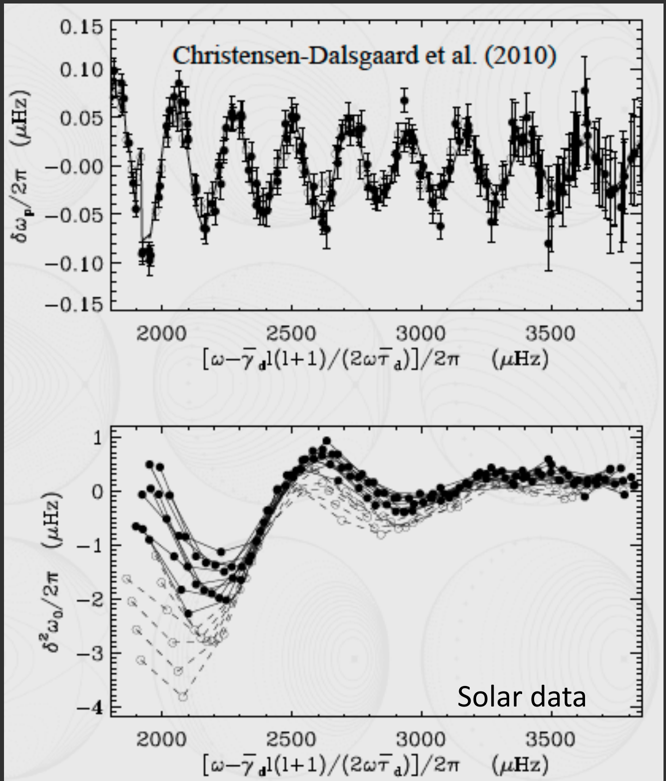
$$\tau_{d} = \tau(r_{d}) = \int_{r_{d}}^{R} \frac{dr}{c}$$

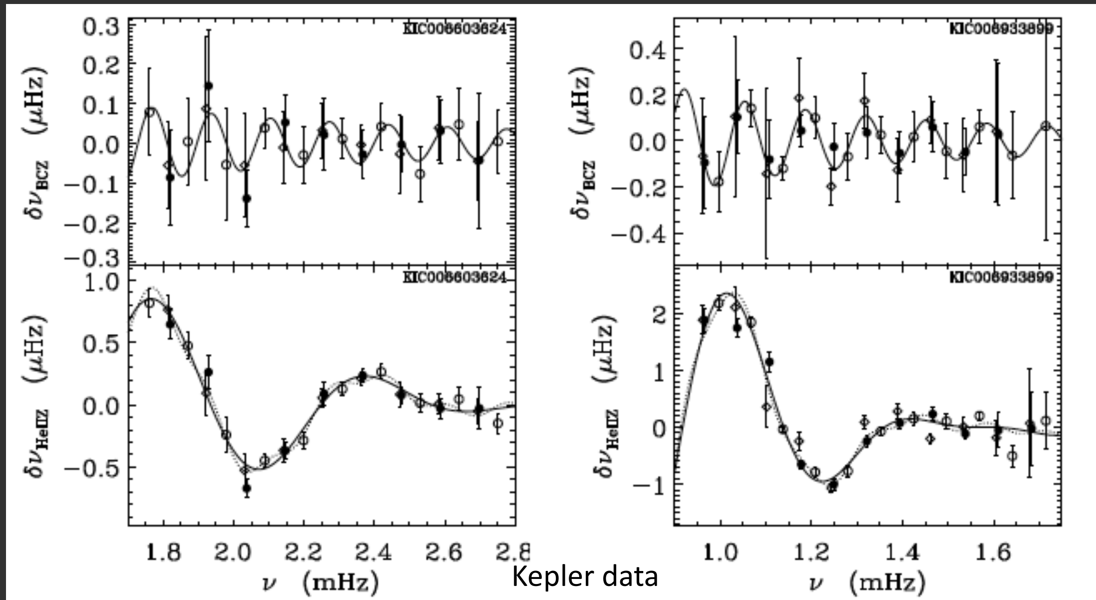


Stellar Interiors and Atmospheres

Asteroseismology:

Glitches: characterizing regions of rapid structural variation





Other topics of research
Examples

- ✧ Estimation of global stellar parameters [Teff; log g; metallicity] based on the analysis of stellar spectra.
- ✧ Coupling between magnetic fields pulsations.
- ✧ MCMC parameter space exploitation.
- ✧ Stellar activity and its relation with stellar ages.
- ✧ Jets / winds in young stars.
- ✧ Star-disk interaction and trace the YSO evolution