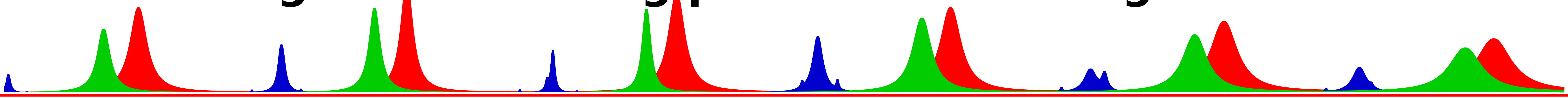
Evolution of the theoretical power spectrum of solar-like oscillations along the ascending phase on the red giant branch.



M.Grosjean[1,3], M.A. Dupret[1],K. Belkacem[2], J.Montalban[1], A. Noels[1], R. Samadi[2]

1 - Institut d'astrophysique, géophyisique et océanographie de l'Université de Liège,Belgium

2 - Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique, Observatoire de Paris-Meudon, France

3 - Docotrant, Boursier F.R.I.A.

Abstract

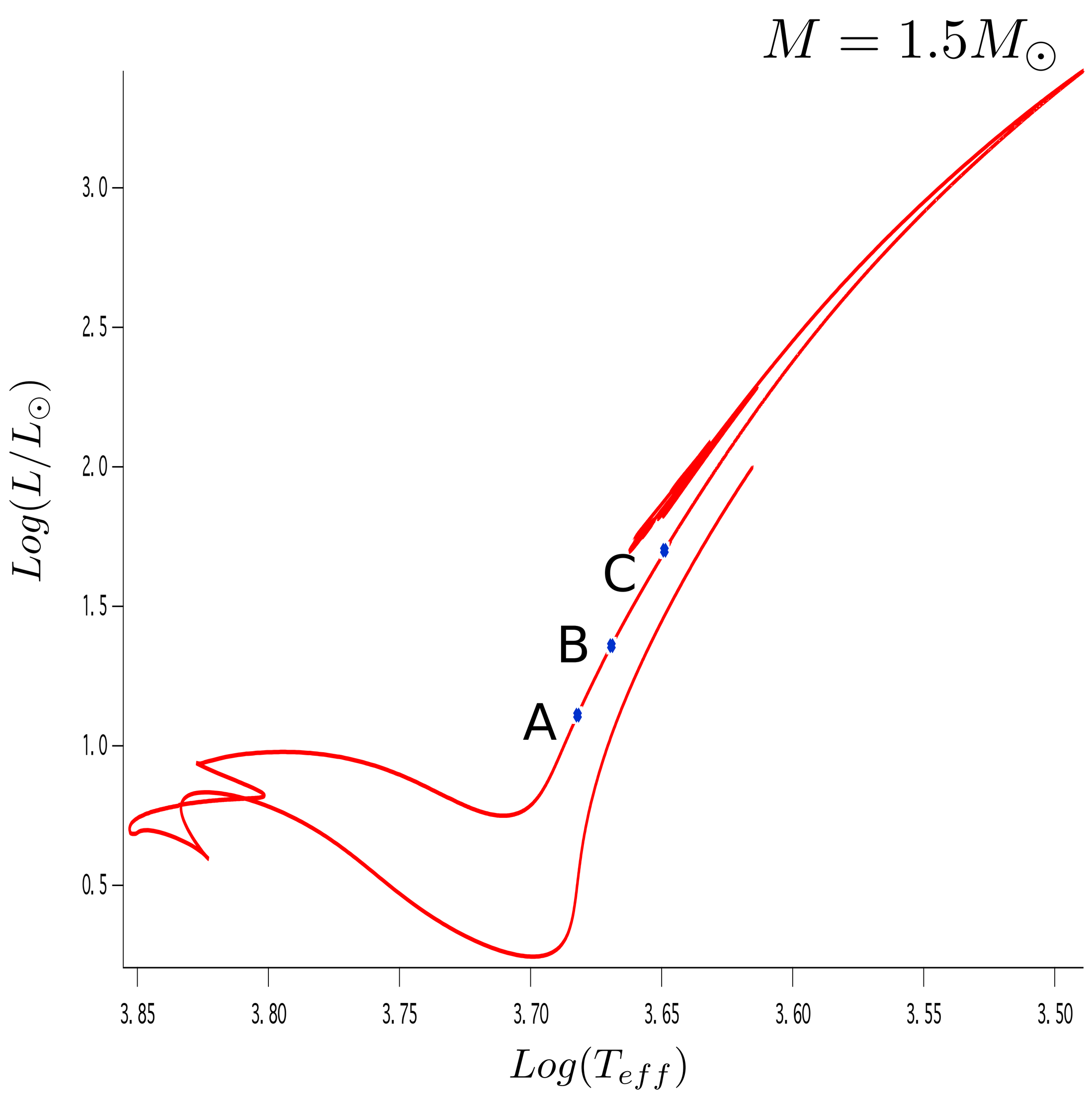
Corot and Kepler observations of red giants reveal rich spectra of non-radial solar-like oscillations allowing to probe their internal structure. An important question comes from the observation of mixed modes : When during the star's ascension on the RGB are mixed-modes more likely to be detectable ? We compute the power spectra of three red giant branch models of 1.5 M⊙ (typical of CoRoT and Kepler targets). The theoretical mode lifetimes are computed with a non-radial non-adiabatic pulsation code including time-dependent convection. Then we computed the oscillation amplitudes through a stochastic excitation model. We found that for the first two models mixed-modes are detectable. This is no longer the case for the third model (higher on the RGB) because of a high radiative damping.

Method :
Stellar models are computed with the code ATON (Ventura et al 2008) using MLT for the treatment of the convection with $\alpha_{MLT} = 1.9$

Non-adiabatic oscillations are modeled with the code MAD (Dupret 2002) including a non-local, time-dependant treatment of the convection (TDC, Grigahcène et al 2005)

Amplitudes are computed using a stochastic excitation model (Samadi & Goupil 2001) with solar parameters for the description of the turbulence.

Models :
We focus on 3 models on the RGB.



Lifetimes :
The TDC treatement involves a β complex parameter in the closure term of the perturbed energy equation. It is adjusted so that the depression of the damping rates occure at ν_{max} (Belkacem et al 2012)
Lifetimes are given by the inverse of damping rates.

Heights
To compute the height (H) of a mode we have to distinguish resolved and unresolved modes.

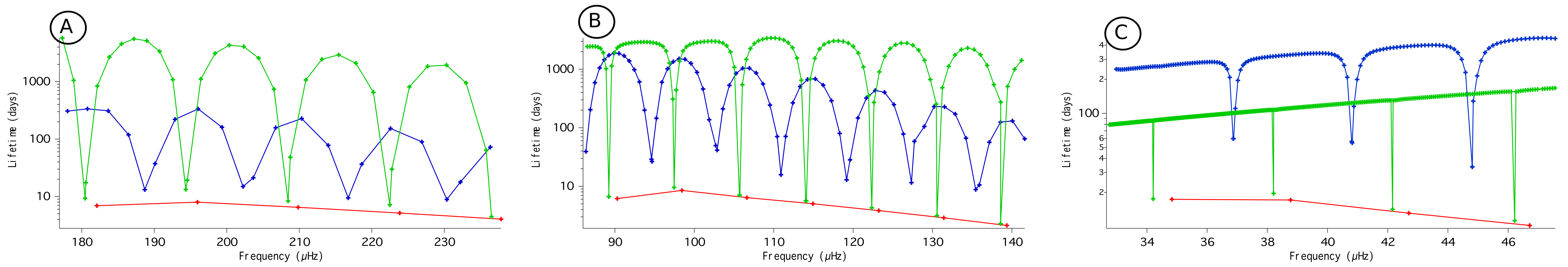
For resolved modes : $\tau < T_{obs}/2$

$$H = V^2(R) * \tau$$

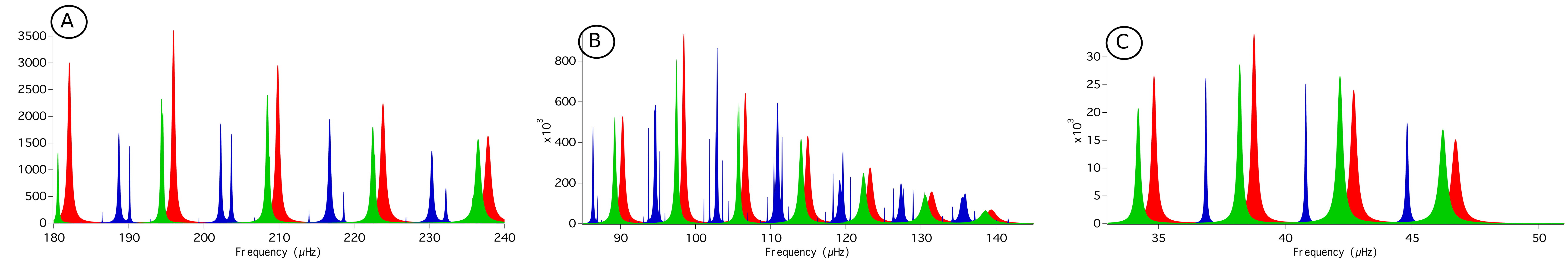
For unresolved modes : $\tau \geq T_{obs}/2$

$$H = V^2(R) * T_{obs}/2$$

where V(r) is the amplitude of the oscillation at the surface, τ the lifetime of the mode and T_{obs} the duration of observations
We used T_{obs} = 150 days, which corresponds to a CoRoT long run.



LIfetimes of modes l=0 (red), l=1 (blue) and l=2 (green). Models A (left) to C (right)



Theoretical power specturm of modes l=0 (red), l=1 (blue) and l=2 (green). Models A (left) to C (right)

All our results extend the tendencies found by Dupret et al 2009 to lower stellar masses, more representative of the mass range of CoRot and Kepler targets.
Model A : Lifetimes are modulated by the inertia because there is no radiative damping in this model and mixed-modes are detectable. Modes have a large period spacing.
Model B : Lifetimes are still modulated by inertia except for the l=2 low frequency g-types modes. This is due to a non negligeable radiative damping. This damping is still low enough to have detectables mixed-modes in the power sepctra. Modes have a smaller period-spacing because of a higher density contrast between the core and the envelope.
Model C : There is a very important radiative damping for all modes except those strongly trapped in the envelope. No mixed-modes are detectable in this model.

Conclusion : On the red-giant branch mixed-modes are detectable until the radiative damping becomes too important. For 1.5 $M_\odot$ stars on the RGB and with 150 days of observations mixed-modes are detcteable for stars with $\nu_{max} \geq 98\ \mu Hz$ and $\Delta\nu \geq 8.3\ \mu HZ$

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