Seismic analysis of HD43587Aa, a solar-like oscillator in a quadruple system

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HD43587

F9V star with a M-type companion (1"; ~30-year period) and a distant common-proper-motion binary system (100")

- HD43587Aa: F9V (~ 1.1 $M_\odot$); m_v = 5.71;

T_{eff} : from 5850 K to 5930 K (past literature)

T_{eff} 5947±17 K (Morel et al. 2013; differential analysis with respect to the Sun).

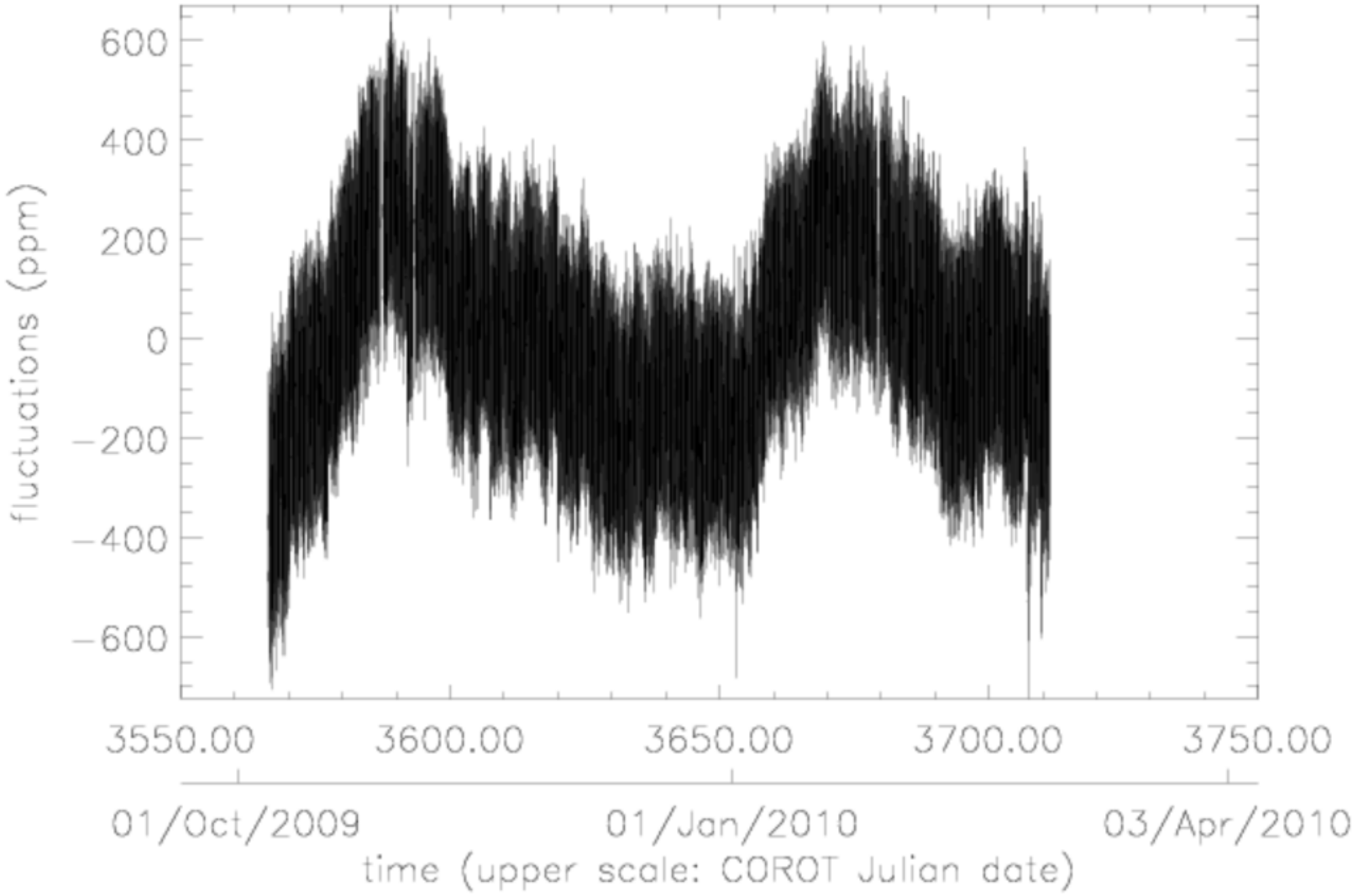
R: 1.28 ± 0.03 $R_\odot$ (Thévenin et al. 2006).

v sin i: from 2.5 km/s to 5.8 km/s in the literature.

- HD43587Ab: M star (~ 0.5 $M_\odot$); m_v=10.5
- HD43587B: M star; m_v=13.3
- HD43587C: M star; m_v=16.5

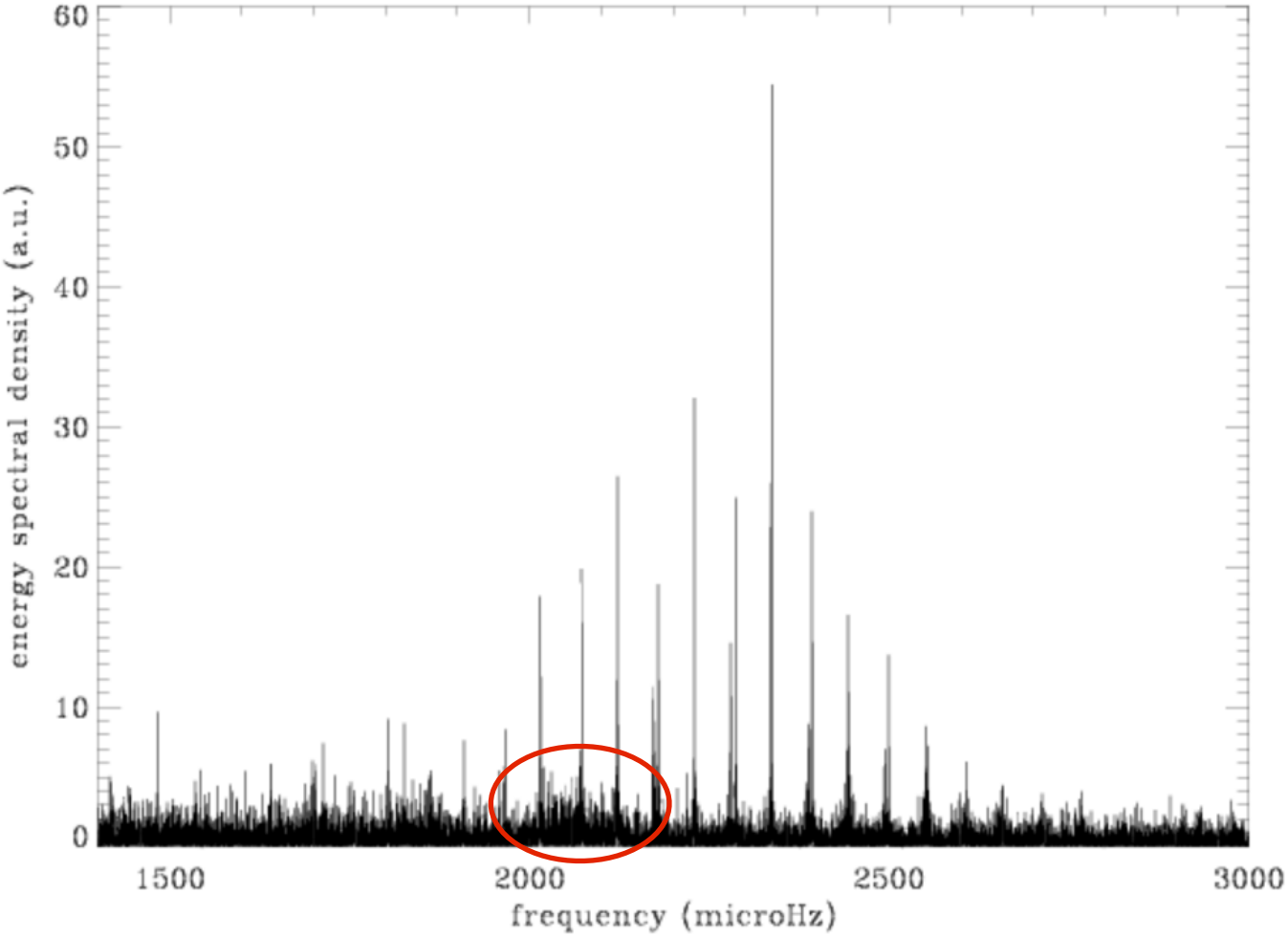
CoRoT: LRa03 145-day series

Light curve with a 2d order polynomial trend subtracted.



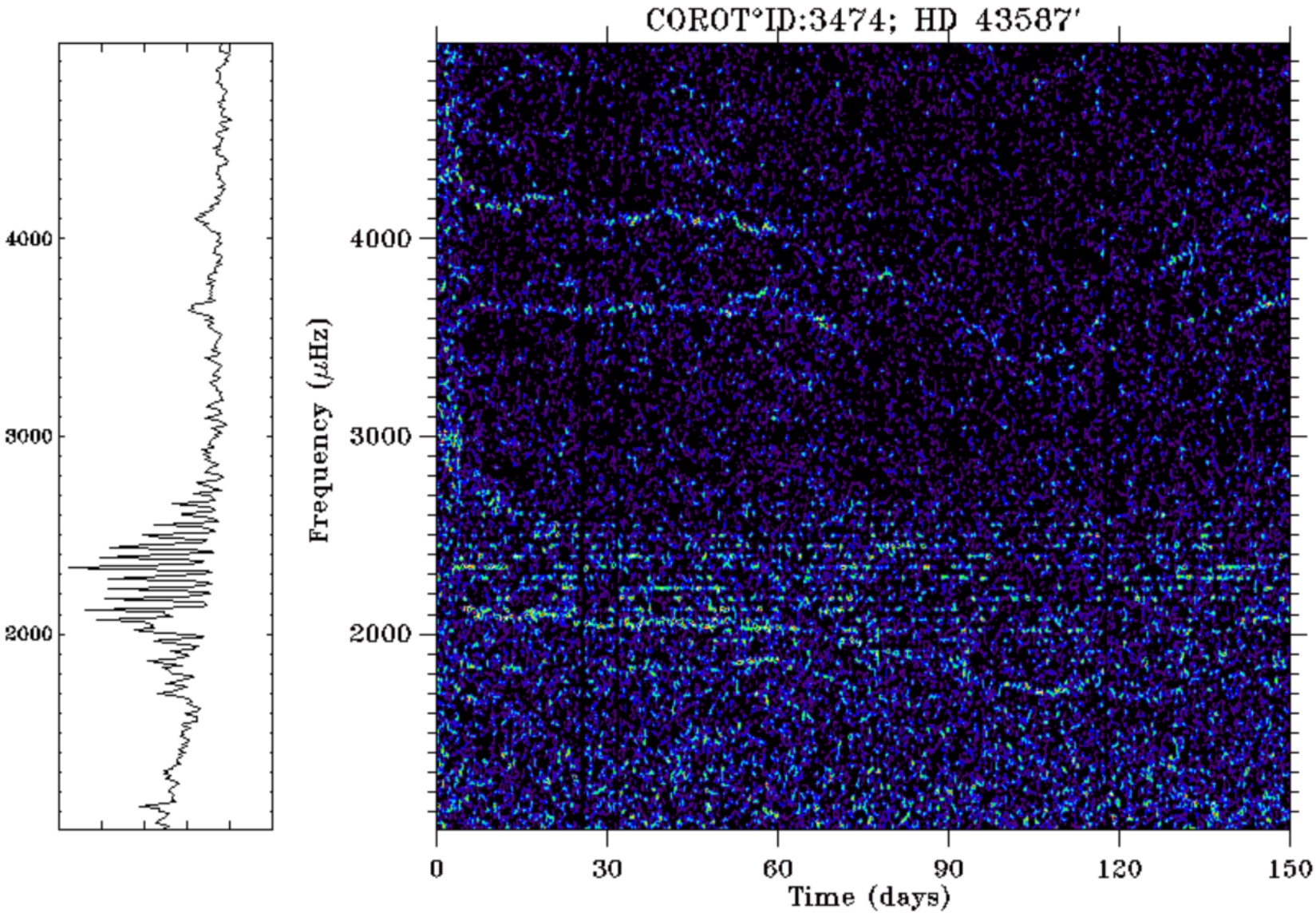
Slow rotation?

Spectral density

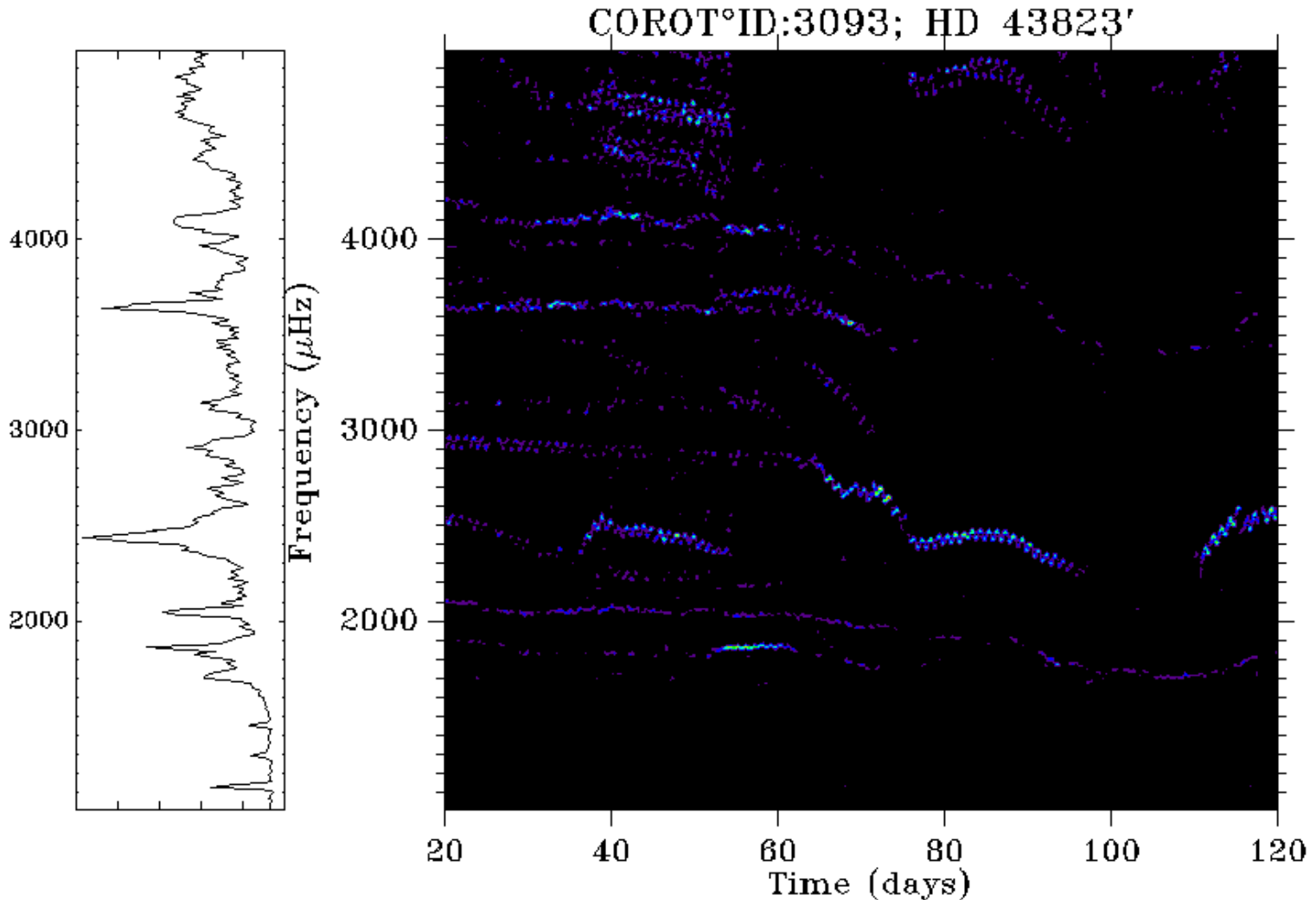


Beautiful acoustic modes + noise features

Time frequency diagnosis



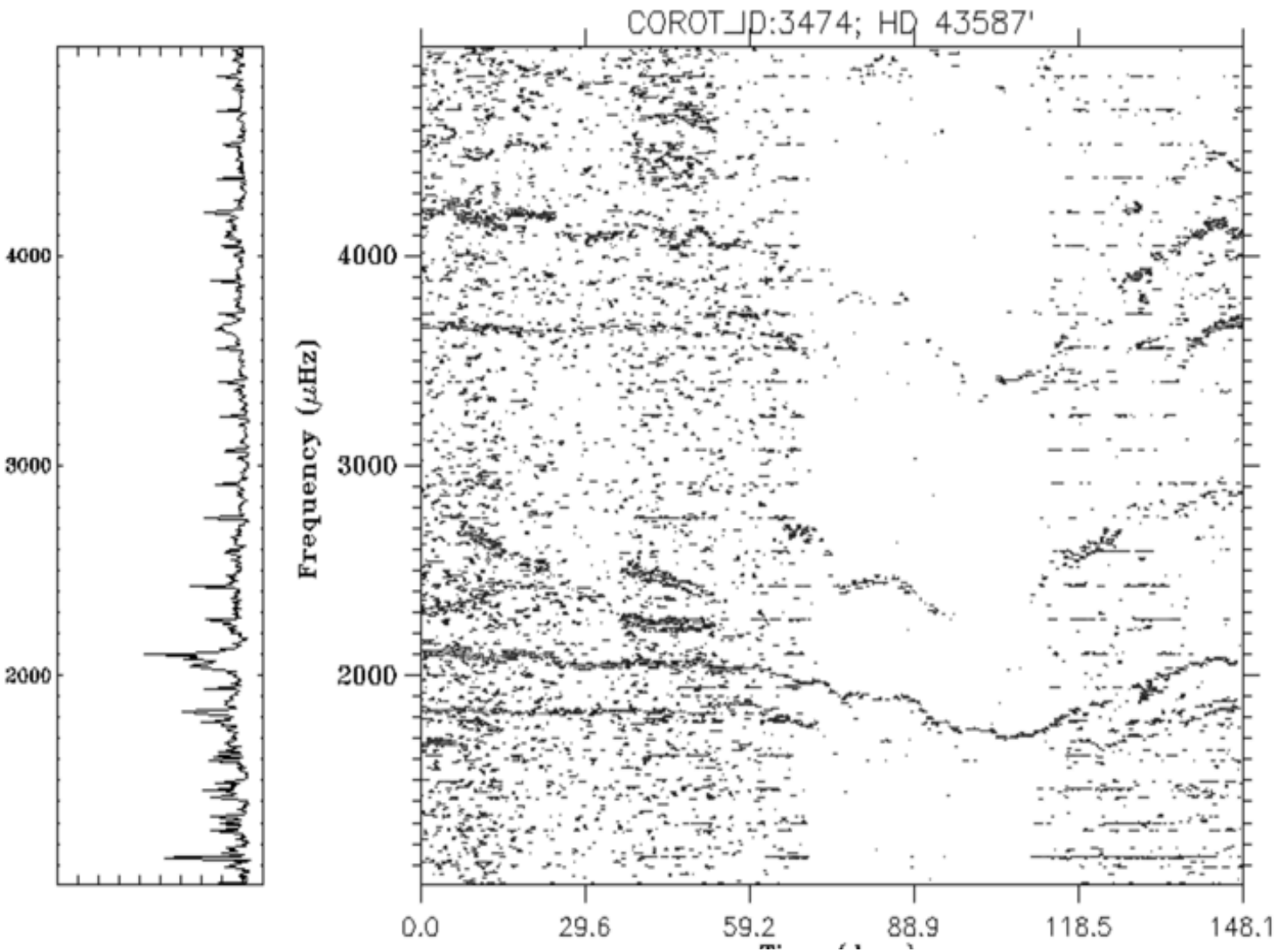
Off-pointing (x axis)



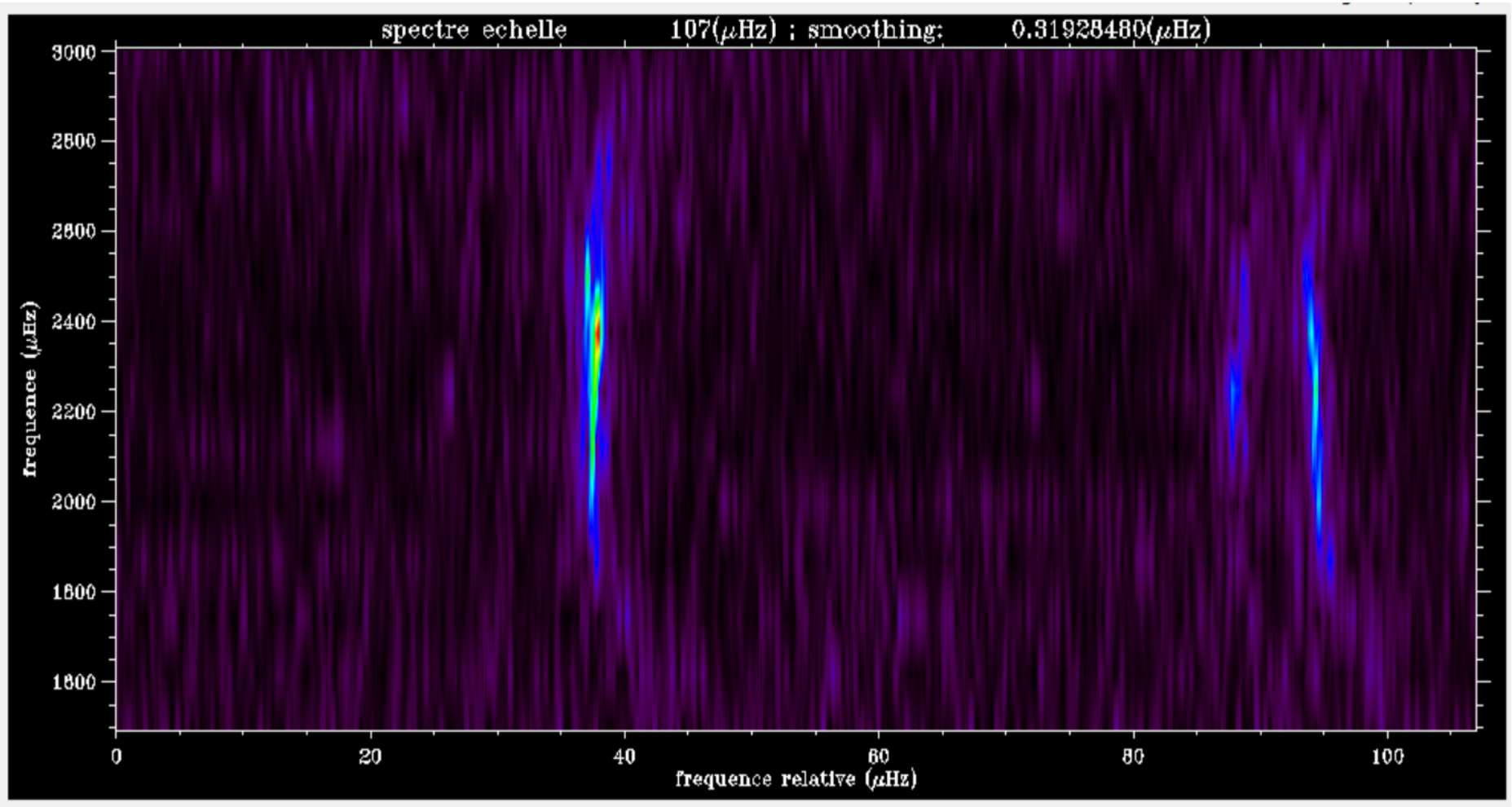
Signal also clearly seen on another star of the run

⇒ specific care needed

Off-pointing $\sqrt{(x^2+y^2)}$



Echelle diagramme



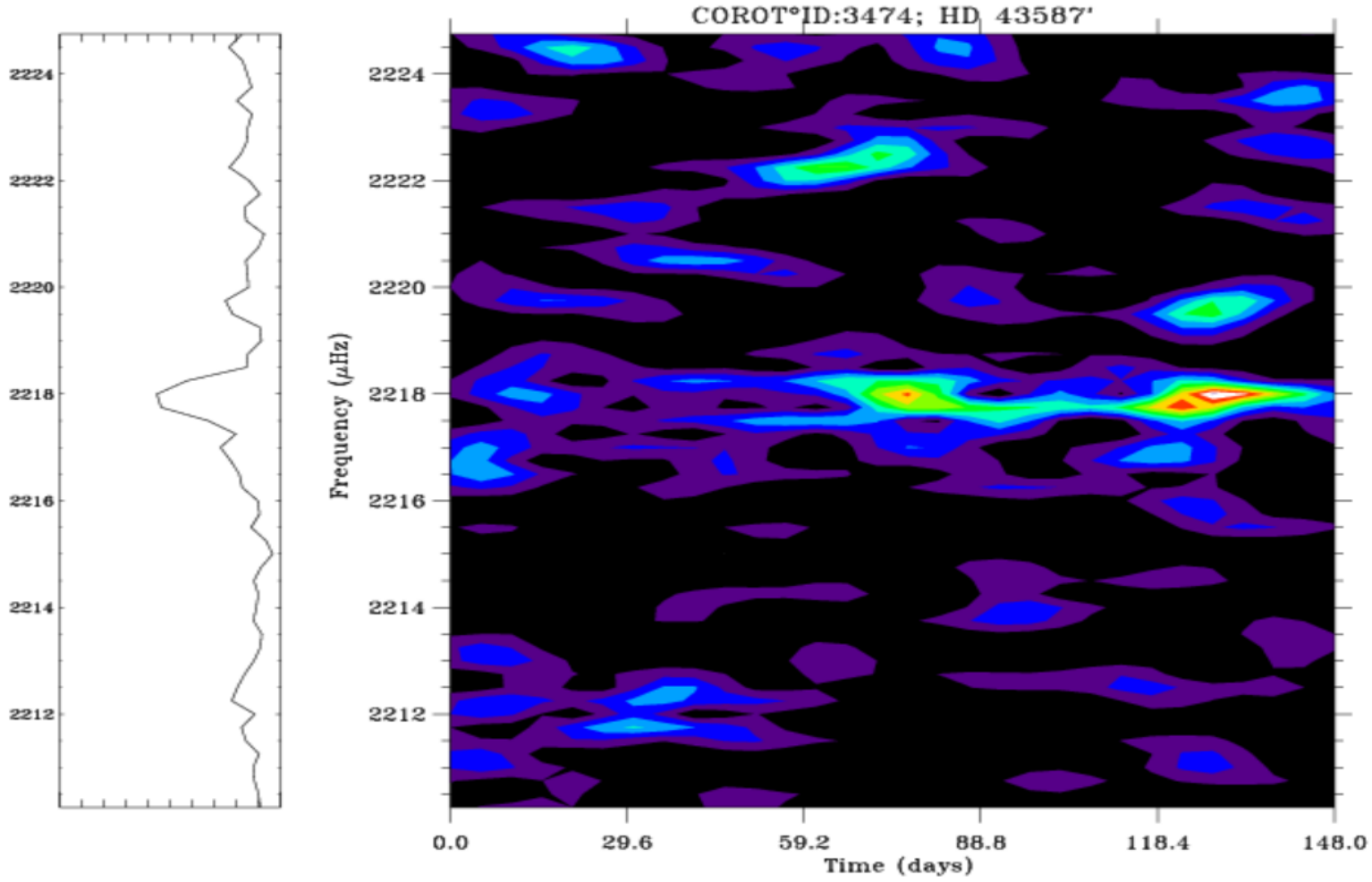
Large separation ~ 107 μHz

Frequency extraction

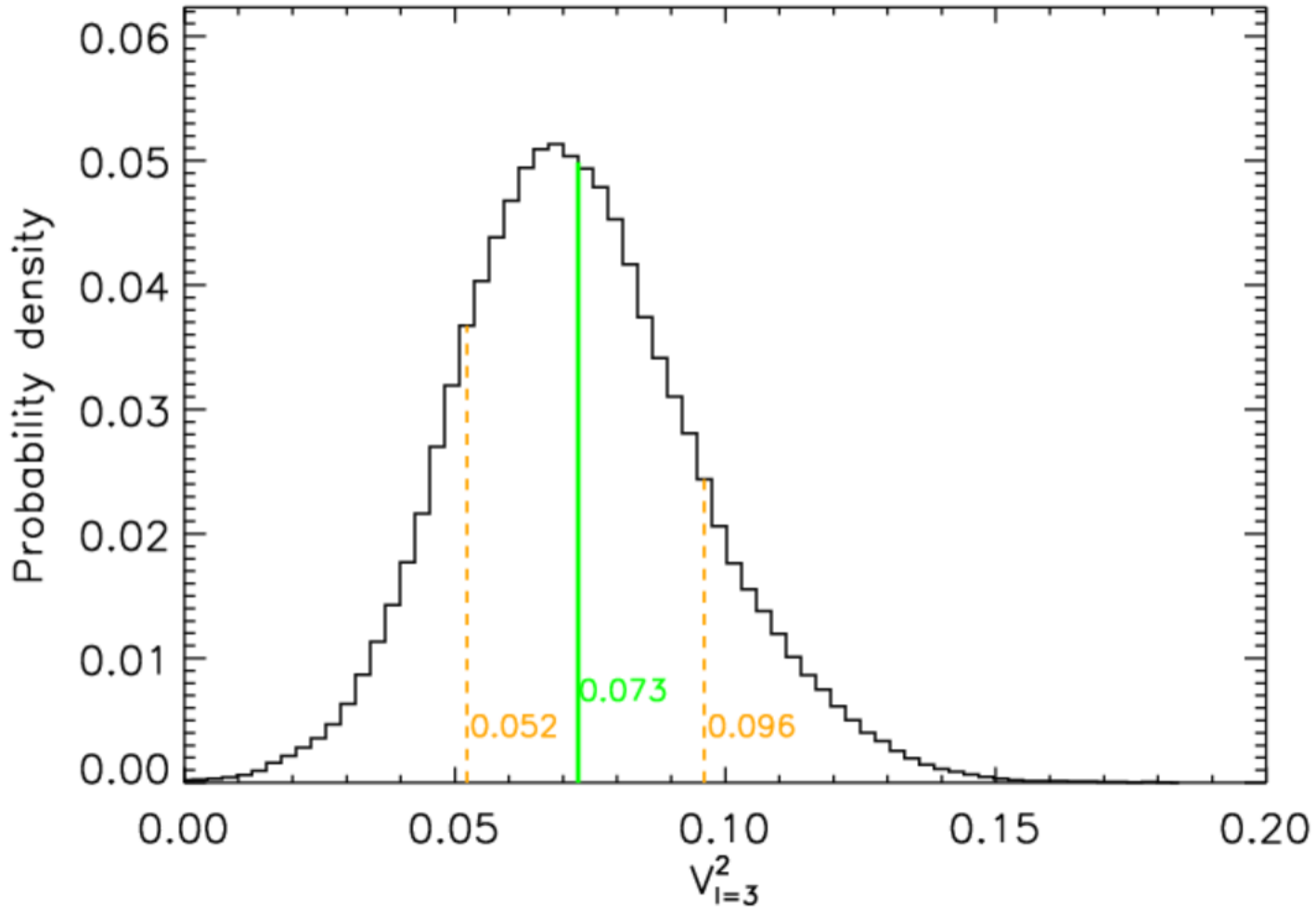
- 10 fitters (9 Maximum Likelihood Estimators; 1 Bayesian+MCMC).
- Hypothesis sometimes different (e.g. ratios of heights for l=0,1,2,3 either fixed or let free).

Excellent agreement between all fitters on a large range (good SNR), some discrepancies at lower SNR, including l=3 modes

Time-frequency analysis of a l=3 mode



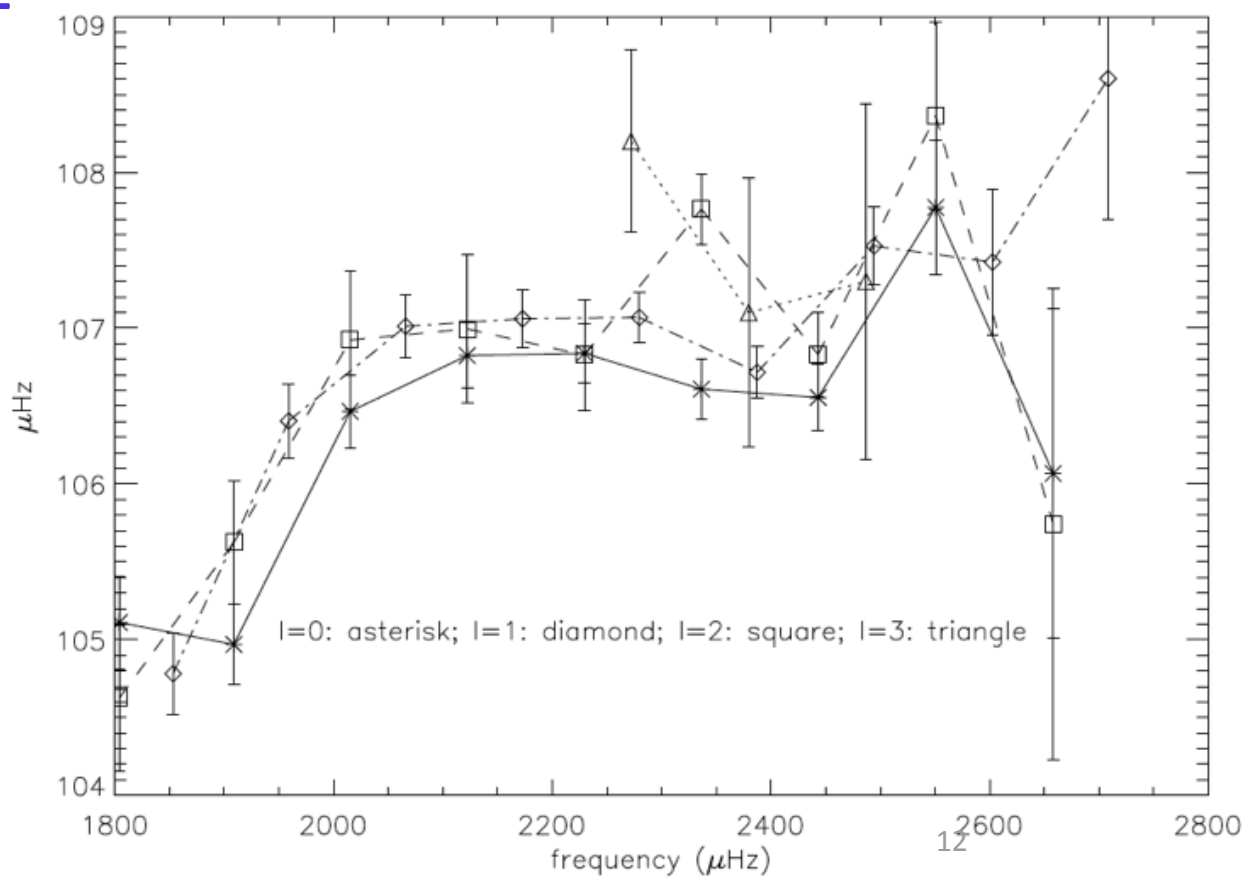
Posterior probability for the l=3 height



Seismic parameters

- ν_{max} ~ 2275 ± 15 μHz
- A_{max} ~ 3.2 ± 0.6 ppm
- $\langle \Delta\nu \rangle$ ~ 107 μHz

Large separations



Seismic parameters

- ν_{max} ~ 2275 ± 15 μHz
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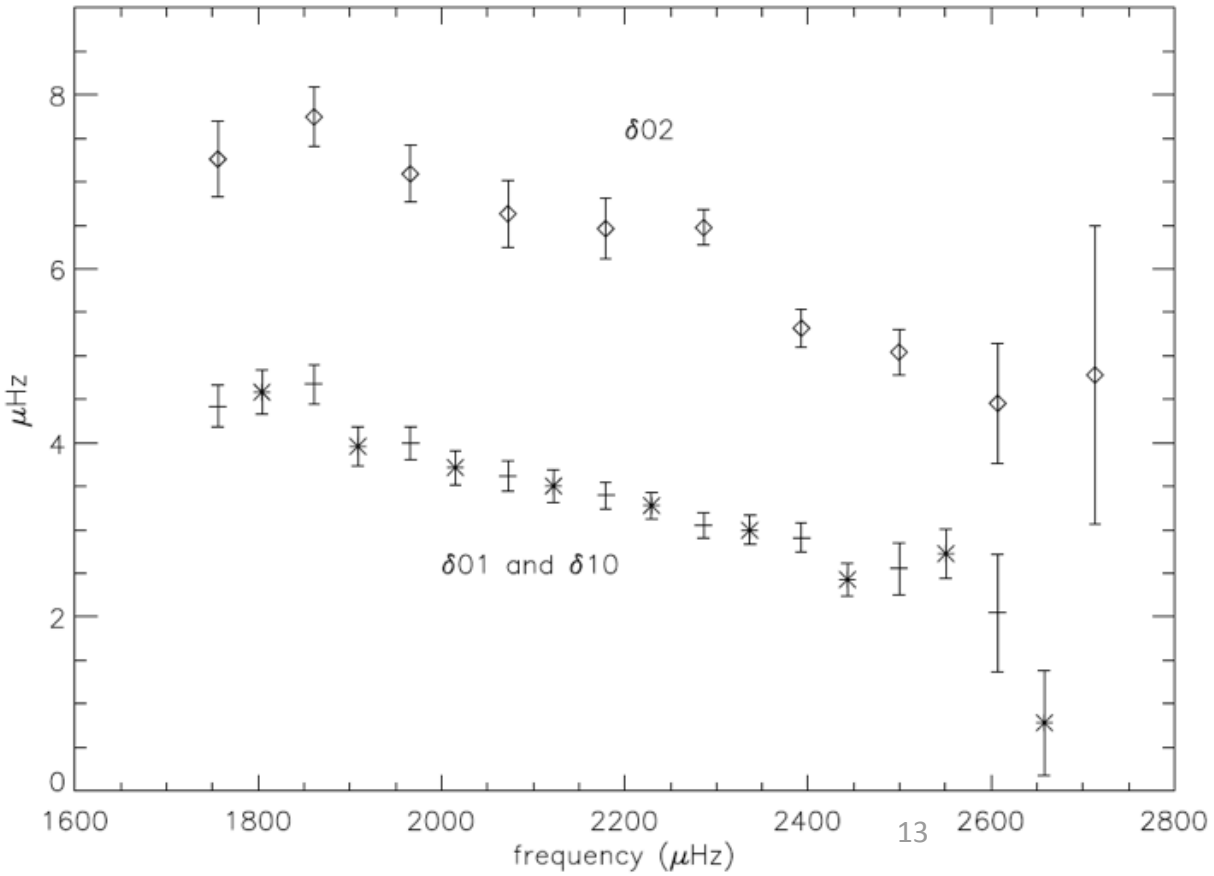
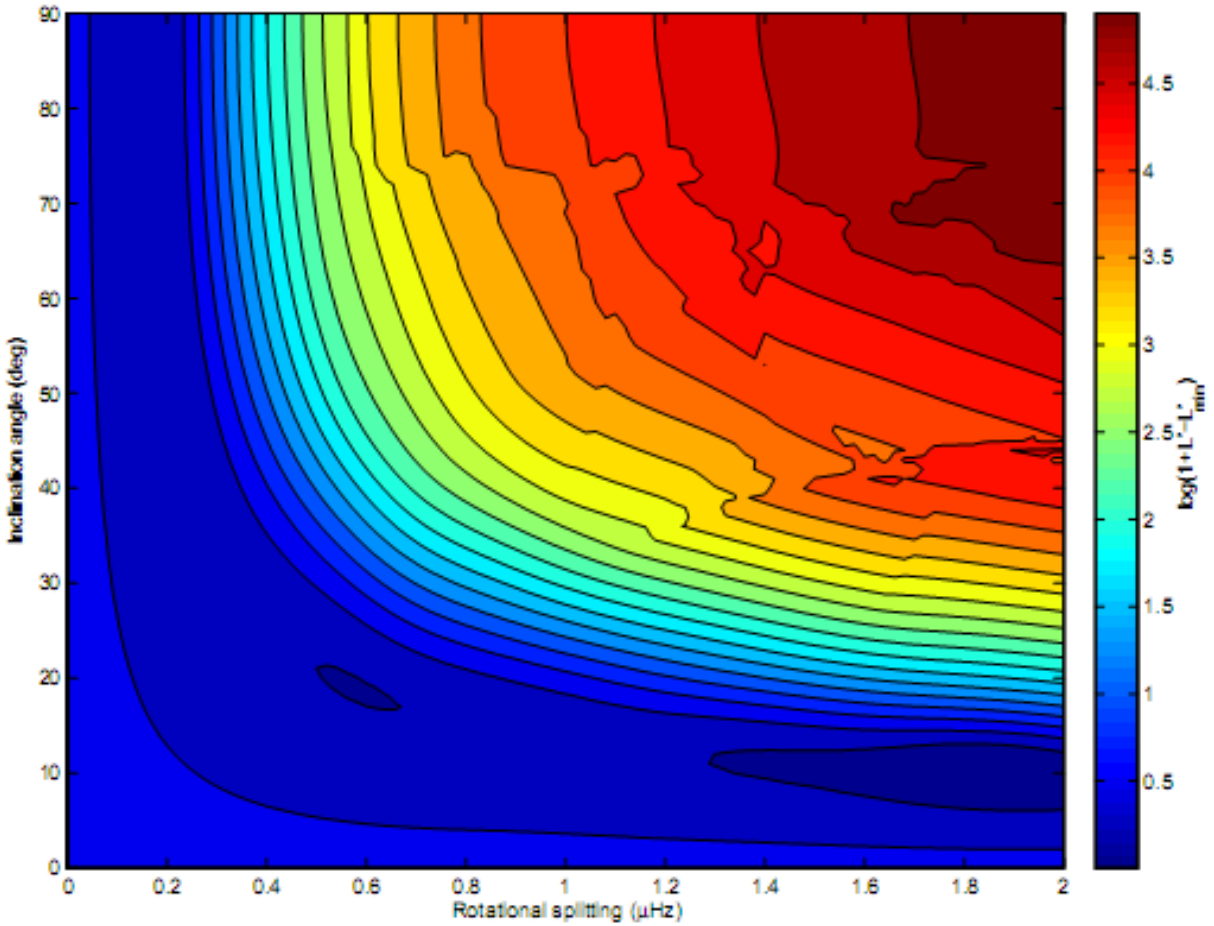
Small separations



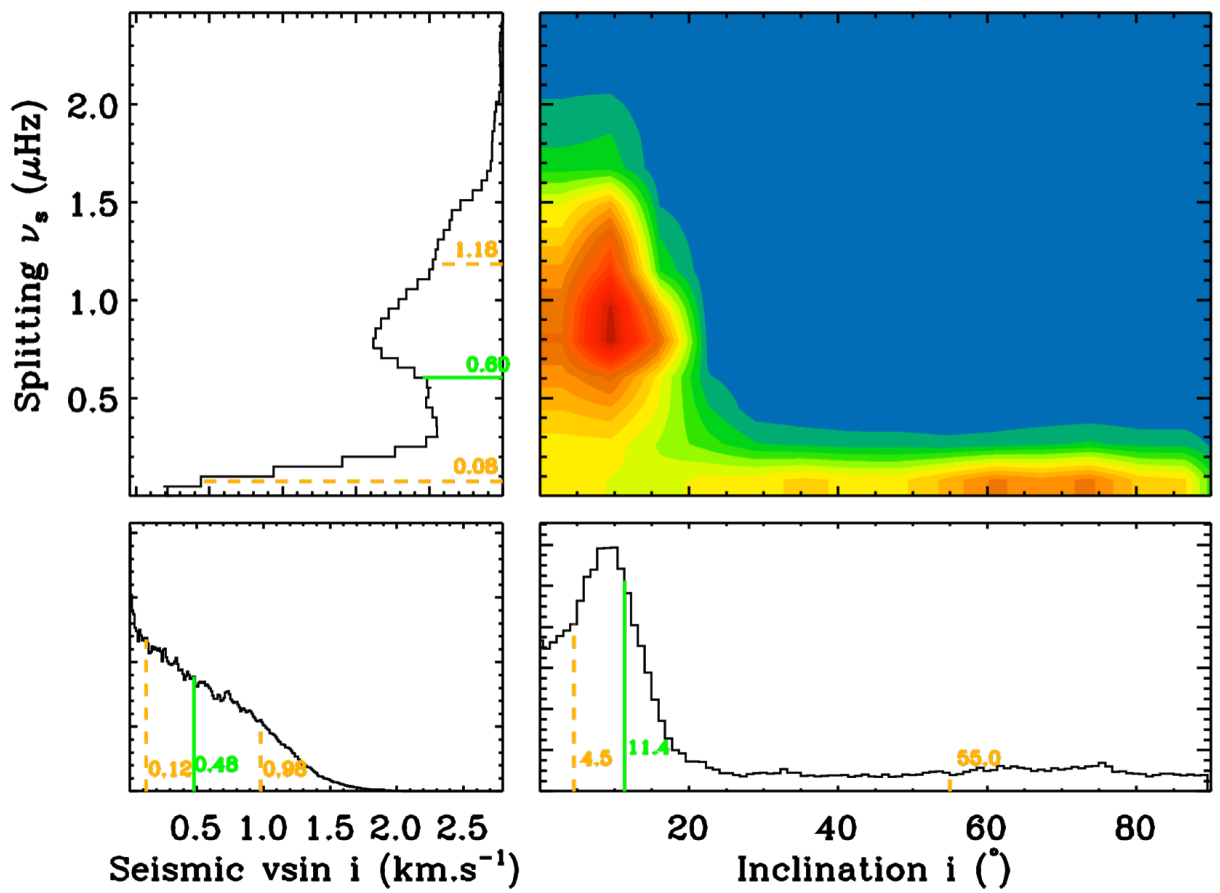
Rotation and inclination

Many discrepancies beween all the fitters



Likelihood map (RF): blue ≡ better fits

MCMC PDF estimates for rotation and inclination



Very difficult to conclude…

Stellar parameters

- Scaling relations (solar values from Huber et al. 2011 and T_{eff} from Morel et al. 2013):

$$M = 1.07 \pm 0.04\ M_{\odot} \quad R = 1.195 \pm 0.015\ R_{\odot}$$

- Previous estimates:

Catala et al. 2006: $M = 1.1 \pm 0.1\ M_{\odot}$

Thévenin et al. 2006: $R = 1.28 \pm 0.03\ R_{\odot}$

- Modelling: (Constraints: frequencies + spectroscopic parameters of Morel et al. 2013)

$$M = 1.043 \pm 0.007\ M_{\odot} \qquad R = 1.19 R_{\odot}$$

$$\text{Age} = 5.63 \pm 0.14\ \text{Gyr}$$

Conclusions

• Mass and radius estimates from scaling laws and modelling in agreement

• Rotational splitting not resolved. Two scenarii:
- Low inclination
- Low internal rotation

• Future:
- Deeper look at the pointing influence
- Deeper look at the influence of companion