Frequency analysis of the sismo-field γ -Doradus star : HD49434

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HD49434 stellar parameters

- F-type γ -Doradus pulsator with solar metallicity

- fast rotator ($v.\sin i = 84 \pm 5$ km.s^{-1})

HD49434 stellar parameters

- F-type γ -Doradus pulsator with solar metallicity

- fast rotator (v.sin*i* = 84±5 km.s^{-1})

  from Masana et al. (2006)

  - R = 1.601 ± 0.052 $R_\odot$

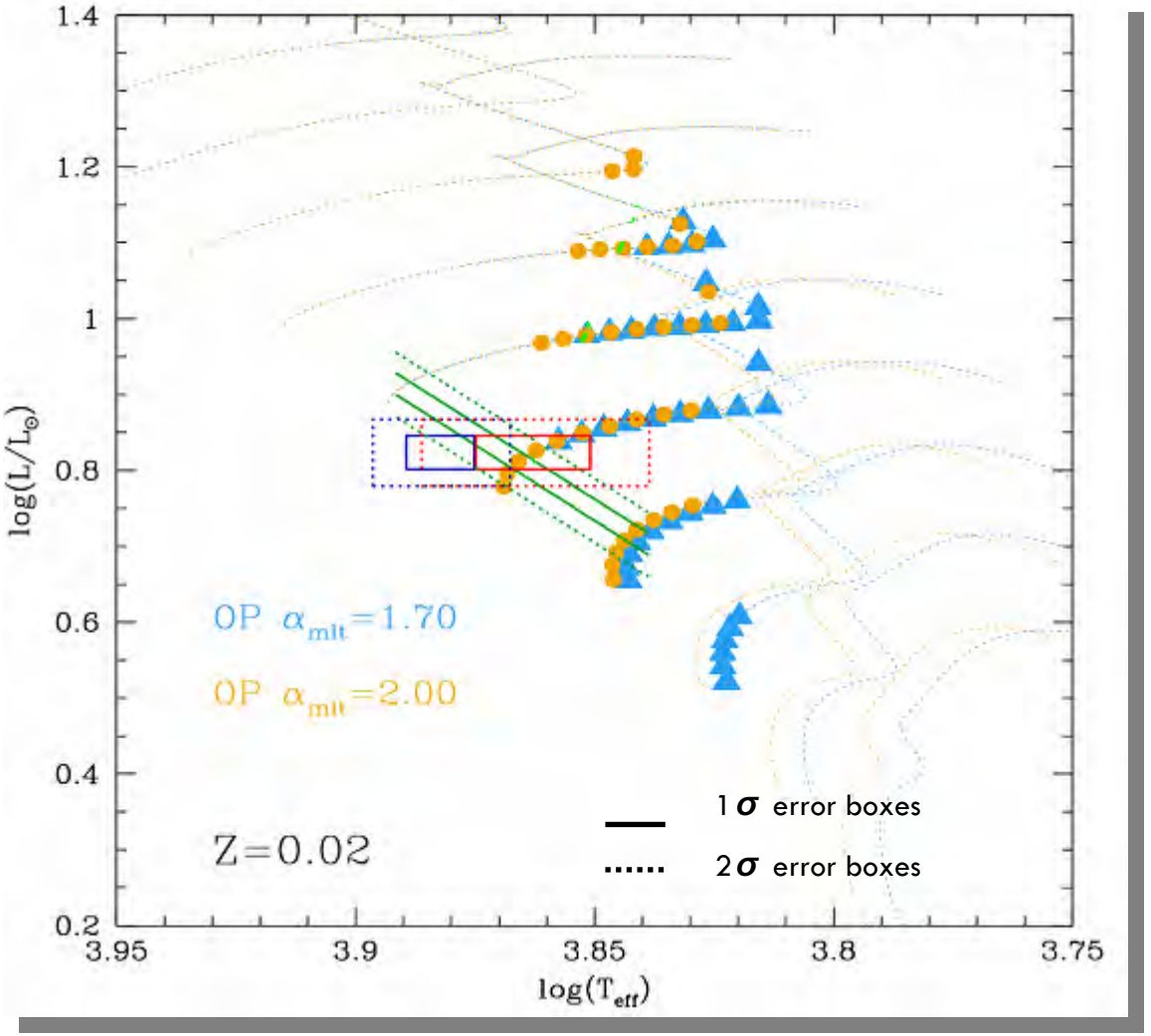
- 2 analysis :

  from Bruntt et al. (2004)

  - T_{eff} = 7300 ± 200 K
  - logg = 4.1 ± 0.2 dex

  from Gillon & Magain (2006)

  - T_{eff} = 7632 ± 126 K
  - logg = 4.43 ± 0.20 dex



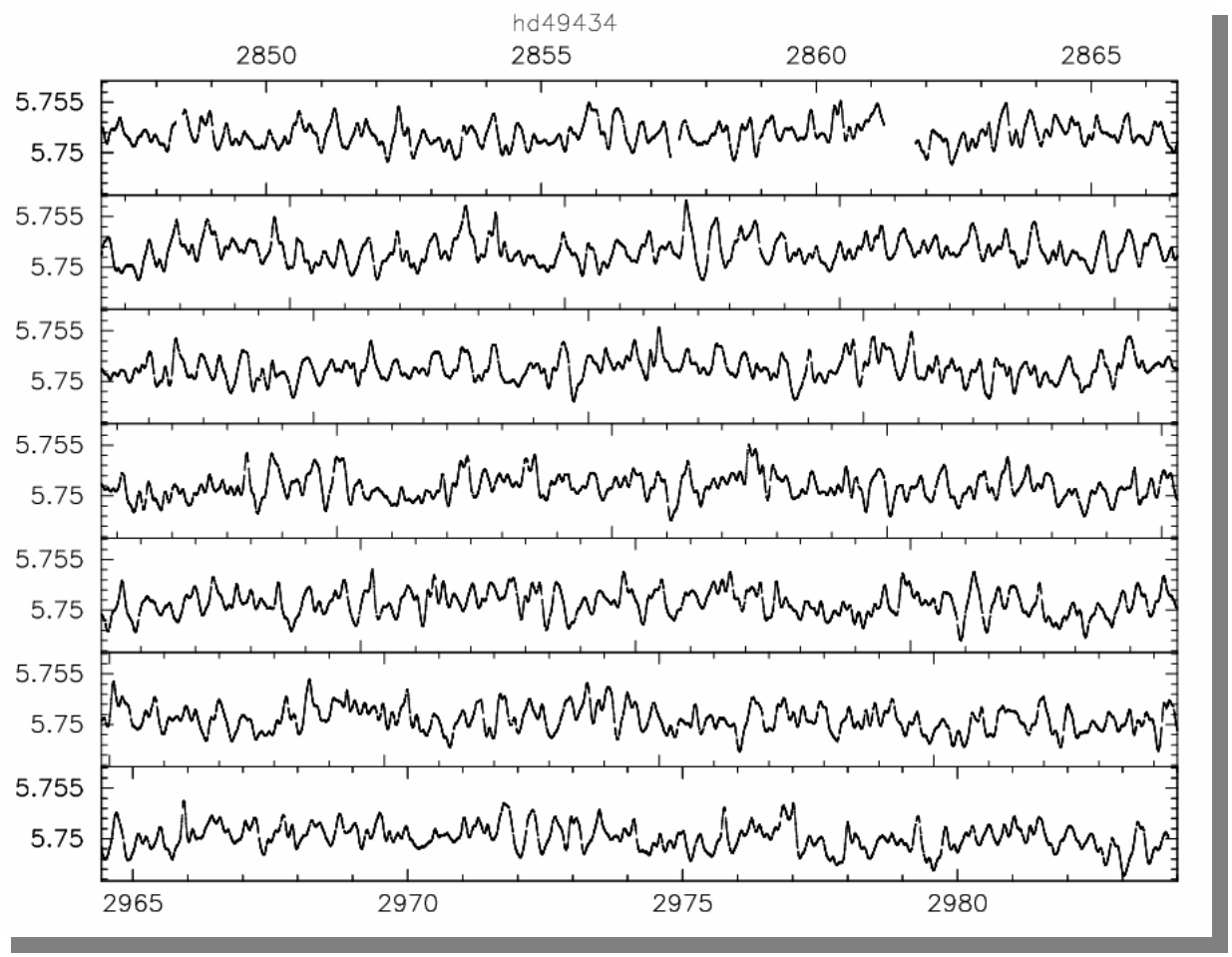
HD49434 in the Corot field

- Primary target of LRa1 long run (October 2007 → March 2008)
- Very complex light curve

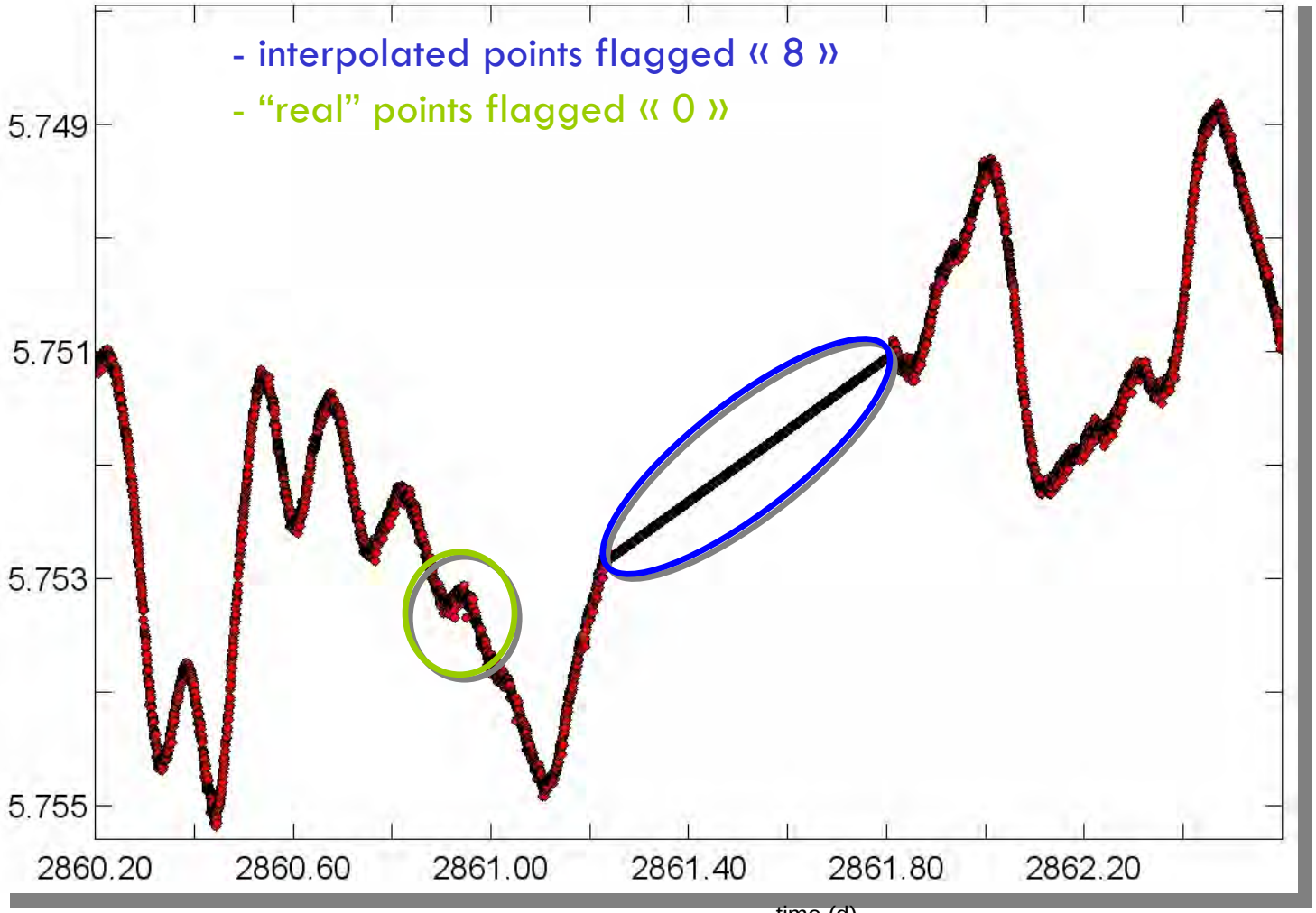
- $\Delta T = 136.9$ days
  - → 1 point every 32 s.
  - → 369630 points expected

  - → After cleanings :

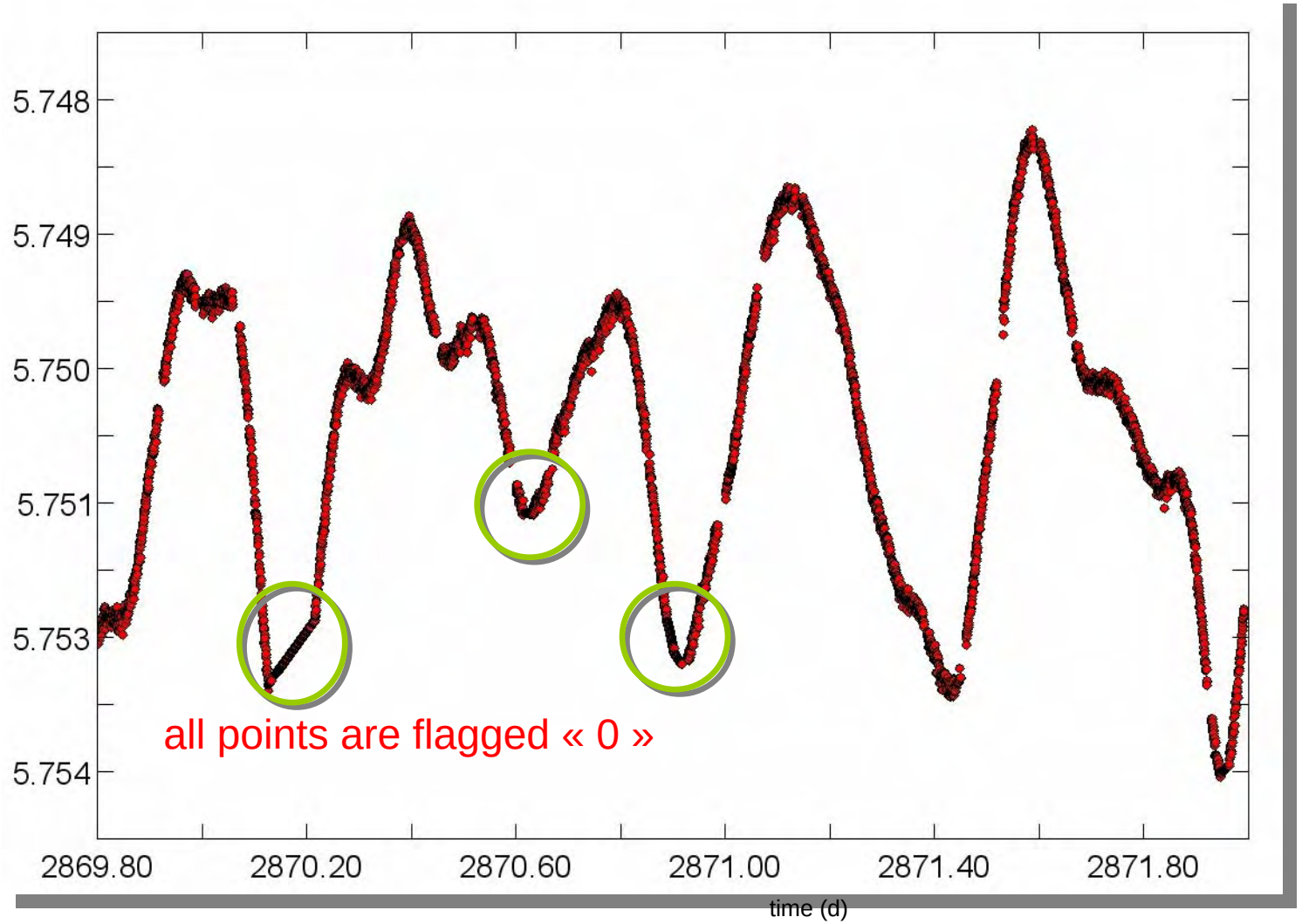
    "only" 325714 usable points !



Problem with points flagged « 0 »



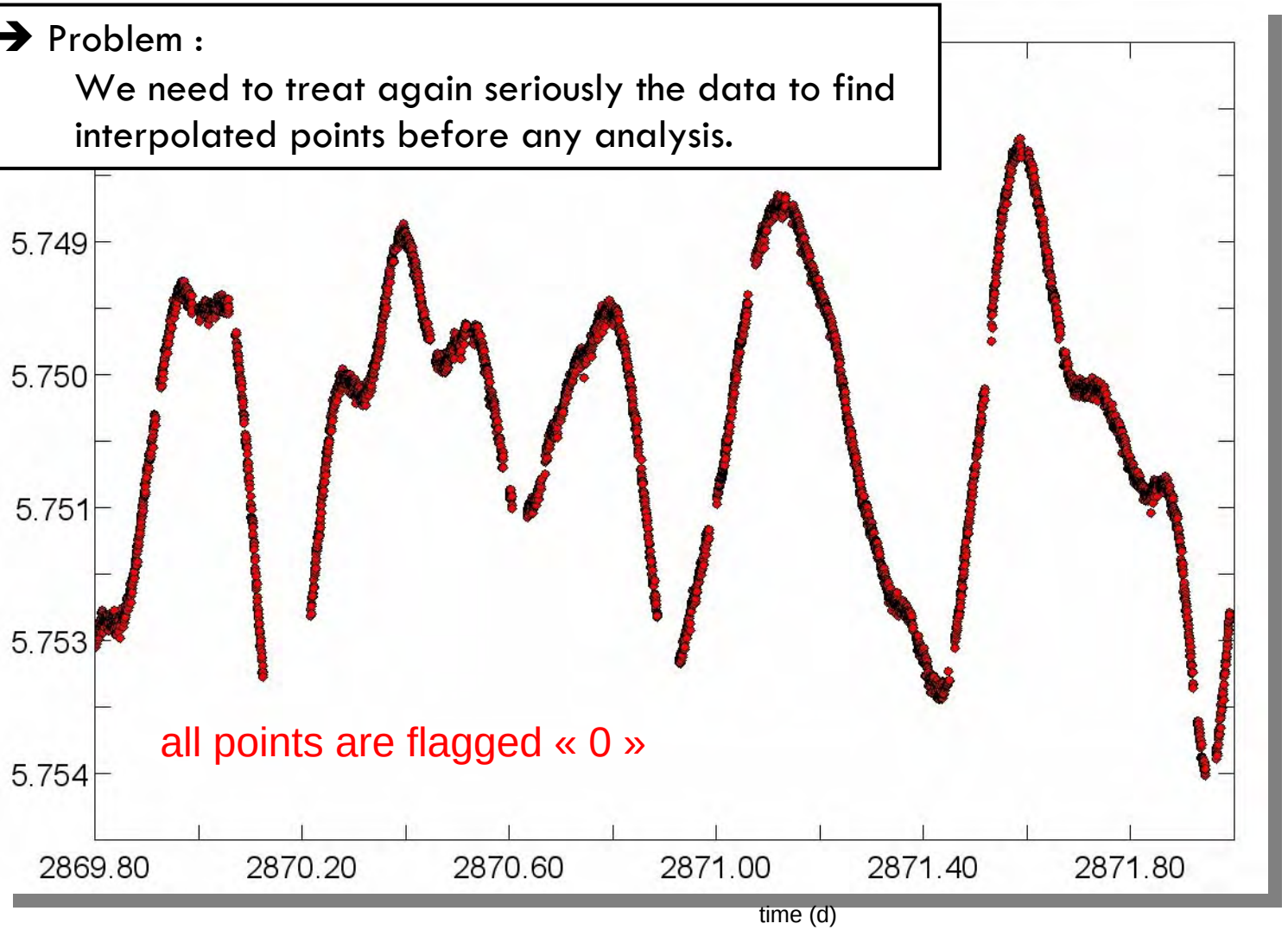
Problem with points flagged « 0 »



Problem with points flagged « 0 »

➔ Problem :

We need to treat again seriously the data to find interpolated points before any analysis.



First frequency analysis – E. Rodriguez

- Analysis of the light curve with the interpolated points flagged « 0 » by E. Rodriguez
- Automatic analysis using SigSpec

- ***Range below 30 d^{-1} (347 μHz) : Region of interest for γ-Doradus and δ-Scuti type oscillations***

  - Using Breger criterion
  - 1686 "formally" significant peaks found (peaks over a S/N ratio of 4.0)

- ***Range larger than 30 d^{-1} (347 μHz) :***

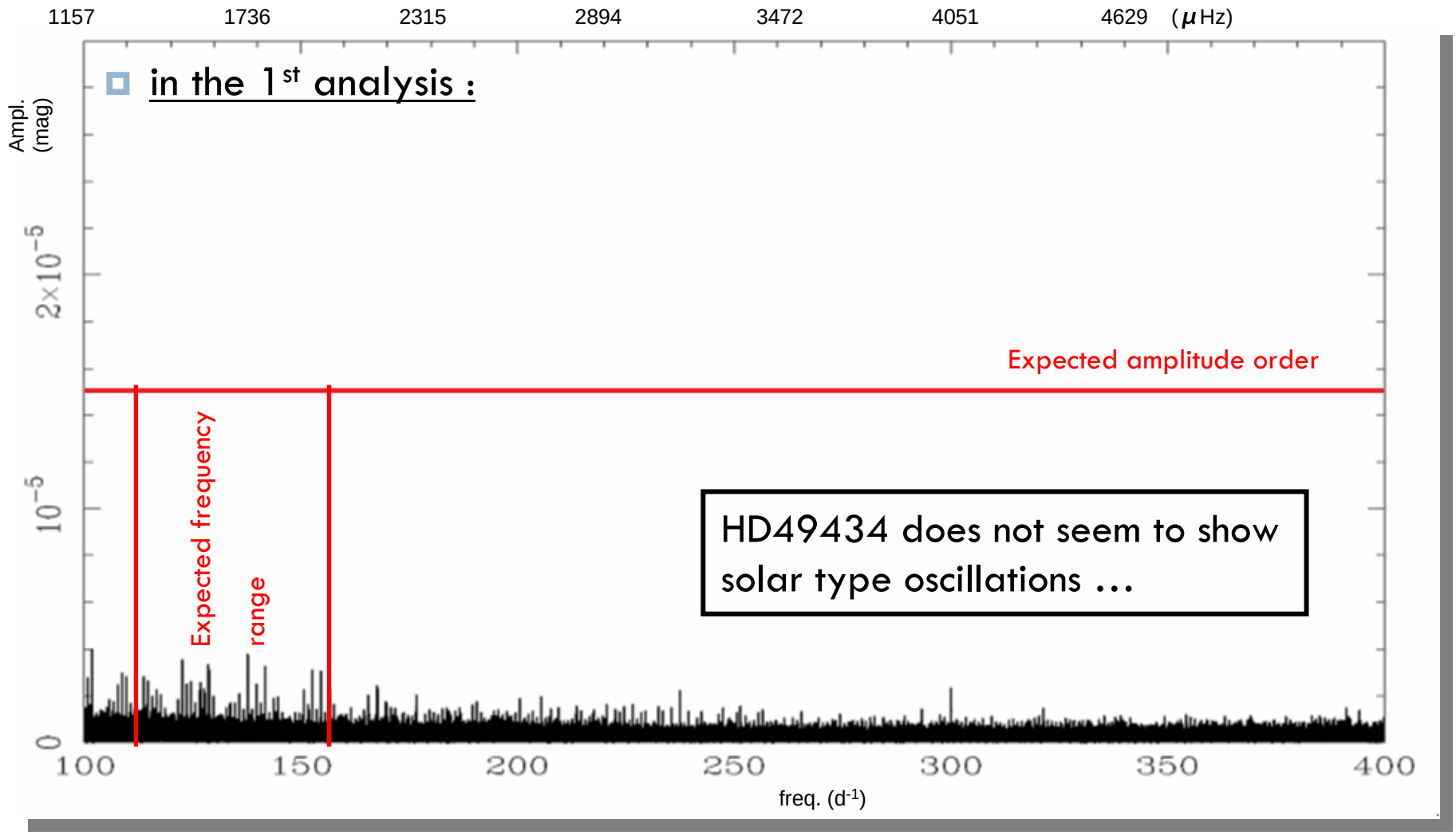
All the most "significant peaks" due to the satellite orbital frequency and its interaction with the frequency f_l=0.01104 d^{-1} (0.1278 μHz) due to the Corot trend.

Research of solar type oscillations

- assuming :
  - T_{eff} = 7300 K
  - R = 1.601 $R_\odot$
  - M = 1.5 $M_\odot$

Using the Kjeldsen & Bedding method (1995) we expect a maximum for the solar type oscillations near 137 d^{-1} (1590 μHz) with an amplitude of the range of 15.5 μmag.

Research of solar type oscillations



Second frequency analysis – Nice team

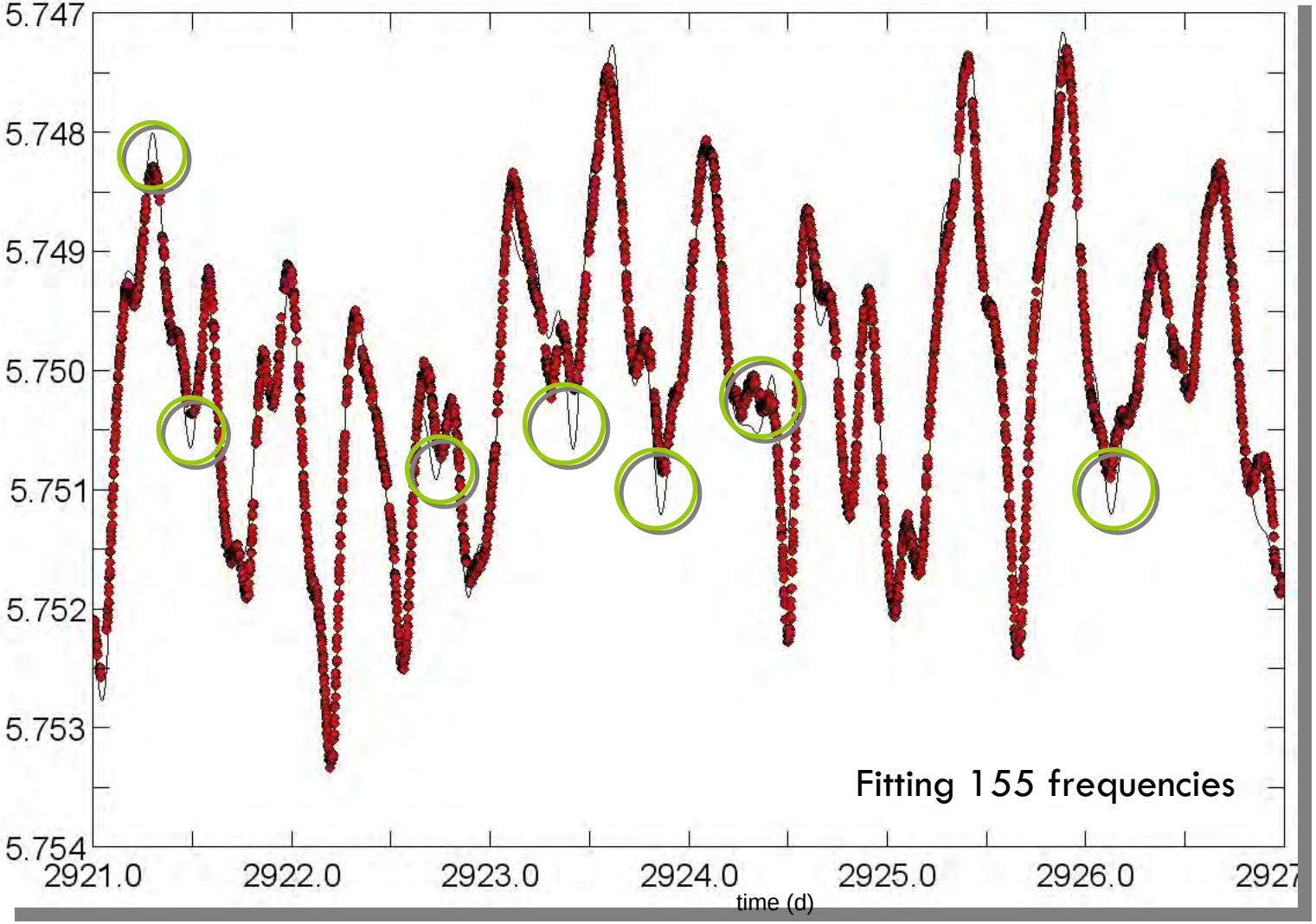
- Analysis of the light curve without the interpolated points flagged « 0 » by E. Chapellier & M.-P. Bouabid
- Manual analysis using Period04

- Cleaned and averaged light curve
  - ➔ Average on 3 points :
    - decrease the noise level
    - decrease the computation time

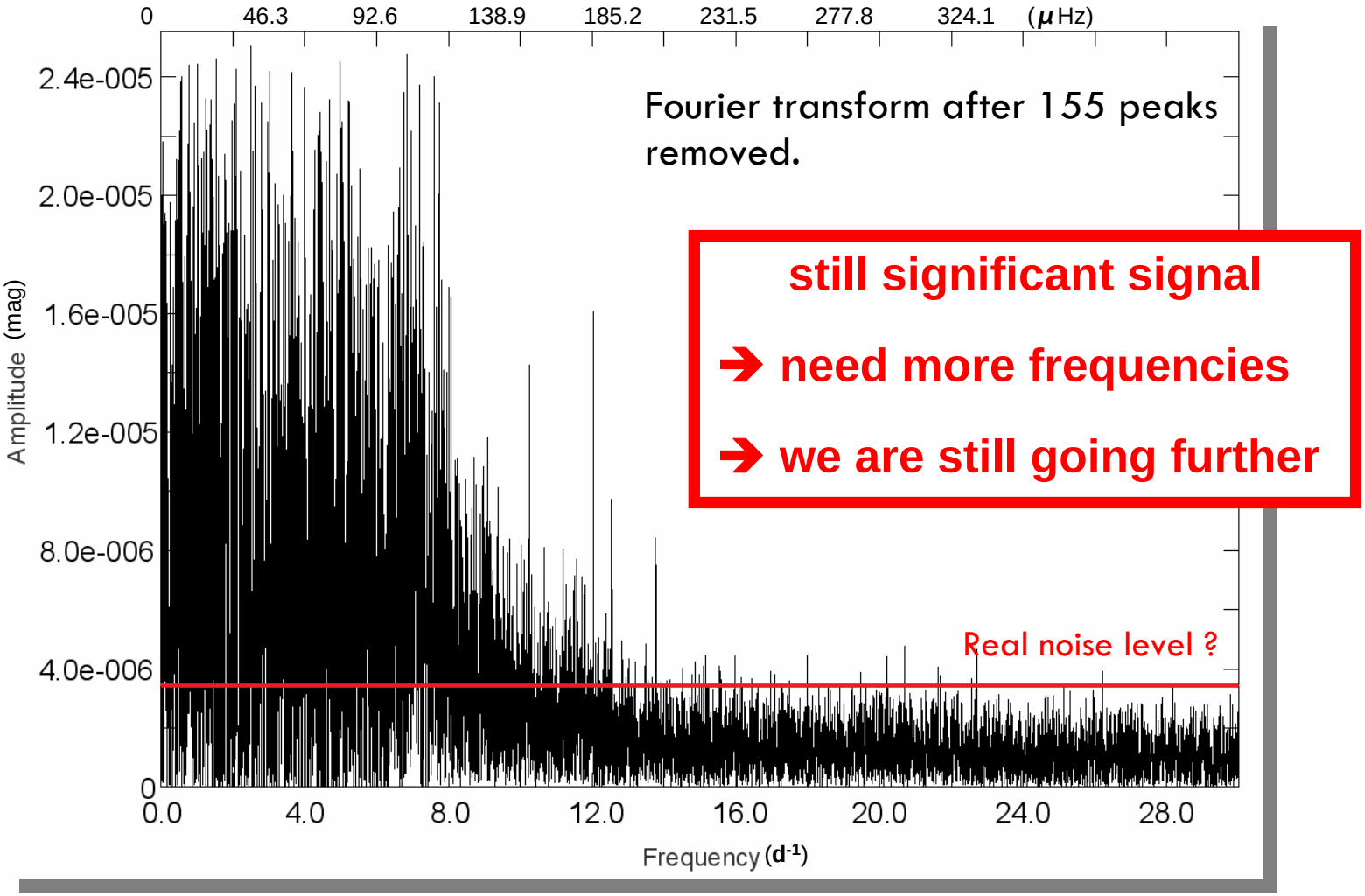
- Analysis from 0 to 30 d^{-1} (347 μHz)

- 155 frequencies found and still in progress

Second frequency analysis – Nice team



Second frequency analysis – Nice team



Comparison with the ground-based data

see poster n° 60 (Uytterhoeven et al.)

	Freq. name	Freq. (d^{-1})	Freq. (μ Hz)	$<\nu>$	$<\nu^2>$	$<\nu^3>$	LPV	Ground based photometry	mode degree ($l \in$)	Rodriguez analysis	Chapellier analysis
γ-Dor	f_1	0.23427(5)	2.711	X	...	...	...	X	...	...	...
	f_2	1.2732(8)	14.74	X	X	X	...	...	[5,7]	...	...
	f_3	1.4831(8)	17.17	X	X	...	X	...	[4,6]	F_{29}	F_{30}
	f_4	1.73480(3)	20.08	...	...	...	...	X	...	F_1	F_2
	f_5	2.253	26.08	...	...	...	...	suspected	...	F_4	F_5
	f_6	2.538	29.38	...	...	...	...	suspected	...	F_2	F_4
	f_7	2.666(2)	30.86	X	...	...	...	...	...	F_{111}	F_{115}
δ-Sct ???	f_8	5.3311(3)	61.70	...	...	...	X	...	[6,8]	F_{369}	...
	f_9	5.583(1)	64.62	X	X	...	...	...	...	F_{65}	F_{69}
	f_{10}	9.3070(3)	107.7	...	...	X	X	...	[4,6]	F_{68}	F_{72}
	f_{11}	6.6841/7.6841	77.36/88.94	...	...	...	X	...	[3,5]	F_{15}	F_{16}
	f_{12}	10.1527/9.1527	117.5/105.9	...	...	...	X	...	[6,8]	...	...
	f_{13}	12.0332/11.0332	139.3/127.7	...	...	...	X	...	[6,8]	F_{320}	...

Comparison with the ground-based data

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Freq. name	Freq. (d^{-1})	Freq. (μHz)	$<\nu>$	$<\nu^2>$	$<\nu^3>$	LPV	Ground based photometry	mode degree ($l \in$)	Rodriguez analysis	Chapellier analysis
f_1	0.23427(5)	2.711	X	...	...	...	X	...	F_3 & F_5	F_3 & F_7
f_2	1.2732(8)	14.74	X	X	X	...	...	[5,7]	...	...
f_3	1.4831(8)	17.17	X	X	...	X	...	[4,6]	F_{29}	F_{30}
f_4	1.73480(3)	20.08						...	F_1	F_2
f_5	2.253	26.08						...	F_4	F_5
f_6	2.538	29.38	...	...	...	...	suspected	...	F_2	F_4
f_7	2.666(2)	30.86	X	...	...	...	...	...	F_{111}	F_{115}
f_8	5.3311(3)	61.70	...	...	...	X	...	[6,8]	F_{369}	...
f_9	5.583(1)	64.62	X	X	...	...	...	...	F_{65}	F_{69}
f_{10}	9.3070(3)	107.7	...	...	X	X	...	[4,6]	F_{68}	F_{72}
f_{11}	6.6841/7.6841	77.36/88.94	...	...	...	X	...	[3,5]	F_{15}	F_{16}
f_{12}	10.1527/9.1527	117.5/105.9	...	...	...	X	...	[6,8]	...	...
f_{13}	12.0332/11.0332	139.3/127.7	...	...	...	X	...	[6,8]	F_{320}	...

Combination of 2 frequencies near 0.224 d^{-1} and 0.249 d^{-1} ?

Comparison with the ground-based data

see poster n° 60 (Uytterhoeven et al.)

Freq. name	Freq. (d^{-1})	Freq. (μHz)	$<\nu>$	$<\nu^2>$	$<\nu^3>$	LPV	Ground based photometry	mode degree ($l \in$)	Rodriguez analysis	Chapellier analysis
f_1	0.23427(5)	2.711	X	...	...	...	X	...	F_3 & F_5	F_3 & F_7
f_2	1.2732(8)	14.74	X	X	X	...	...	[5,7]	...	...
f_3	1.4831(8)	17.17	X	X	...	X	...	[4,6]	F_{29}	F_{30}
f_4	1.73480(3)	20.08	...	...	...	...	X	...	F_1	F_2
f_5	2.253	26.08	...	...	...	...	suspected	...	F_4	F_5
f_6	2.538	29.38	...	...	...	...	suspected	...	F_2	F_4
f_7	2.666(2)	30.86	X	...	...	...	...	...	F_{111}	F_{115}
f_8	5.3311(3)	61.70	...	...	...	X	...	[6,8]	F_{369}	...
f_9	5.583(1)	64.62	X	X	...	...	...	...	F_{65}	F_{69}
f_{10}	9.3070(3)	107.7	...	...	X	X	...	[4,6]	F_{68}	F_{72}
f_{11}	6.6841/7.6841	77.36/88.94	...	...	...	X	...	[3,5]	F_{15}	F_{16}
f_{12}	10.1527/9.1527	117.5/105.9	...	...	...	X	...	[6,8]	...	...
f_{13}	12.0332/11.0332	139.3/127.7	...	...	...	X	...	[6,8]	F_{320}	...

Summary

- Need to make our own estimation of HD49434 effective temperature
- Need hundreds frequencies to fit the light curve → Go further in the second analysis
  → See which frequencies are real
- This star does not seem to show solar oscillations
- Find again the approved and suspected ground-based frequencies (except two)

We can see high degree modes with Corot !

Future prospects for the γ -Doradus thematic team

- 2nd sismo-field γ -Doradus star HD171834 (LRc2 long run) : ground-based and Corot data analysis

- Analysis of exo-field γ -Doradus light curves

  → see poster n° 44 (Mathias & al.)

- Modelling of the γ -Doradus targets with the « BAG grid of models for γ -Doradus stars »

  → see poster n° 45 (Miglio et al.)

Appendix 1 :
Method for solar type oscillations prediction

From Kjeldsen & Bedding 1995 (A&A 297, 87) :

Assuming $$v_{osc} = \frac{L * M_o}{L_o * M} * (0.234 \pm 0.014) \quad m.s^{-1}$$

with $$L = 4.\pi.R^2.\sigma.T^4$$

We have : $$\left(\frac{\delta L}{L}\right)_{bol} = \frac{R^2 * T_{eff}^3 * 0.234}{R_o^2 * T_o^3 * \frac{M}{M_o}} * 17.7 * 1.086 \quad \mu mag$$

and $$\nu_{max} = \frac{M/M_o}{\left(R/R_o\right)^2 * \sqrt{\frac{T_{eff}}{T_o}}} * 3050 \quad \mu Hz$$ ***for solar type oscillations***

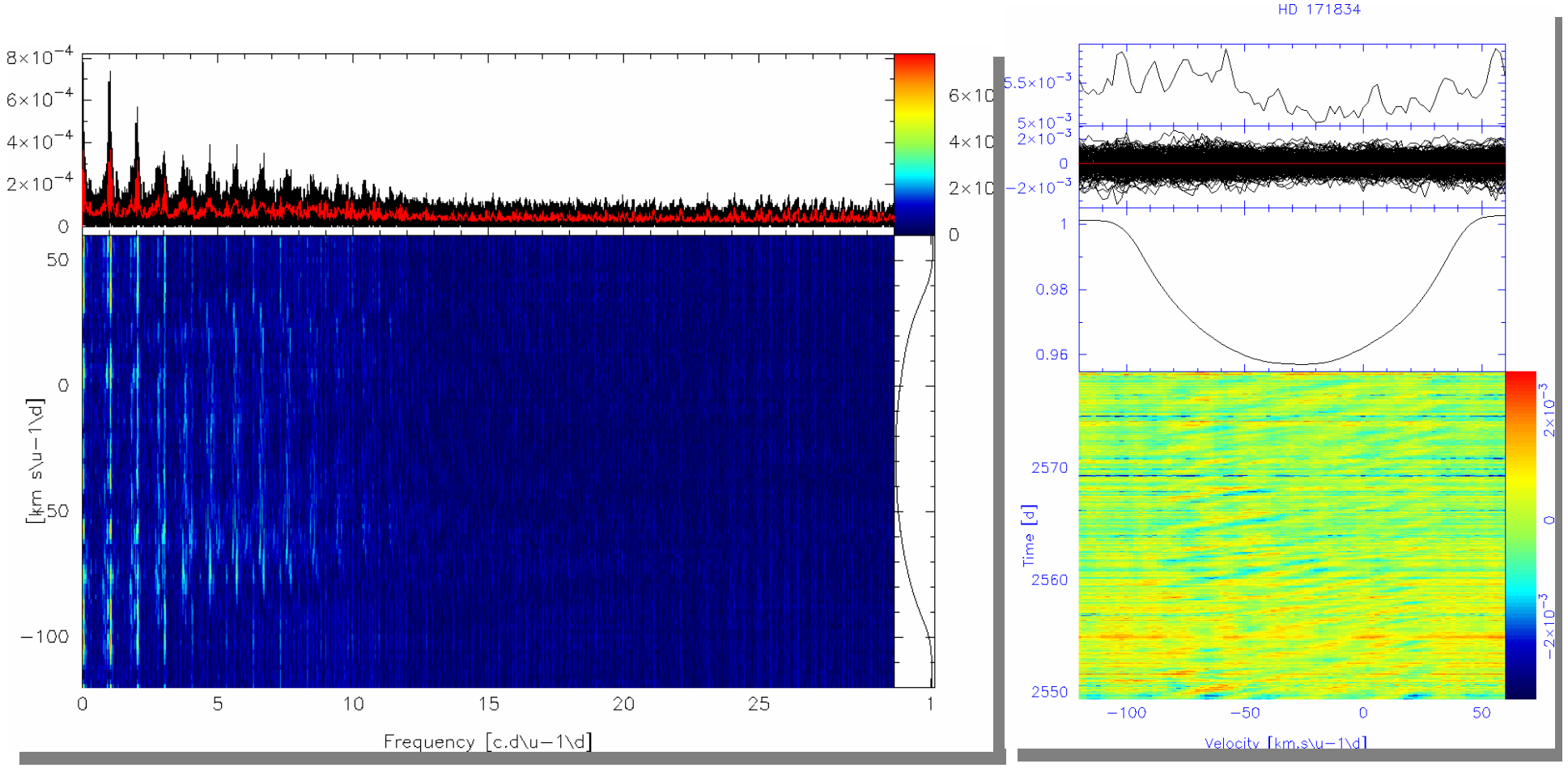
Appendix 2 : SigSpec applied to the ground-based data

Freq. name	Freq. (d^{-1})	Freq. (μHz)	u	b	v	y	Rodriguez analysis	Chapellier analysis	Remarks
f_1	0.23427(5)		X	X	X	X	F_3 and F_5	F_3 & F_7	
f_4	1.73480(3)		X	X	X	X	F_1	F_2	
f_5	2.253		X	X	X	X	F_4	F_5	
f_6	2.538		...	X	X	X	F_2	F_4	
f_{14}	2.4747		X	X	X	X	not found	not found	$f_3 + 1\ cd^{-1}$
f_{15}	2.38		X	X	X	X	F_9	F_{10}	
f_{16}	1.5442		...	...	...	X	F_8	F_9	

Appendix 3 : Comparison of the two analysis

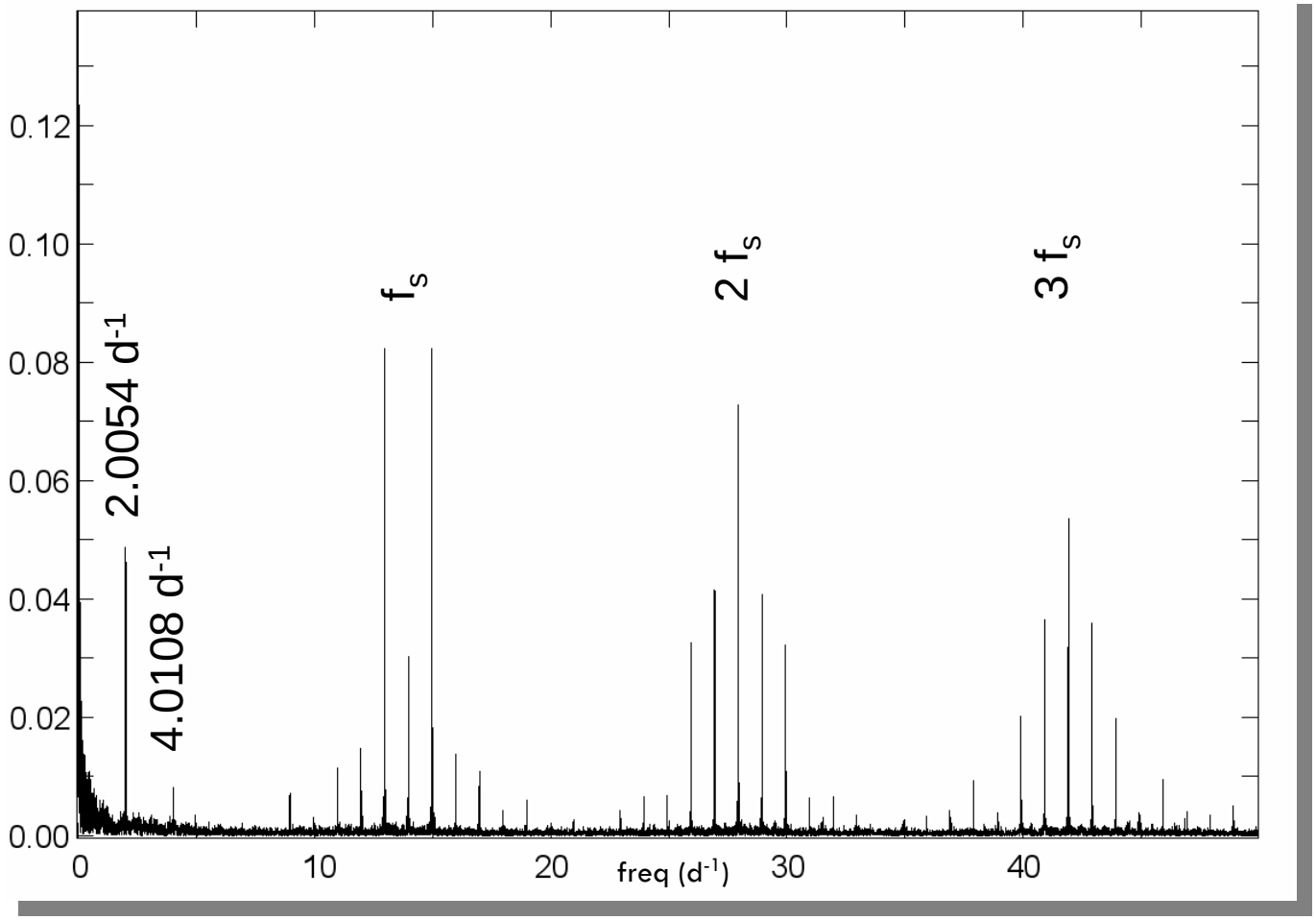
- All the 155 peaks of the second analysis are included in the 200 first peaks of the first analysis with :
  - Near the same detection order from the 1st to the 30th frequency
  - Detection order at $\pm$ 10 from the 30th to the 100th frequency
  - Detection order at $\pm$ 20 from the 100th to the 130th frequency
  - Detection order at $\pm$ 50 from the 130th to the 155th frequency

Appendix 4 : HD171834 is a variable star



Appendix 5 : Frequency analysis

Spectral window



Appendix 6a :
Are all peaks « real peaks » ?

- Are all the peaks true peaks ?

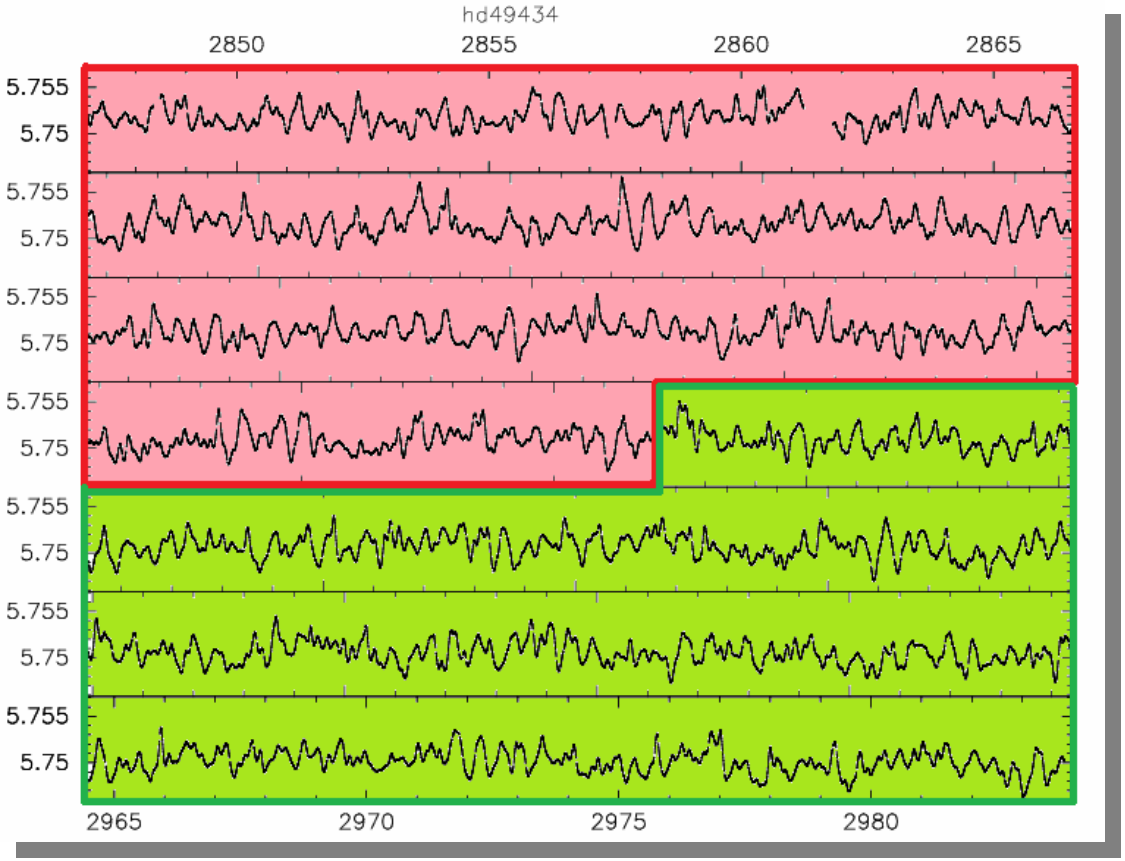
  (not due to the analysis)

  ➔ Using different methods on the whole data (W) (See second analysis)

- Are all true peaks real peaks ?

  (intrinsic of the star)

  - ➔ Comparing 2 subsets :
    - subset S1 from day 0 to day 70 (166089 points)
    - subset S2 from day 70 to day 136,9 (165202 points)



Appendix 6b :
Are all peaks « real peaks » ?

- 3 coincidence criterions :
  - on the frequency range
  - on the amplitude
  - on the number of the frequency in the list

- Caution with the criterion on the amplitudes :

  → Possibility of energetical interaction between modes during "short" time scales

  → Can induce amplitudes variations from a subset to another.

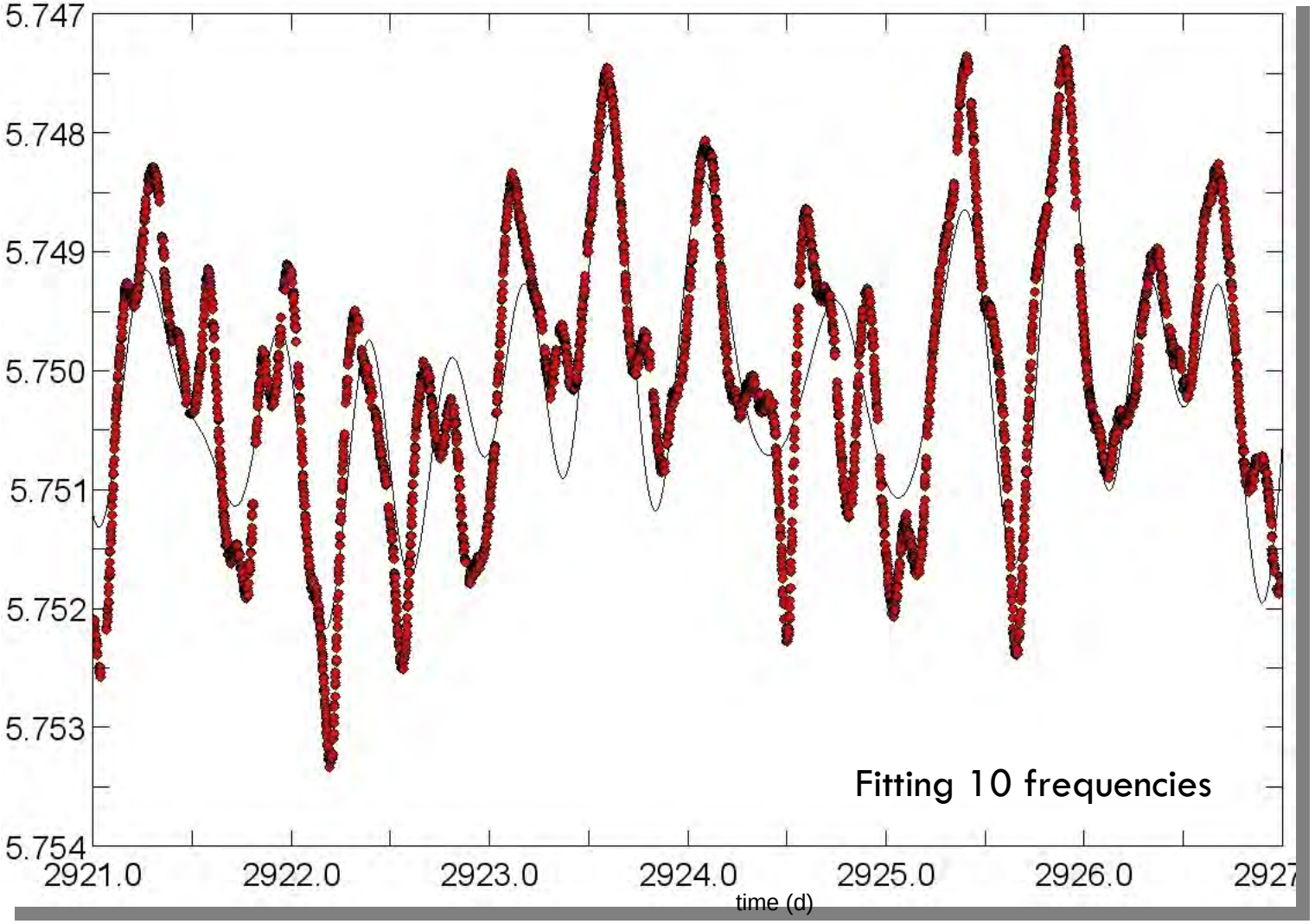
- S1 versus S2 :

Range (d^{-1})	Real	Probable	300
0.005	183	334	146
0.01	281	522	207

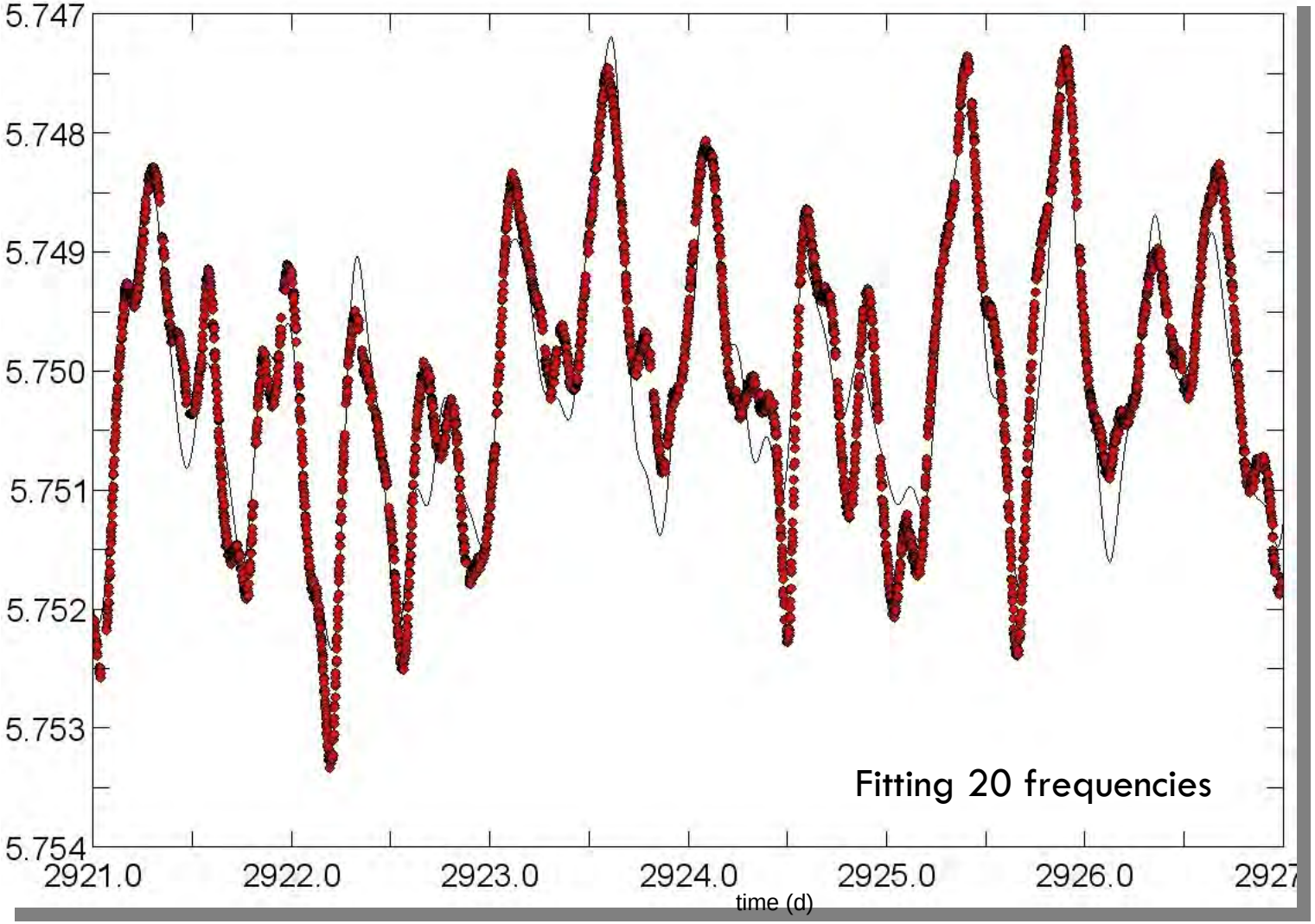
S1 and S2 versus W :

Subset	Range (d^{-1})	Real	Probable	300
S1	0.005	219	646	231
S2	0.005	211	600	223
S1	0.01	301	854	276
S2	0.01	280	769	277

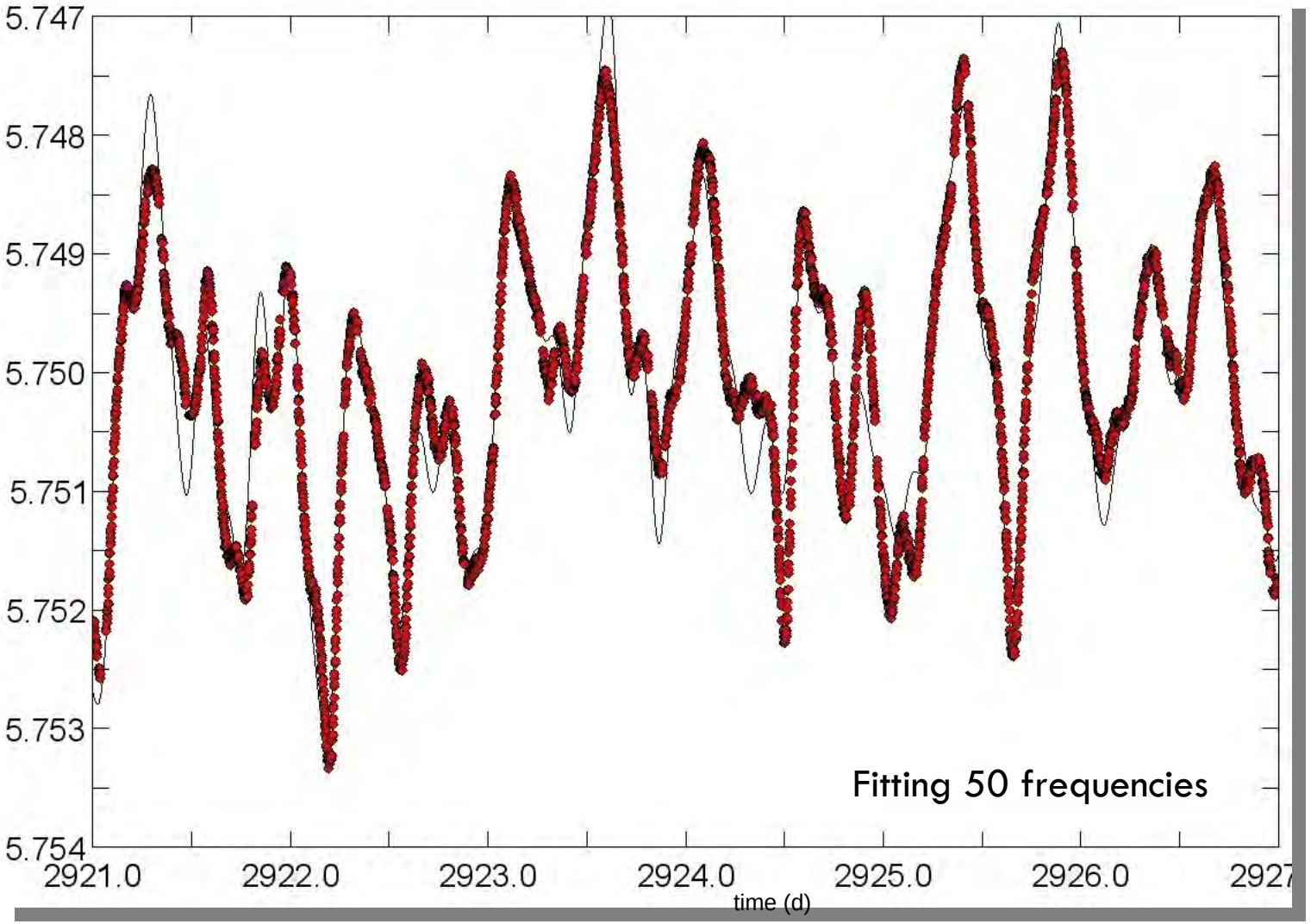
Appendix 7a :
Second frequency analysis



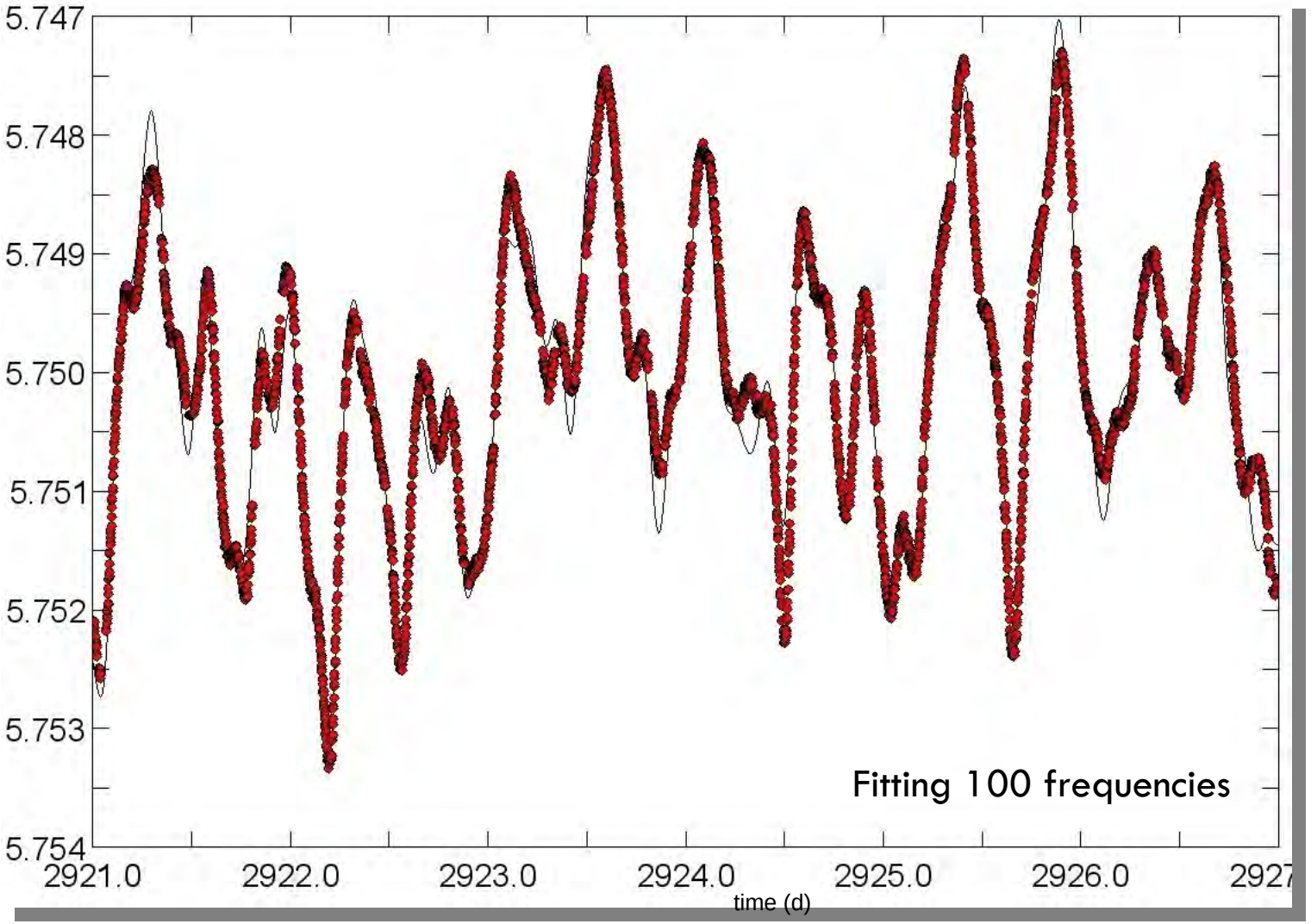
Appendix 7b :
Second frequency analysis



Appendix 7c :
Second frequency analysis



Appendix 7d :
Second frequency analysis



Appendix 7e :
Second frequency analysis