# Hungarian participation in COROT

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# Hungarian Asteroseismology Group

www.konkoly.hu/HAG

established at the beginning of this year

for joining the preparatory work of COROT via ESA


Members - Experts

- Margit Paparó – δScutis
- Zoltán Csubry - modelling
- Zoltán Kolláth - modelling
- József Benkö – RR Lyraes
- Róbert Szabó – RR Lyraes
- László Szabados - Cepheids

# Fields of activities

search for a meaningful task in the preparatory work at late phase of joining

- Photometric characterization of seismo targets
- Time series photometry of exofields
- Guide for subfield selection: ROTSE-I
- Tests for time series analysis
- Strömgren calibration of exofields

# Photometry of seismo targets

- Characterization of stars in Ennio Poretti' s team:
  - HD 181555 – δScuti – main target
  - HD 180642 – βCephei
  - HD 181231 – Be star
  - HD 181147 – δScuti
- HD 49434 - Gamma Dor star – with Philippe Mathias
- V920 Aql - RR Lyrae star on the exofield with possible Blazhko effect – collaboration with Ennio Poretti

# Time series: Schmidt telescope (90/60 cm)

to find interesting targets for possible oversampling on exofields

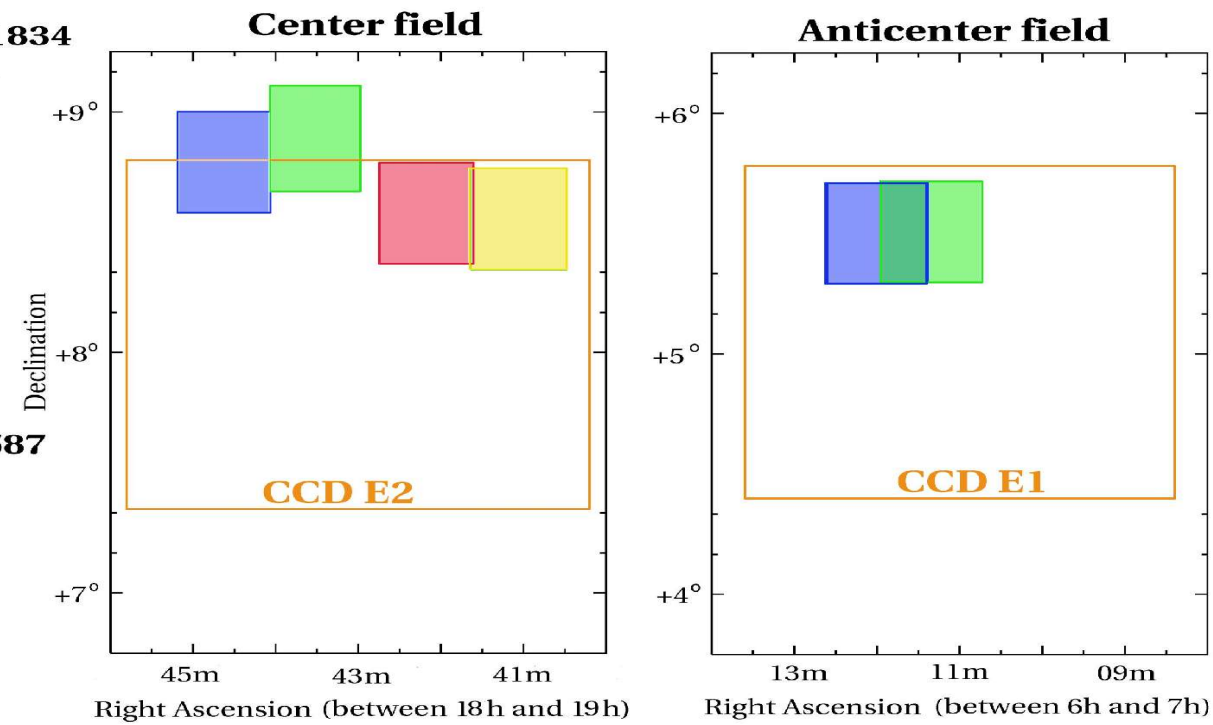
## COROT field maps

**Center field**

**Main target: HD 171834**
RA = 18h 36m 39s
DEC = +6d 40m 18s
RA = 18h 44m 37s
DEC = +8d 47m 17s
RA = 18h 43m 31s
DEC = +8d 52m 42s
RA = 18h 42m 09s
DEC = +8d 34m 39s
RA = 18h 41m 02s
DEC = +8d 33m 06s

**Anticenter field**

**Main target: HD 43587**
RA = 06h 17m 16s
DEC = +5d 06m 00s
RA = 06h 11m 54s
DEC = +5d 35m 50s
RA = 06h 11m 20s
DEC = +5d 35m 50s



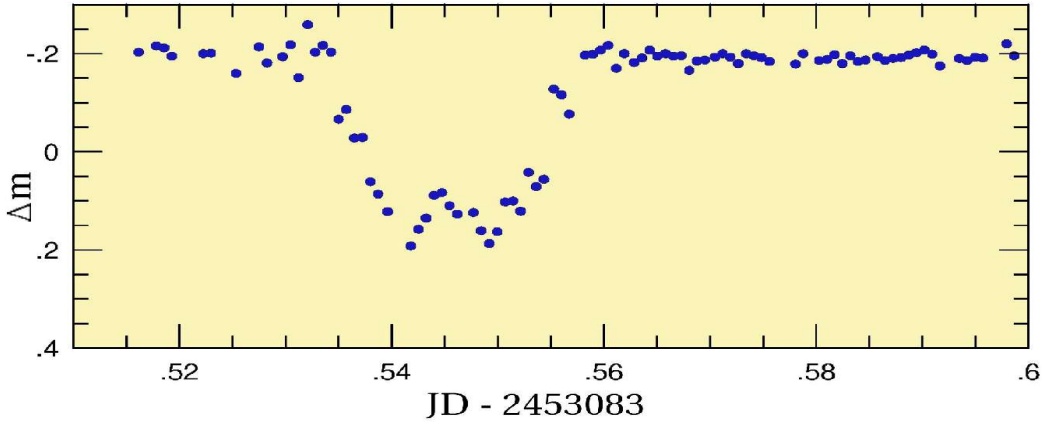
# Binaries can interfere recognization of exoplanetary transits: excluded in advance

or

some of them can be oversampled

## Newly discovered eclipsing binary

### on COROT exoplanet field




**Preliminary parameters**

***Time of eclipse***
**35 minutes**

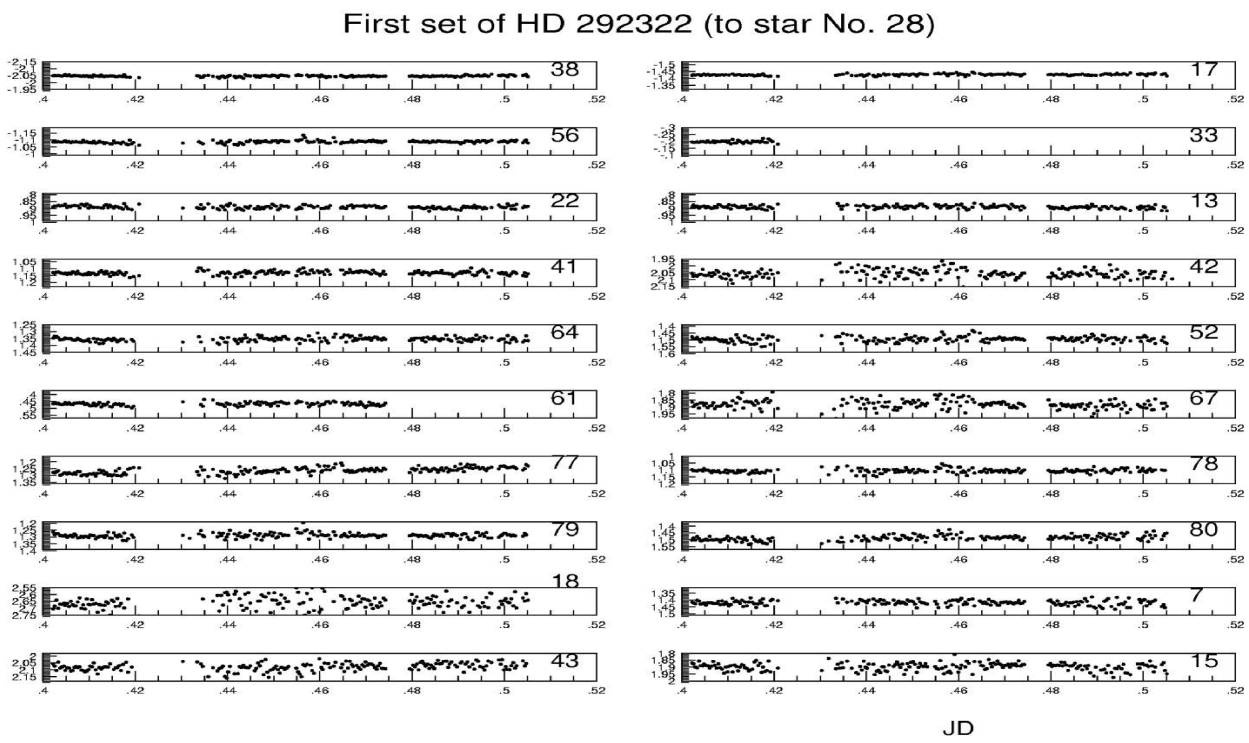
***Depth of eclipse***
**0.4 mag**

***Time of total eclipse***
**10 minutes**

***Height of inversion***
**0.1 mag**

# Time series on exofield of HD 49933+ HD 49434

selection on star density or well-known star in the field:
precise photometry of stars in BVRI colours:
selection for dwarfs and giants



# More effective selection of subfields: ROTSE - I

Details in poster:

József M. Benkö and Zoltán Csubry

ROTSE-I All Sky Survey as a Tool of Target Selection in the COROT Fields

# Effective variability search in large database:
# MuFrAn

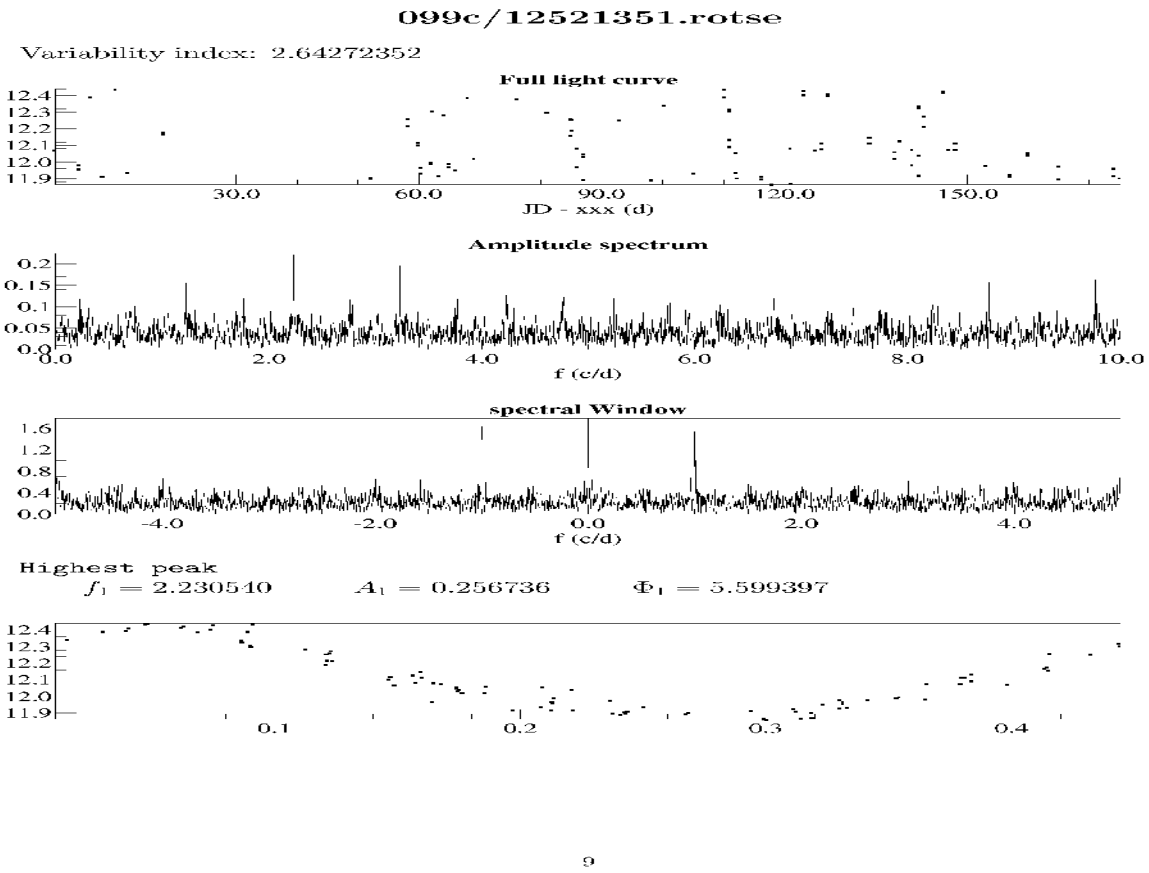
Details in poster:

Zoltán Csubry and Zoltán Kolláth

MuFrAn – A scriptable data processing tool for variable stars

# Output of automatic data process by MuFrAn

can be modified for automatic variable star selection




Input data

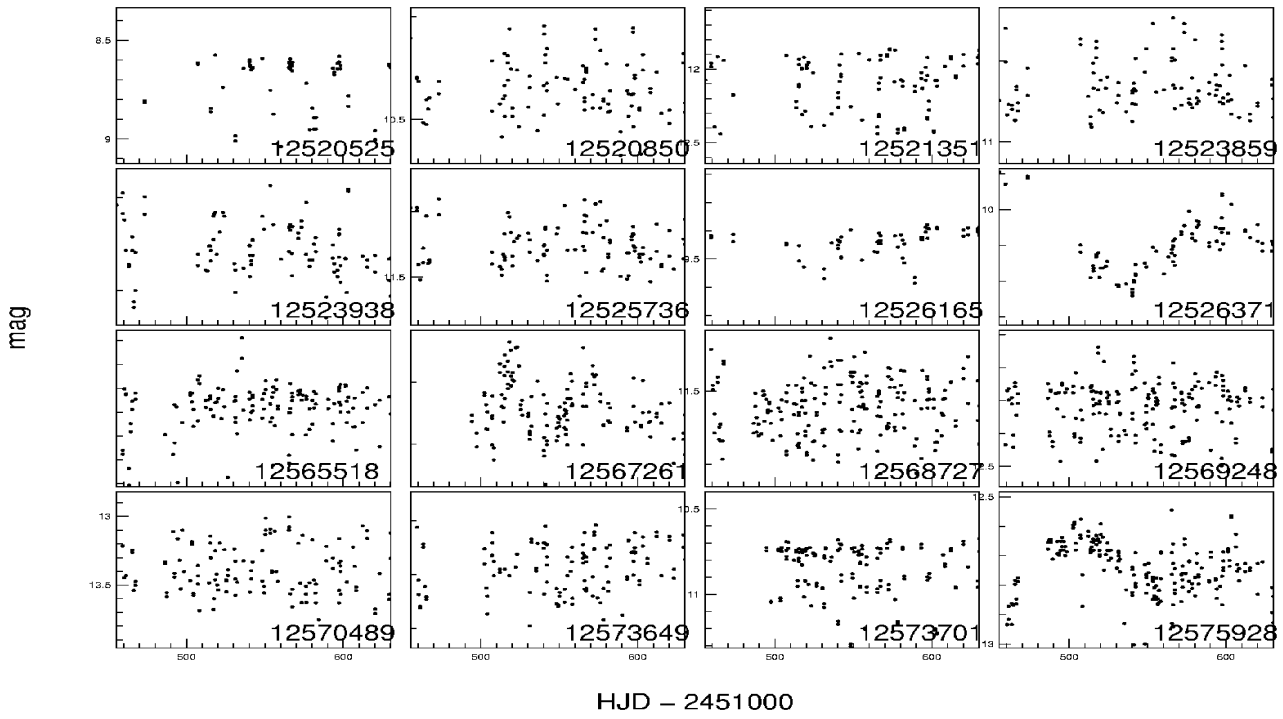
Amplitude spectrum

Spectral window

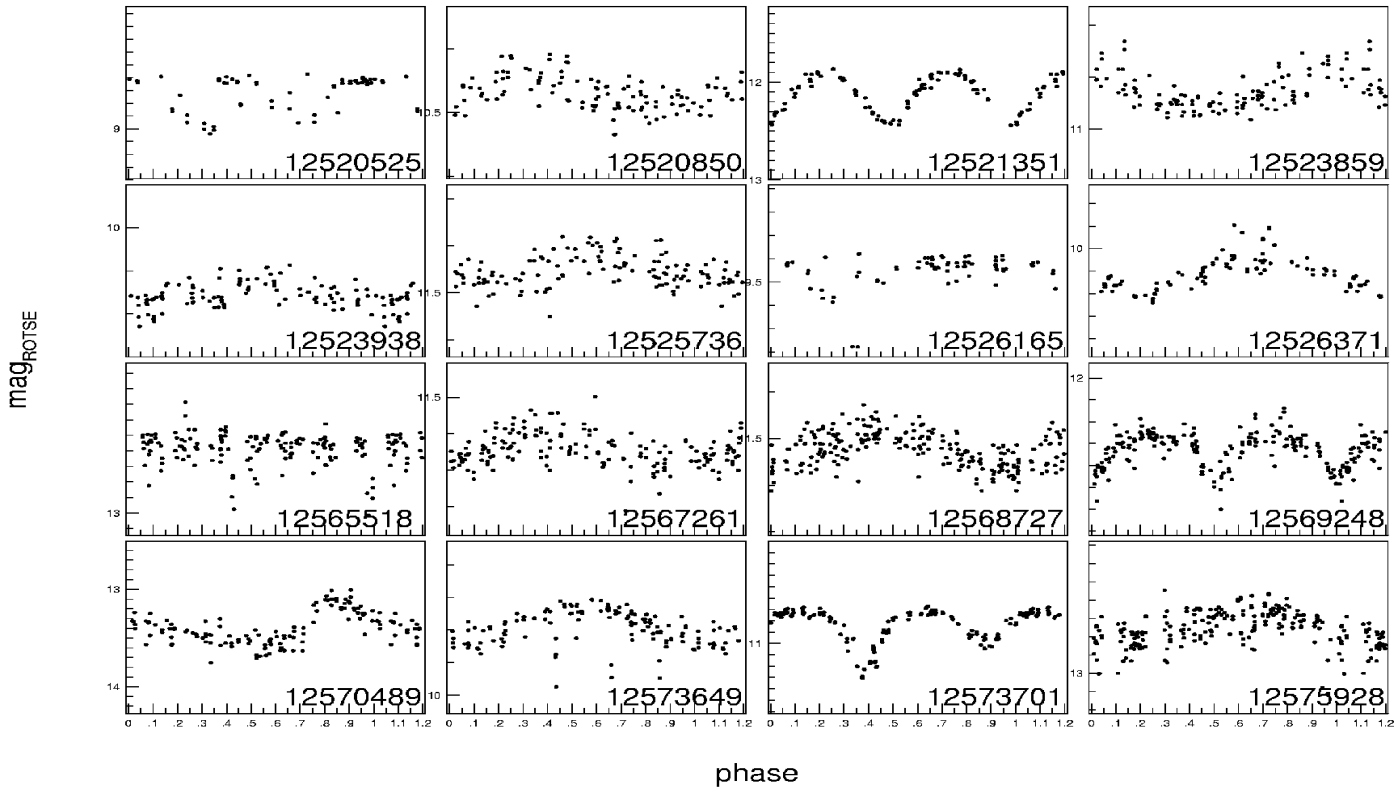
Folded light curve

# ROTSE-I database on COROT fields

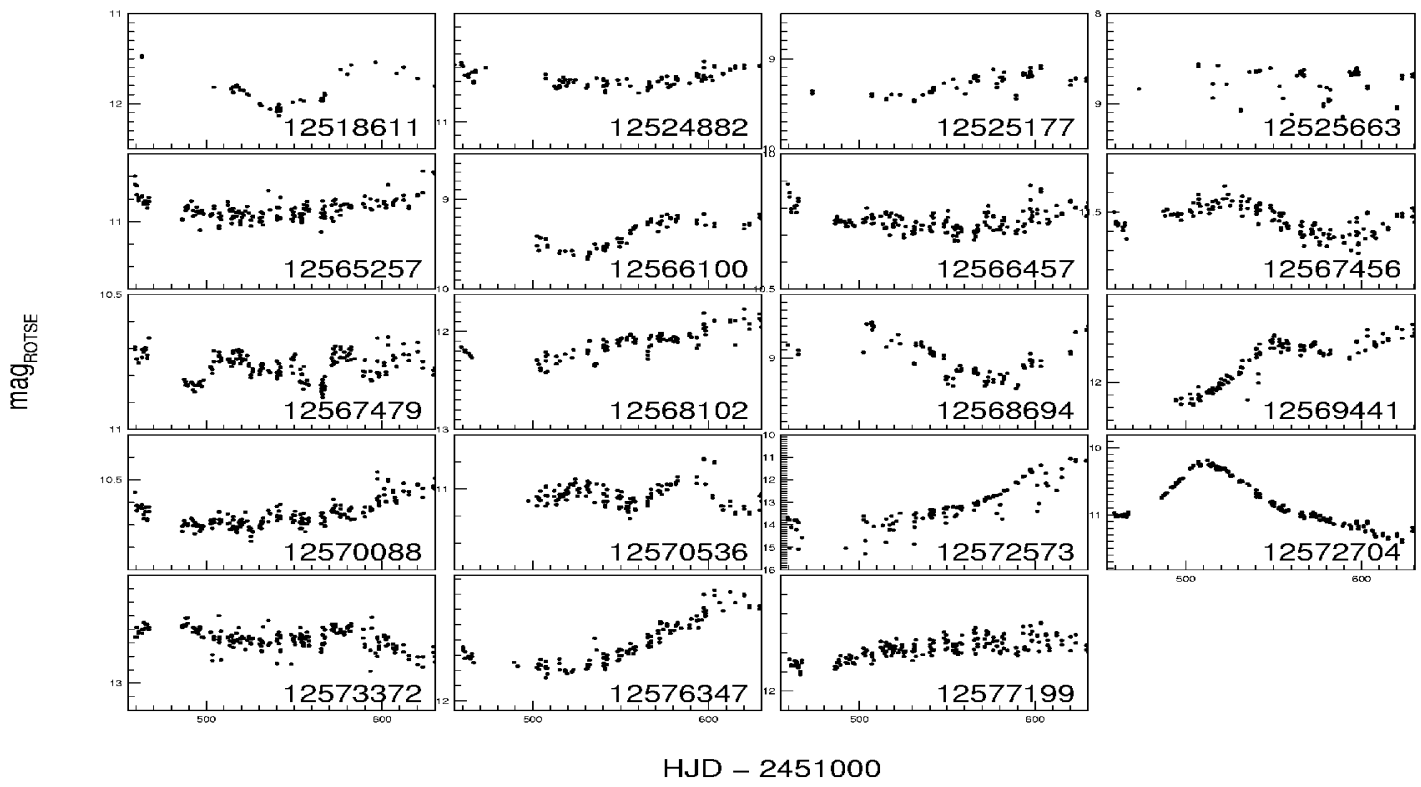
## non-folded light curves on HD 49933 + HD 49434



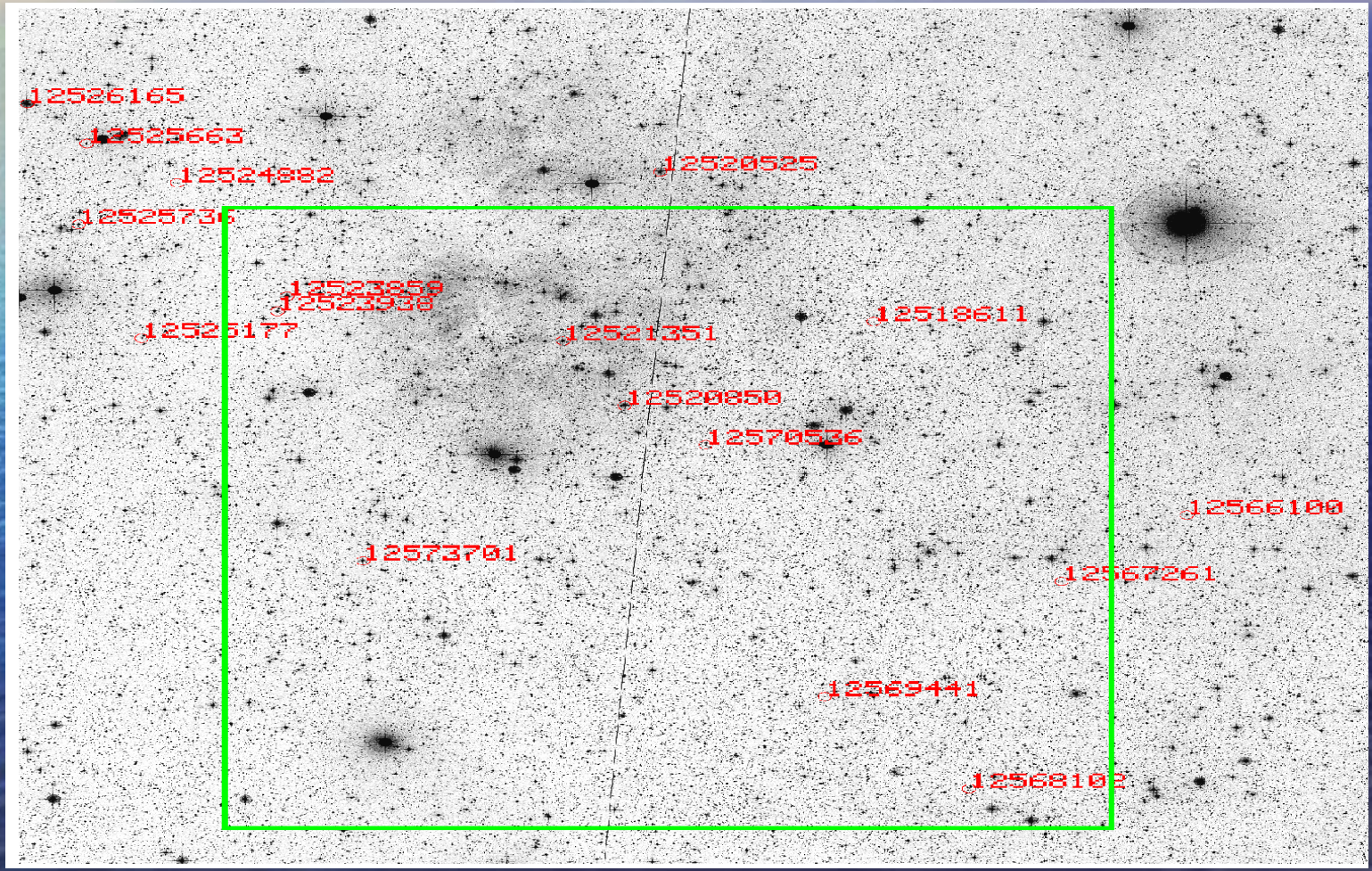
# Folded light curves



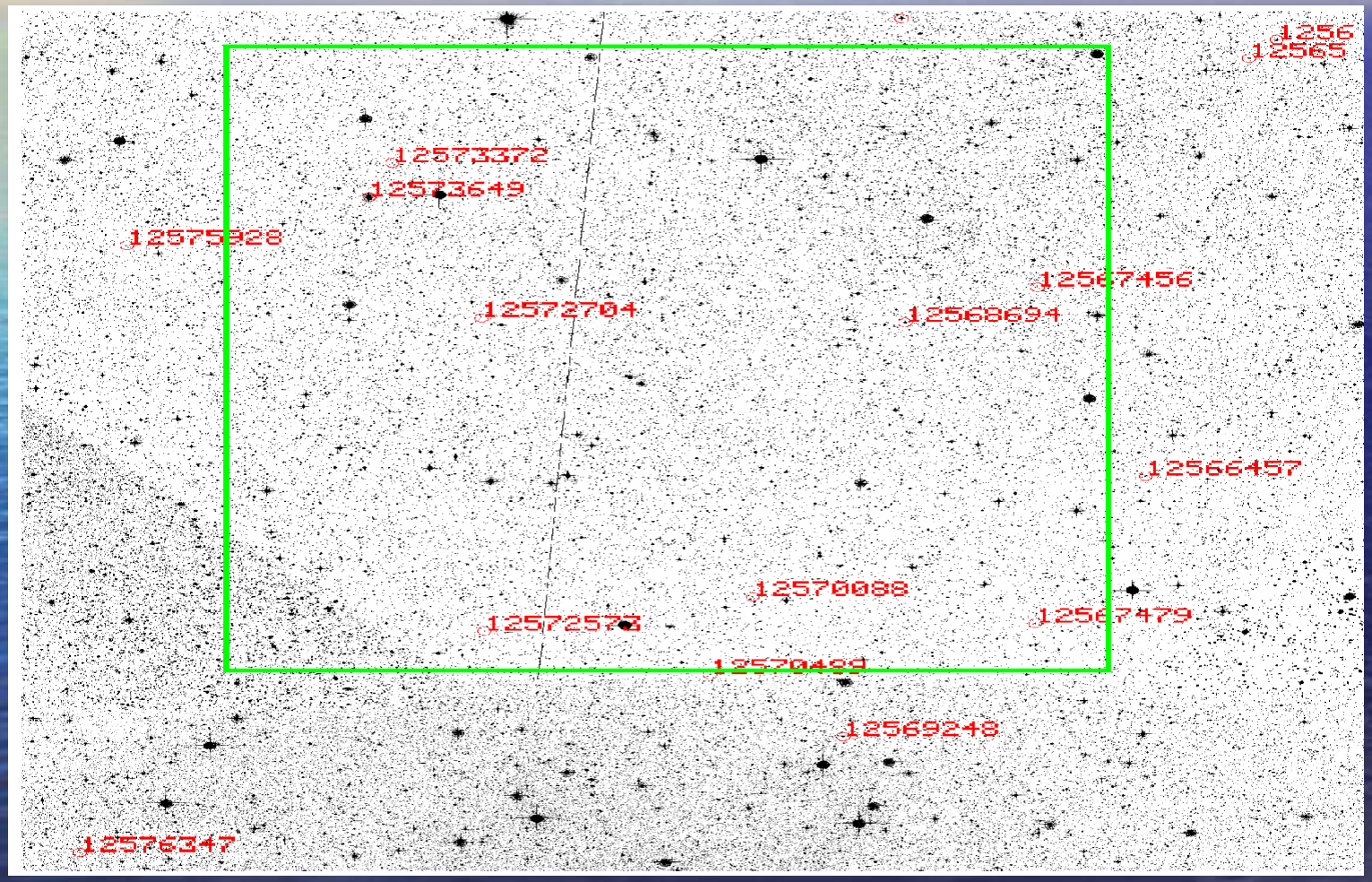
# Long period variables in ROTSE-I



# Upper exo CCD and ROTSE-I variables



# Lower exo CCD and ROTSE-I variables



# Test for time series analysis with MUFRAN on exodata

## Test cases

- RR Lyrae: double-mode, Blazhko effect, non-radial modes
- Critical frequency separation
- Cepheids: single, double-modes, non-radial modes
- Delta Scuti stars : 12 modes
- Results for systematic residuals

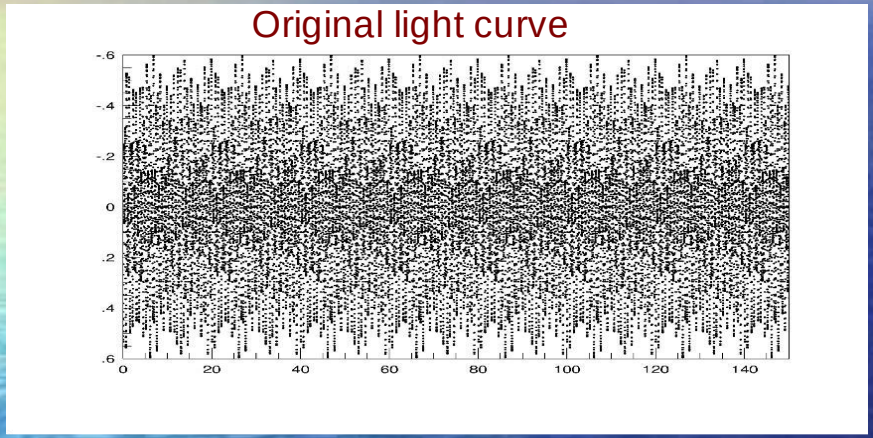
# Generation of synthetic data

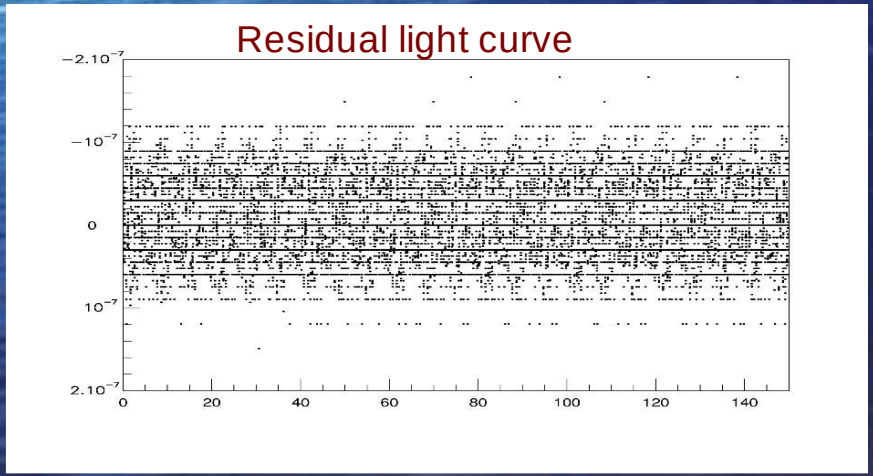
- Pure sine waves were used, sampled in every 8th minutes
- No noise was added
- Double mode pulsation is represented by approximate proper period ratio
- Blazhko effect is simulated by equally spaced triplet (amplitudes: 10% of the main peak)
- Non-radial modes are represented as lower amplitude modes: 10 % of a radial mode but much lower is needed
- Large separation of fundamental and first overtone:

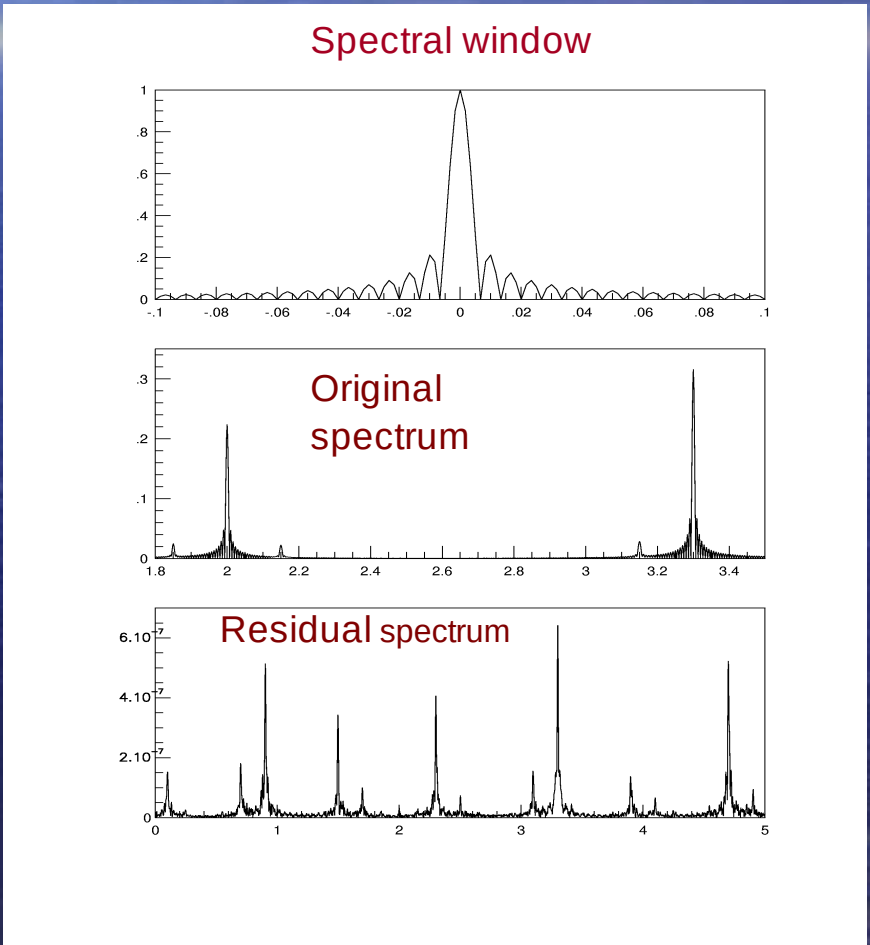
  all cases are presented in a single slide

# RR Lyrae stars

Frequencies: 2.0, 2.15, 1.85, 3.30, 3.15 c/d modes



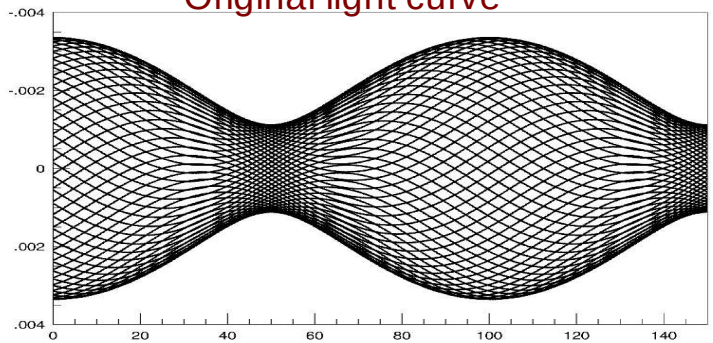

First side lobe: 0.01 c/d, amplitude: 22%; Halfwidth of main peak: 0.004 c/d

# Critical frequency separation

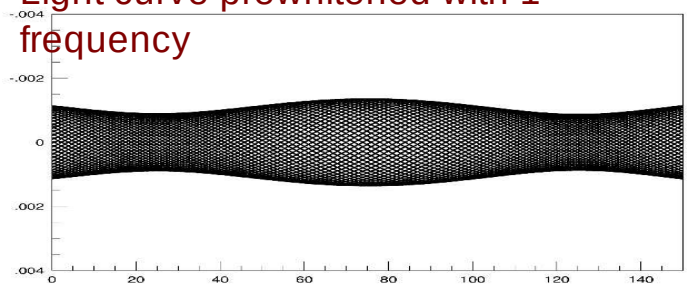
- Light curve was generated using frequency separation of the first side lobe (0.01 c/d)
- Frequency separation was decreased by one order of magnitude in each steps
- 2:1 ampliude ratio was used
- Limit separation: if two closely spaced frequencies can not be resolved (0.0001 c/d): closer than the halfwidth of the main peak

# Frequencies: 3.0 and 3.01 c/d
# amplitude ratio: 2:1

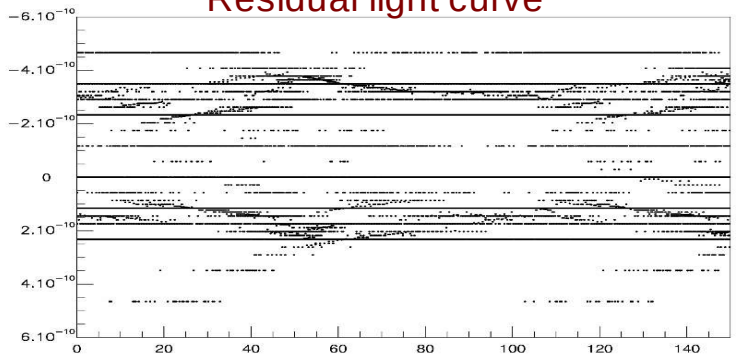
Original light curve

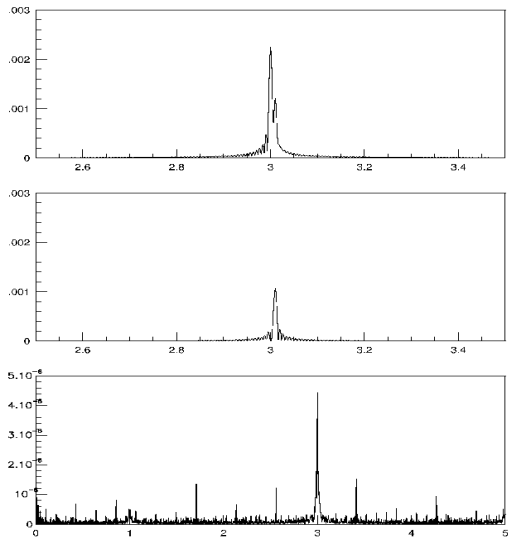



Light curve prewhitened with 1 frequency




Residual light curve



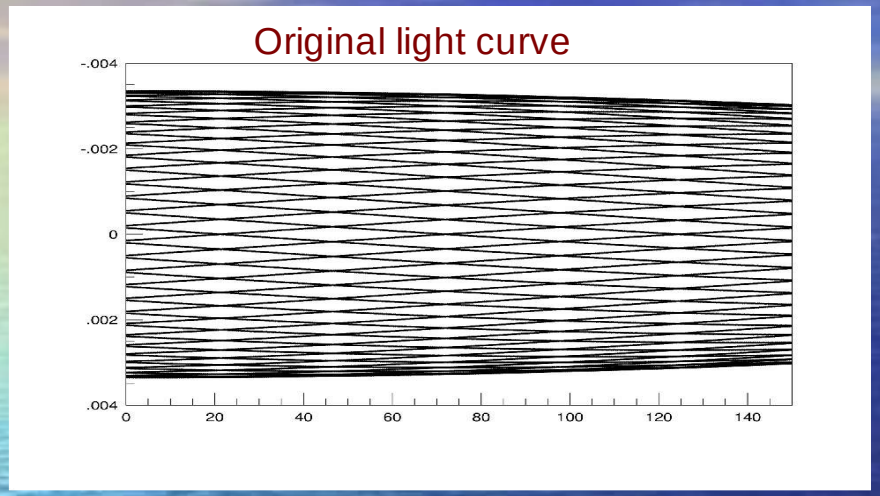



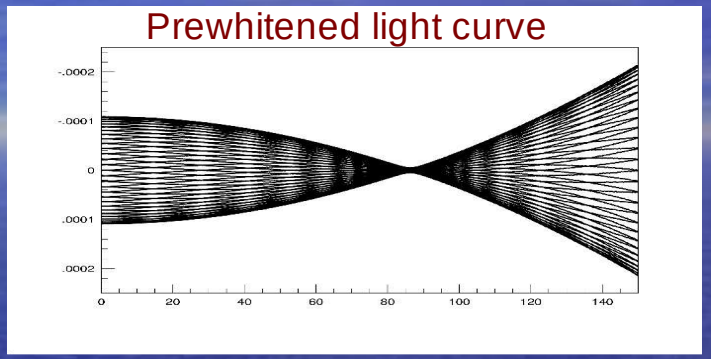

Original spectr.

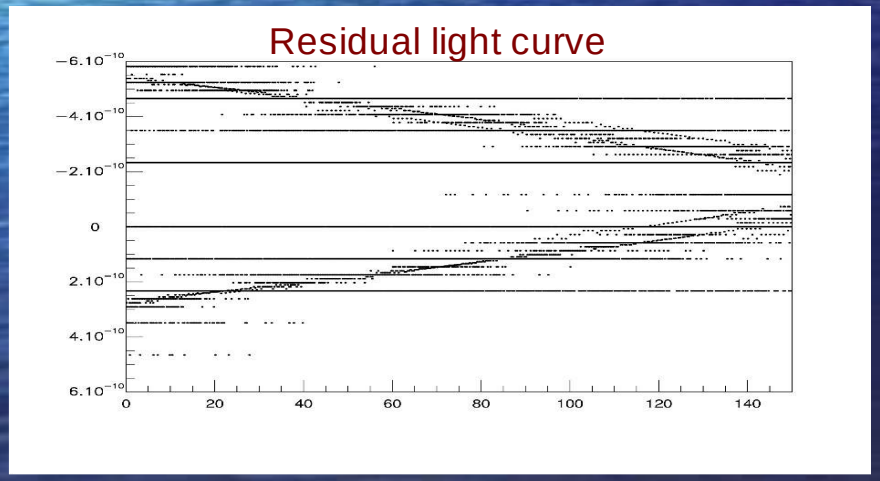
Prewhitened

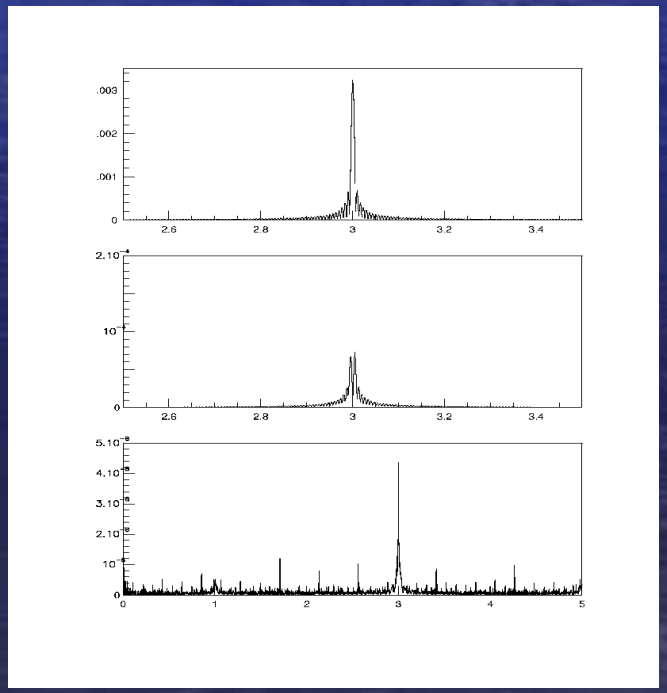
Residual

# Frequencies: 3.0 and 3.001 c/d




Original

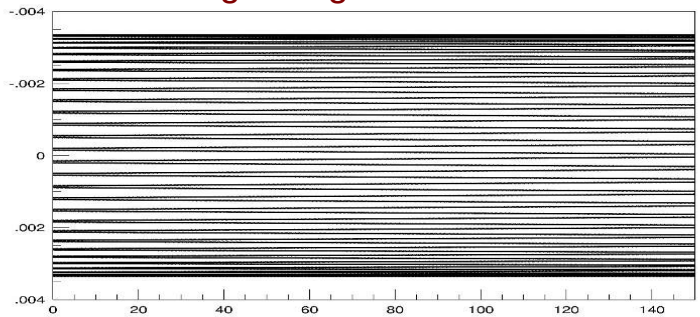
Prewhitened

Residual

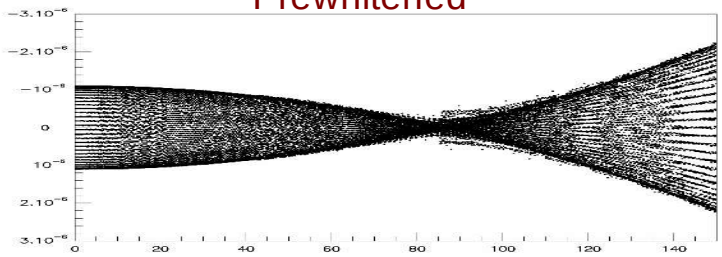
# Limit separation

# Frequencies: 3.0 and 3.0001 c/d

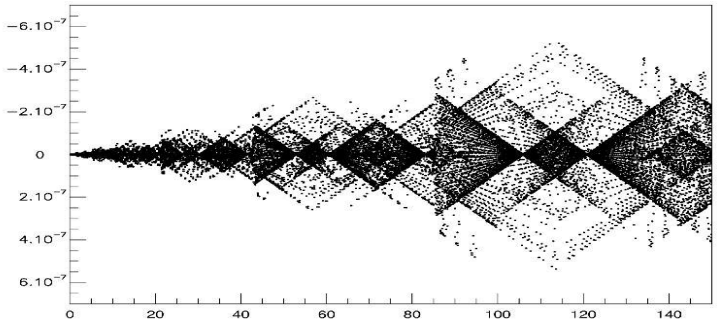
Original light curve

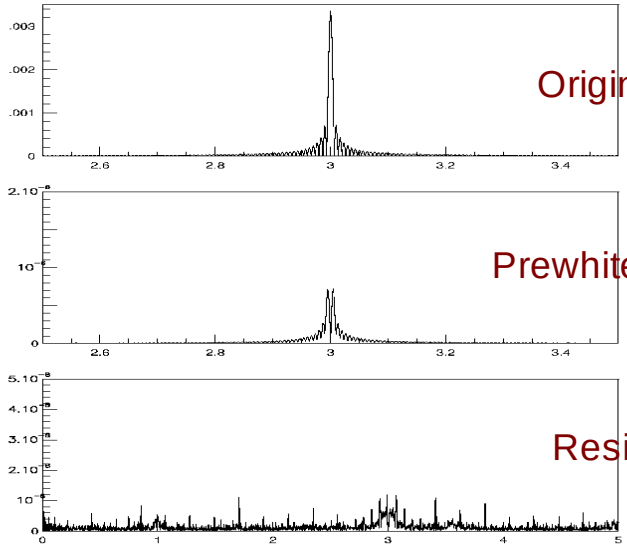



Prewhitened




Residual



# Conclusion on RR Lyrae and critical separation cases

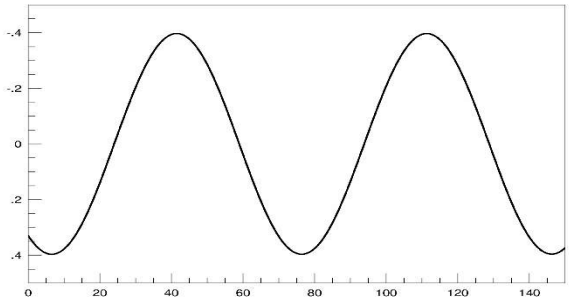
- Spectral window is nice
- Exofields sampling (8 minutes) is enough for long period variables
- Easy to find even the closely spaced modes
- There are residual light curves on $10^{-7}$ – $10^{-10}$ magnitude amplitude level (depending on the complexity of the spectrum)
- Sharp, systematic peaks in residual spectra because of computational errors

# Cepheids: closely spaced radial and non-radial modes

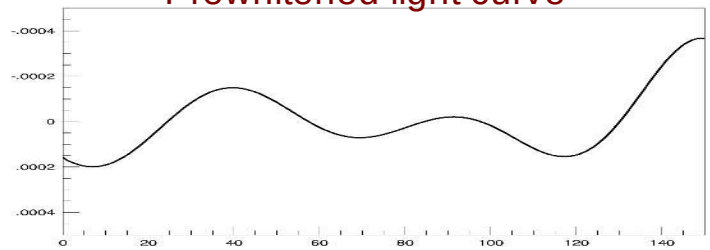
- Regarded the longer periods of Cepheids the sampling is more proper
- Double mode and possible Blazhko effect cases are similar to the RR Lyrae cases
- 0-1 c/d frequency range is influenced by the negative side of the spectral window
- Almost resonant (closly spaced) radial and non-radial modes were simulated
- Separation is less than the halfwidth of the main peak in the spectral window
- Amplitude ratio 10:1 was used

# Frequencies: 0.0143 and 0.0145 c/d
# Periods: 70 and 69 days

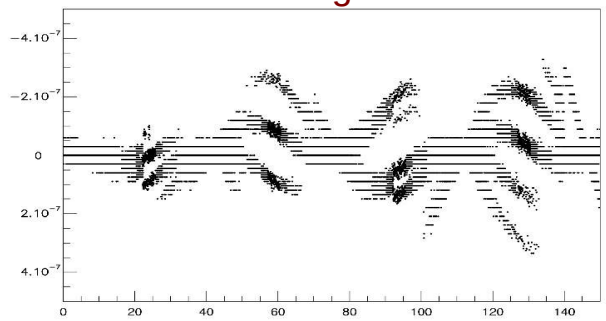
Original light curve

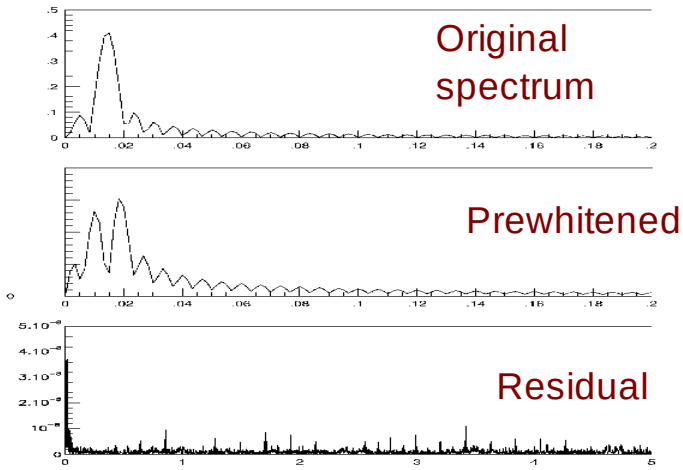



Prewhitened light curve




Residual light curve



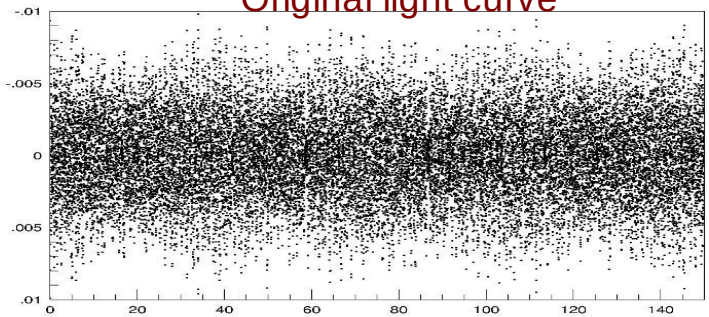



# δScuti stars on exofields

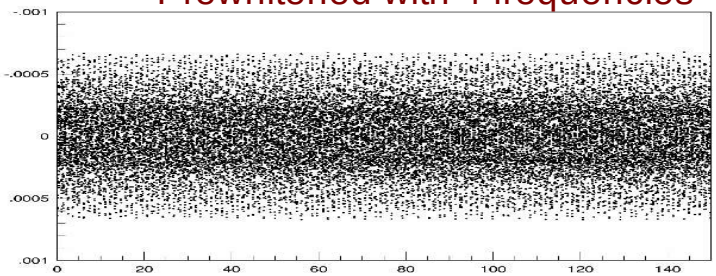
- Large (8 minutes) sampling comparing to the shorter periods is tested
- Frequency distribution is more complex: many closely spaced modes can be expected
- Amplitudes are much smaller
- A real case: 12 closely spaced frequencies of FG Vir with realistic amplitudes were used for simulation

# Frequencies: 24.228, 23.403, 21.052, 19.868, 19.228, 20.288, 24.200, 21.232, 25.432, 21.551, 24.354, 22.372 c/d

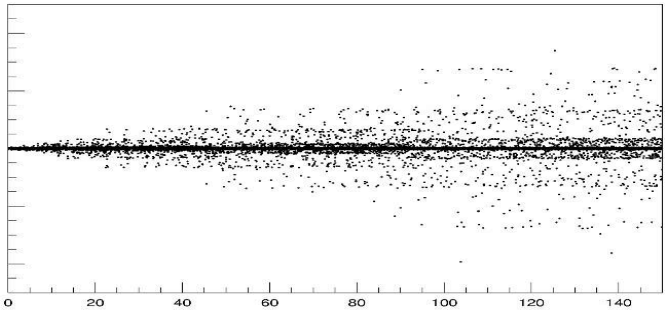
Original light curve

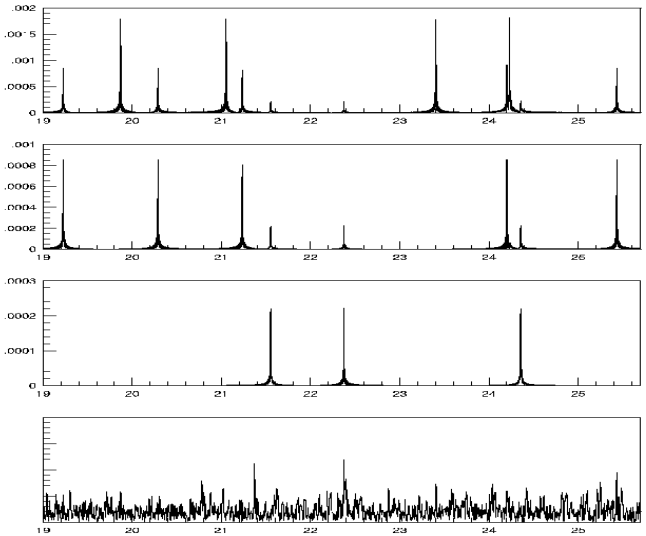



Prewhitened with 4 frequencies




Residual light curve




Scale: 0.000005 mag

# Conclusion on Cepheids and FG Vir cases

- No serious effect from the overflow of the negative side: closely spaced modes can be obtained by simultaneous search for both frequencies in Cepheids
- Sampling seems to be enough for FG Vir
- Exact values of the 12 frequencies can be obtained in the analyses
- Systematic peaks are in the residual spectra for both Cepheids and the δScuti star, FG Vir

# Collection of residual spectra for different test cases

FFT: Fast Fourier Transform for RR Lyrae and critical separations
DFT: Discrete Fourier Transform, FFT-1: one segment, FFT-8: 8 segments

**FFT**

**RR Lyr**

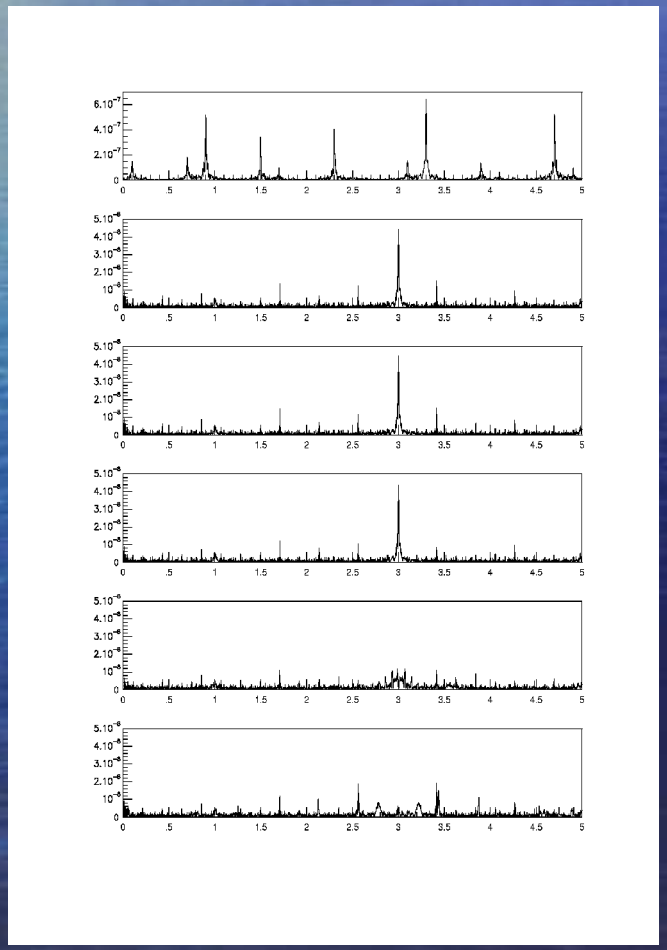
$\Delta f$=0.01

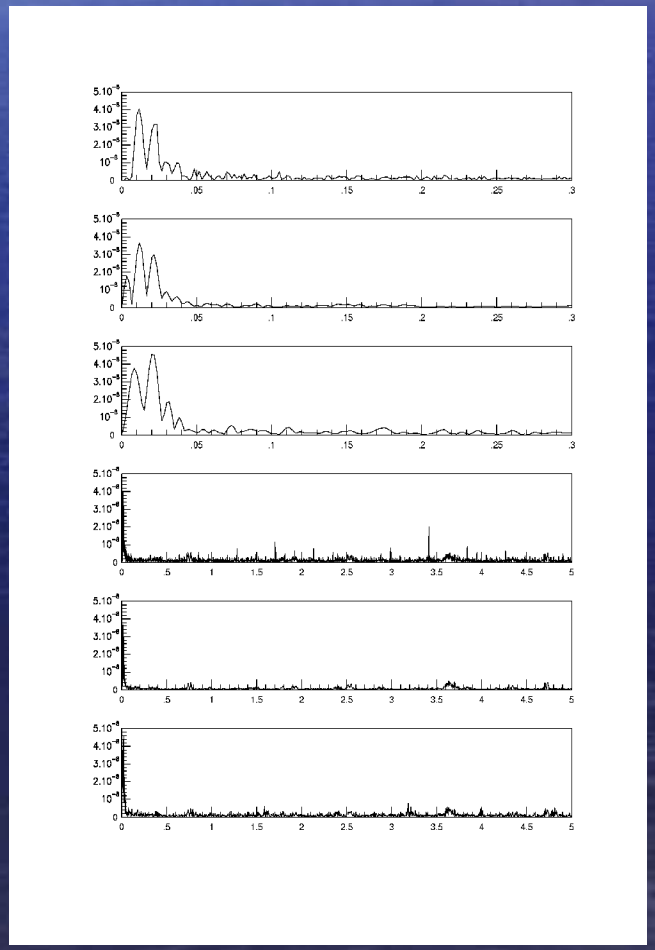
$\Delta f$=0.005

$\Delta f$=0.001

$\Delta f$=0.0001

$\Delta f$=0.00001





**FFT – 1**

**DFT**

**FFT - 8**

**FFT - 1**

**DFT**

**FFT - 8**

# General conclusion

- Systematics are in residual spectra on low amplitude level
- Different systematic peaks appear using different methods (FFT with special algorythm for unevenly spaced data, DFT a dedicated method for unevenly distributed data)
- Different residuals are given for a single continuous segment or 8 segments without gaps

- Final conclusion: treating the COROT exadata for delicate investigation of variable stars we have to go back to the classical Fourier method for evenly spaced data. Methods used for unevenly spaced data can add some false frequencies to our final frequency solution on a specific star.

# Strömgren calibration of exofields

- Collaboration in observation with Hans Deeg if it is needed
- Standardization: trial on M67 cluster – low position
- Transformation to physical parameters: collaboration with Werner Wiess

Thank you