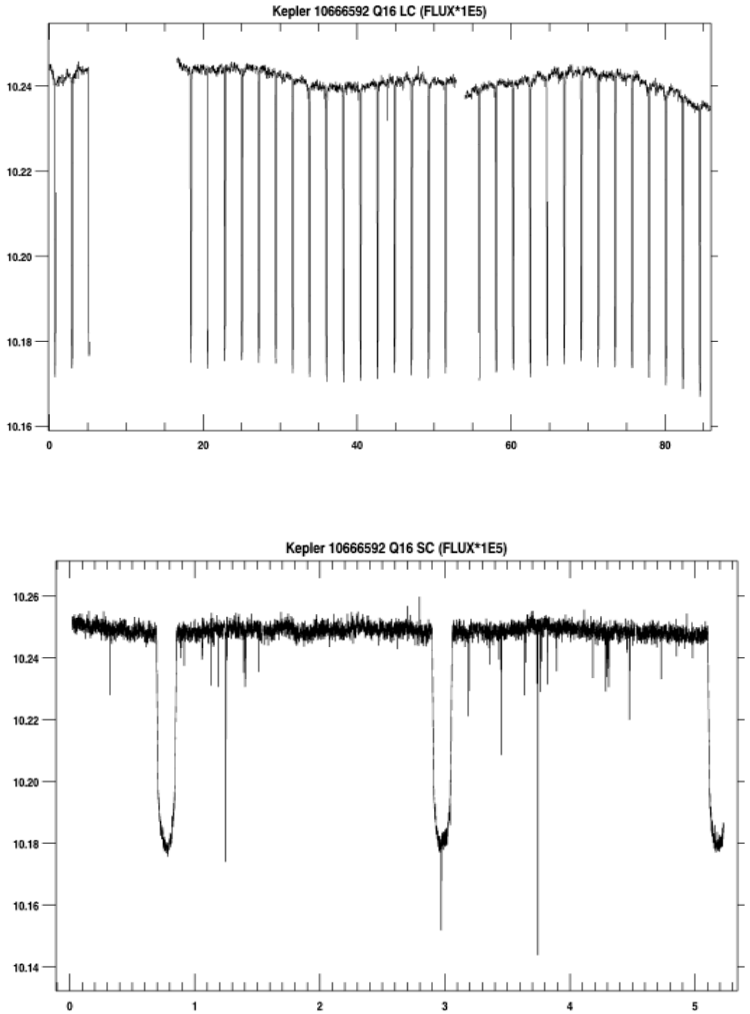
WP128.300: Preparation of the asteroseismic analysis ready light curves

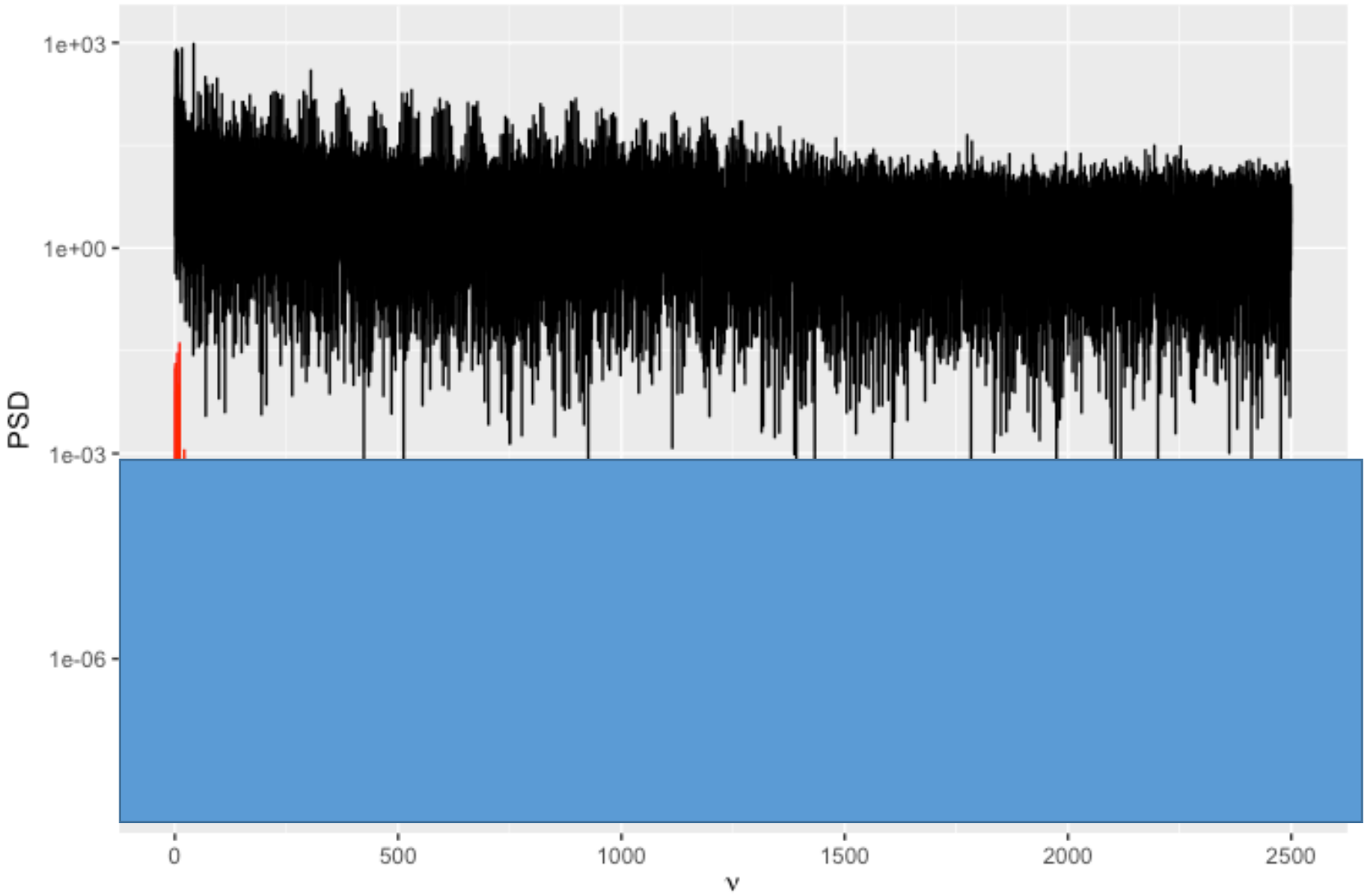
A. Moya, R. Alonso, W.J. Chaplin, G.R. Davies, R.A. García, P. Gaulme, M.N. Lund, S. Mathur, M.B. Nielsen, J. Pascual-Granados

Goal

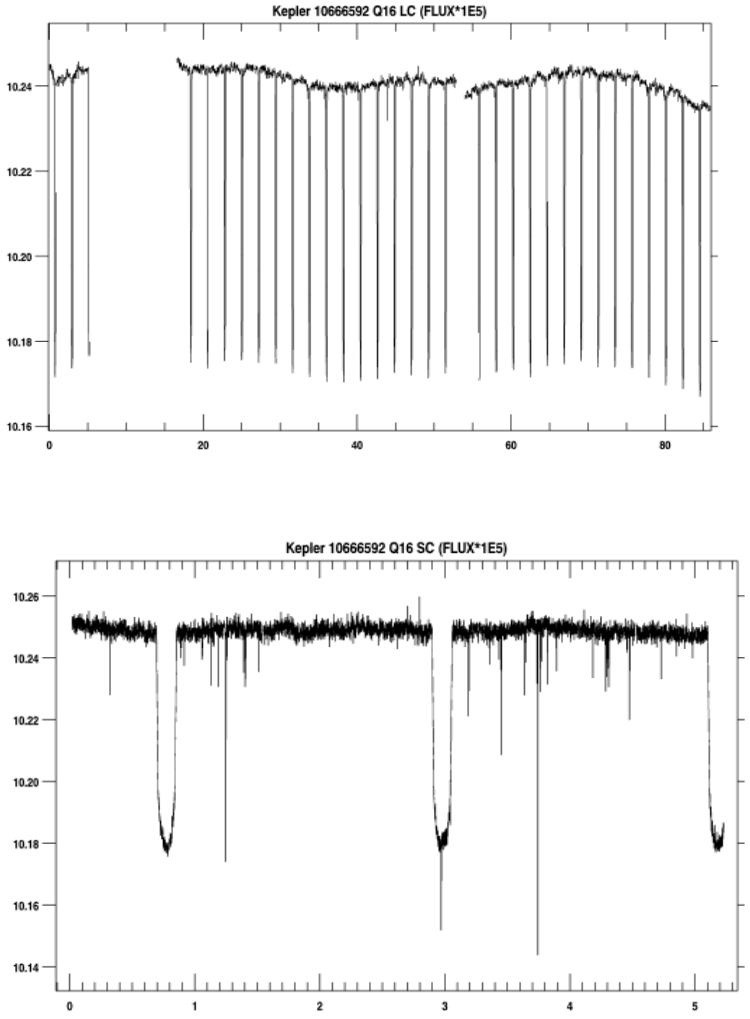
Specify techniques and procedures needed to prepare lightcurves for asteroseismic analysis

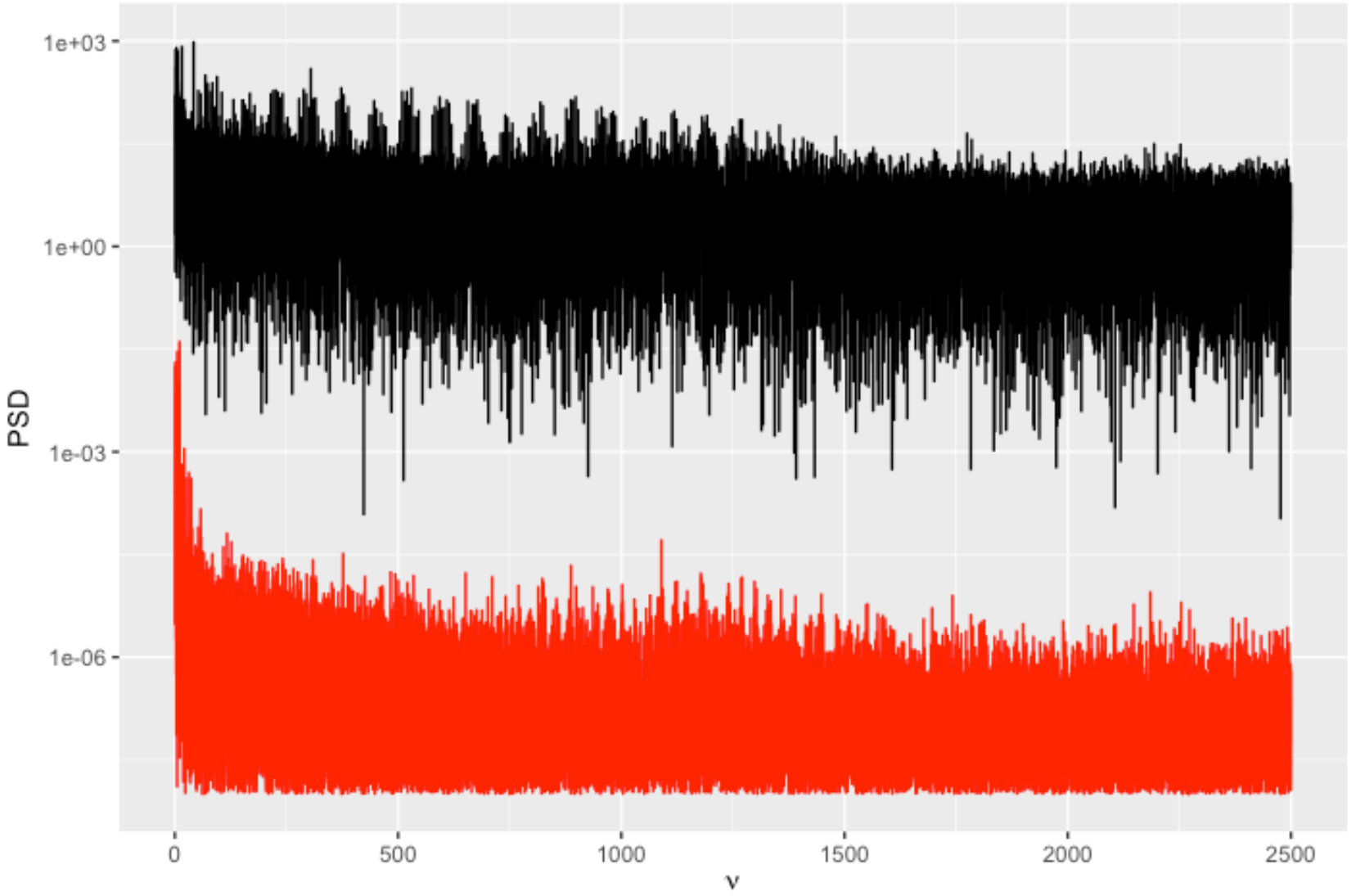
Why?


Kepler 10666592 Q16 LC (FLUX*1E5)
Kepler 10666592 Q16 SC (FLUX*1E5)


PSD
1e+03
1e+00
1e-03
1e-06
0
500
1000
1500
2000
2500
ν

Why?


Kepler 10666592 Q16 LC (FLUX*1E5)
10.24
10.22
10.20
10.18
10.16
0
20
40
60
80
Kepler 10666592 Q16 SC (FLUX*1E5)
10.26
10.24
10.22
10.20
10.18
10.16
10.14
0
1
2
3
4
5


1e+03
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PSD
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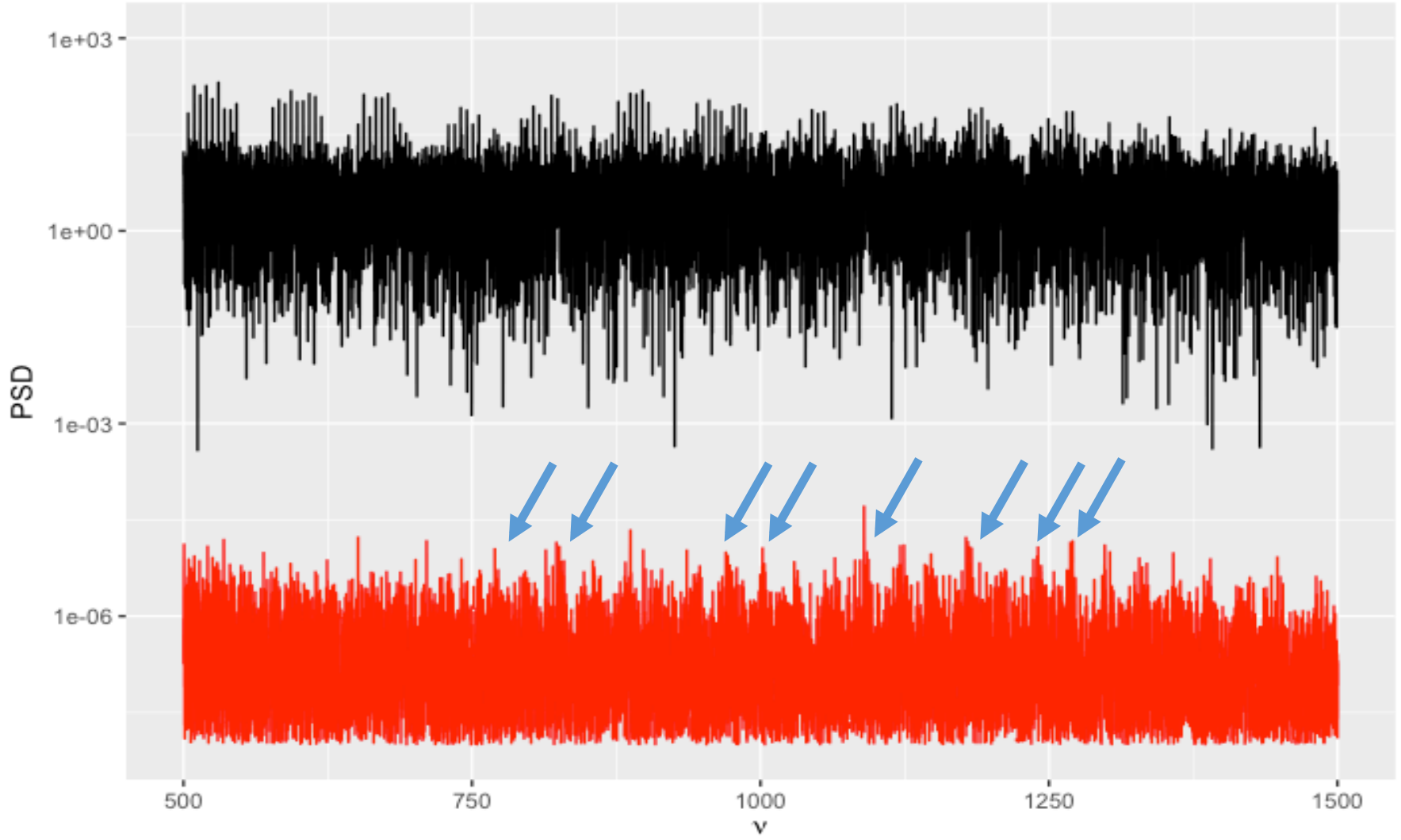
ν

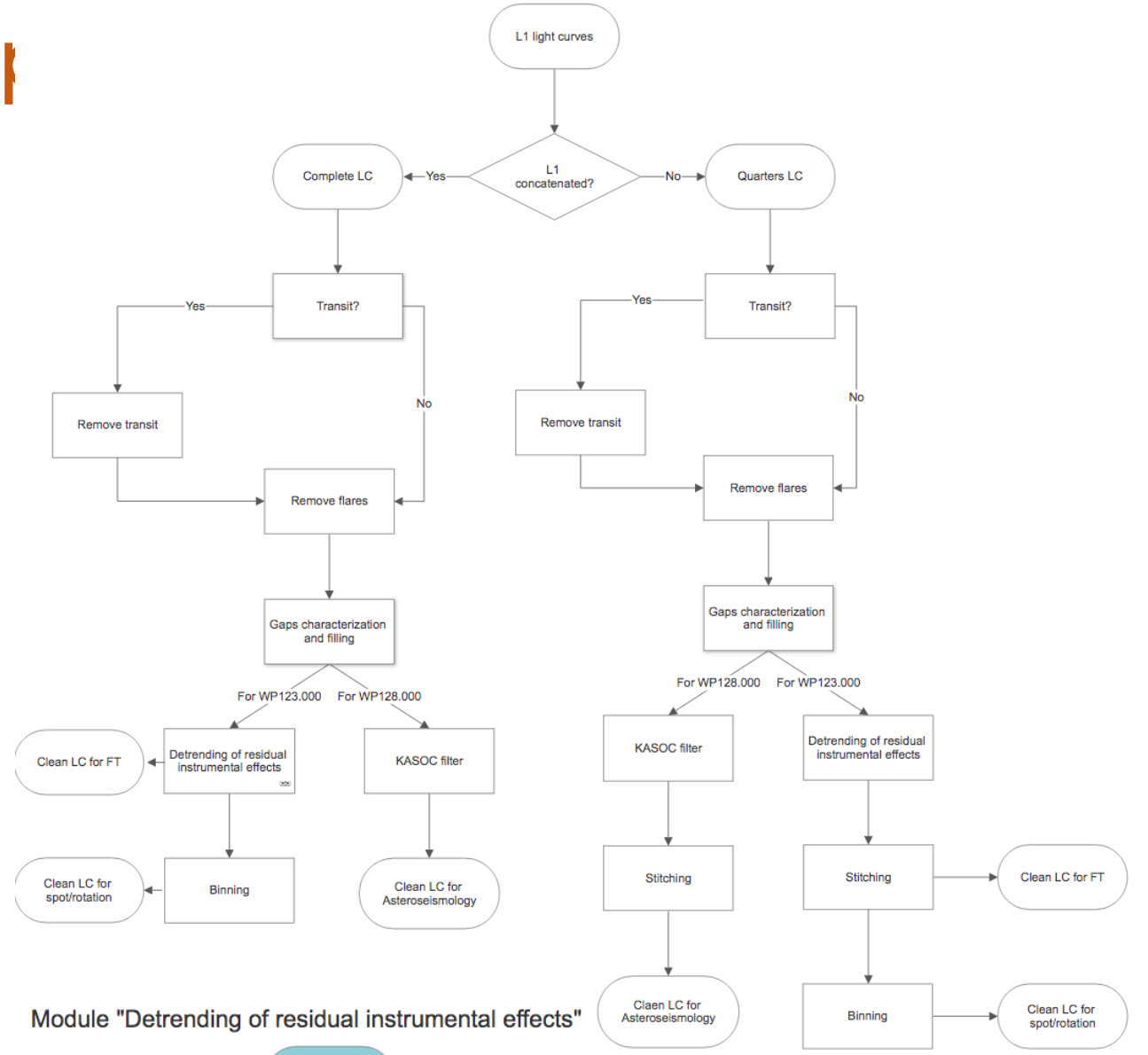
Why?



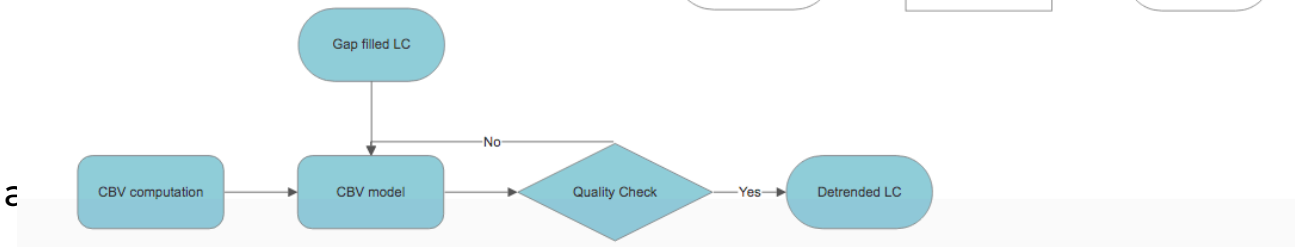
Joint proposal WP128.300 and WP123.000 (see next talk, A. Lanza)

WP128.300: Preparation of the asteroseismic analysis ready light curves. Barcelona, 19/11/2019.

Joint prop 23.000

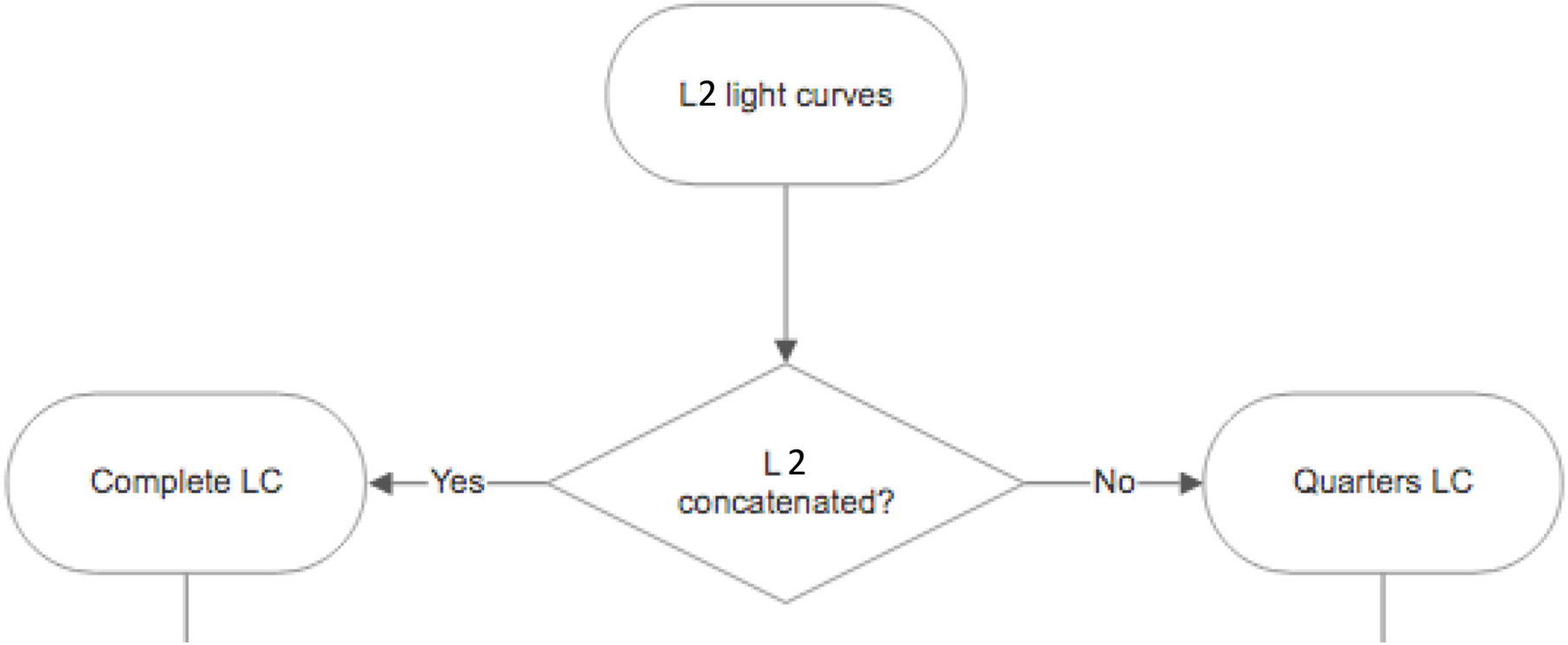


Module "Detrending of residual instrumental effects"



WP128.300: Preparation of the a

Joint proposal WP128.300 and WP123.000 (see next talk, A. Lanza)



WP128.300: Preparation of the asteroseismic analysis ready light curves. Barcelona, 19/11/2019.

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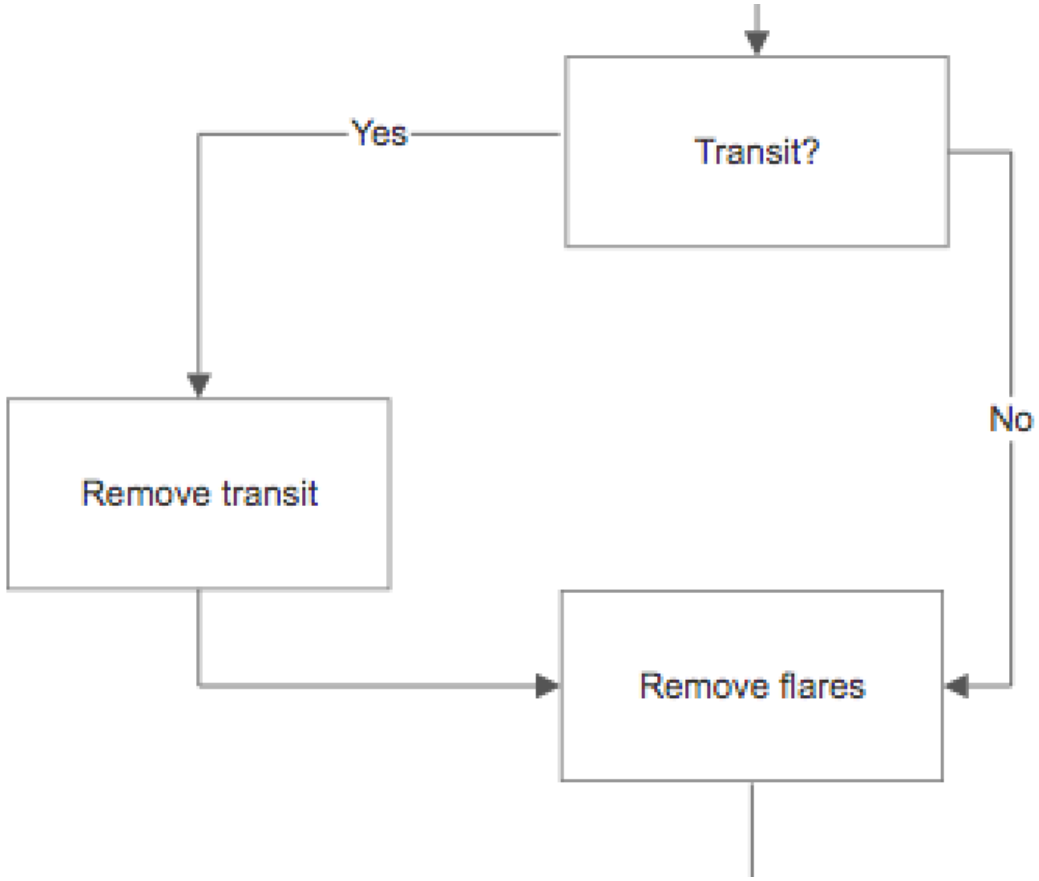
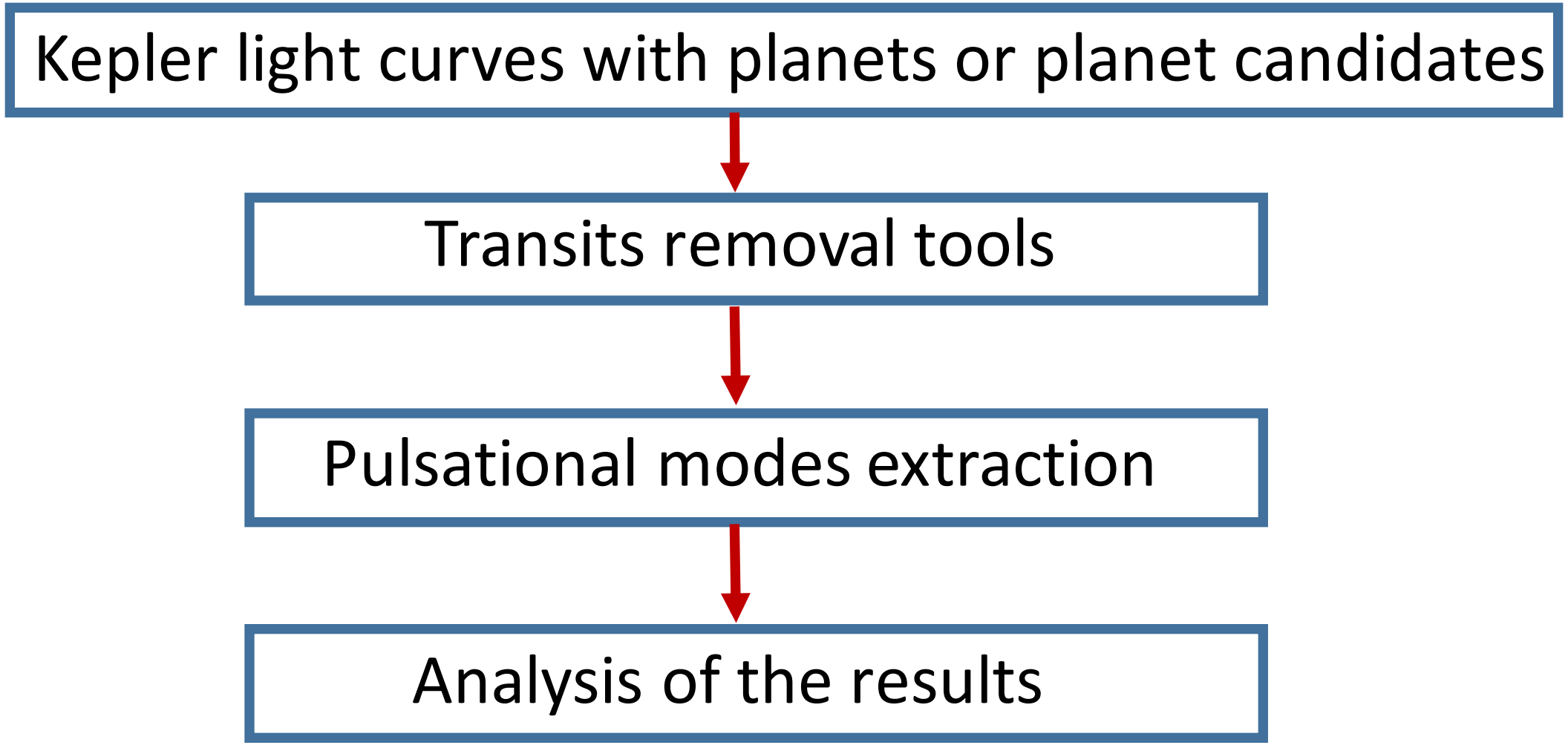
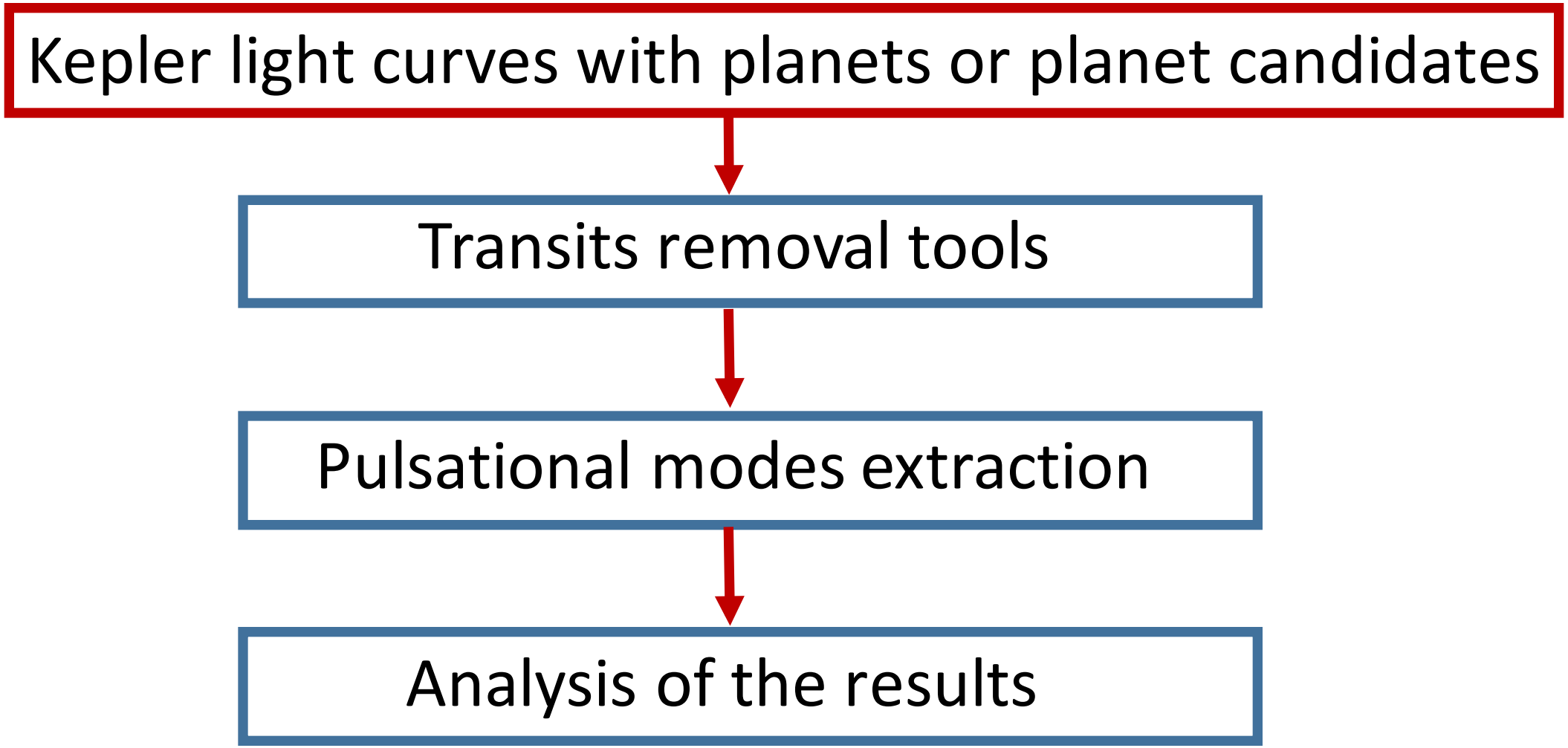


Exercise #1


Kepler light curves with planets or planet candidates
Transits removal tools
Pulsational modes extraction
Analysis of the results

Exercise #1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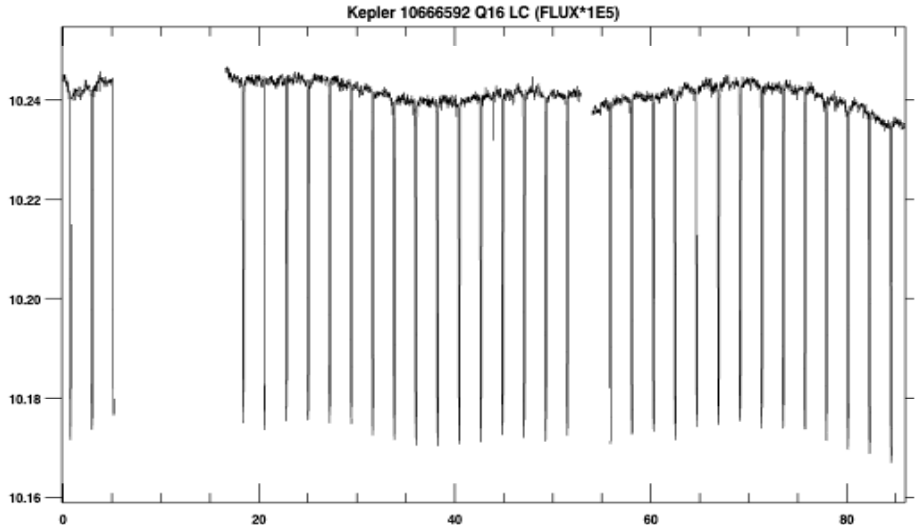
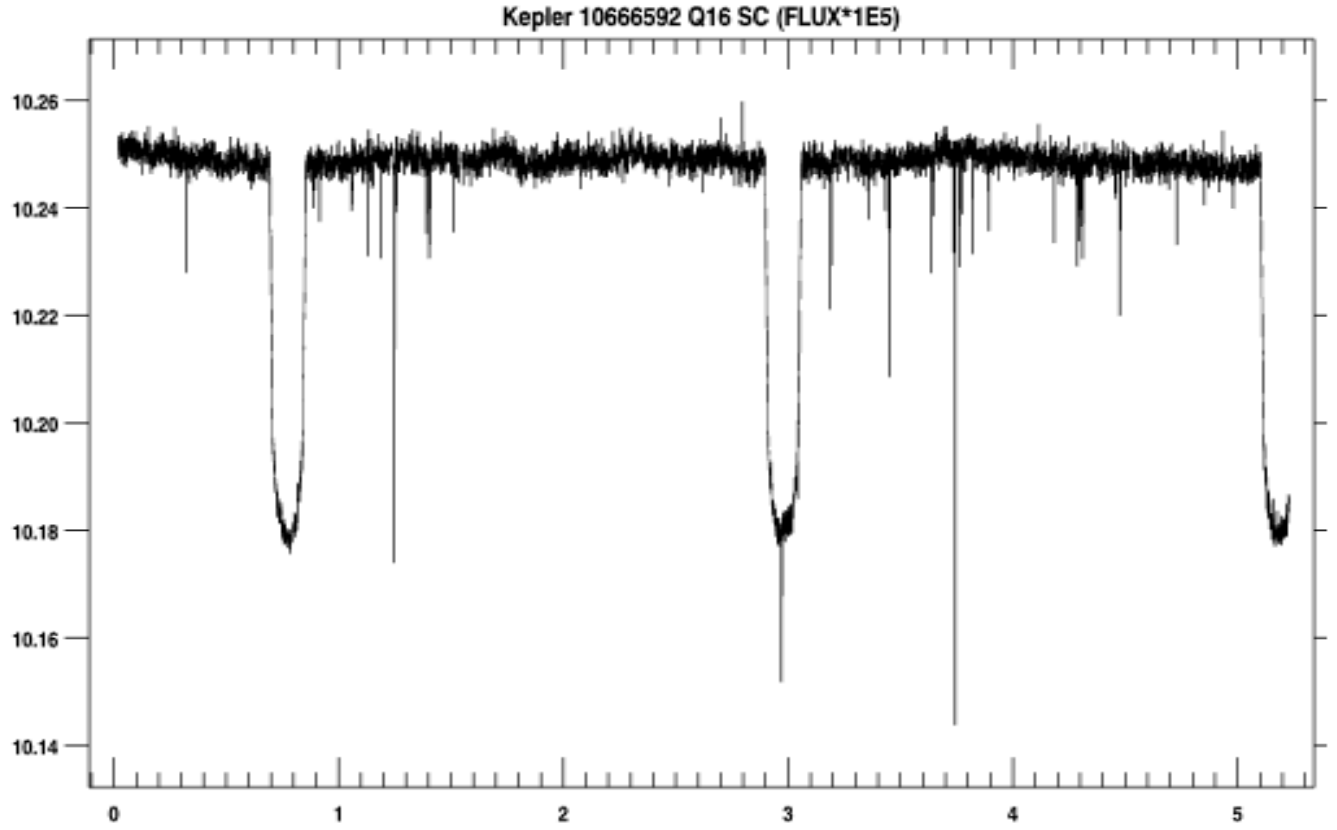
Kepler light curves

Kepler-2 (HAT-P-7, KIC-10666592)



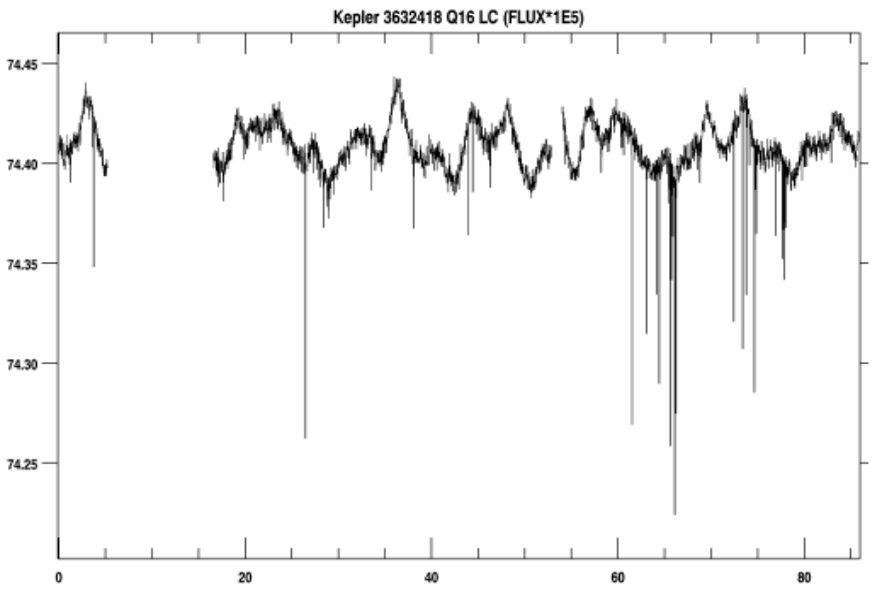


Main characteristics:

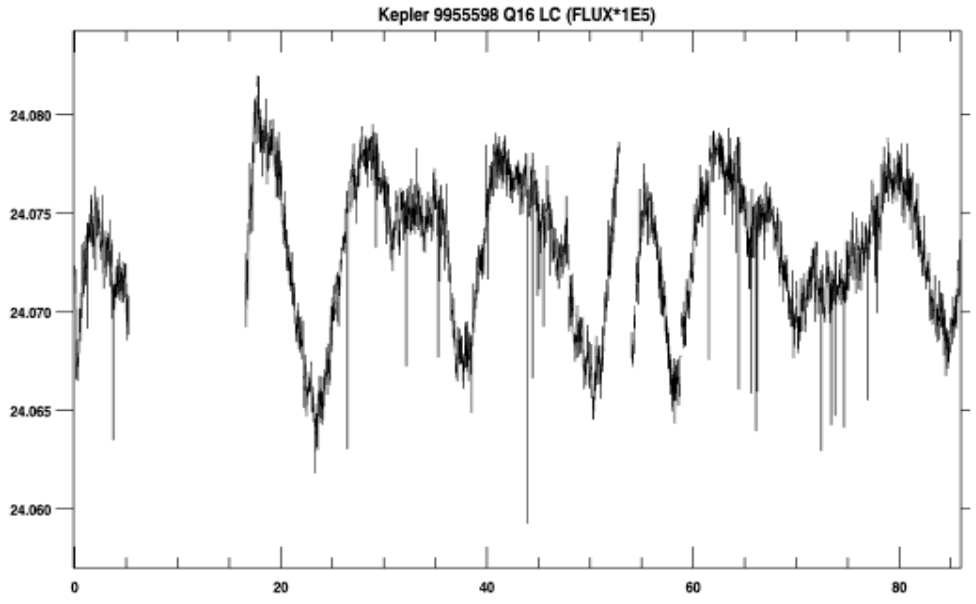
1) Clear transits
2) Deep transits
3) Very accurate transit characterization
4) Some long term variability

Kepler light curves

Kepler-21 (KIC-3632418)

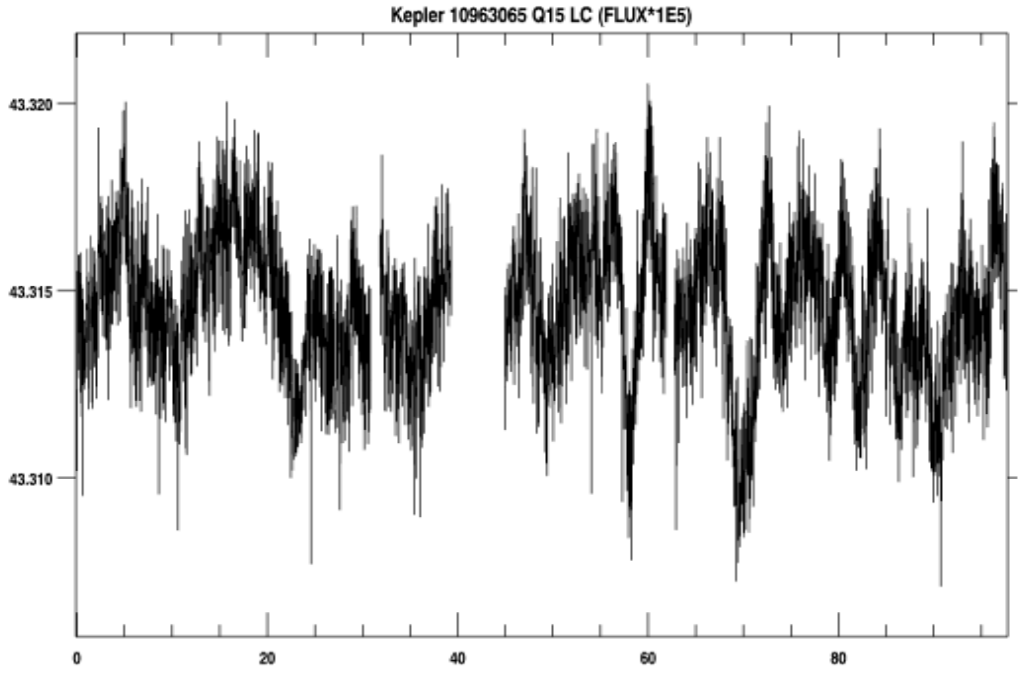


Kepler-409 (KIC-9955598)

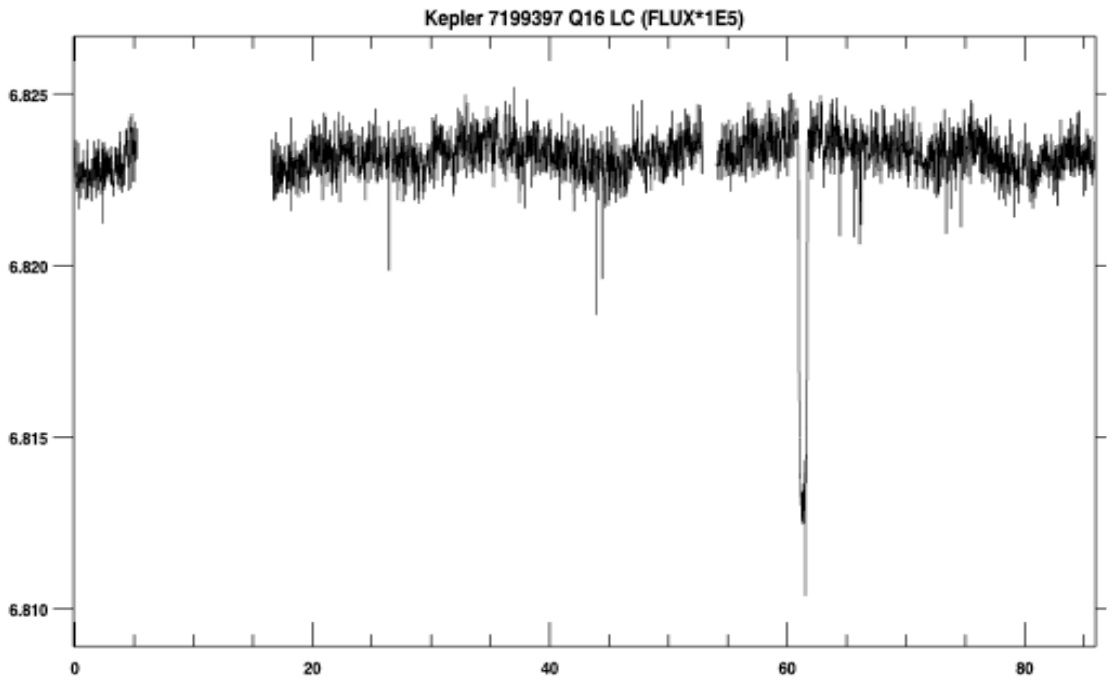


Kepler light curves

Kepler-408 (KIC-10963065)



KOI-75 (KIC-7199397)



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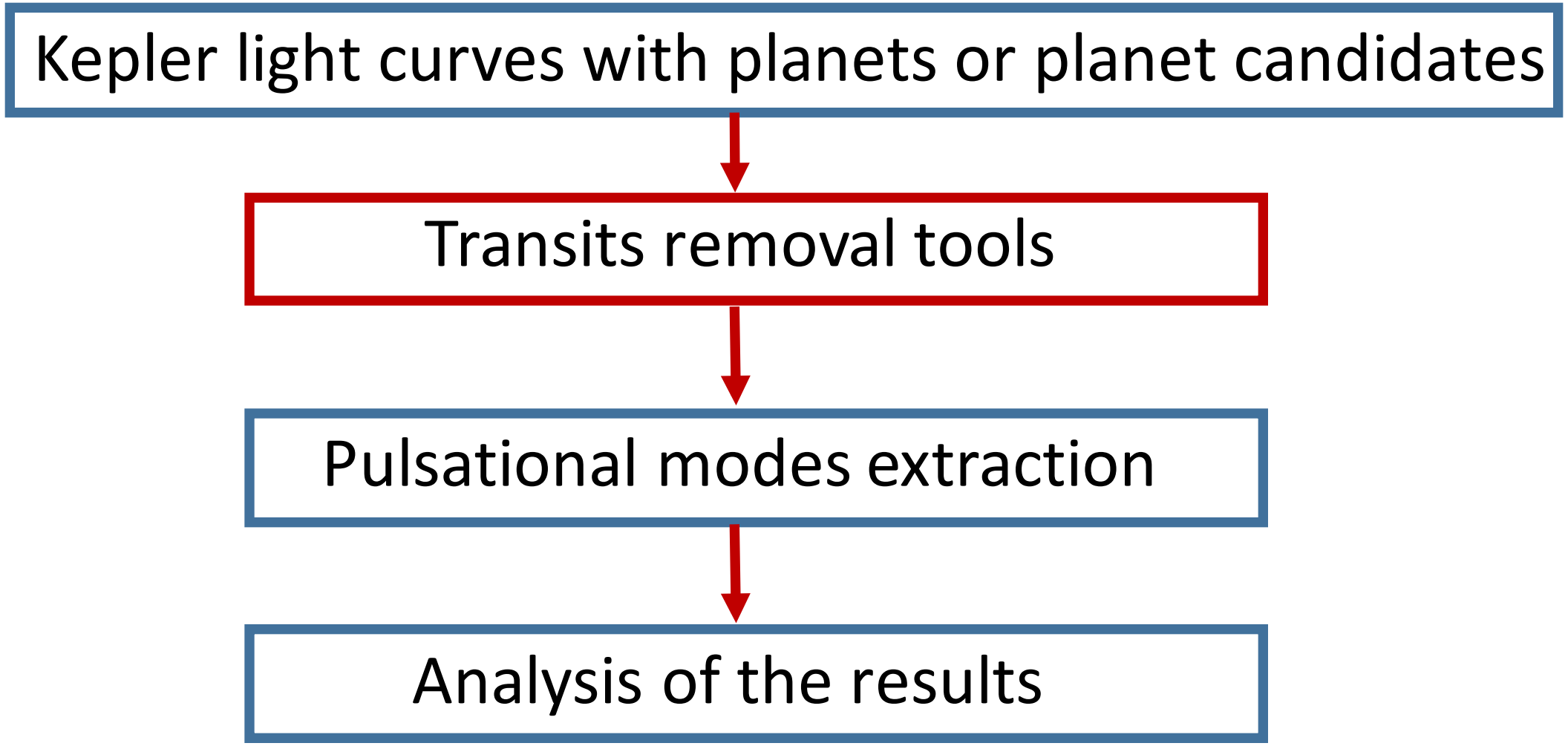
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Transit removal tools (1-2/5)

KASOC filter, weighted and unweighted

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **445,** 2698–2709 (2014) doi:10.1093/mnras/stu1823

Automated preparation of *Kepler* time series of planet hosts for asteroseismic analysis

R. Handberg[1,2★] and M. N. Lund[1,2,3]

[1]*School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK*
[2]*Stellar Astrophysics Centre (SAC), Department of Physics and Astronomy, Aarhus University, DK-8000 Aarhus C, Denmark*
[3]*Sydney Institute for Astronomy (SIfA), School of Physics, University of Sydney, NSW 2006, Australia*

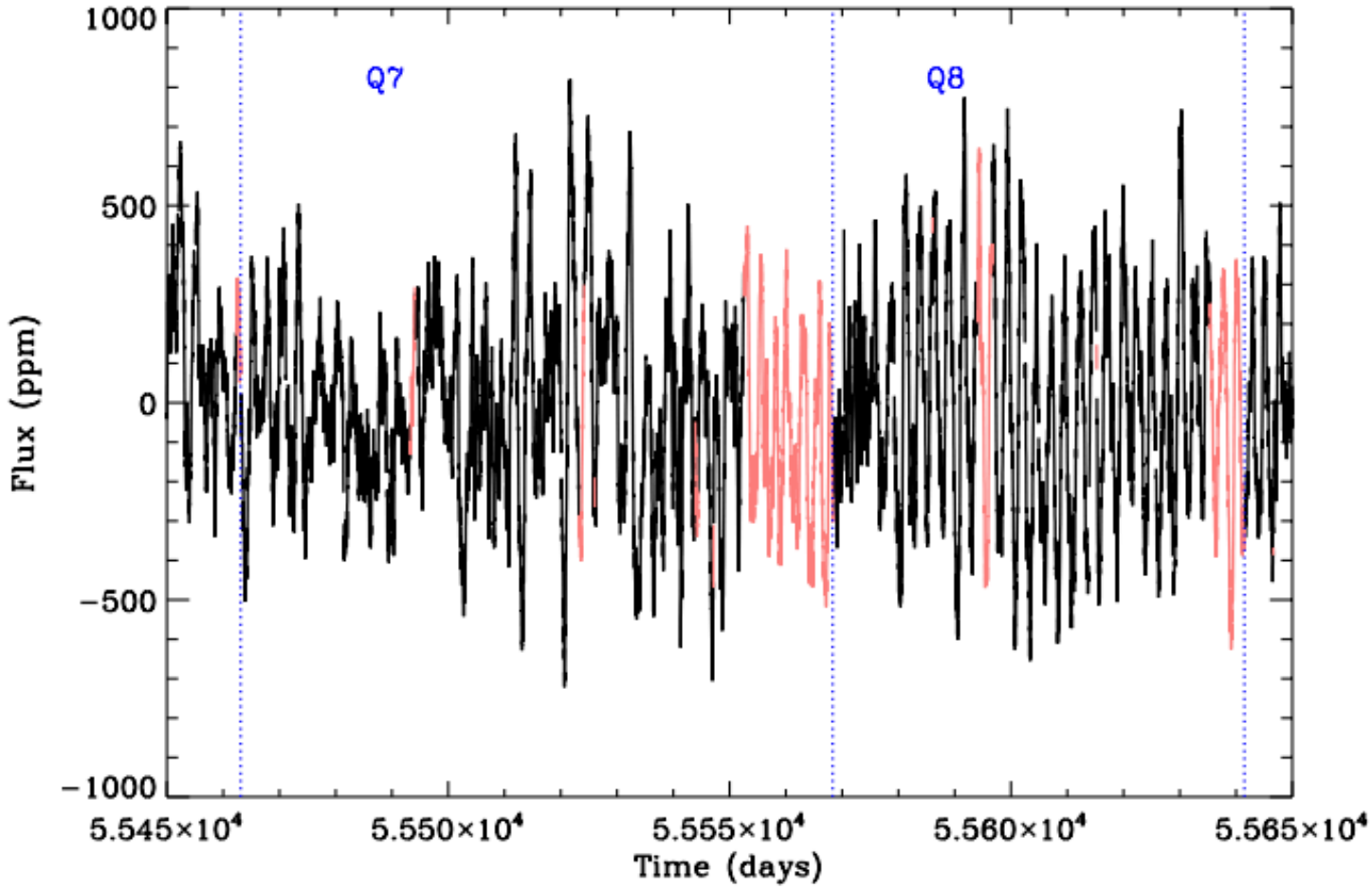
8 steps:

1) Light curve extraction
2) Select correct time stamps
3) Correct jumps
4) Gaps filled with NaN
5) Remove long trends using a moving median
6) Remove transit by smoothing the phase curve using the planetary period
7) Remove additional features (instrumental)
8) Error estimation

Transit removal tools (3/5)

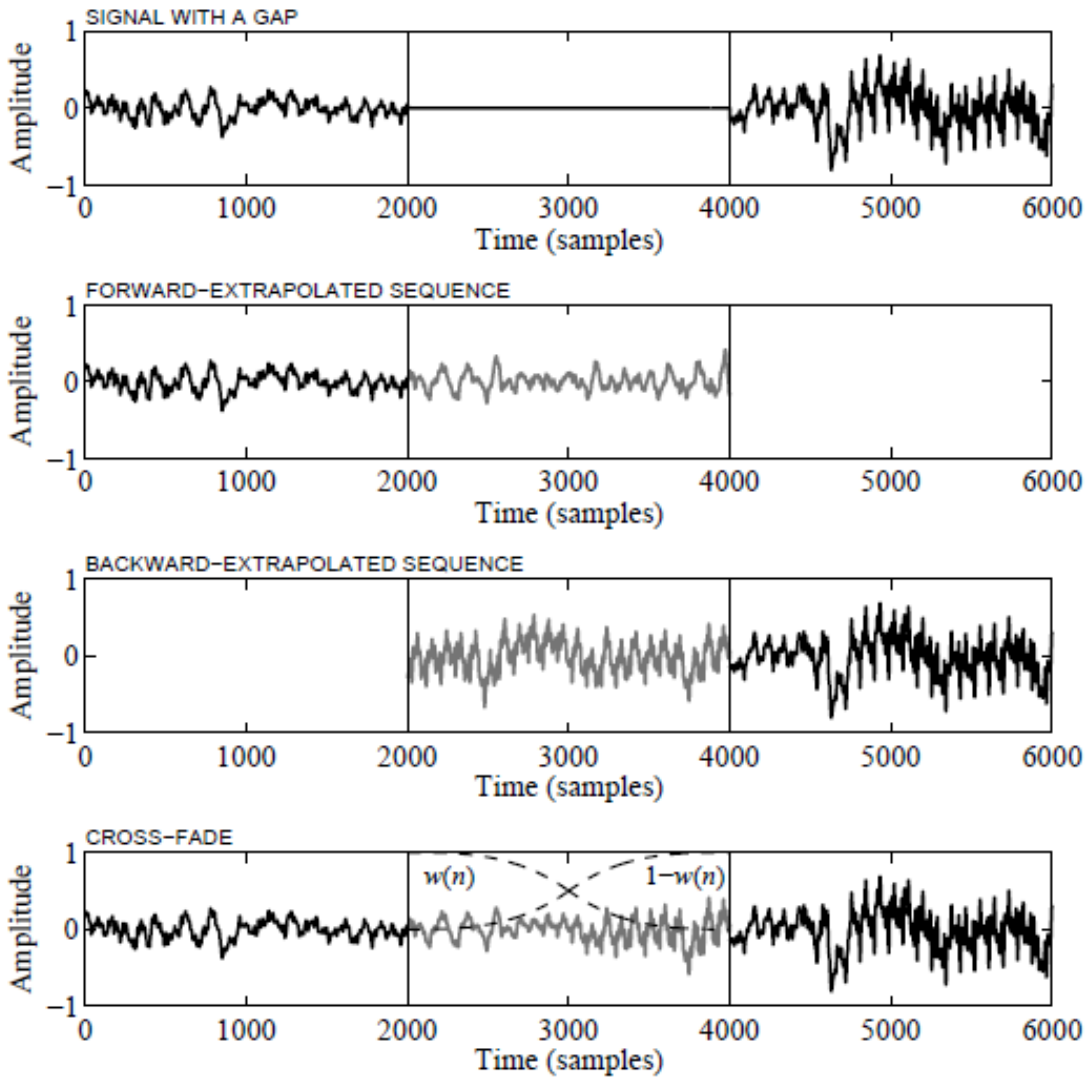
KADACS

Interpolation using inpaint



Transit removal tools (4/5)

MIARMA



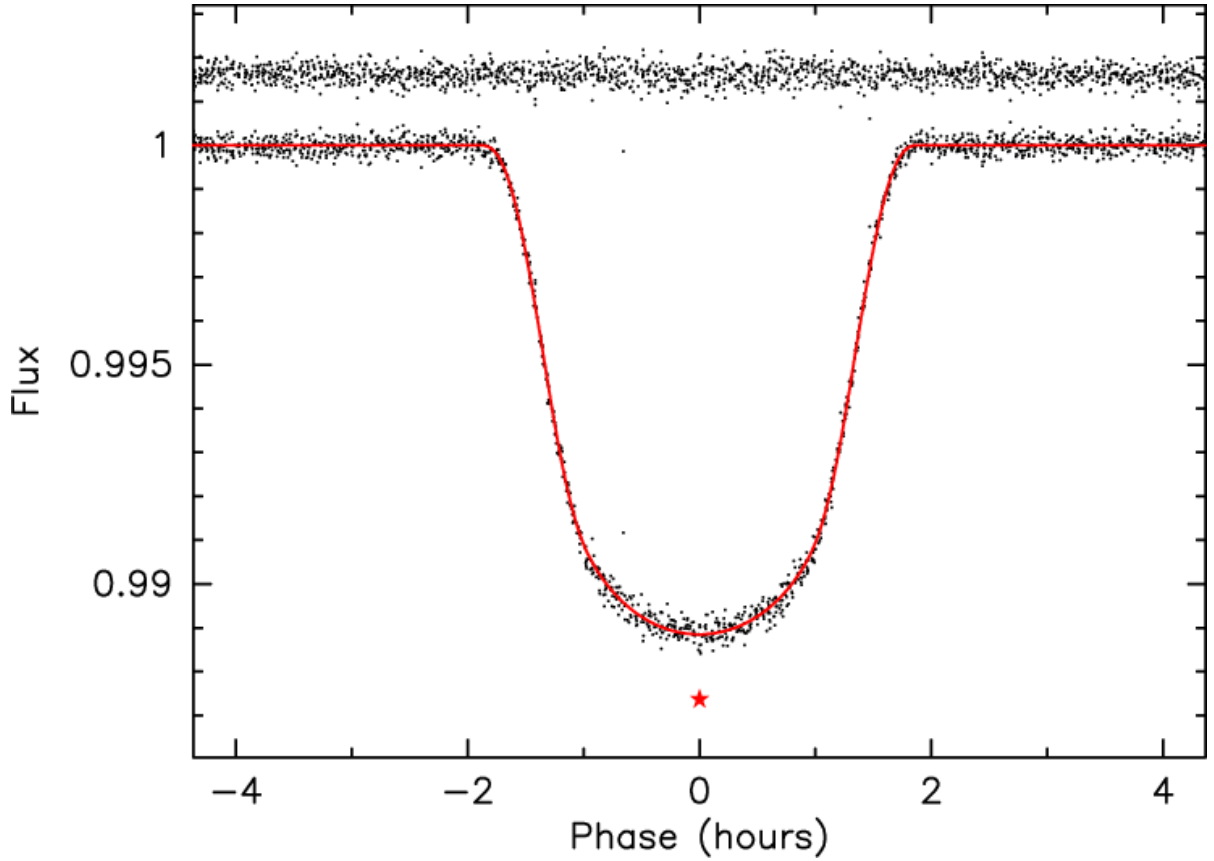
AR + MA = ARMA

$$y_t = \sum_{k=1}^{p} \alpha_k y_{t-k} + n_t - \sum_{k=1}^{p} \alpha_k n_{t-k}$$

No analytical functional form assumed for the signal

Transit removal tools (5/5)

Transit removal using transit models (Roi)



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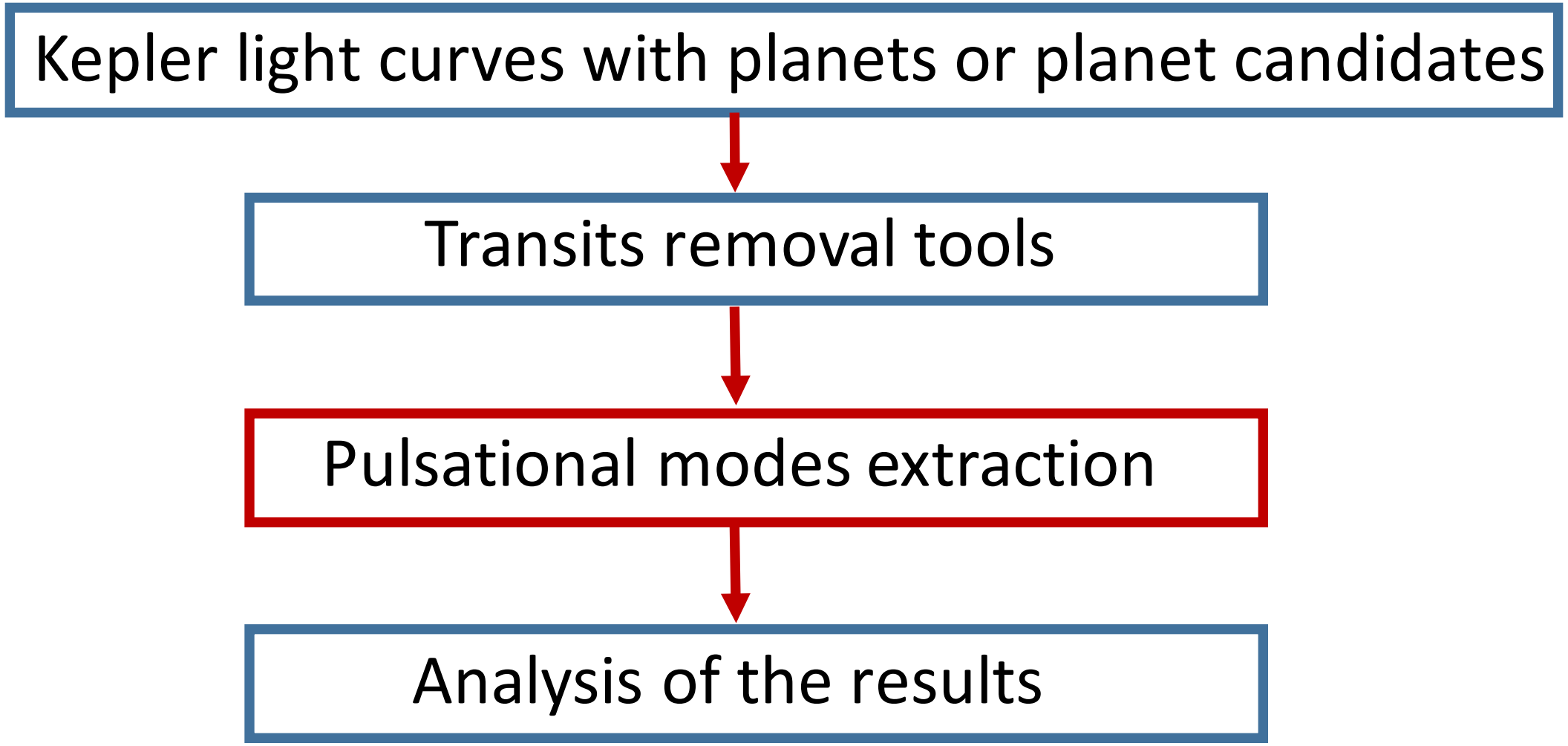
Kepler light curves with planets or planet candidates
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Pulsational modes extraction

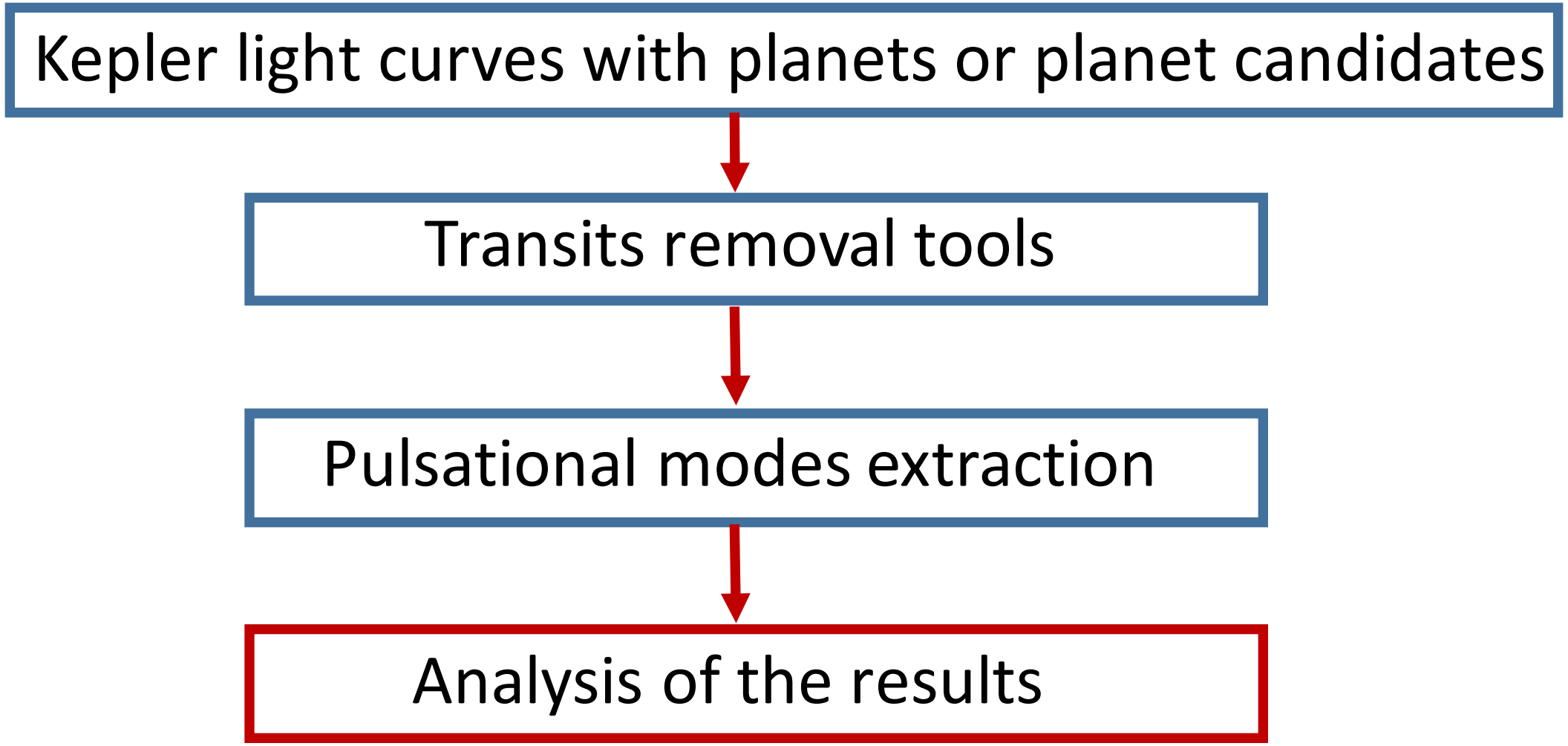
Peakbagging Made Easy (PME)

Martin B. Nielsen

https://github.com/nielsenmb/peakbagging-made-easy

Output: Frequencies, heights, and line widths

Exercise #1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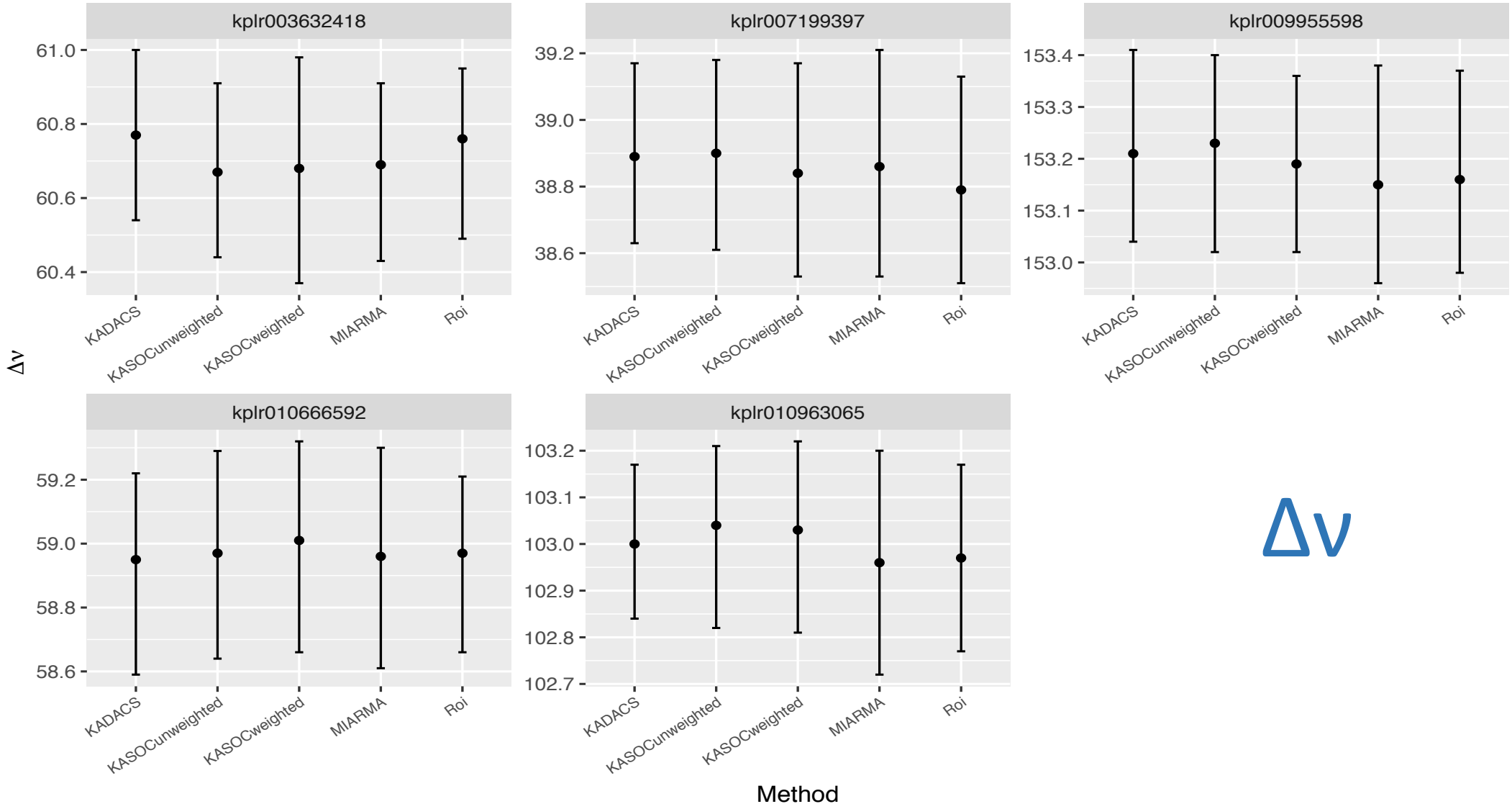
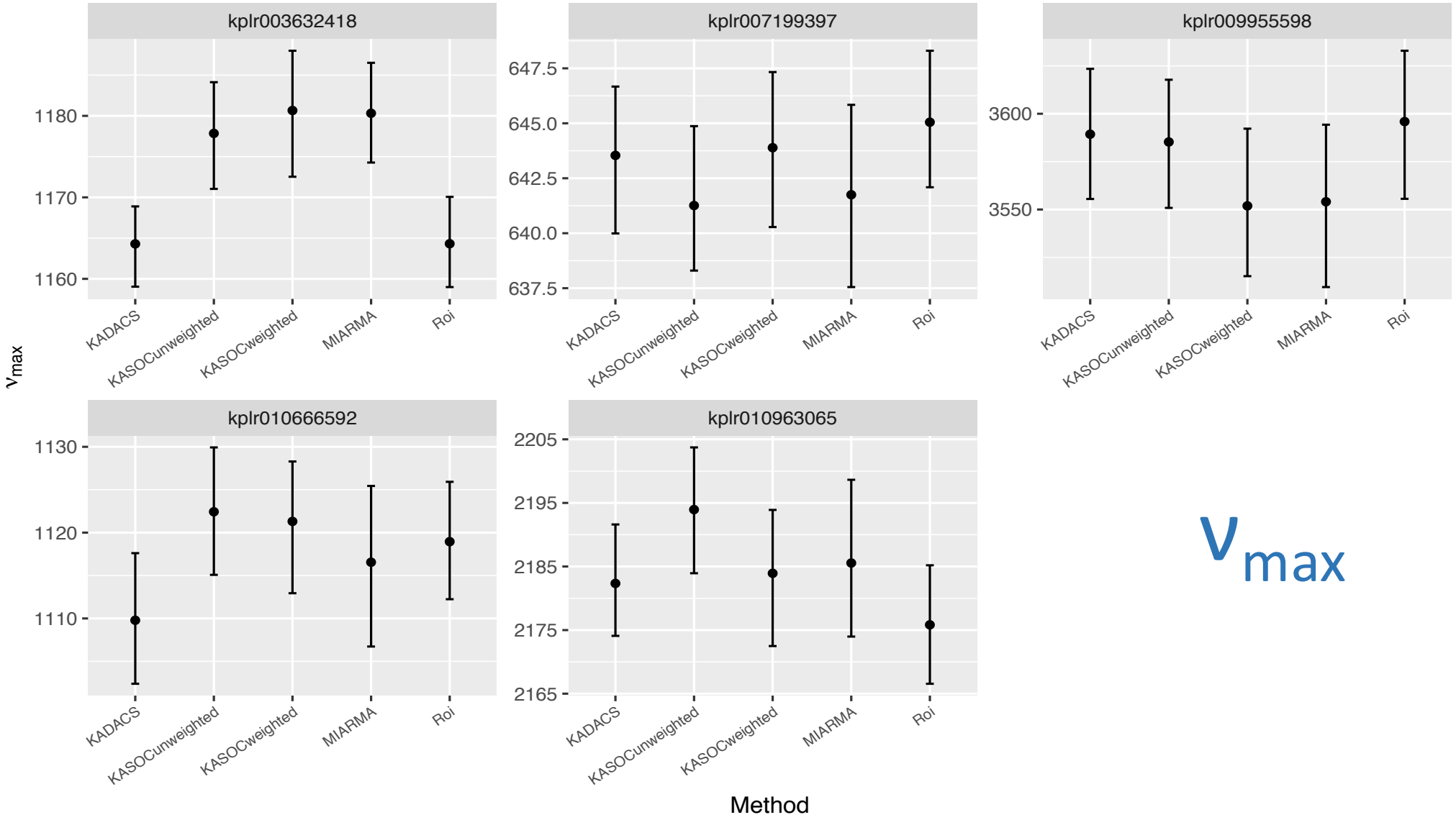
General characteristics



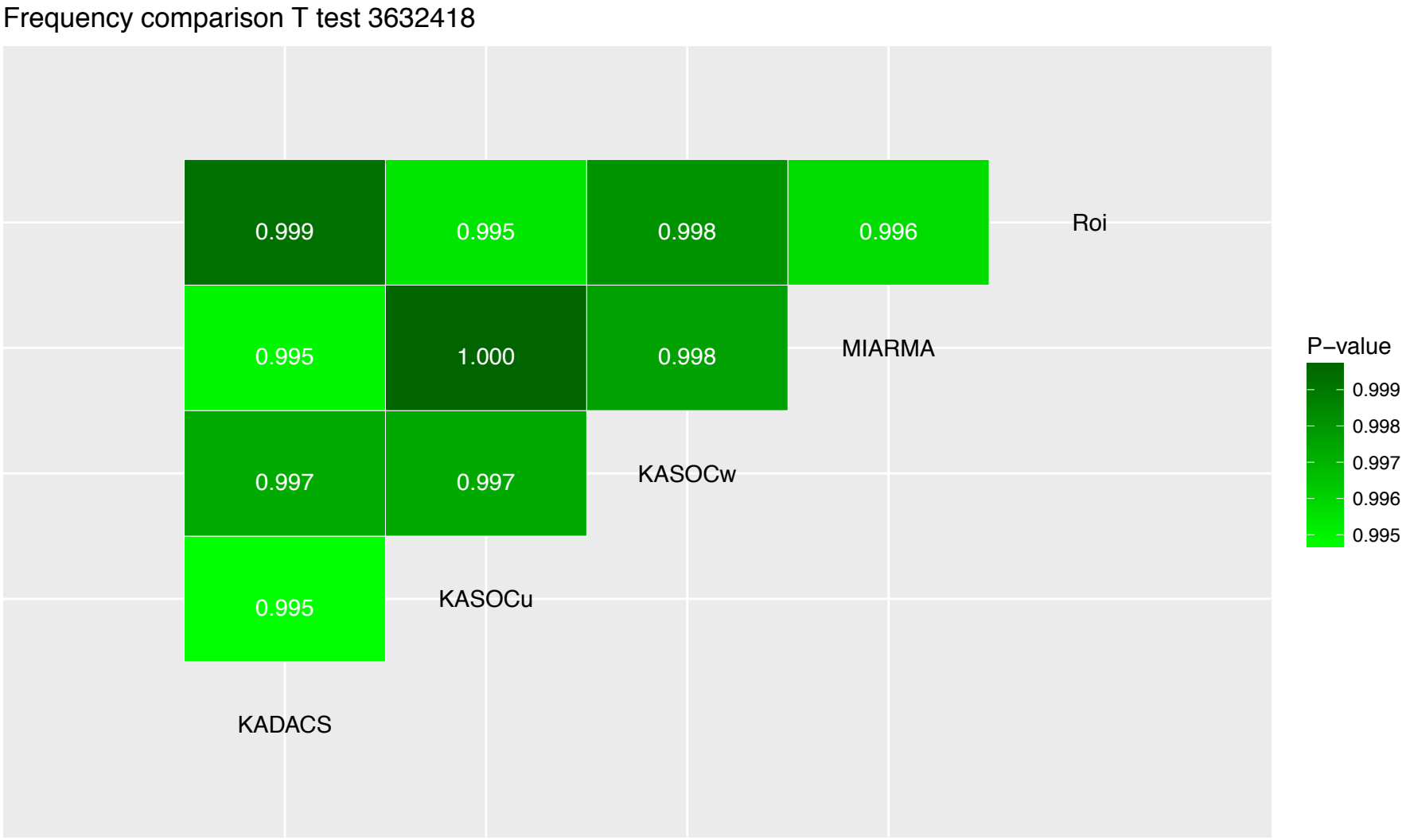
Δν

General characteristics

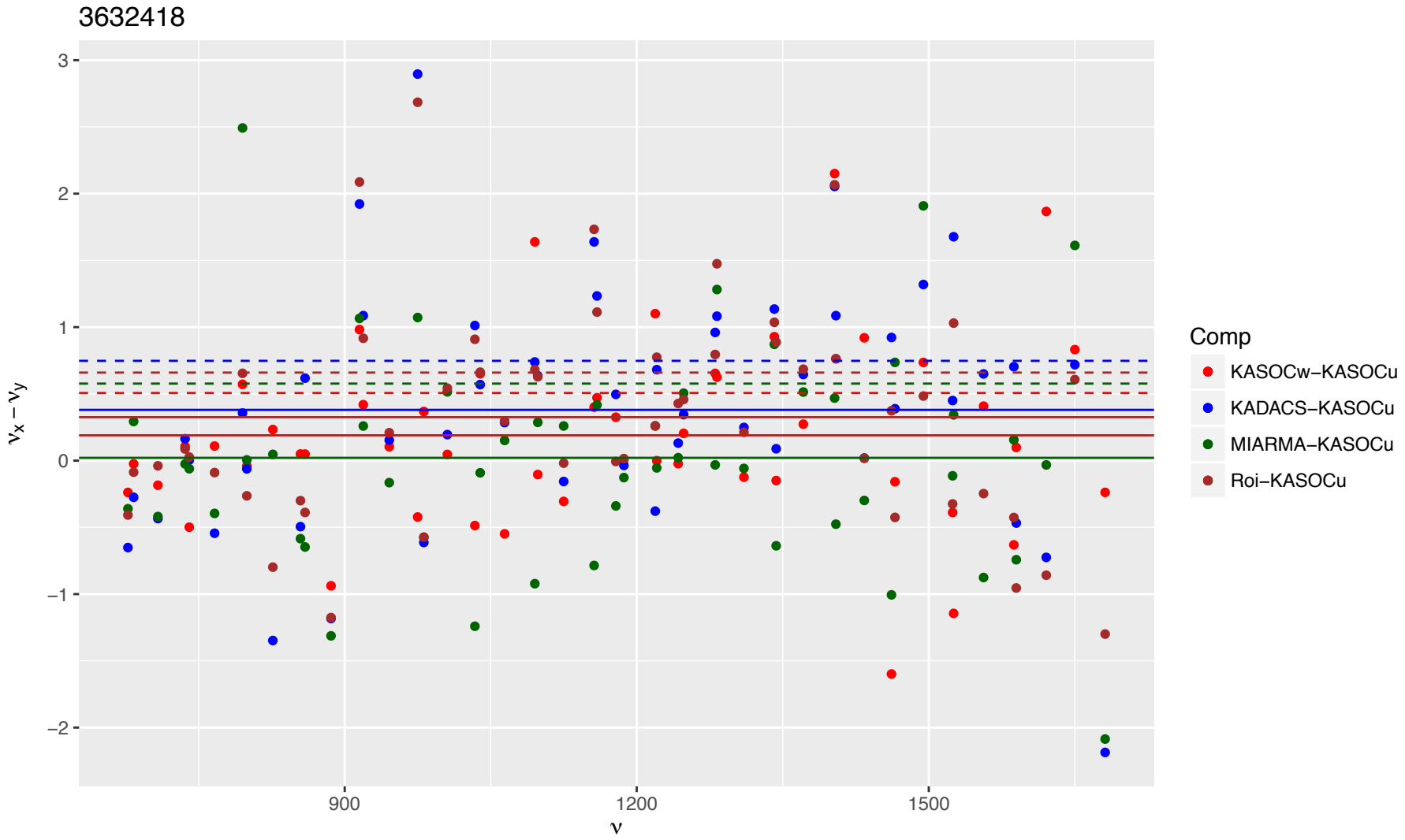


ν_{max}

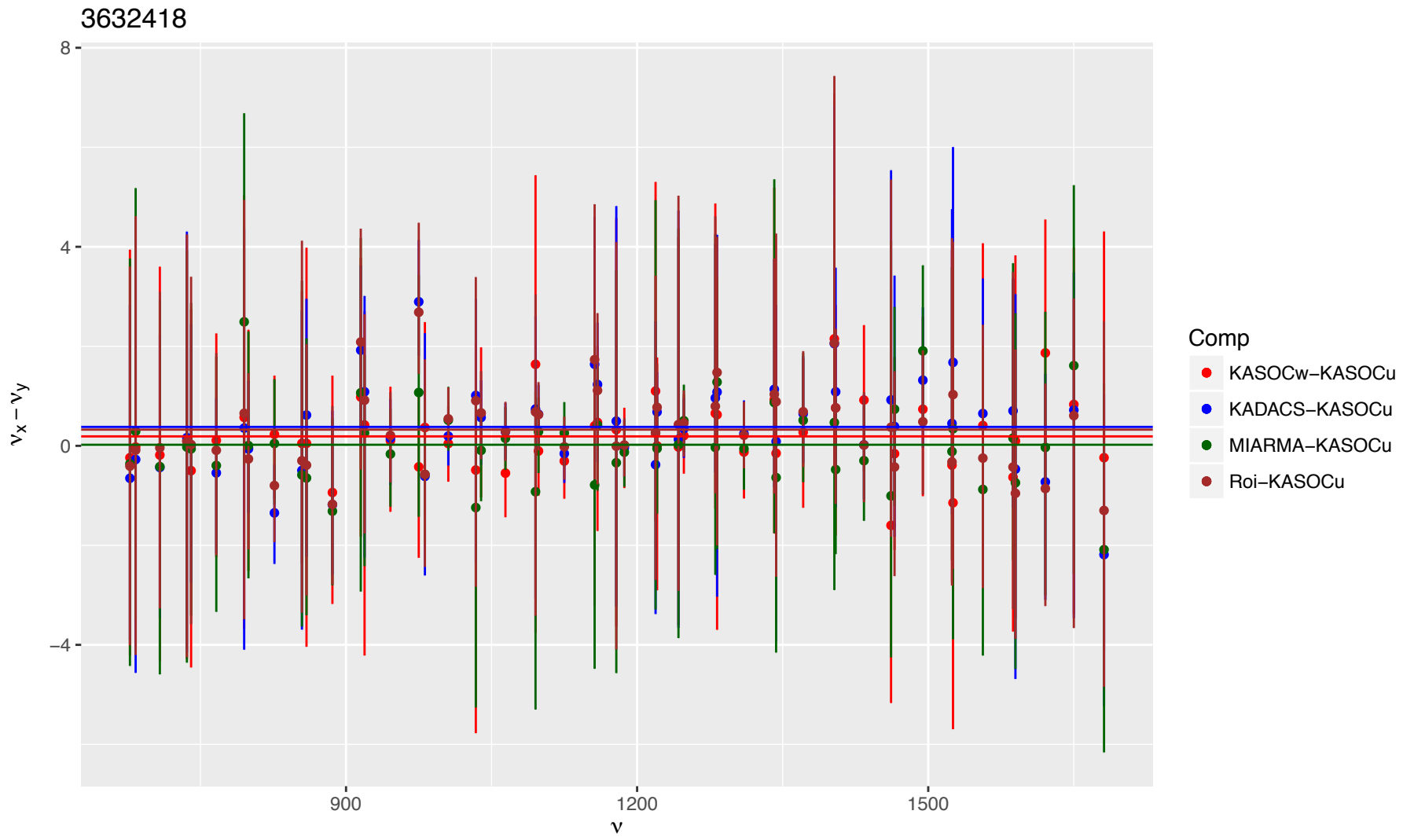
Frequencies



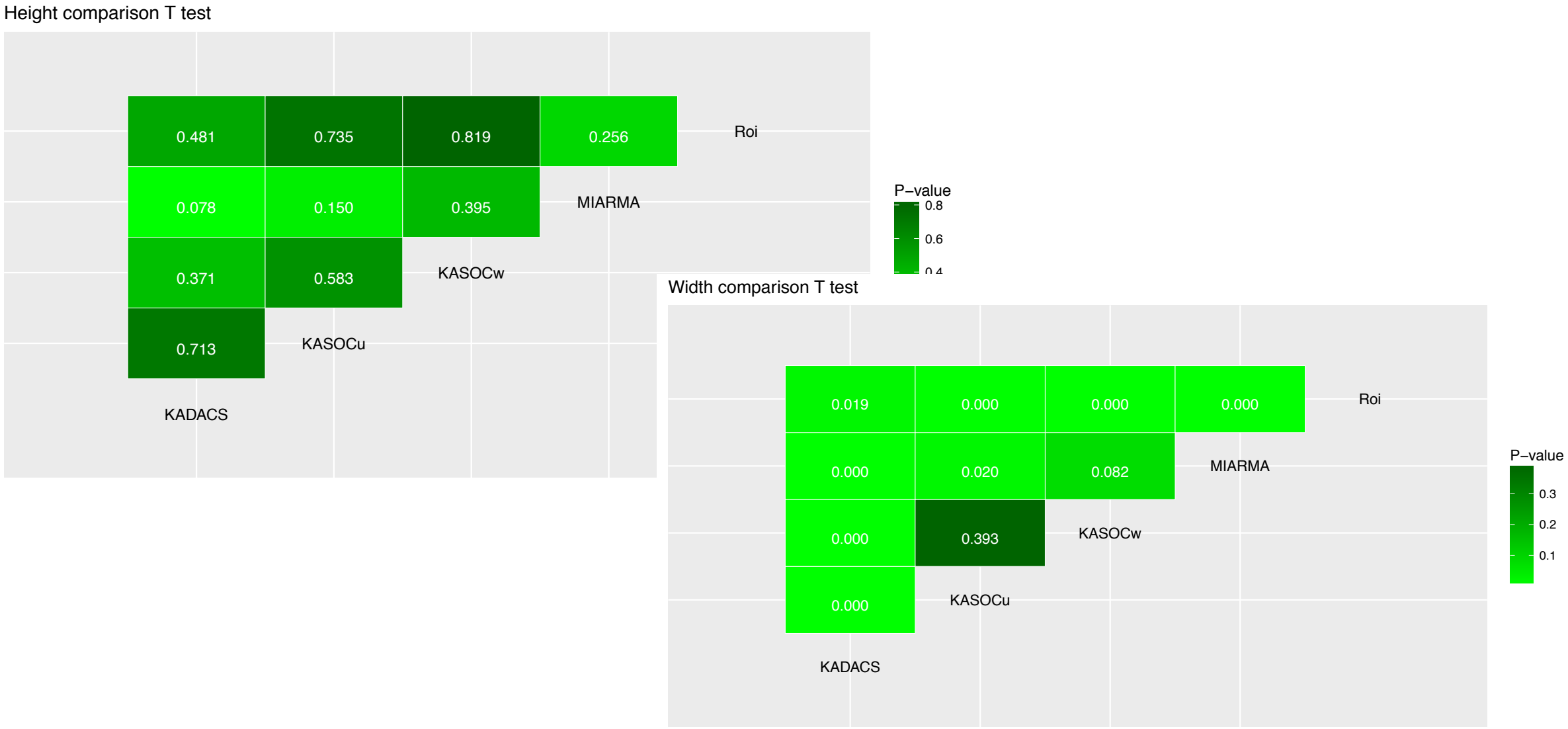
Frequencies



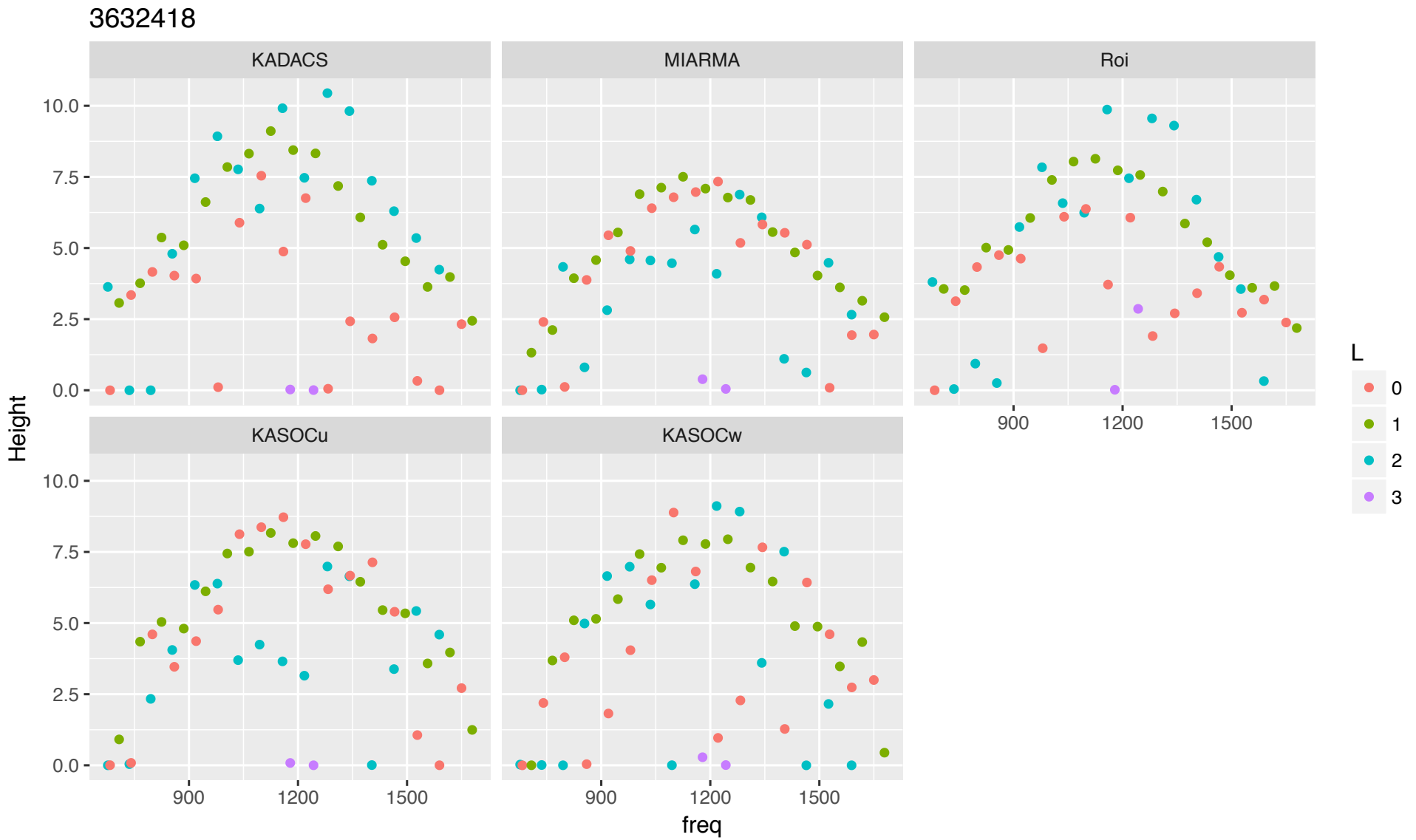
Frequencies



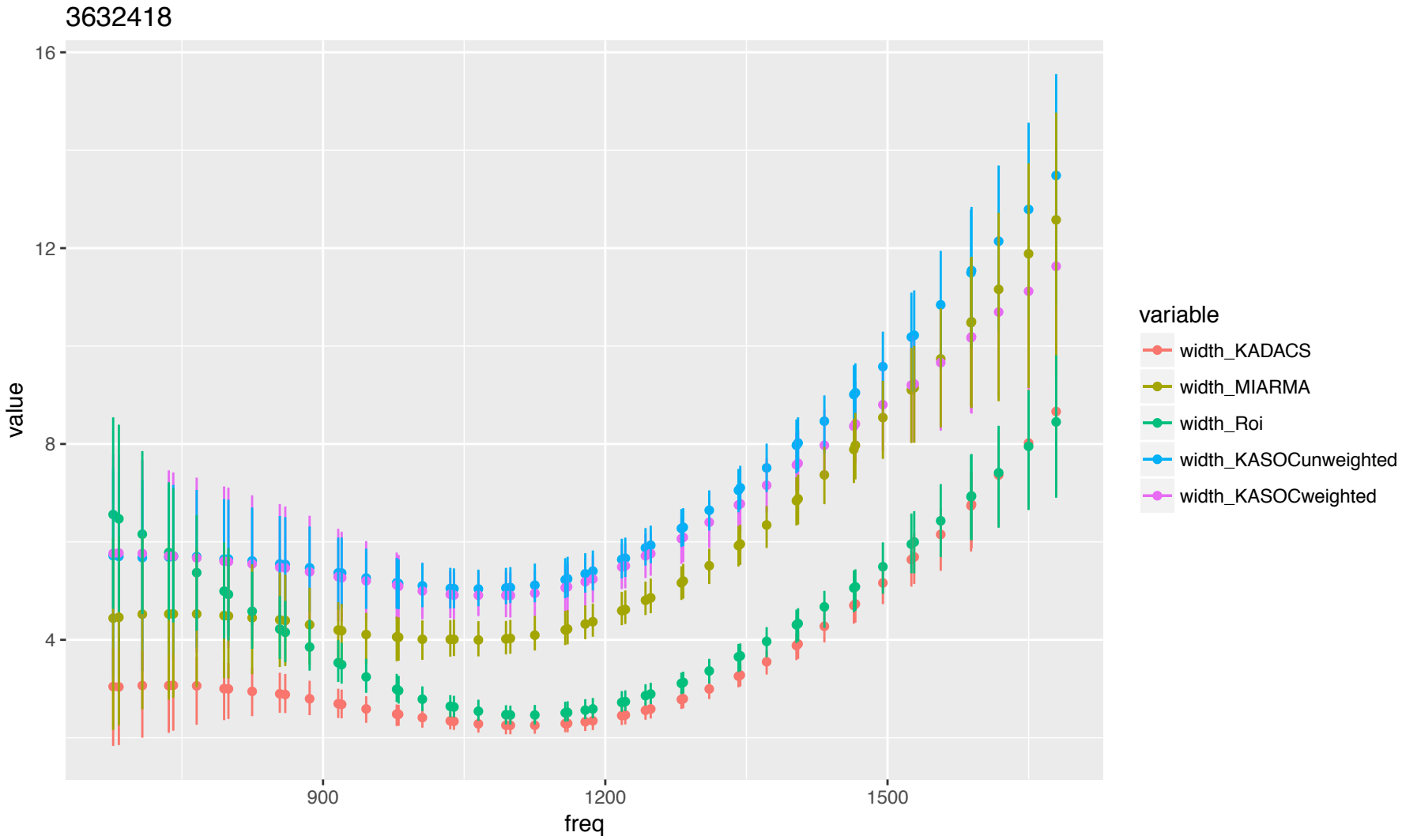
Heights and line widths



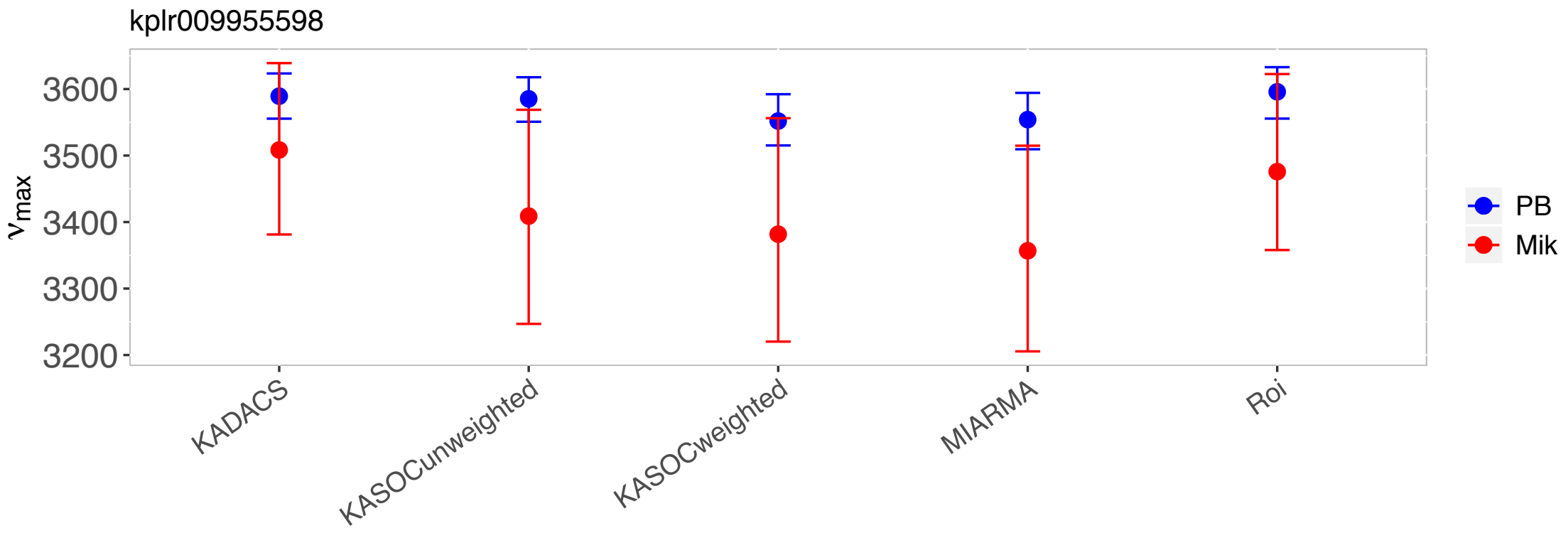
Heights and line widths



Heights and line widths



Is the peak-bagging algorithm complexity the differences source?



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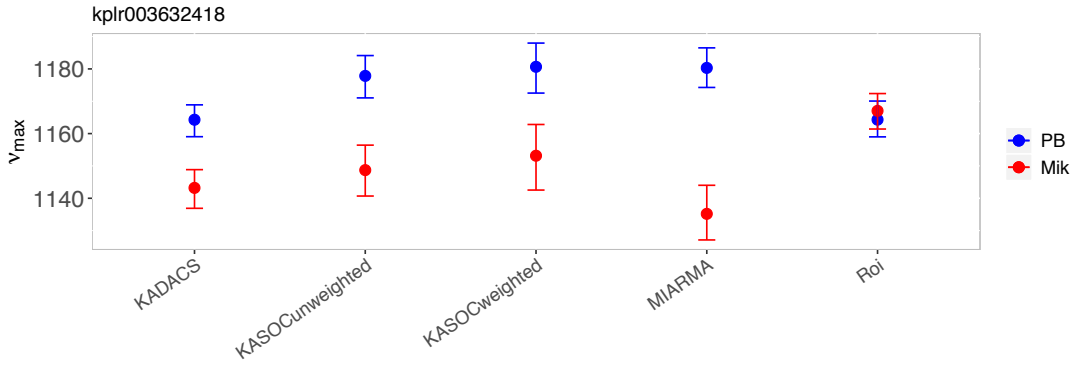

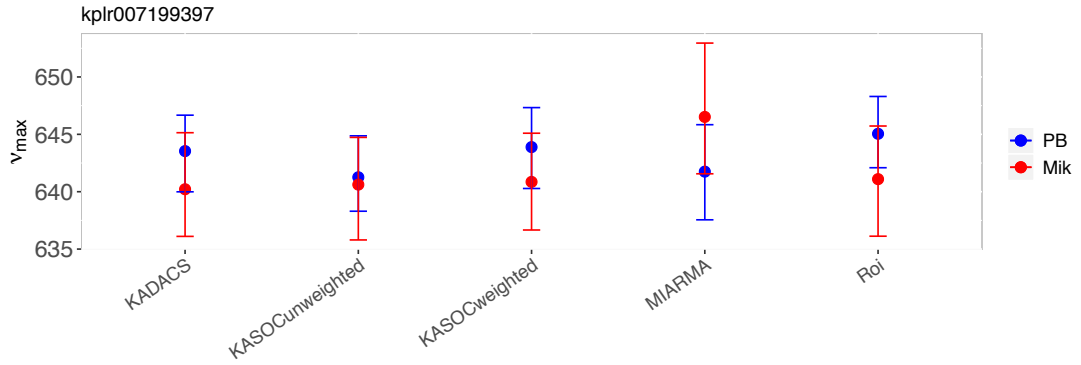

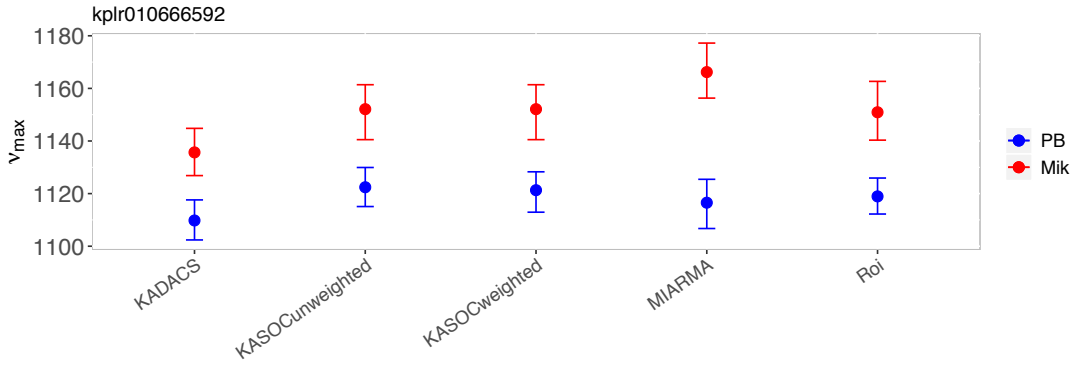

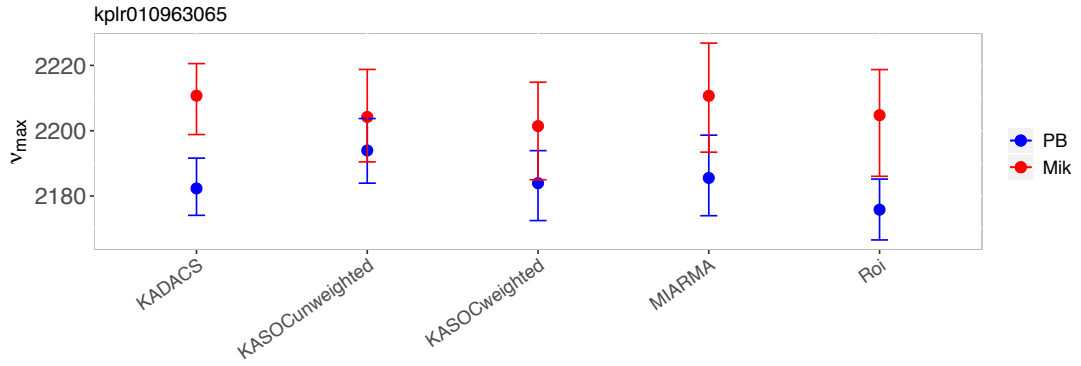

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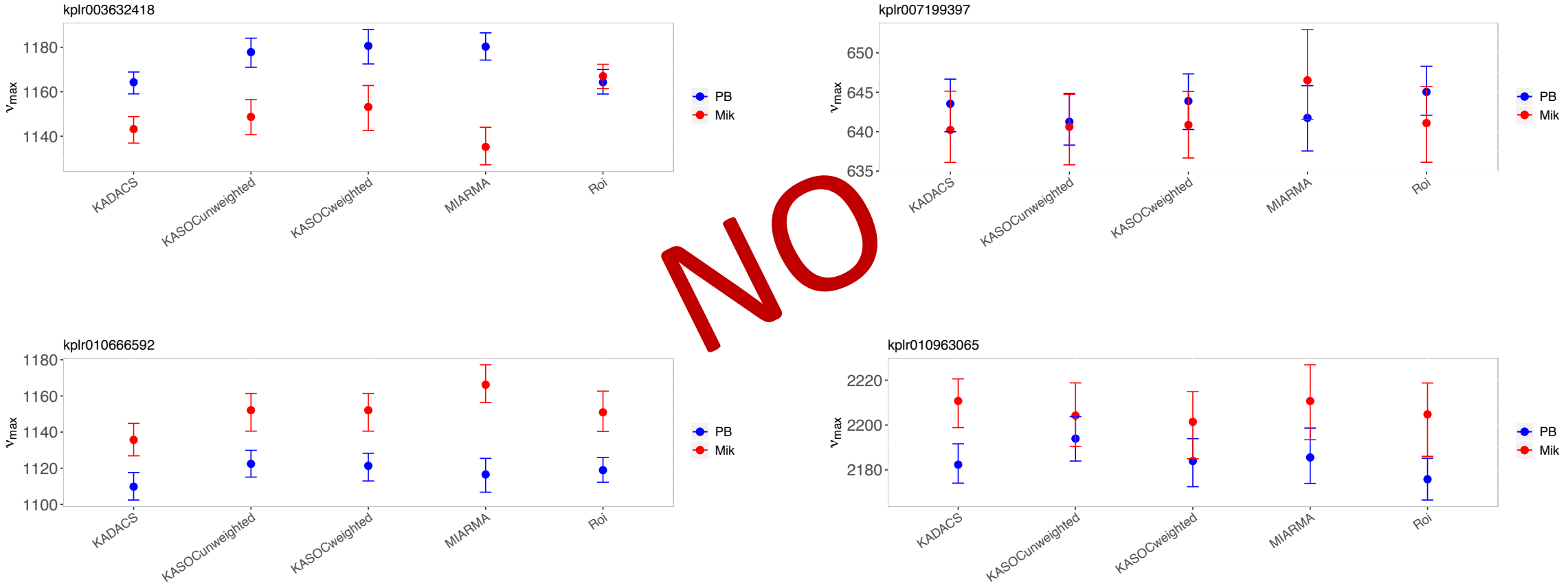
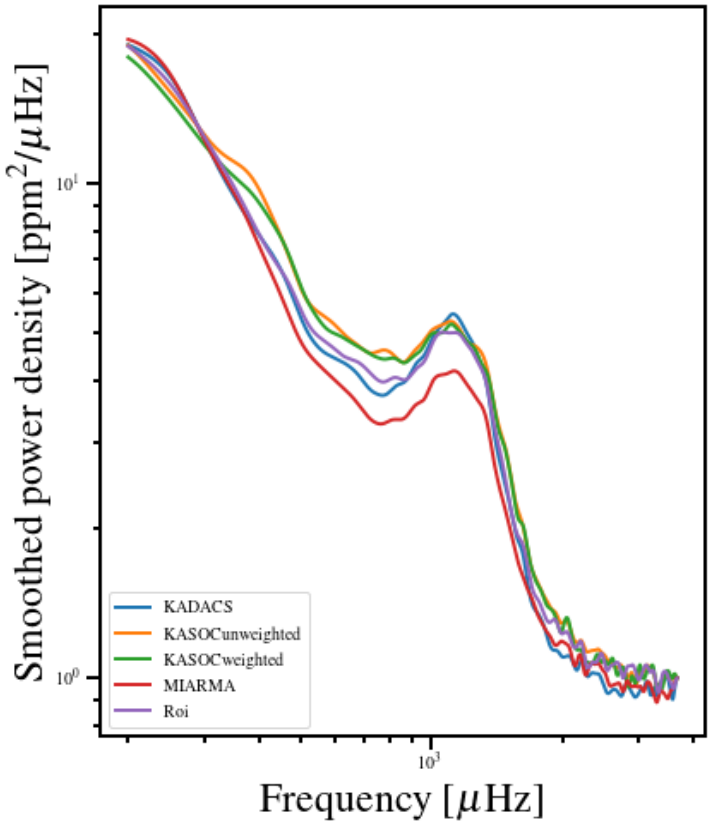
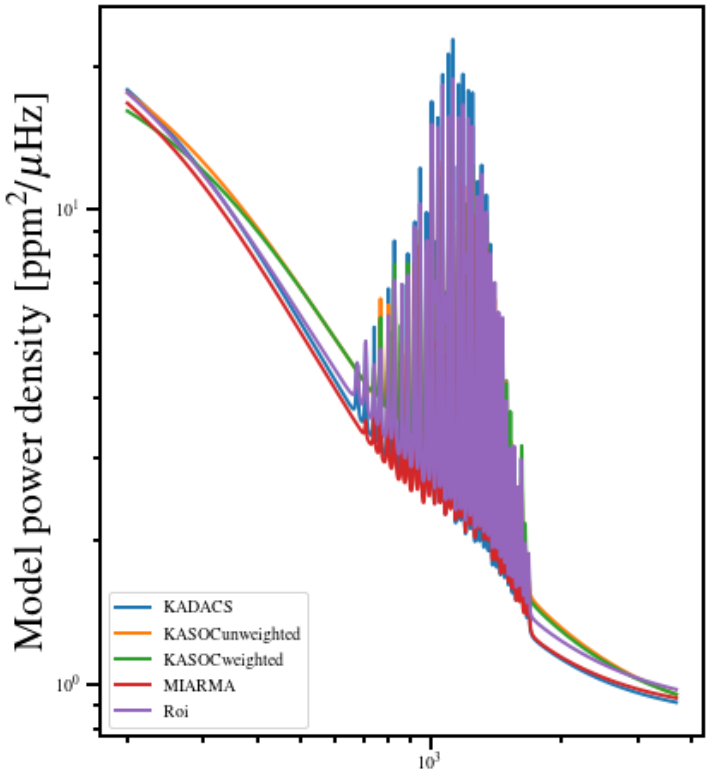
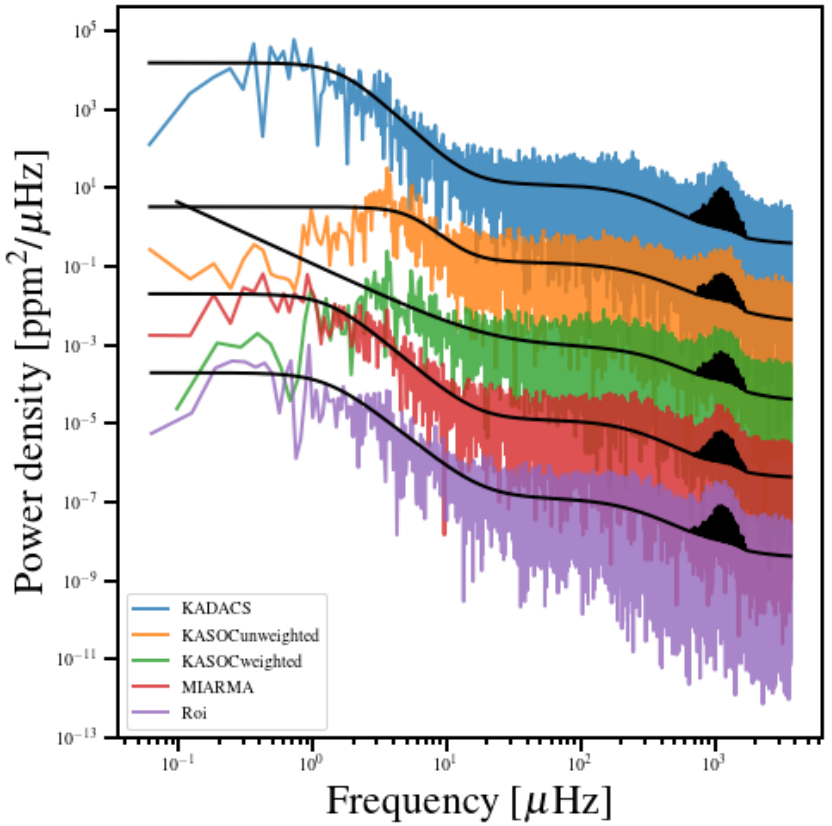


The background?







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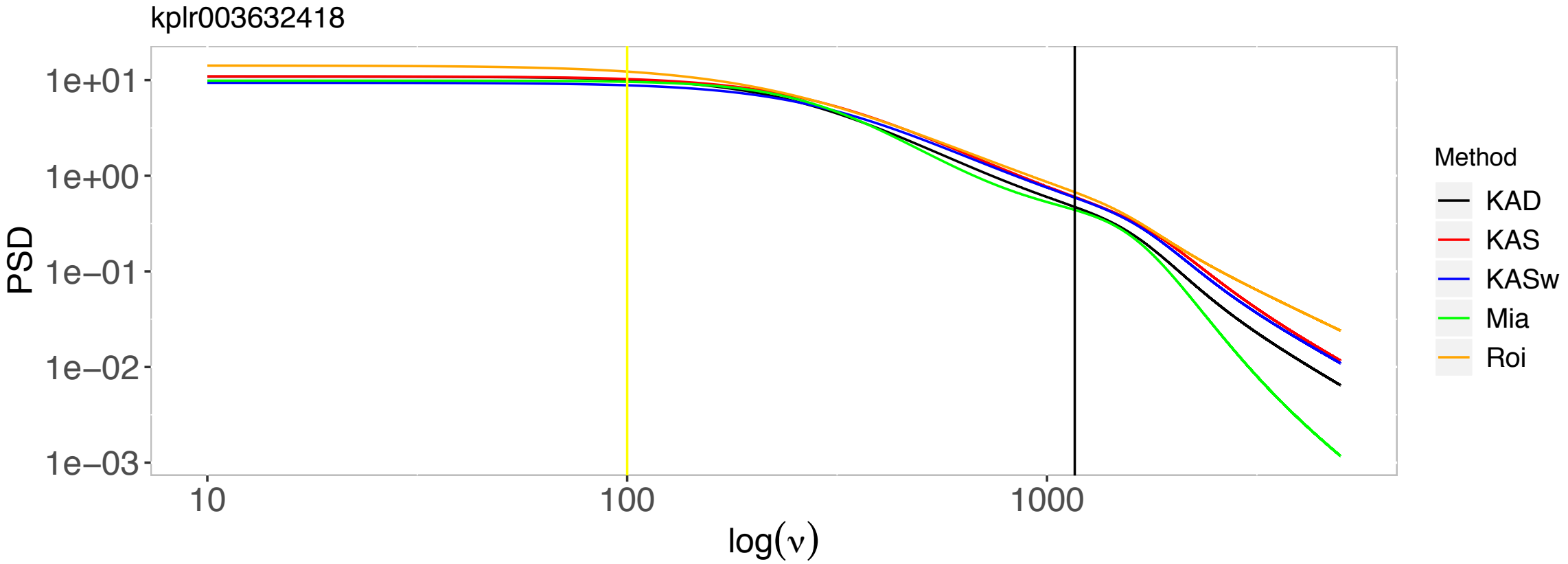

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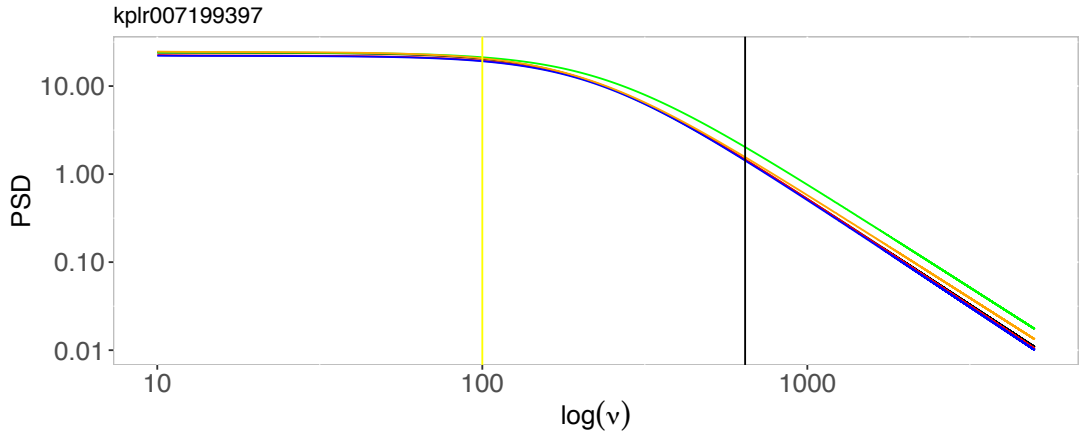

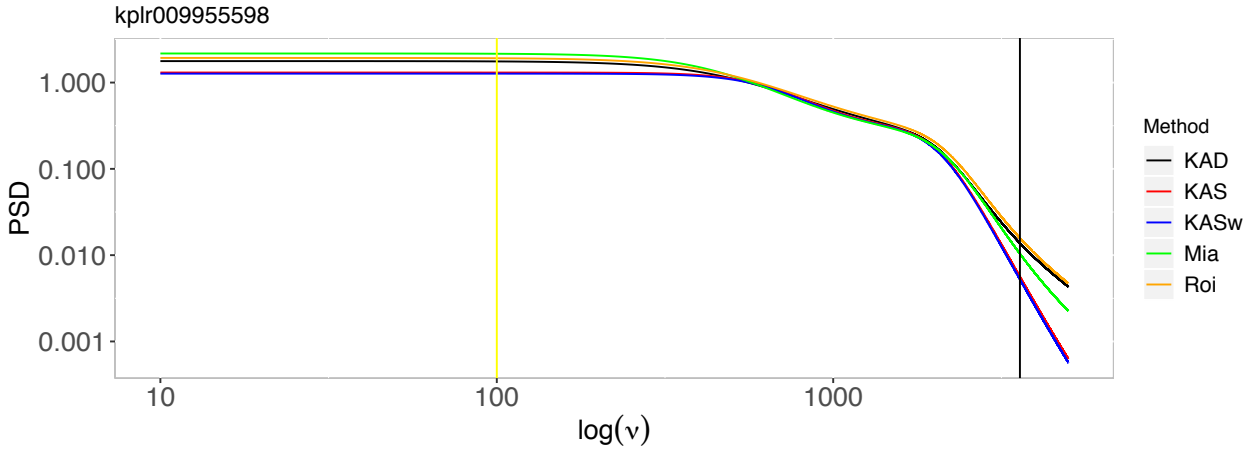

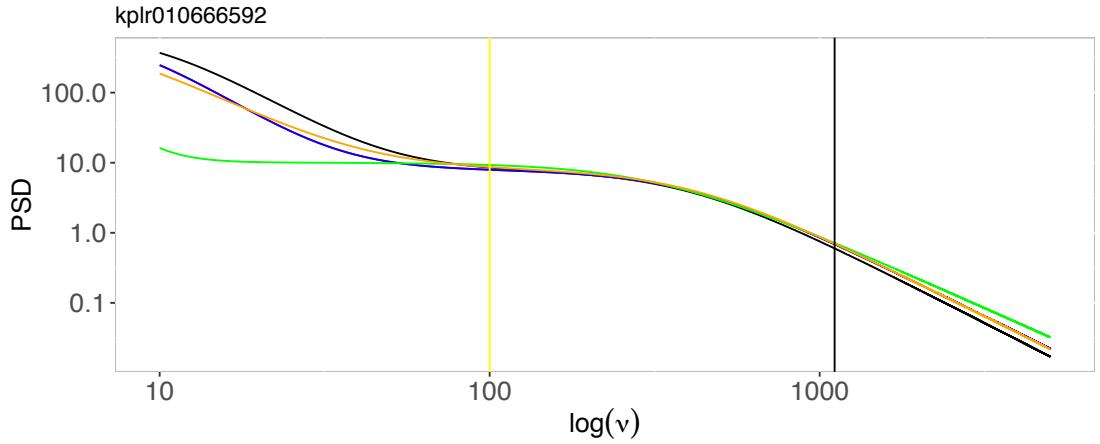

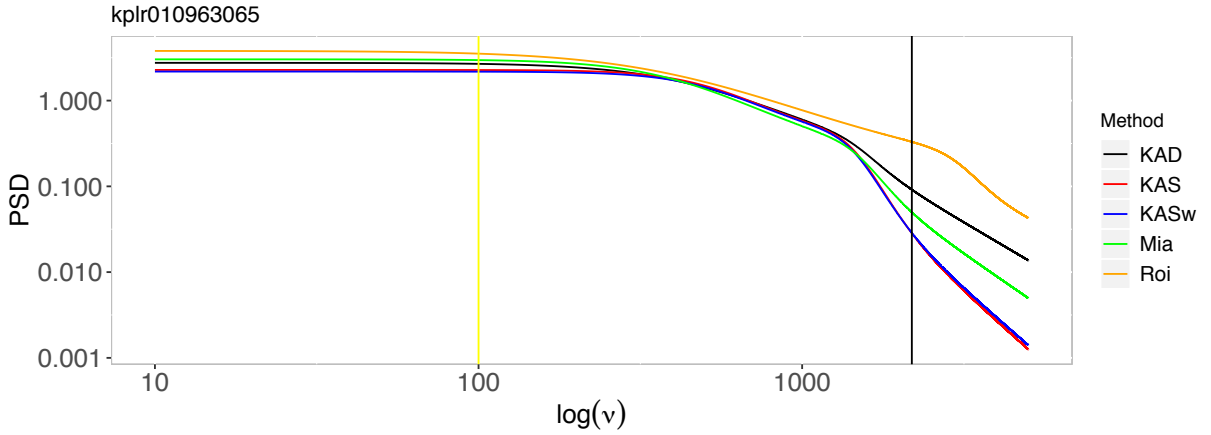

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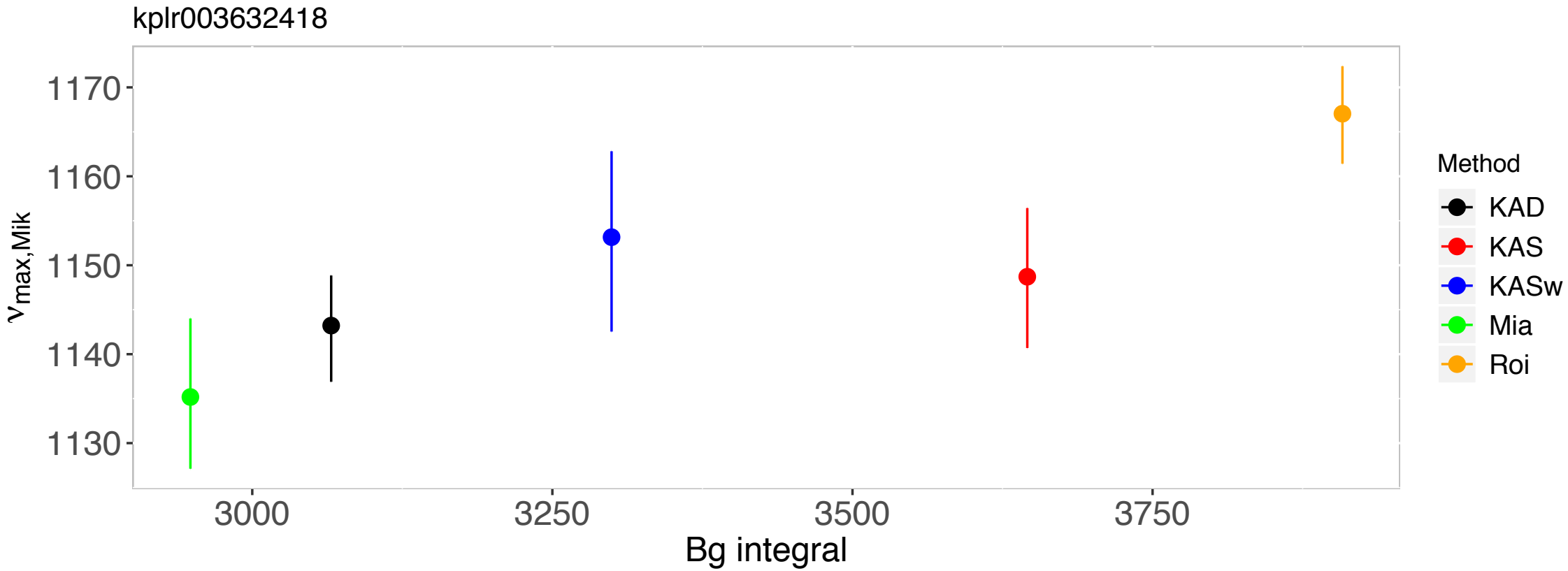
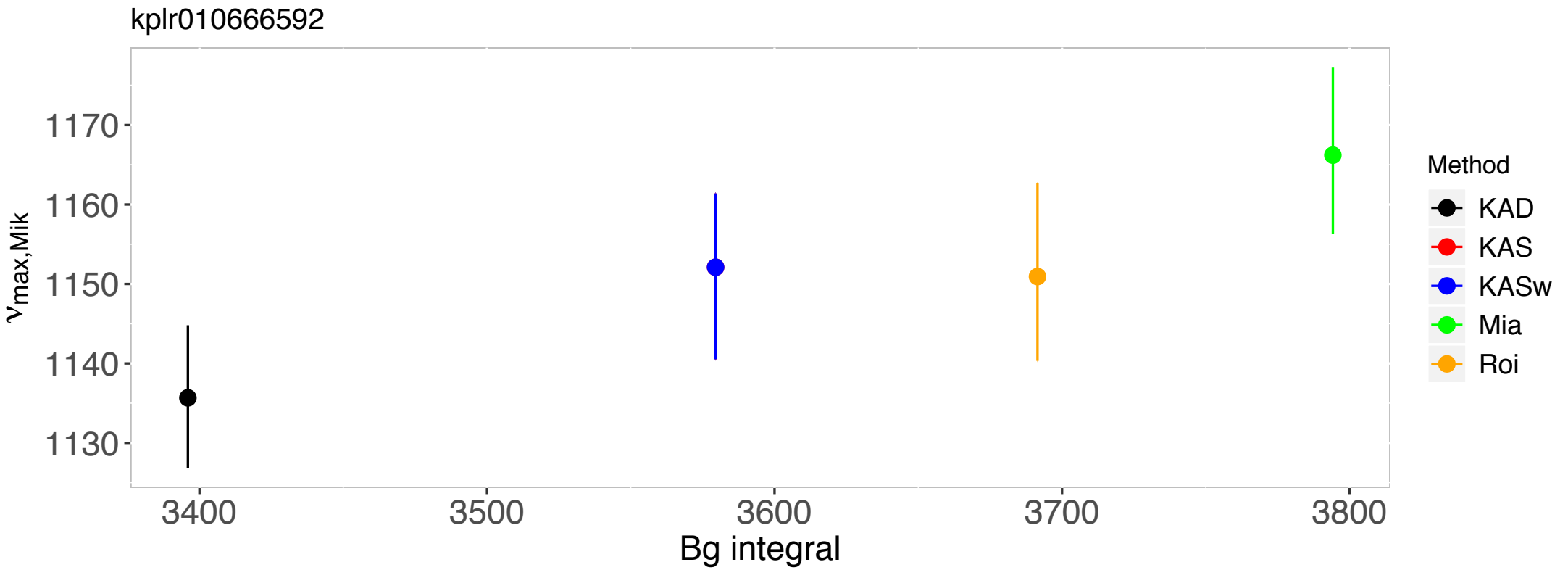


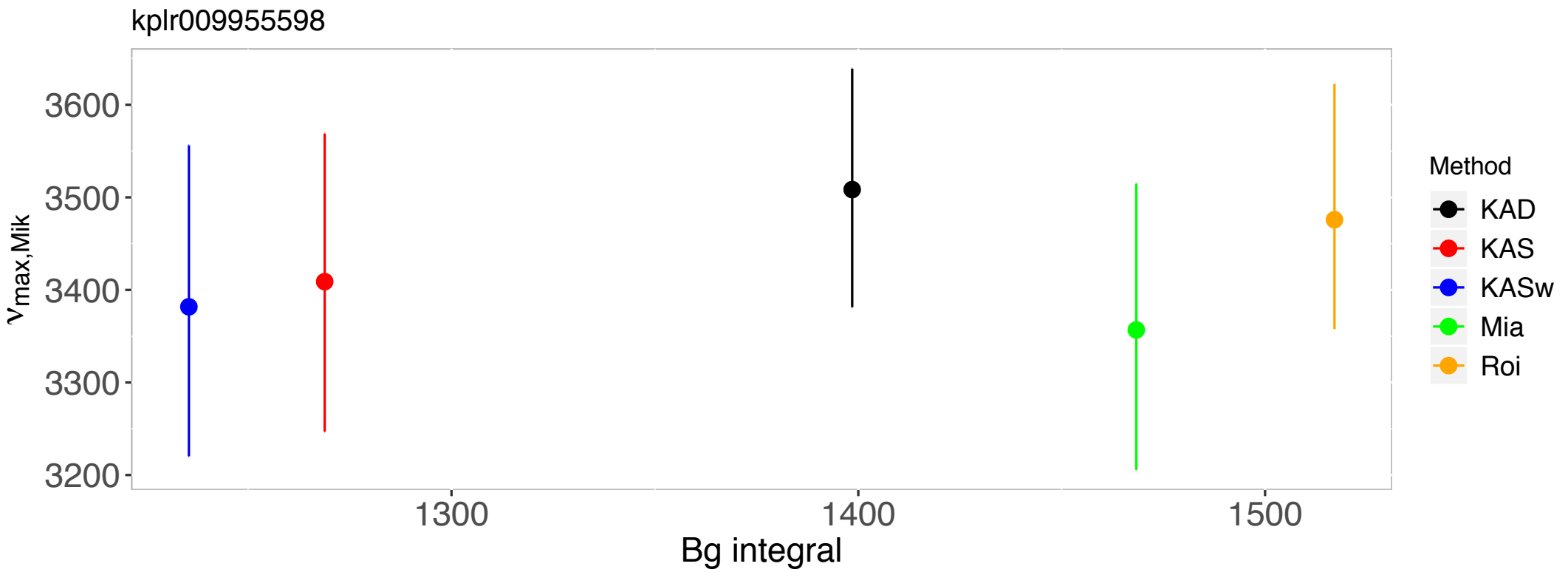
Period = 2.8 days, transit = 3.6 h

The background?



Period = 2.2 days, transit = 3.9 h

The background?



Period = 69 days, transit = 3 h

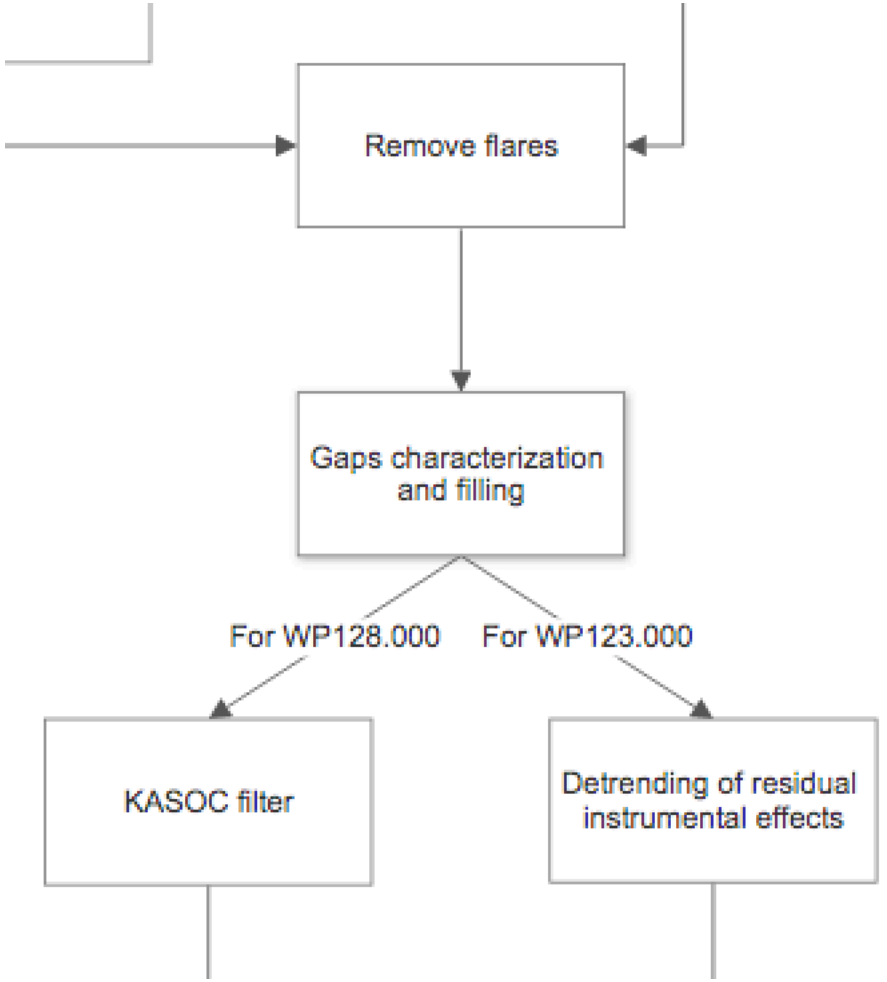
Next steps

1) Dependence with background integral and slope
2) Disentangle which procedure is the best for different situations

   (synthetic light-curves, PSLS, exercise #2)

3) Analyse the results
   a) Propose algorithm details
   b) Propose exercise #3

Joint proposal WP128.300 and WP123.000 (see next talk, A. Lanza)



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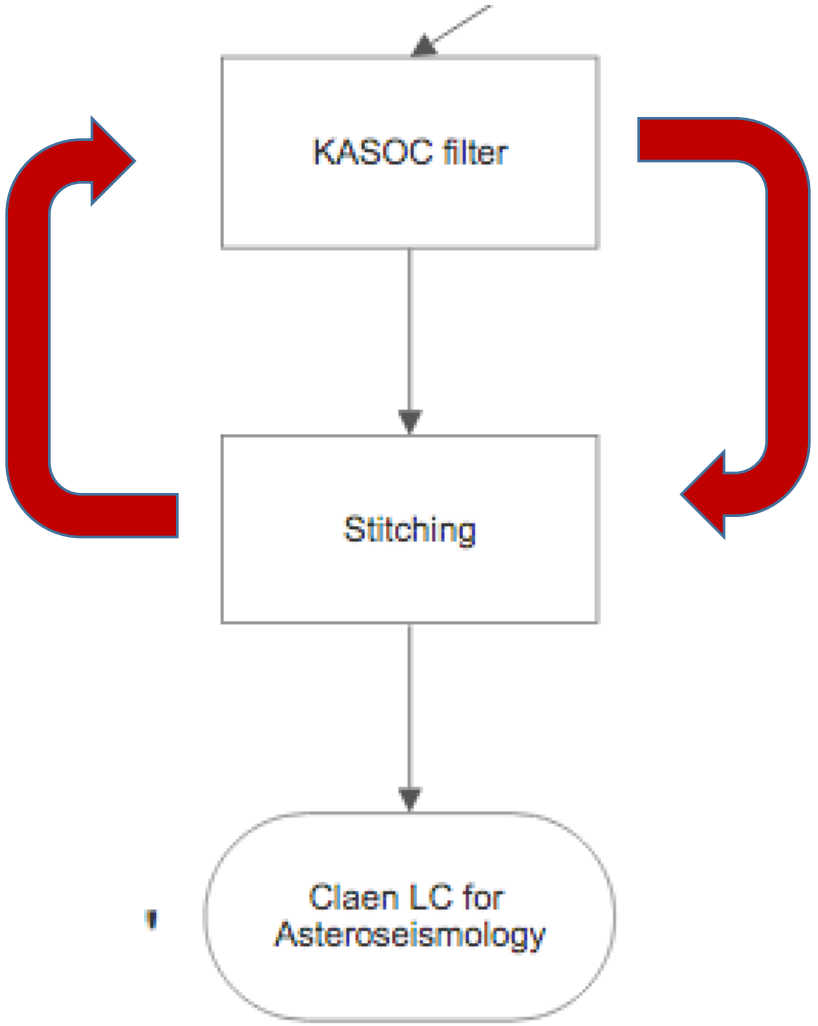

WP128.300: Preparation of the asteroseismic analysis ready light curves. Barcelona, 19/11/2019.


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