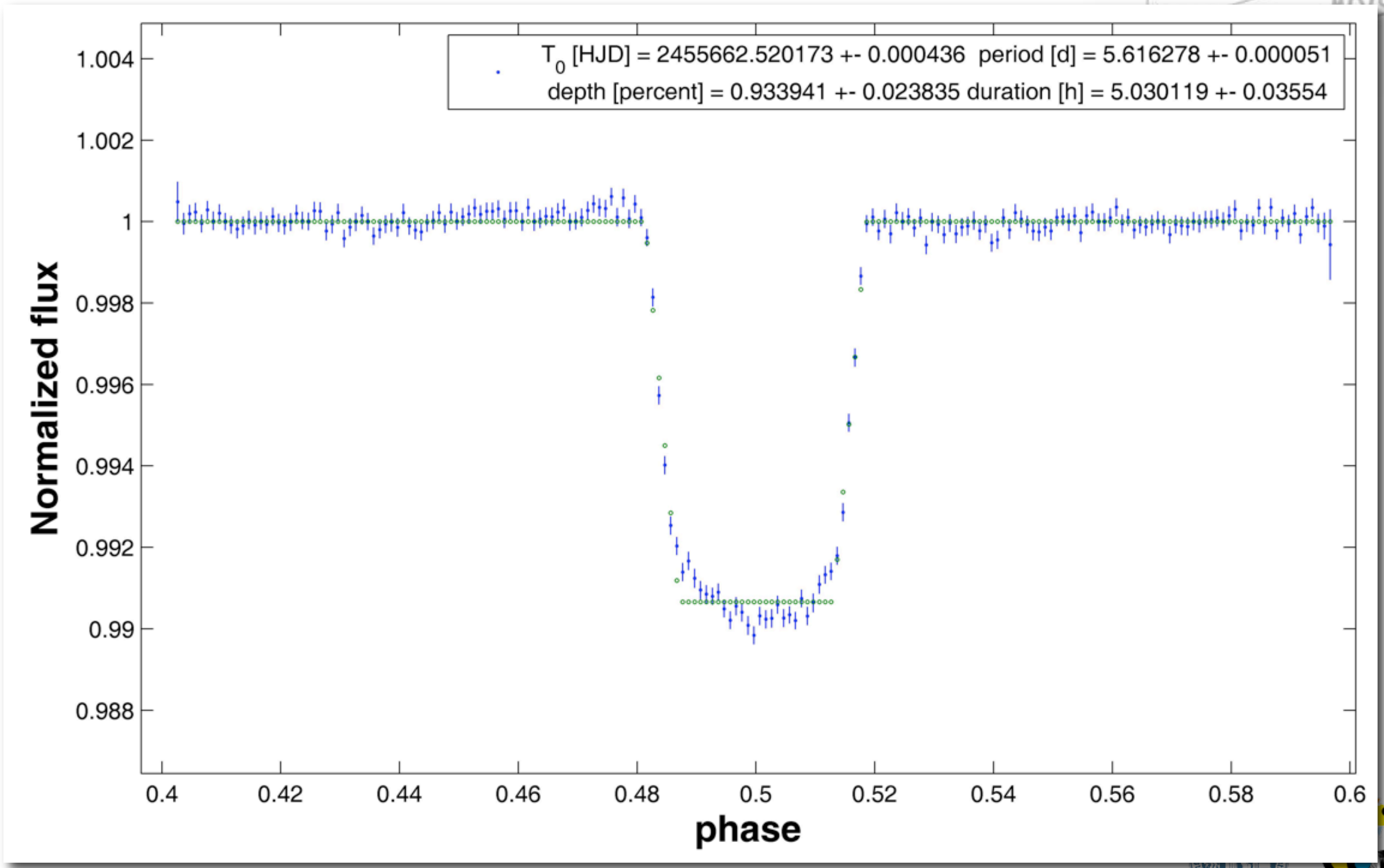
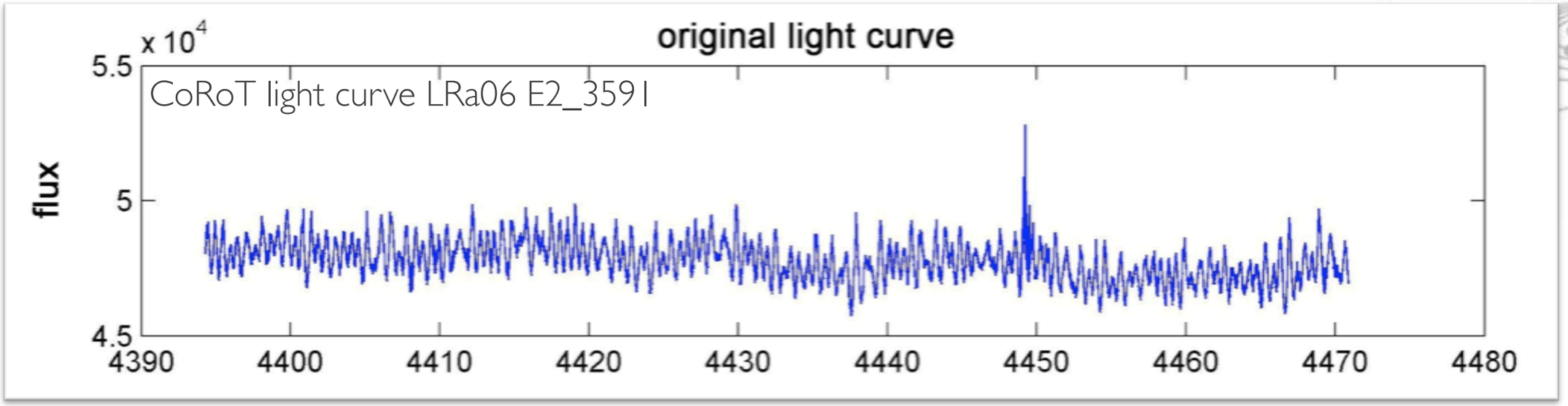
VARLET and PHALET:
Two wavelet based filter methods to separate stellar variation, orbital disturbances and instrumental effects from transit events in CoRoT light curves.

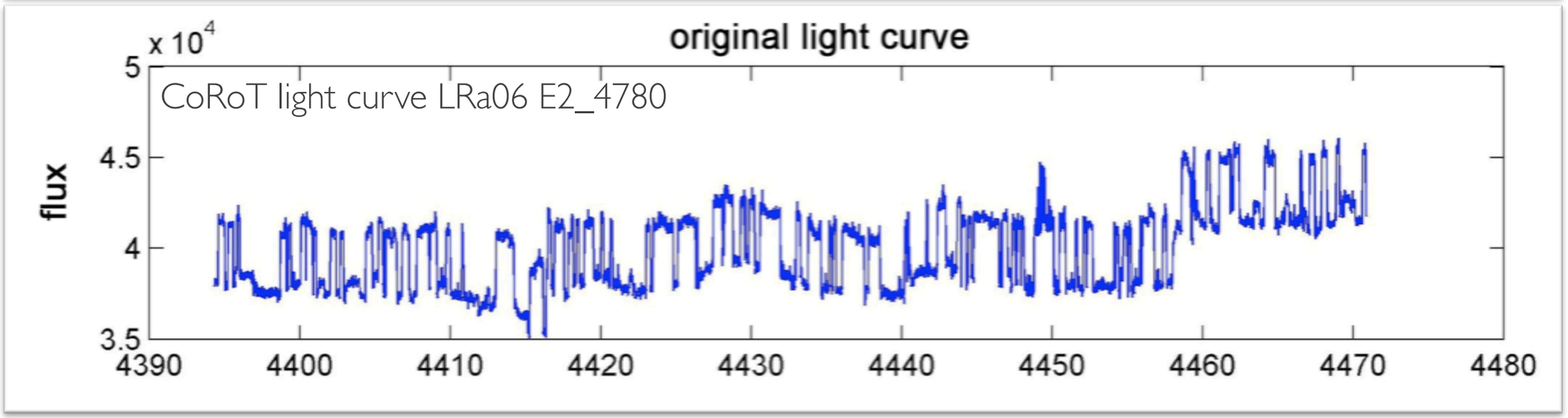
Sascha Grziwa, Judith Korth, Martin Pätzold
RIU-Planetenforschung an der Universität zu Köln
11th CoRoT Week, San Cristobal de La Laguna, 19.03.2013

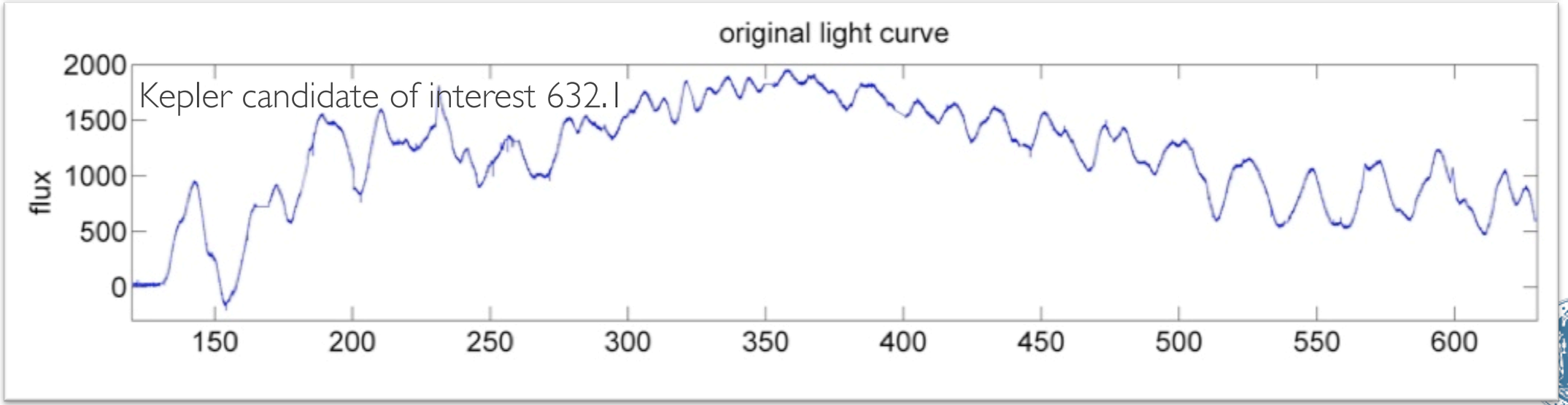
candidate of LRc07 E2_0307



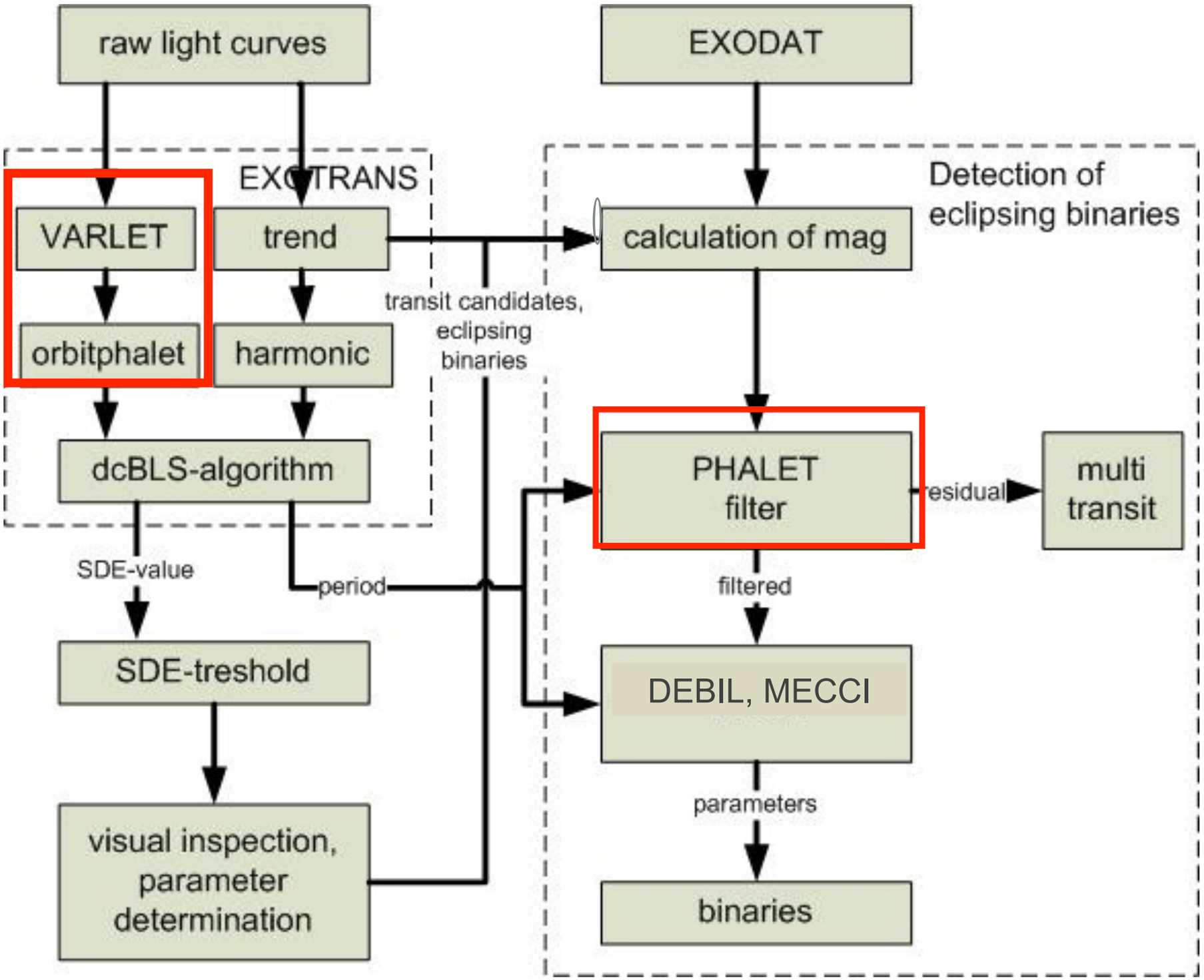
examples of strong variability in light curves



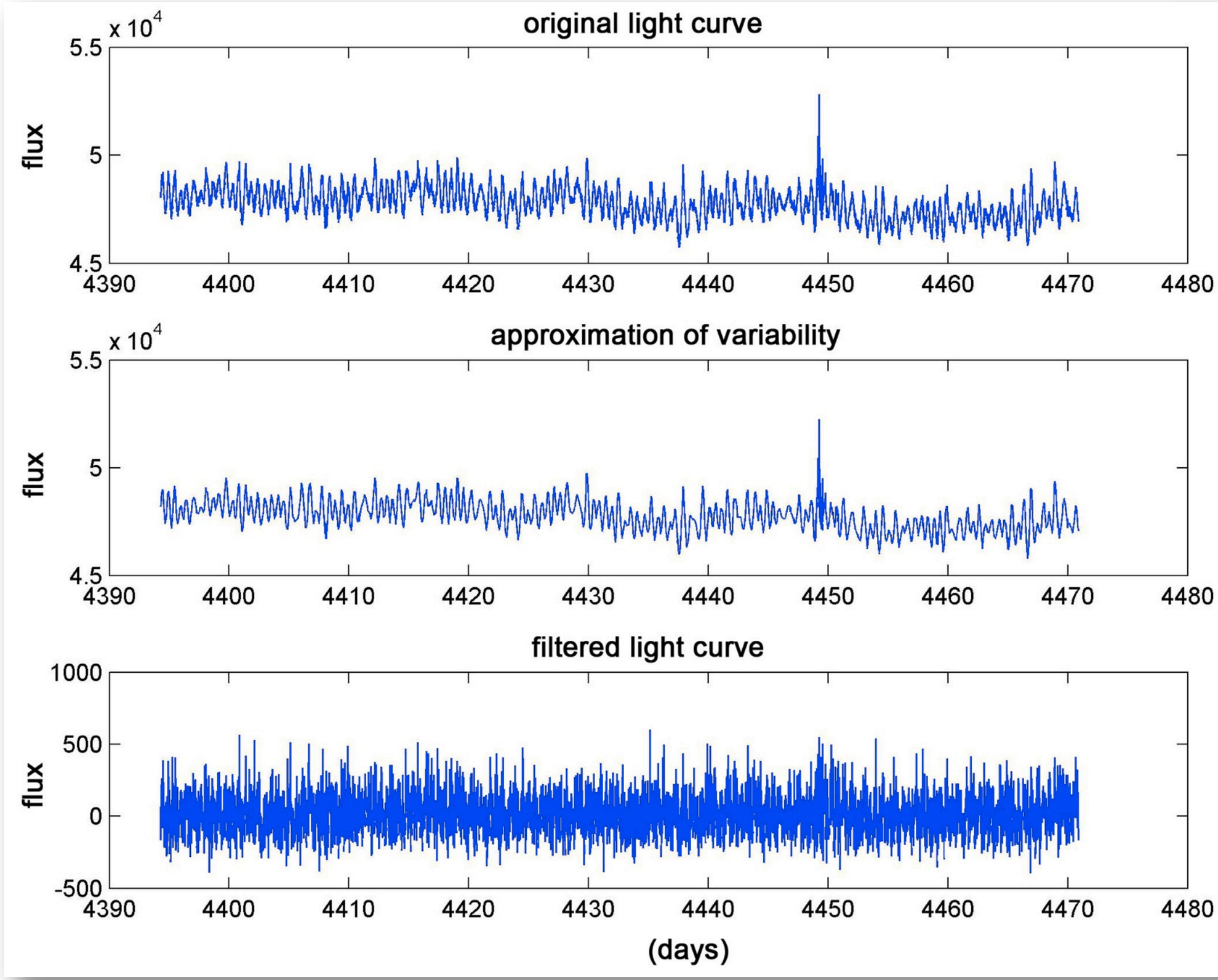




RIU exoplanet detection pipeline



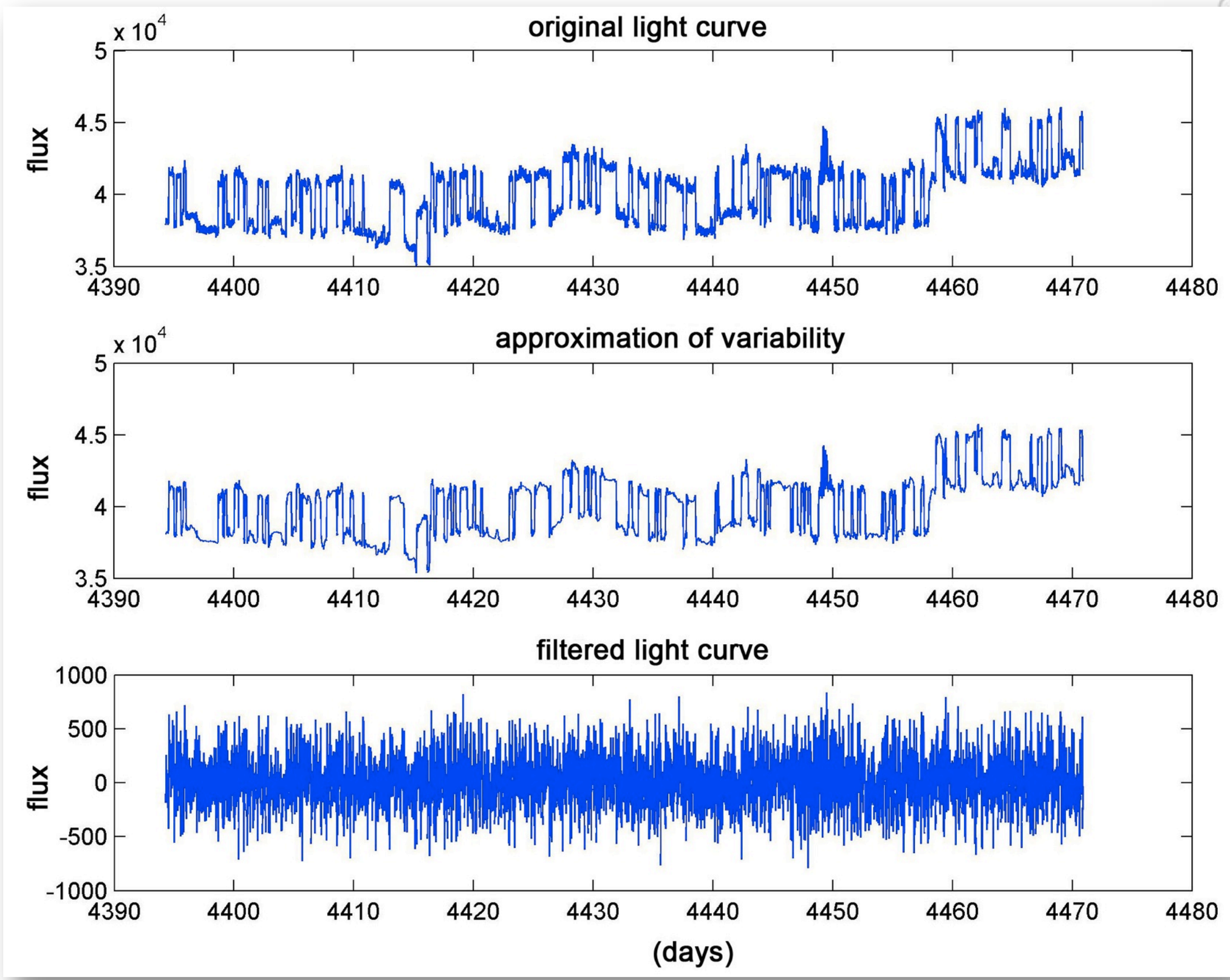
VARLET on CoRoT light curve LRa06 E2_3591



=

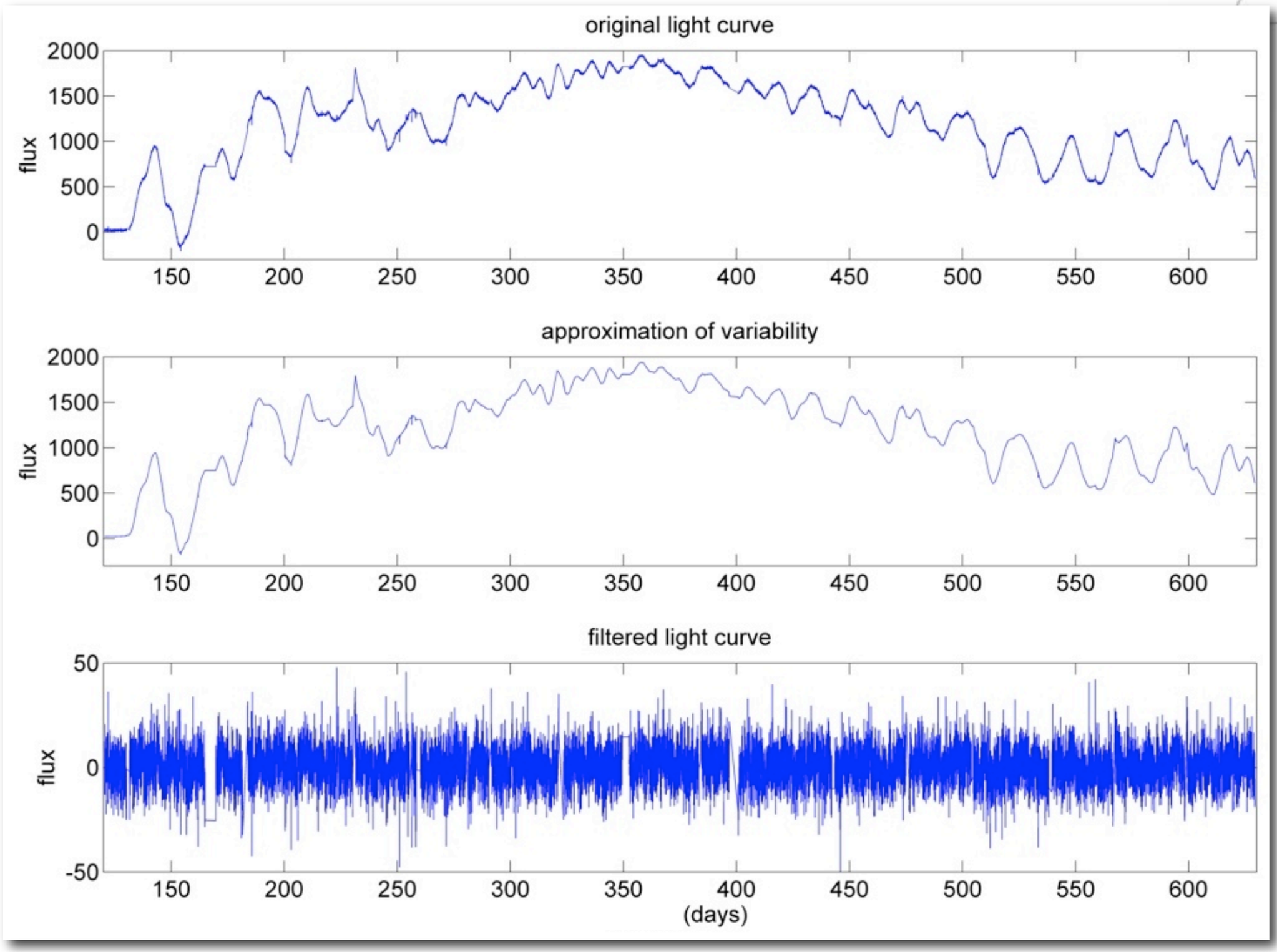
contains
transit + noise

VARLET on CoRoT light curve LRa06 E2_4780



contains
transit + noise

Varlet on Kepler candidate of interest 632.01

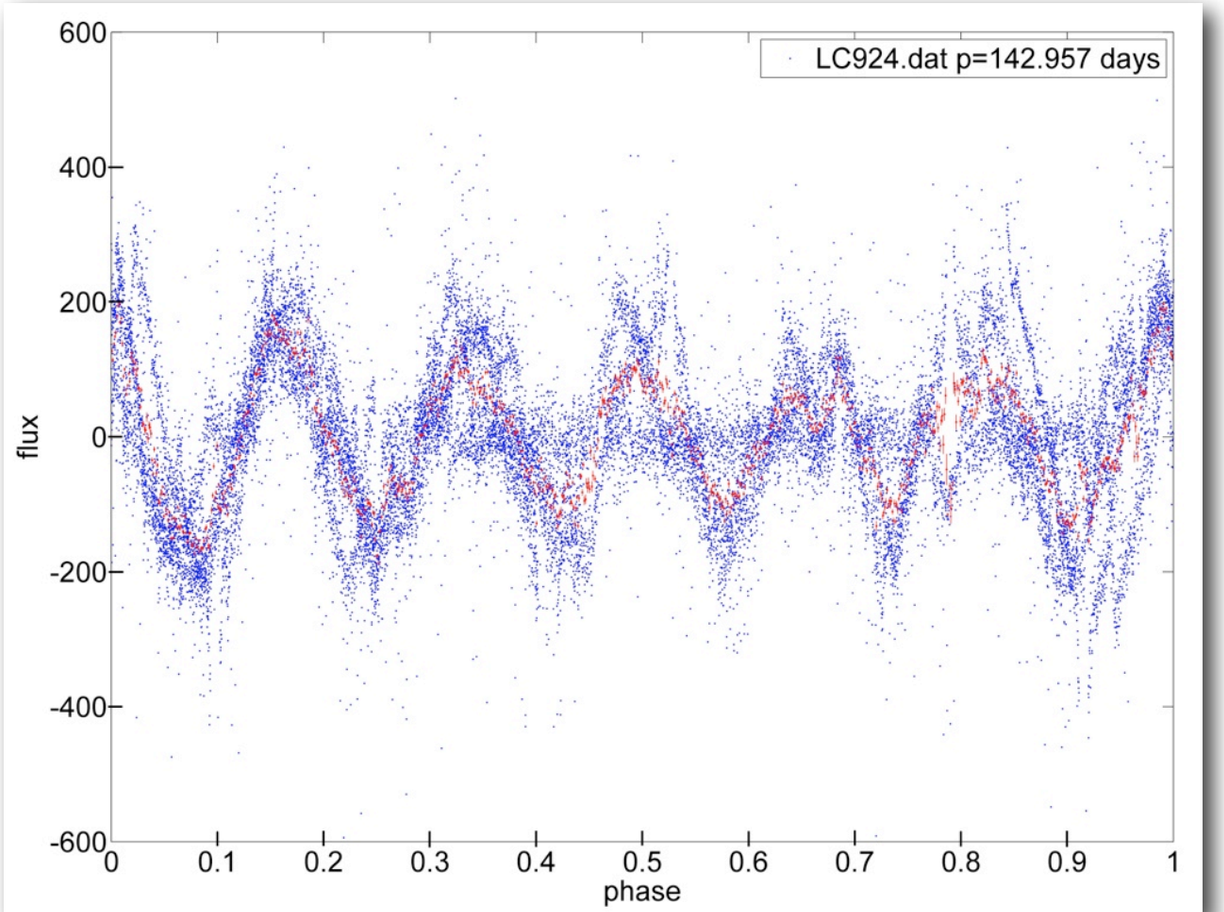


=

contains
transit + noise

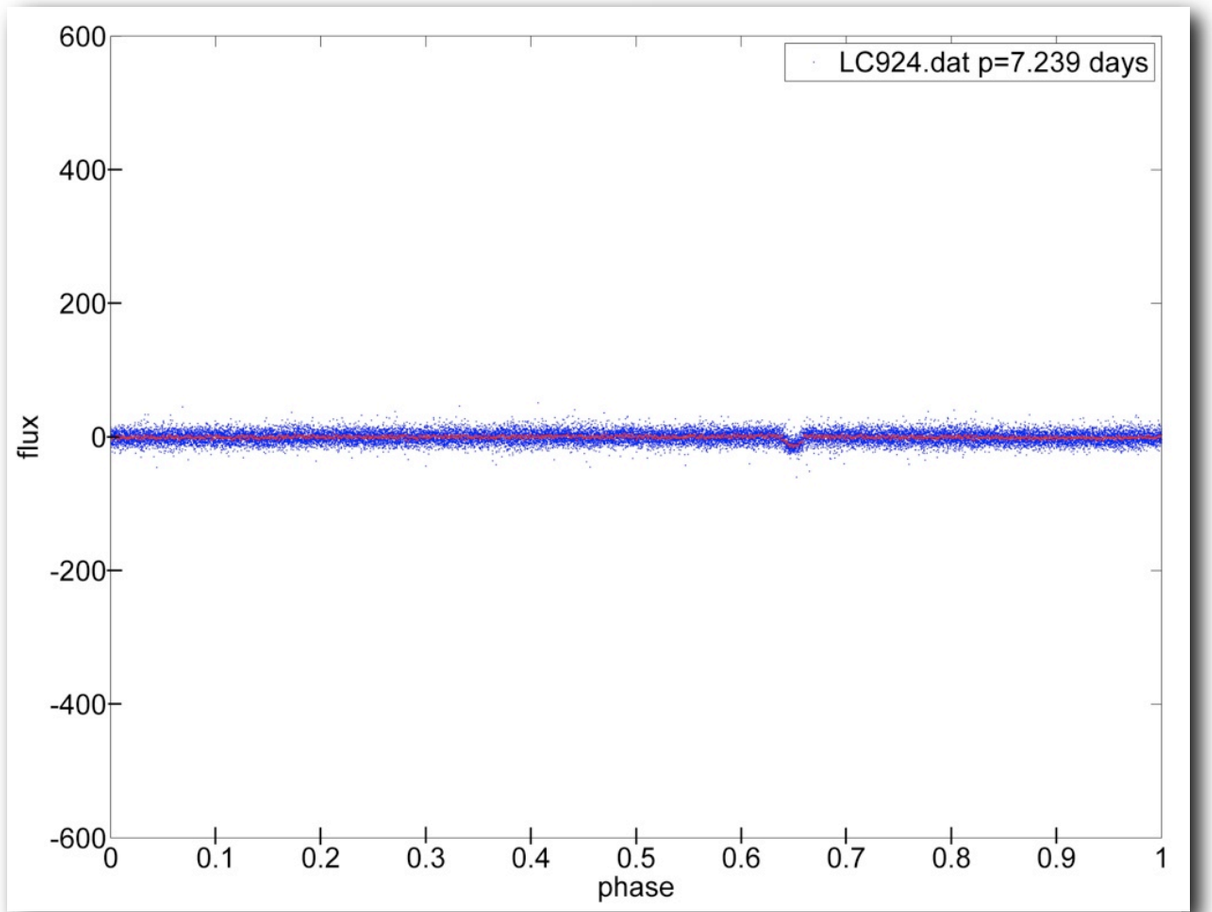
Kepler candidate of interest 632.01 (7.239 days)

trend-harmonic



The wrong period of 142.96 days
was detected after trend-harmonic filtering
due to stellar variation.

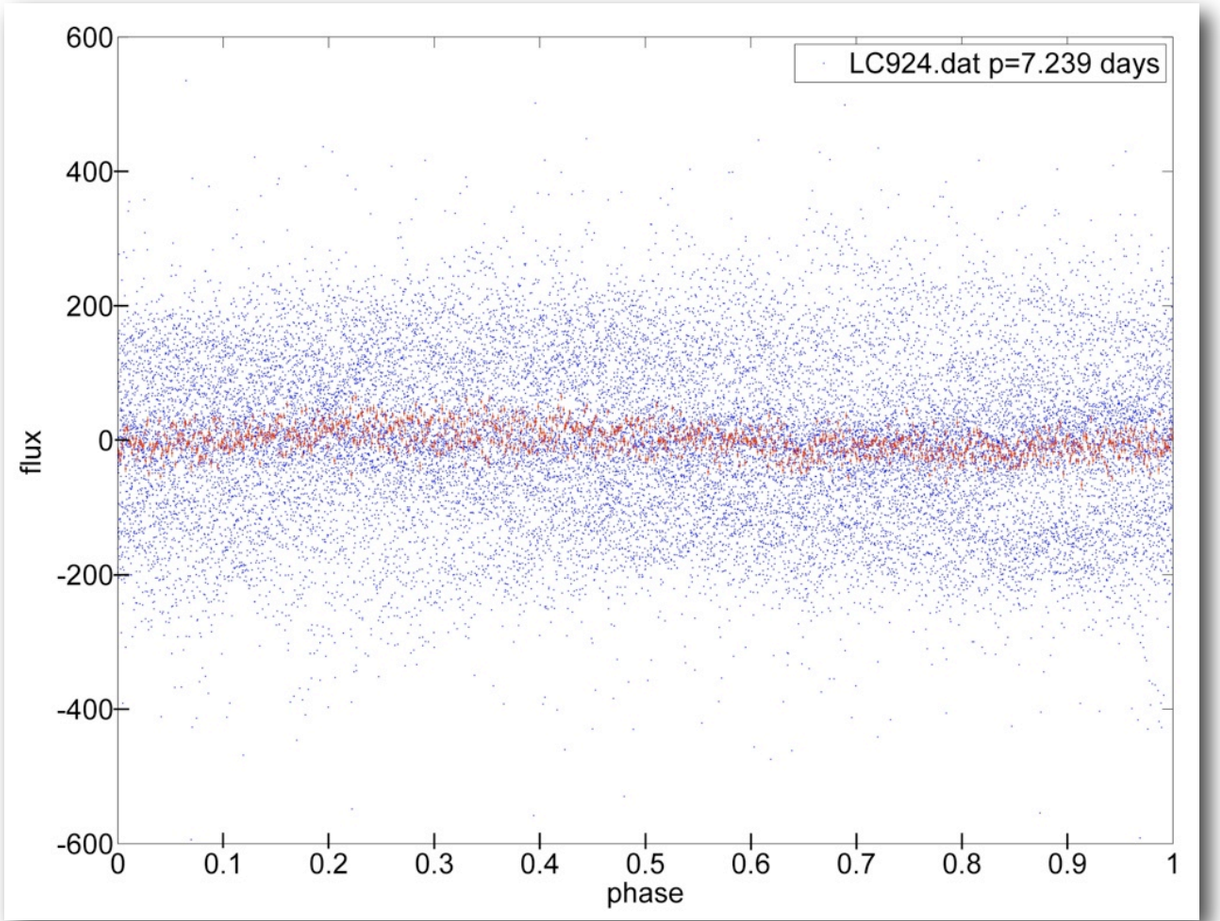
VARLET



The correct period of 7.24 days
was detected after VARLET filtering.

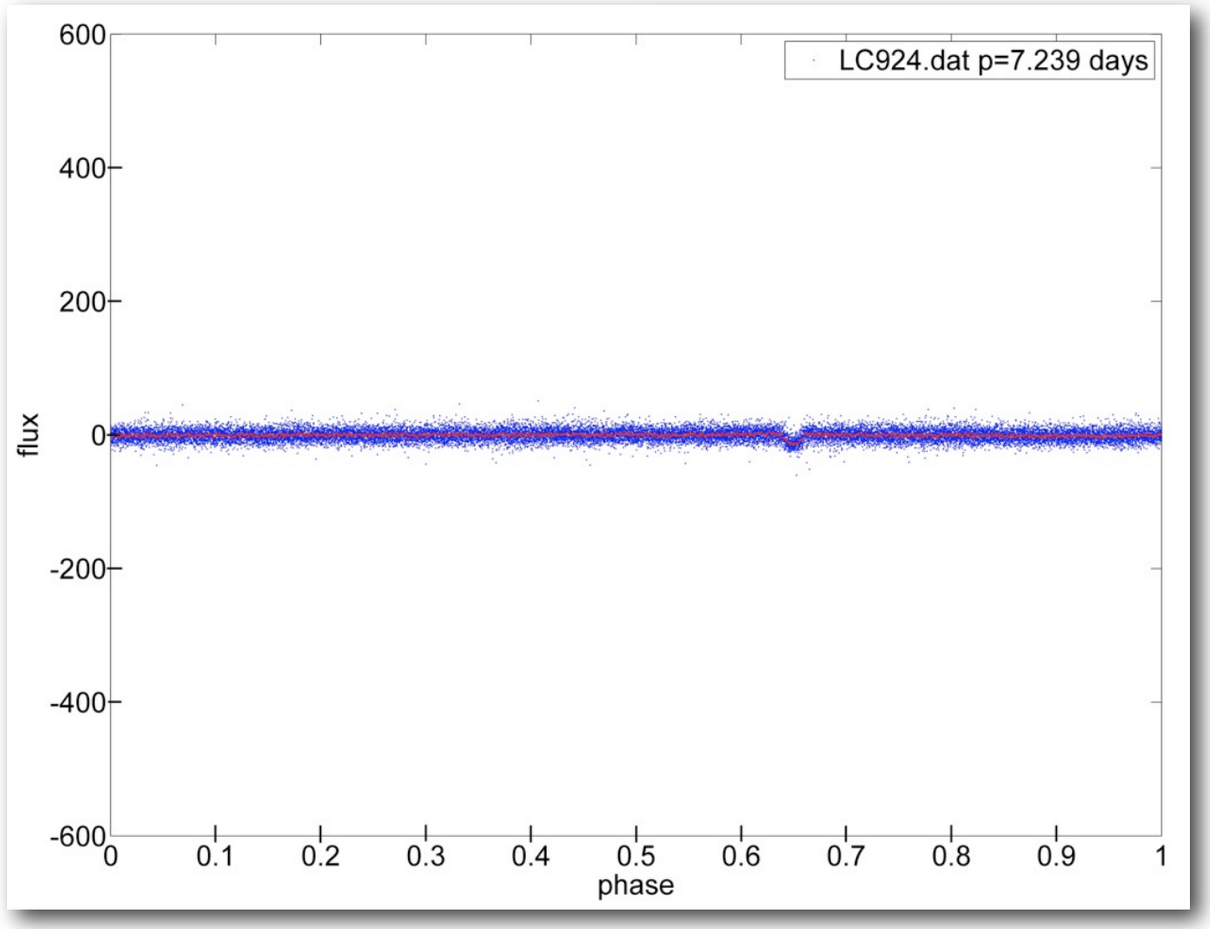
Kepler candidate of interest 632.01 (7.239 days)

trend-harmonic



Even phase folding this light curve with the correct period of 7.24 days shows a very faint transit.

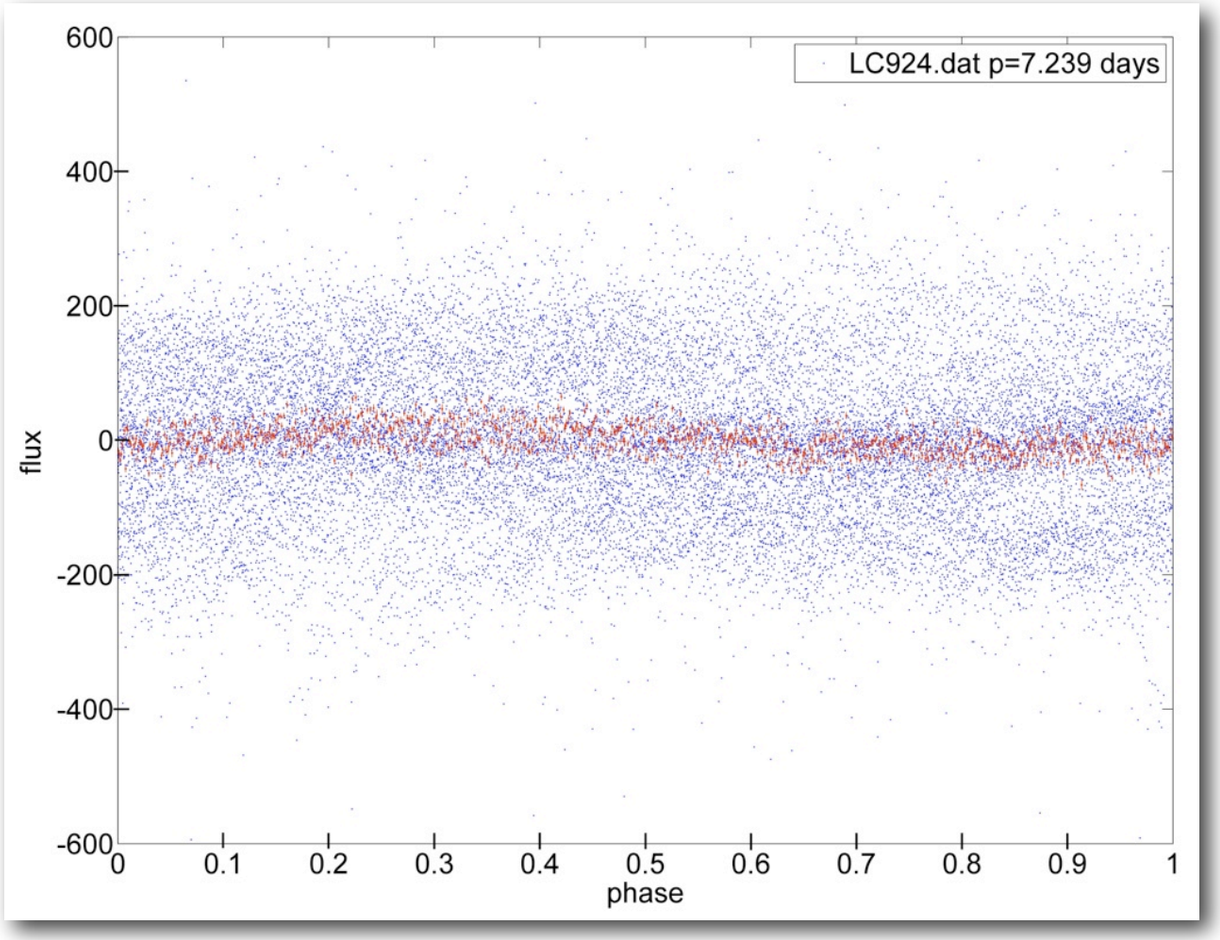
VARLET



The correct period of 7.24 days was detected after VARLET filtering.

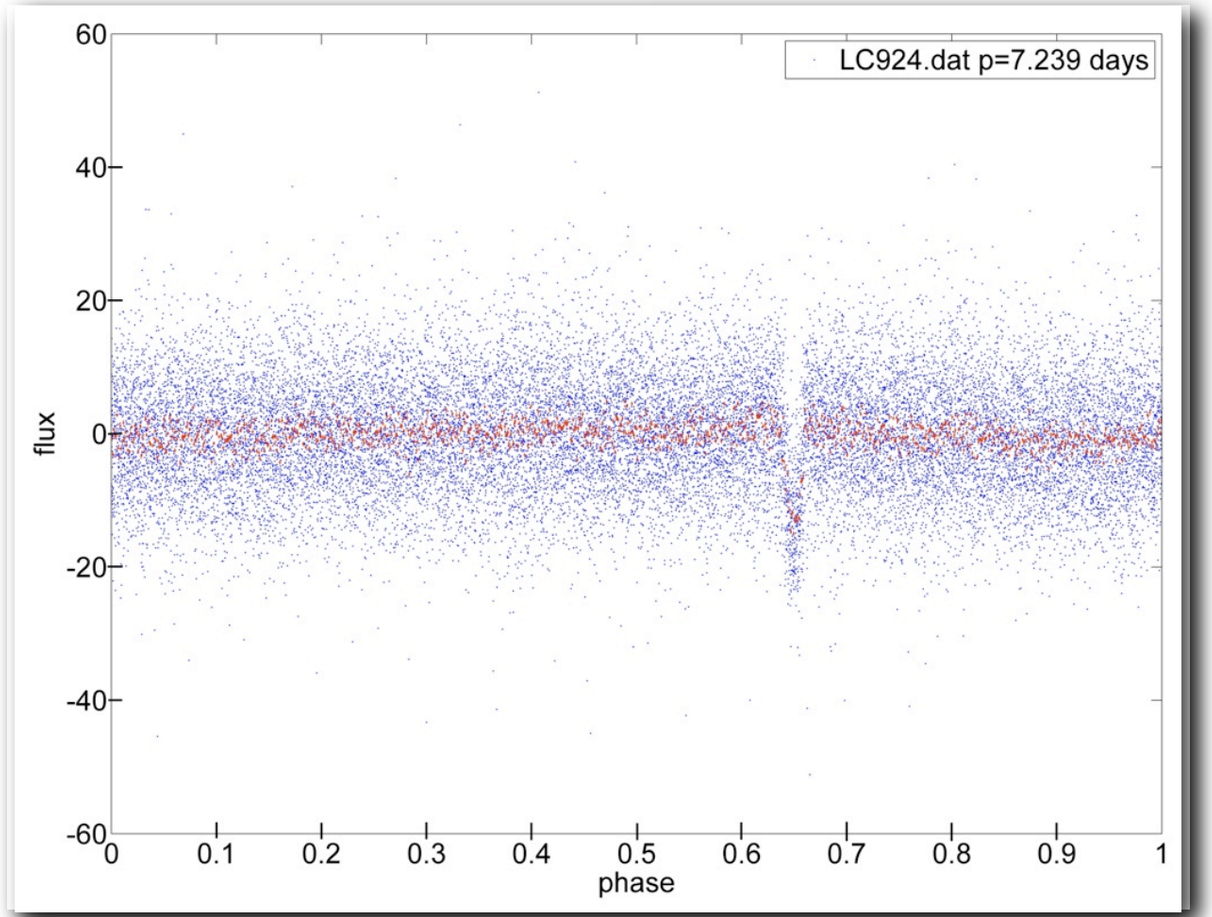
Kepler candidate of interest 632.01 (7.239 days)

trend-harmonic



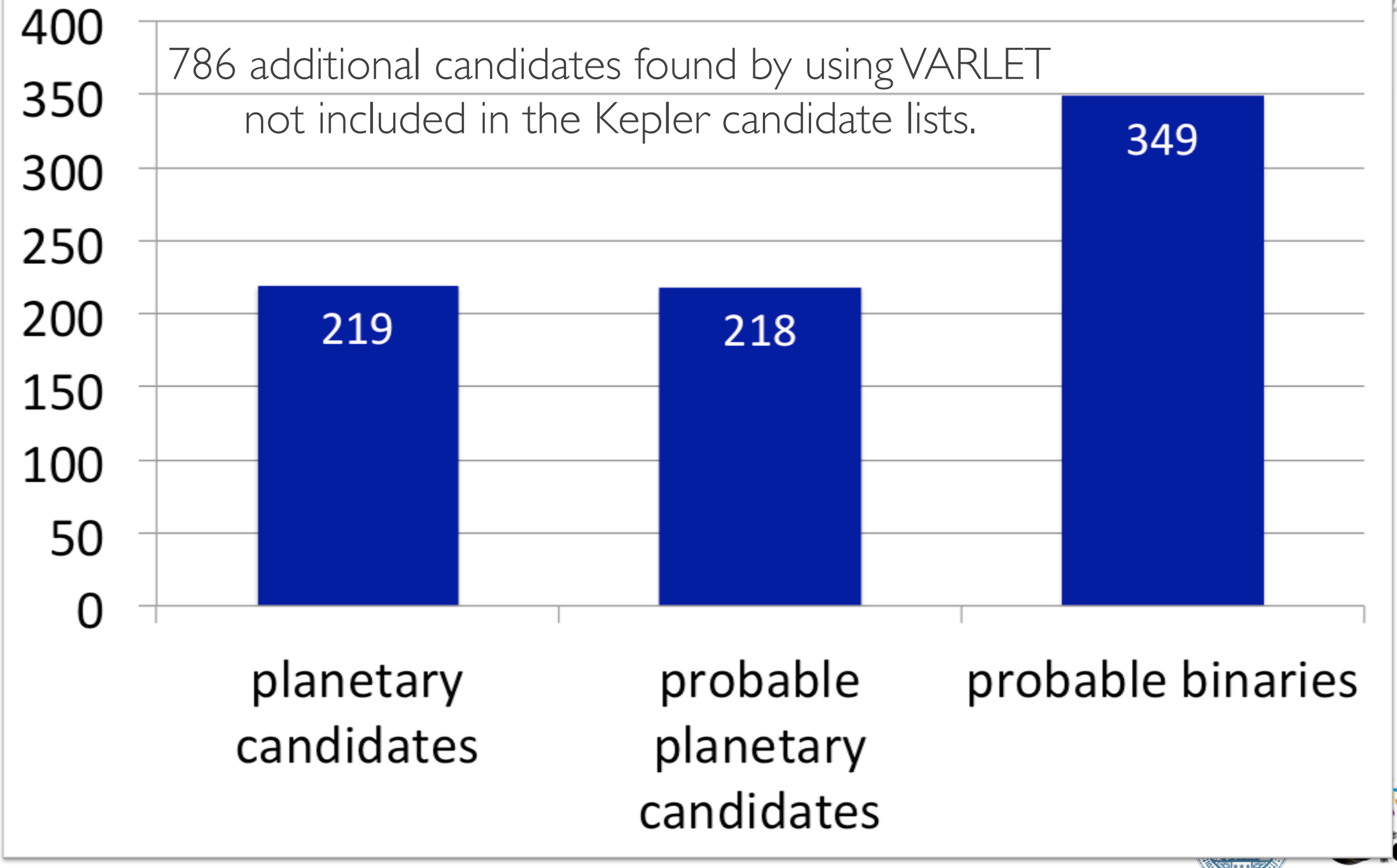
Even phase folding this light curve with the correct period of 7.24 days shows a very faint transit.

VARLET



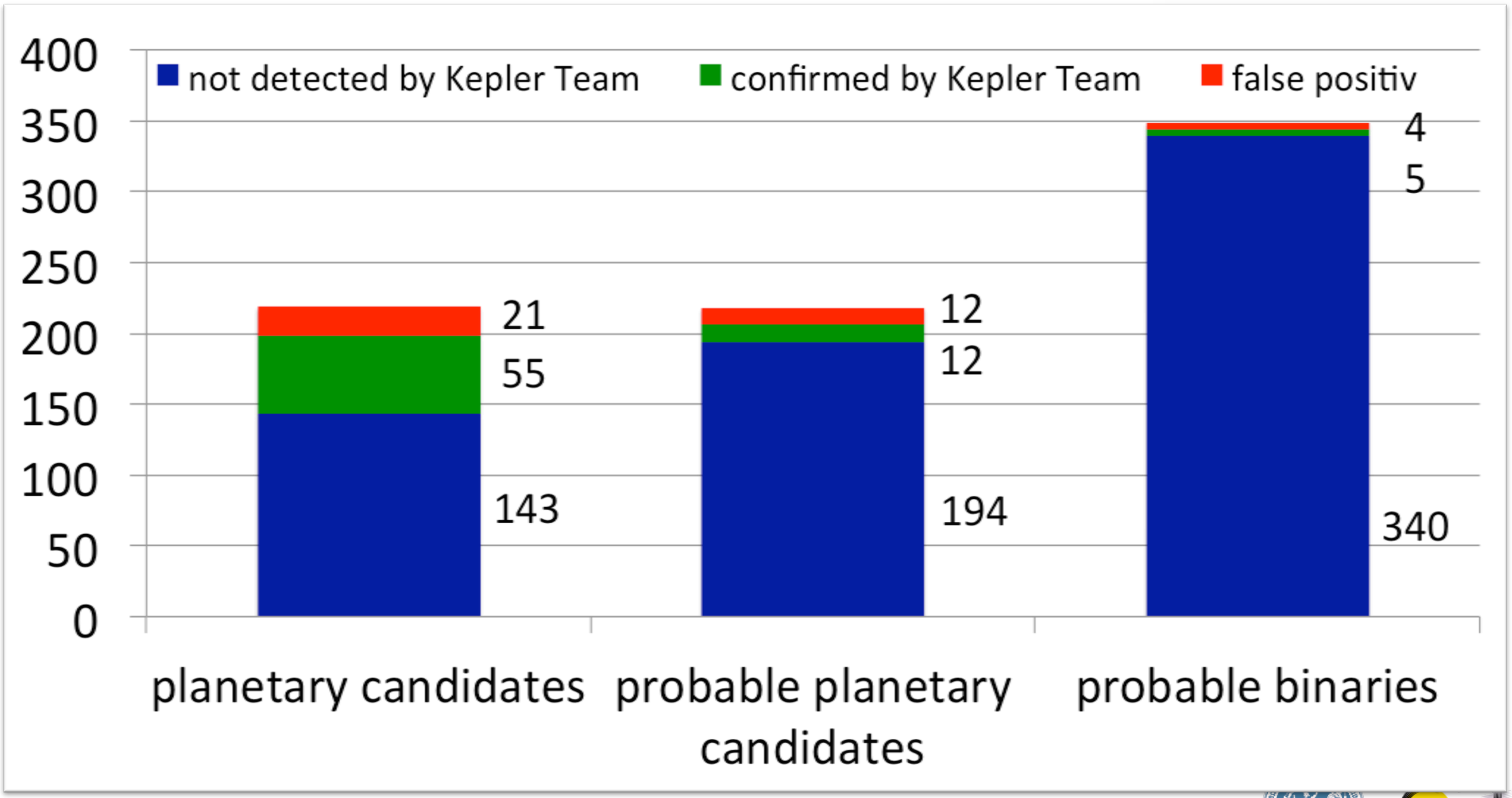
Increasing the resolution by a factor of 10 shows a planetary candidate with a radius of 1.46 r_{Earth} around a 0.9 R_{Sun} star.

August 2012


400
350
300
250
200
150
100
50
0
786 additional candidates found by using VARLET
not included in the Kepler candidate lists.
219
218
349
planetary candidates
probable planetary candidates
probable binaries

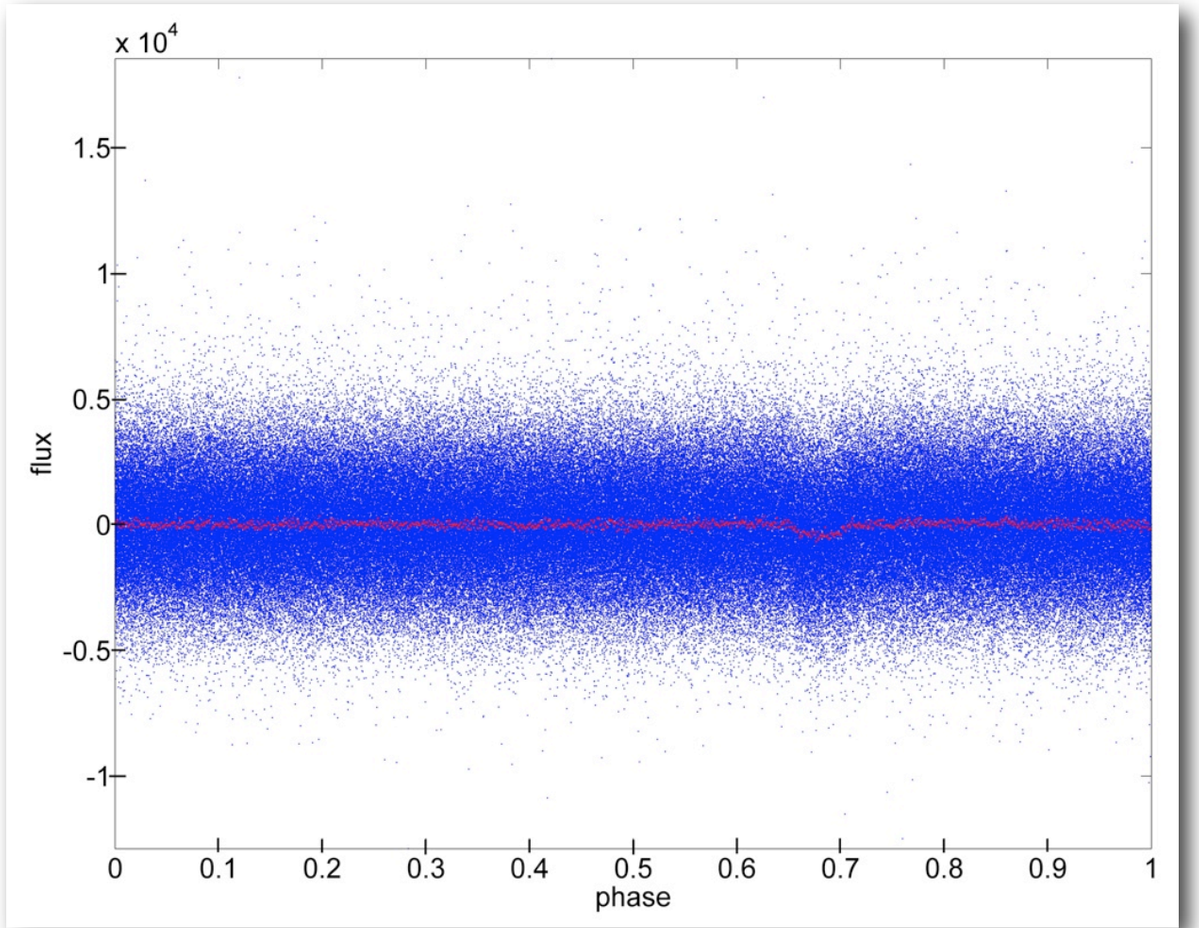
January 2013

109 candidates are now included in the Kepler list.
72 candidates are now included in the Kepler candidate list.



Corot-7b (0.85353 days)

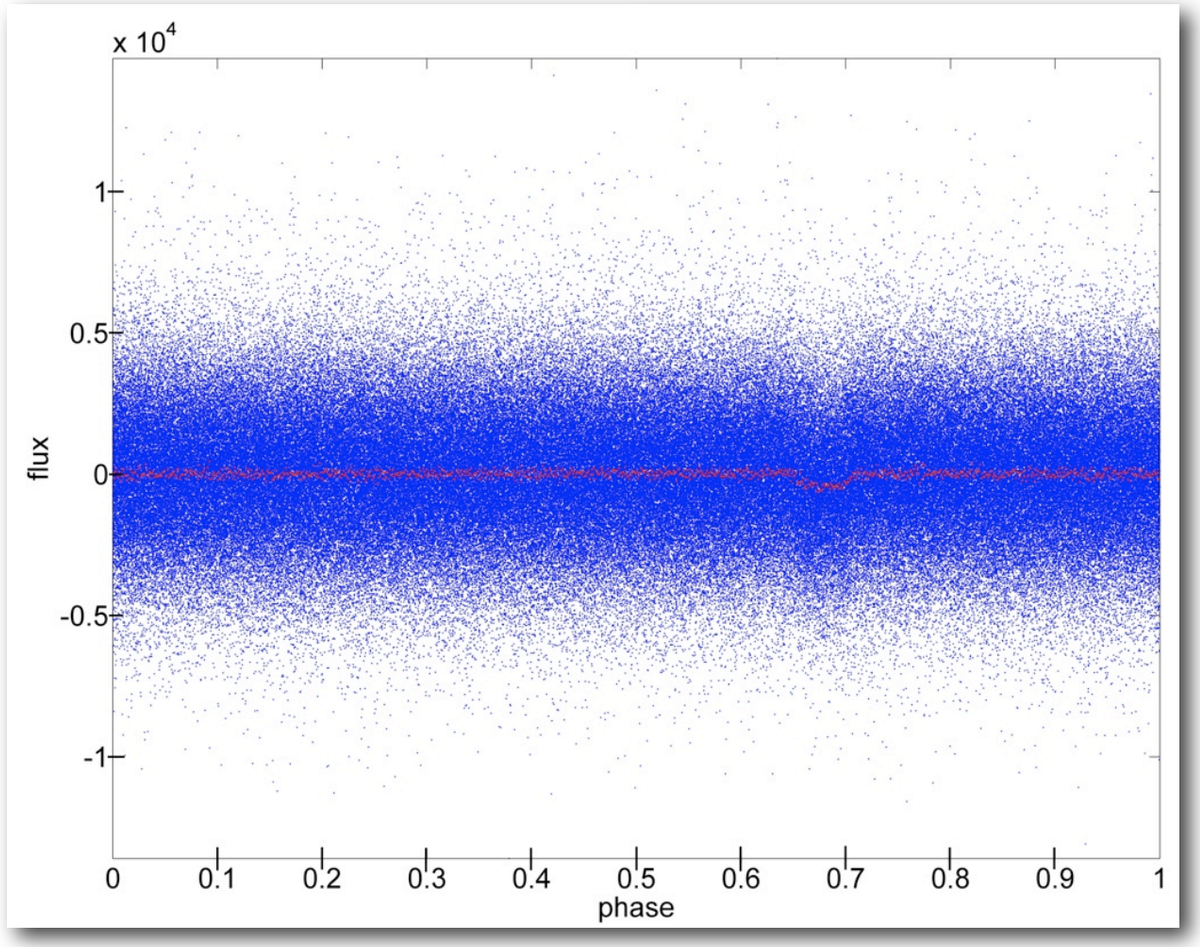
trend-harmonic



SDE -- SDE-limit

12.3 > 10.4

VARLET



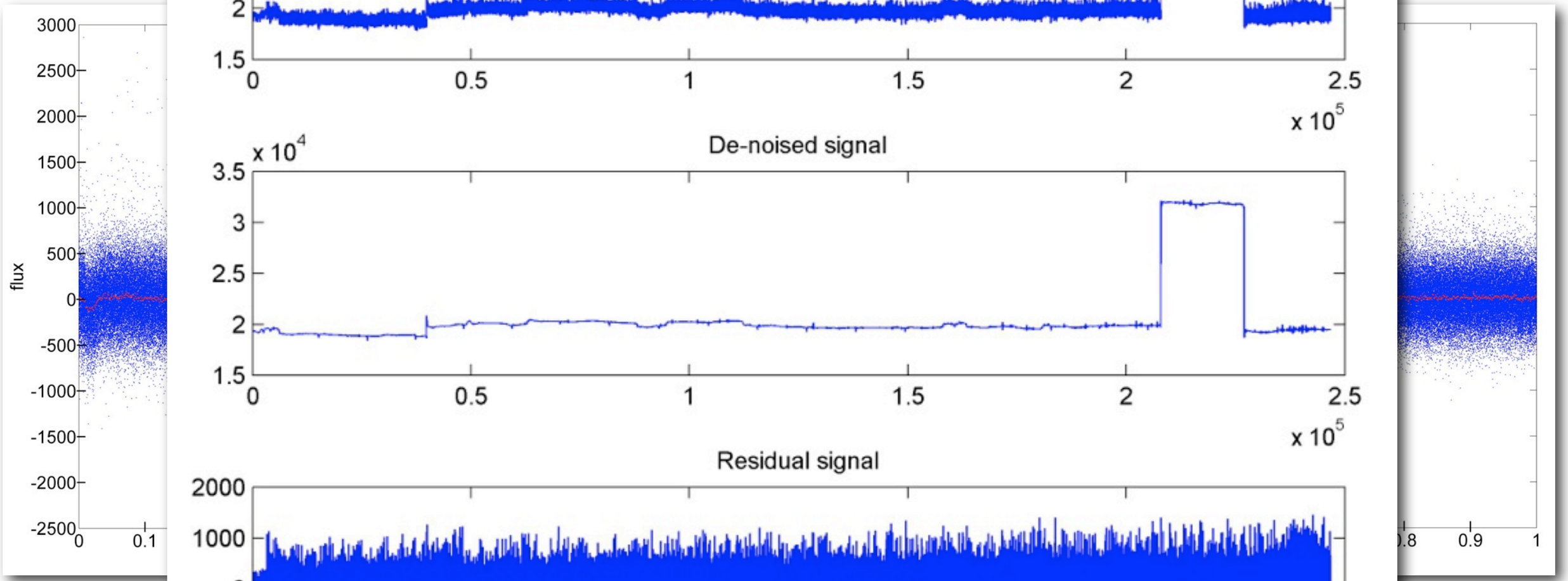
SDE -- SDE-limit

16.9 > 10.2

SDE is significantly improved

LRa01 mon E2_1907 (4.6535 days)

trend

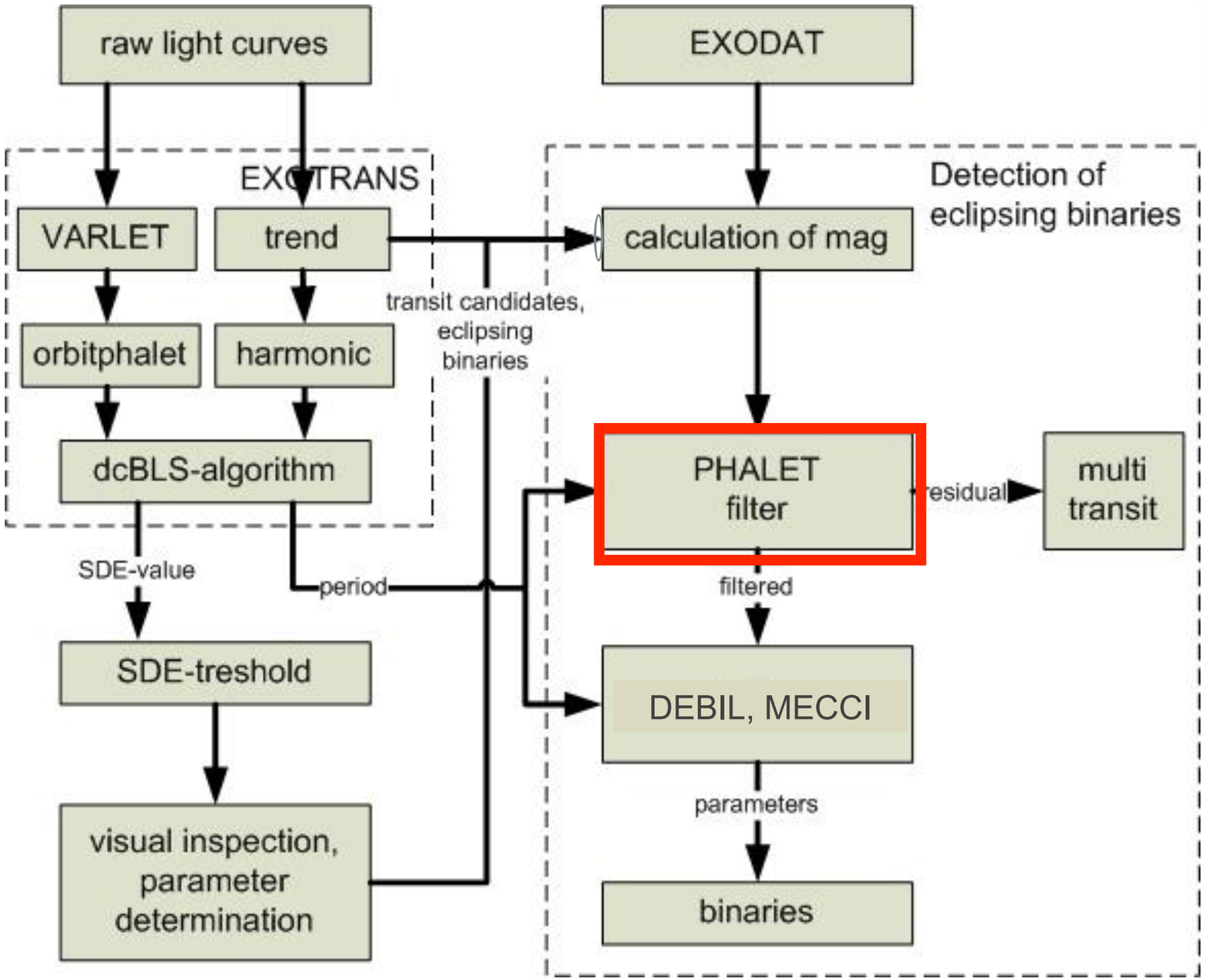


SD

not considered

obvious candidate

RIU exoplanet detection pipeline

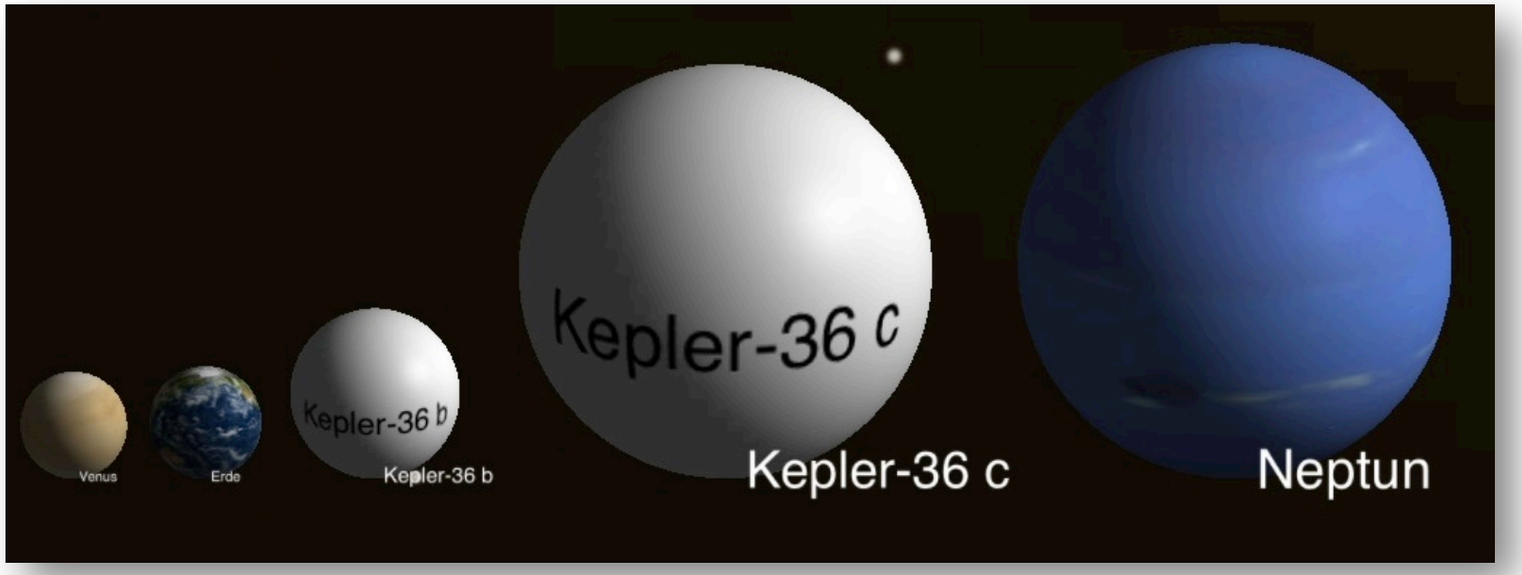


PHALET on Multisystem Kepler 36b,c

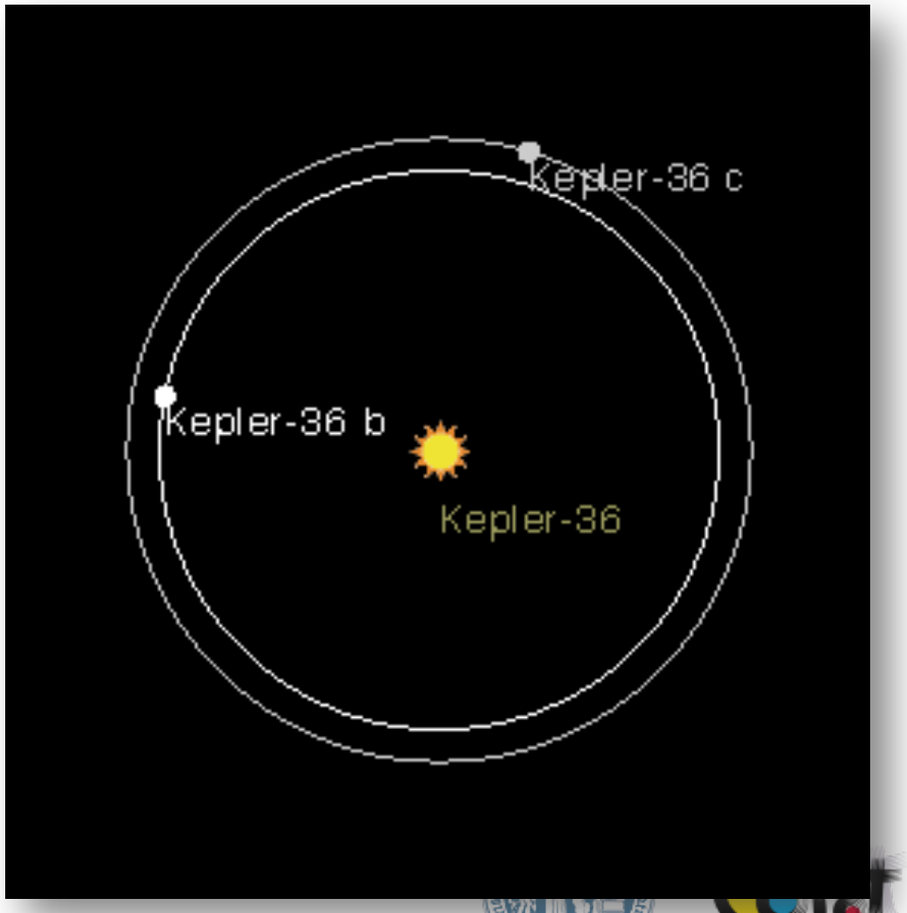
Carter et al. detected
Kepler 36c by transit and
Kepler 36b by Transit Time Variation (TTV)

They claimed that Kepler 36b can not be detected in transit because of strong TTV.

(Carter et al. Science 2012)

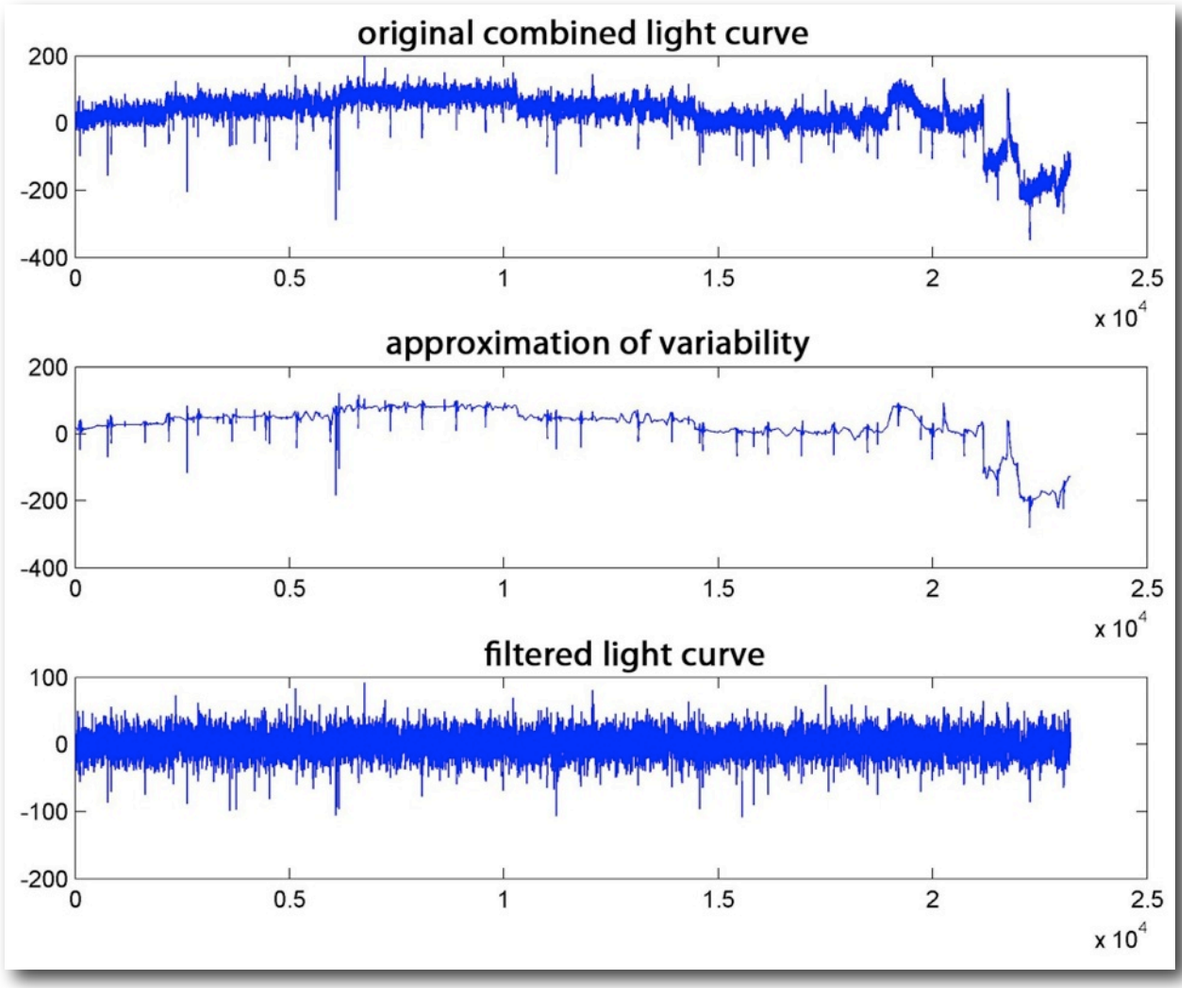


© Exoplanet App

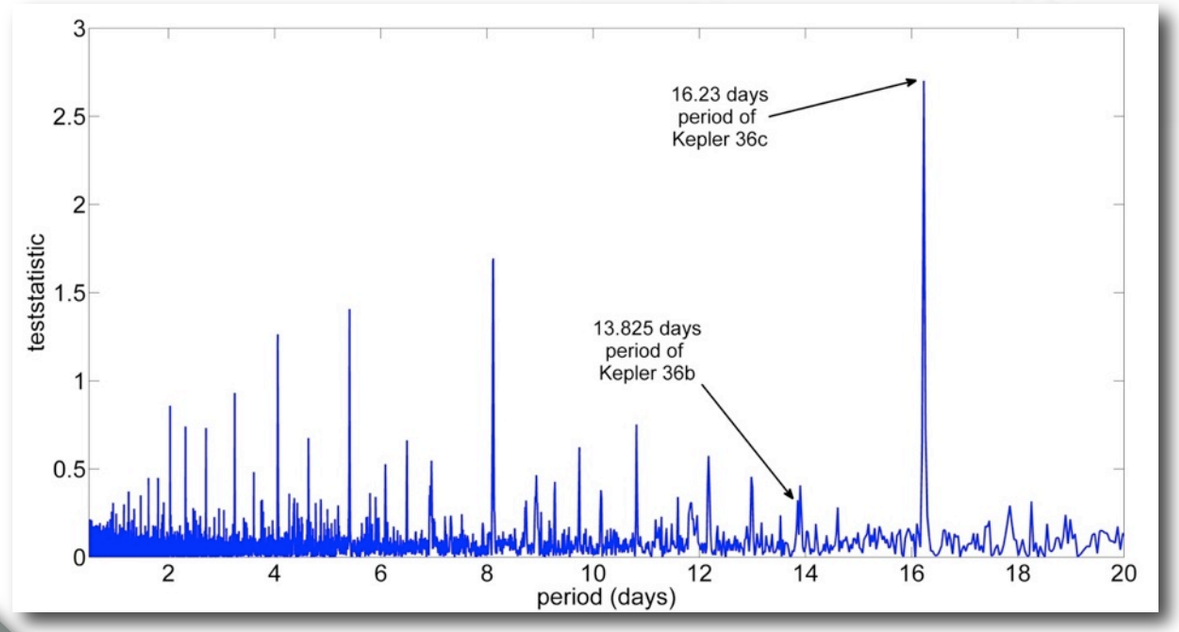


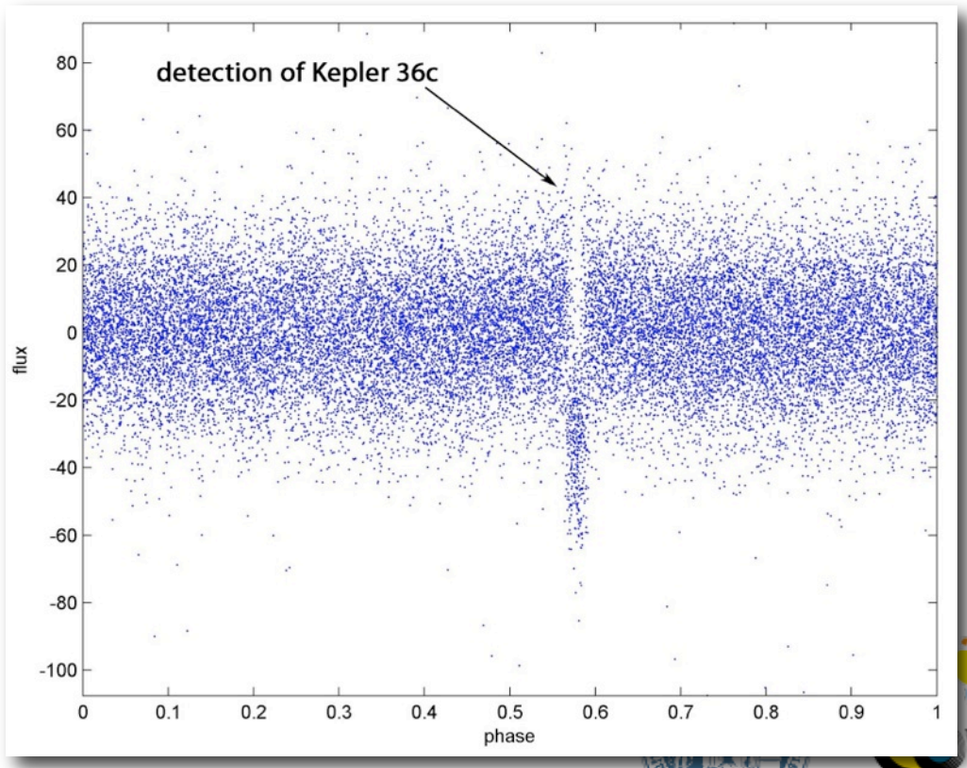
© Exoplanet App

PHALET on Multisystem Kepler 36b,c



original BLS spectrum

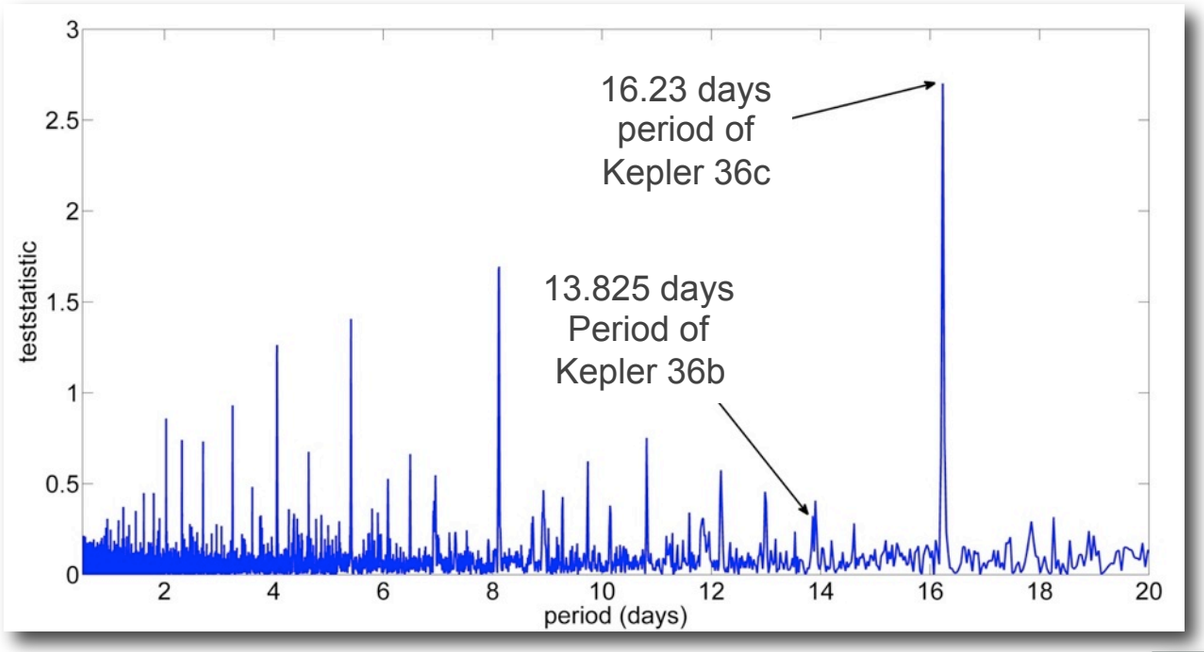




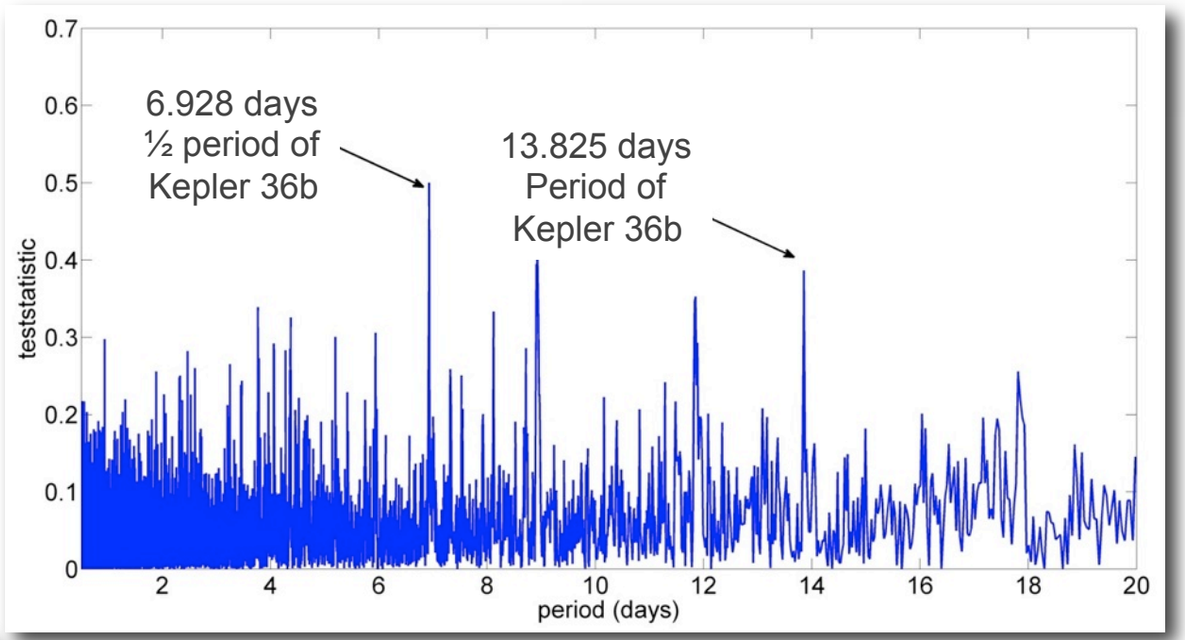
obvious detection of Kepler 36c by EXOTRANS

PHALET on Multisystem Kepler 36b,c

original BLS spectrum



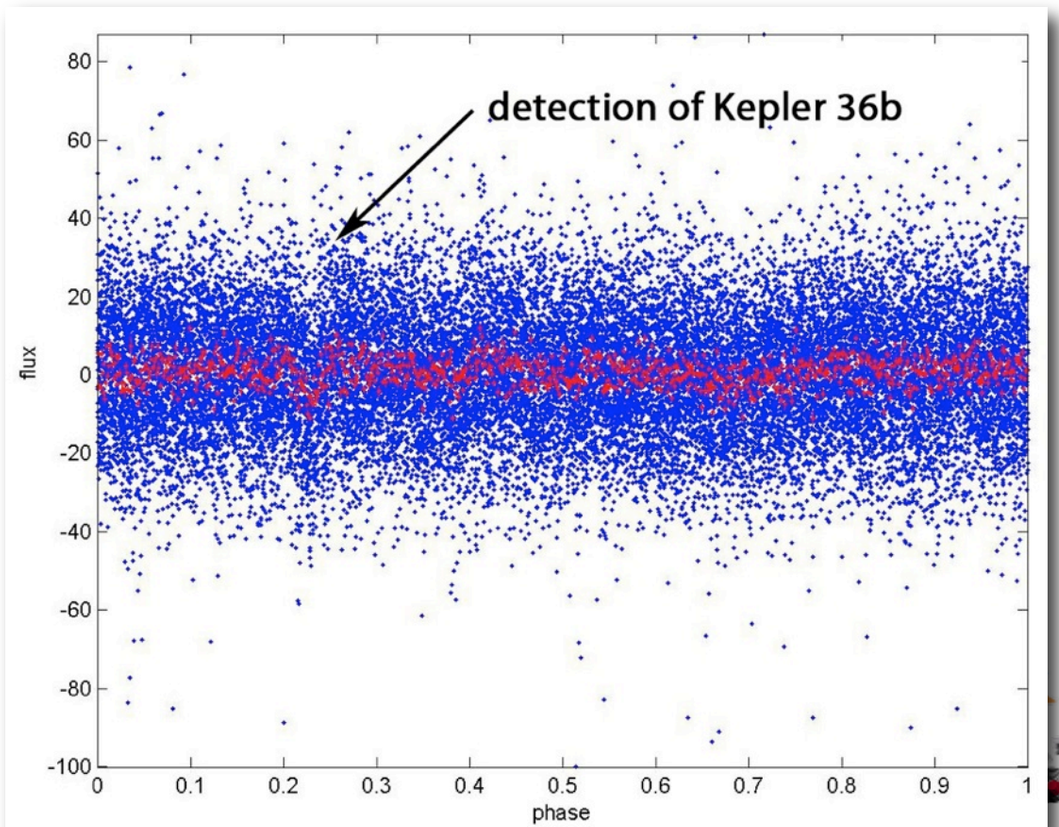
BLS spectrum after subtraction of Kepler 36c



Automatic detection of Kepler 36c and Kepler 36b by our CoRoT pipeline EXOTRANS.

- Using VARLET for filtering star variations and discontinuities.
- Detection of Kepler 36c by BLS algorithm.
- Kepler 36c transit subtracted from original light curve
- Modified light curve reanalyzed by EXOTRANS.

→ Detection of Kepler 36b without a priori knowledge of TTV.



Summary

PHALET applied to CoRoT and Kepler light curves:

- Separation of periodicities with known frequencies.

  →Complete separation of detected candidates in light curves.
  →Analysis of multi-systems

  →Reduction of disturbing signals with well known periods
  (e.g. Earth orbital period).

VARLET applied to CoRoT and Kepler light curves:

- Superior correction of variability, discontinuities and flares.

  →Faster automatic search; less false detection

  → Detection of more and fainter candidates.