WASP-19b

Winter 2010 Observations, Data Analysis and Issues

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WASP-19/b

- **The star WASP19**
  - Type: G8V
  - Magnitude V = 12.3
  - Teff = 5500K
  - M* = 0.95 Msol
  - R* = 0.93 Rsol
- **The planet WASP-19b**
  - Mp = 1.15 Mjup
  - Rp = 1.31 Rjup (transit depth ~2%)
  - Period = 0.7888399 days

Observed from April 30th to May 23rd 2010
➔ detect secondary transit, or put a limit to its depth

WASP-19/b Observations

- **Observing conditions**
  - temperatures from (approx.) -55C to -75C
  - sun elevation from -35 to -7.6 degrees below horizon
  - optics frosting occured repeatedly but not systematically (M1 only or M1 and M2)
  - desnowing was done almost every day (use of a special brush)
  - 130 sec. exposure time
- **Data processing**
  - on-site data reduction (raw data transmission is impossible form Dome C)
  - 6TB data available in Nice from mid-January

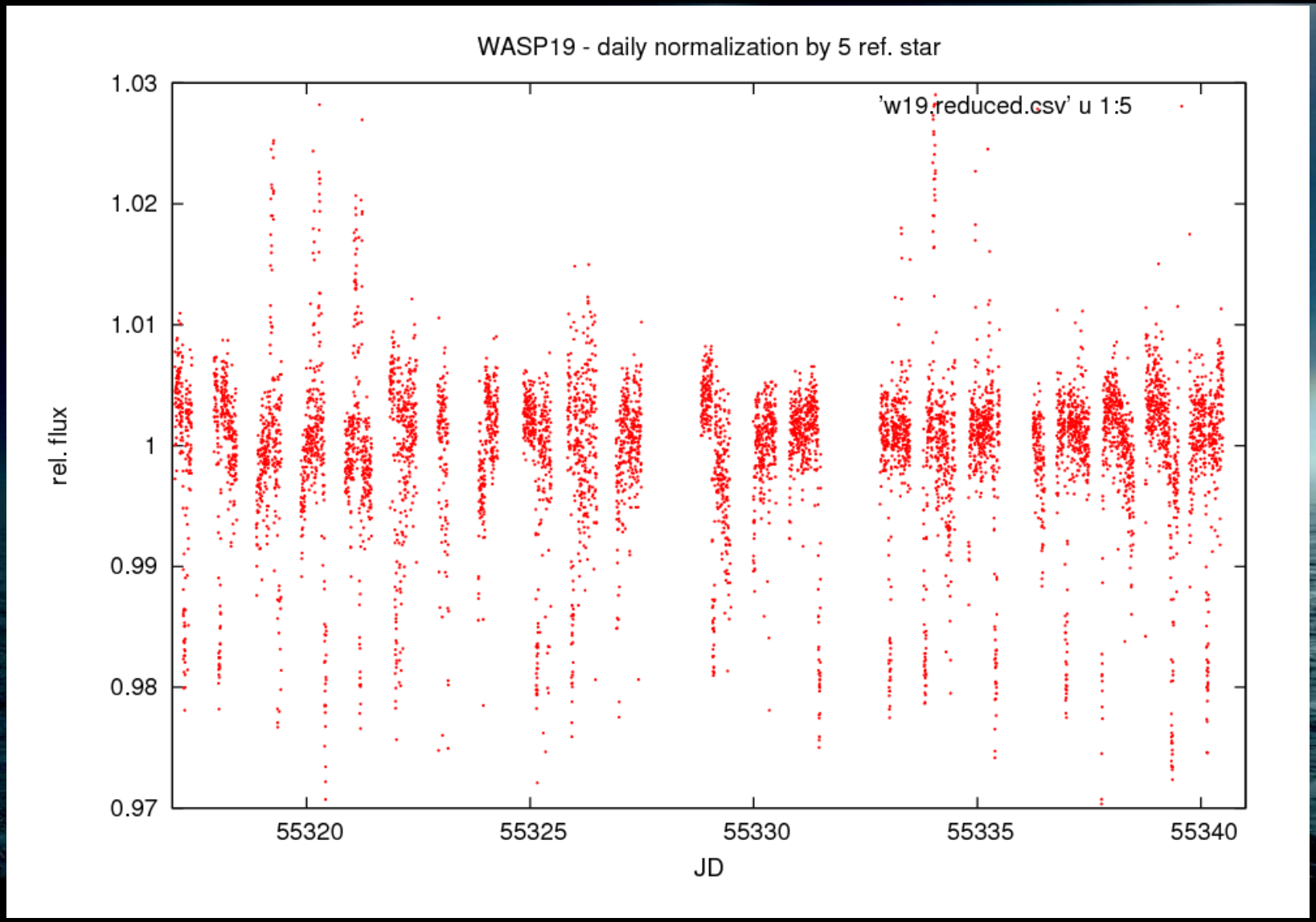
First data processing attempts

- **Data processing: daily calibration**
  - Each night is calibrated using « best reference stars » : only reference stars that improve the out-of-transit LC RMS are kept

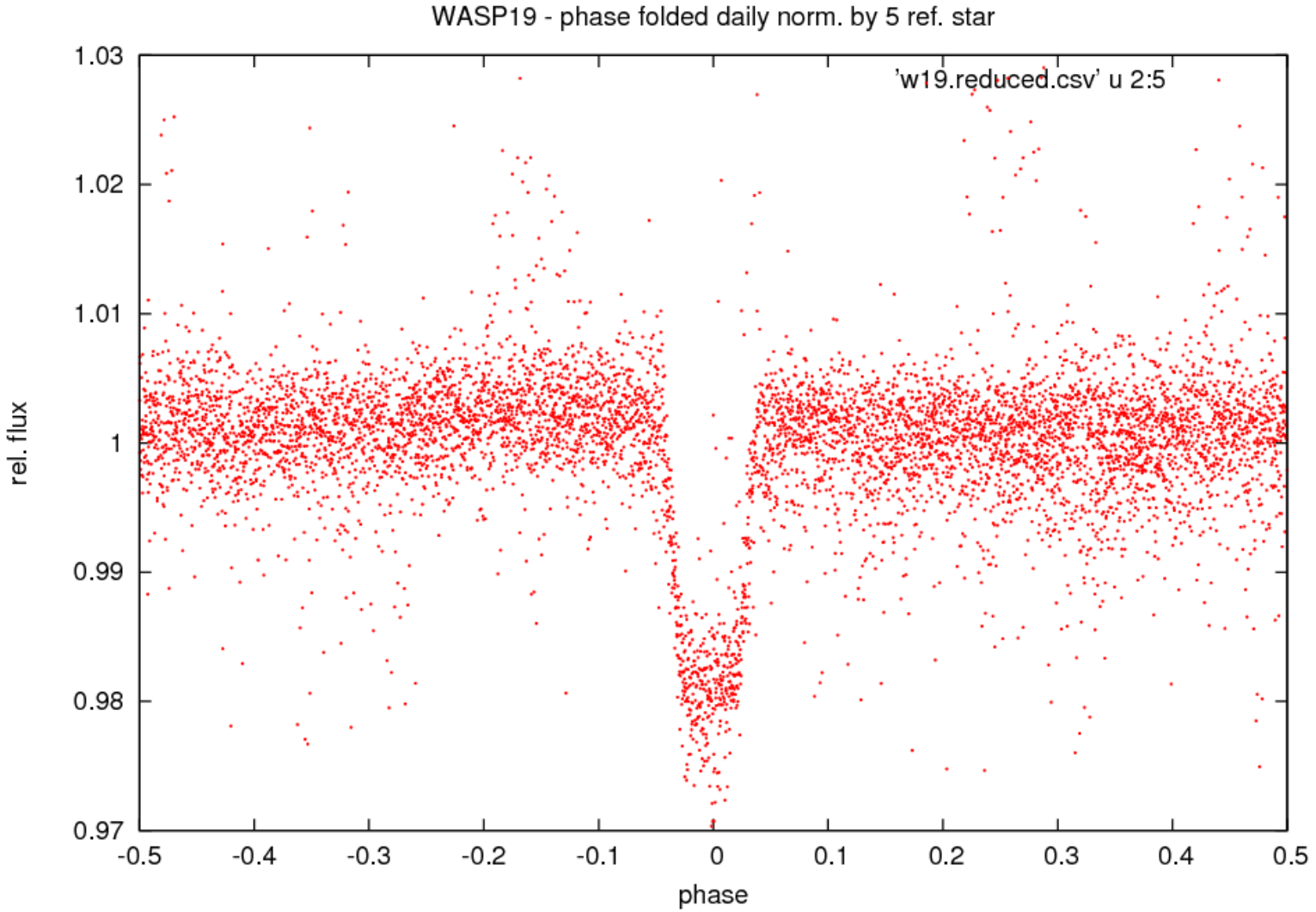
  ➔ Good for transit detection

  ➔ problem: does not provide accurate absolute photometry (WASP19 has a significant periodic variability)

Daily normalization (5 ref. stars)



Phase folded (daily normalization)



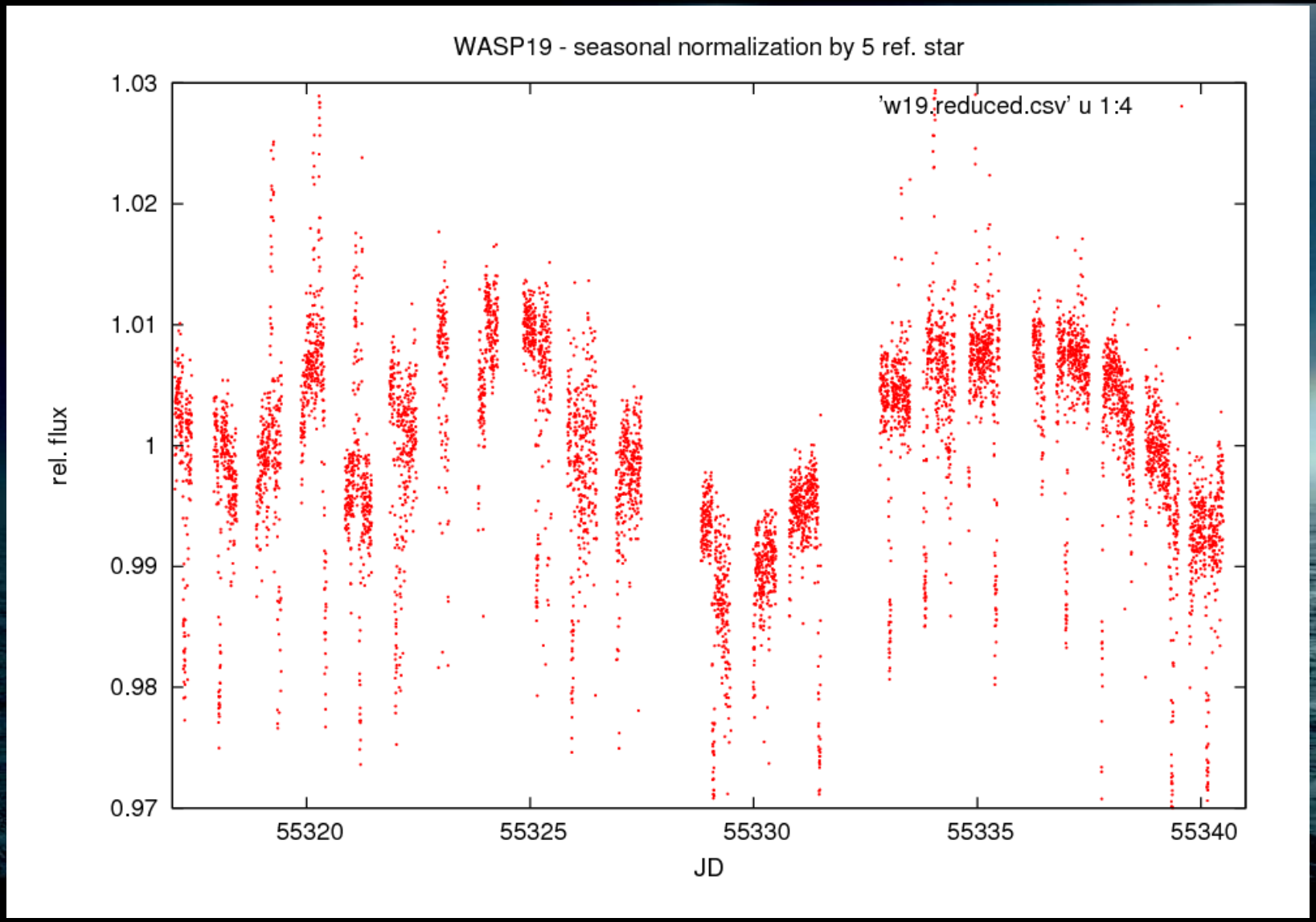
Seasonal normalization

- **Seasonal calibration**
  - Each night is calibrated using « fixed reference stars » throughout the observing period (can be chosen using the same criteria as for multiple ref. stars)

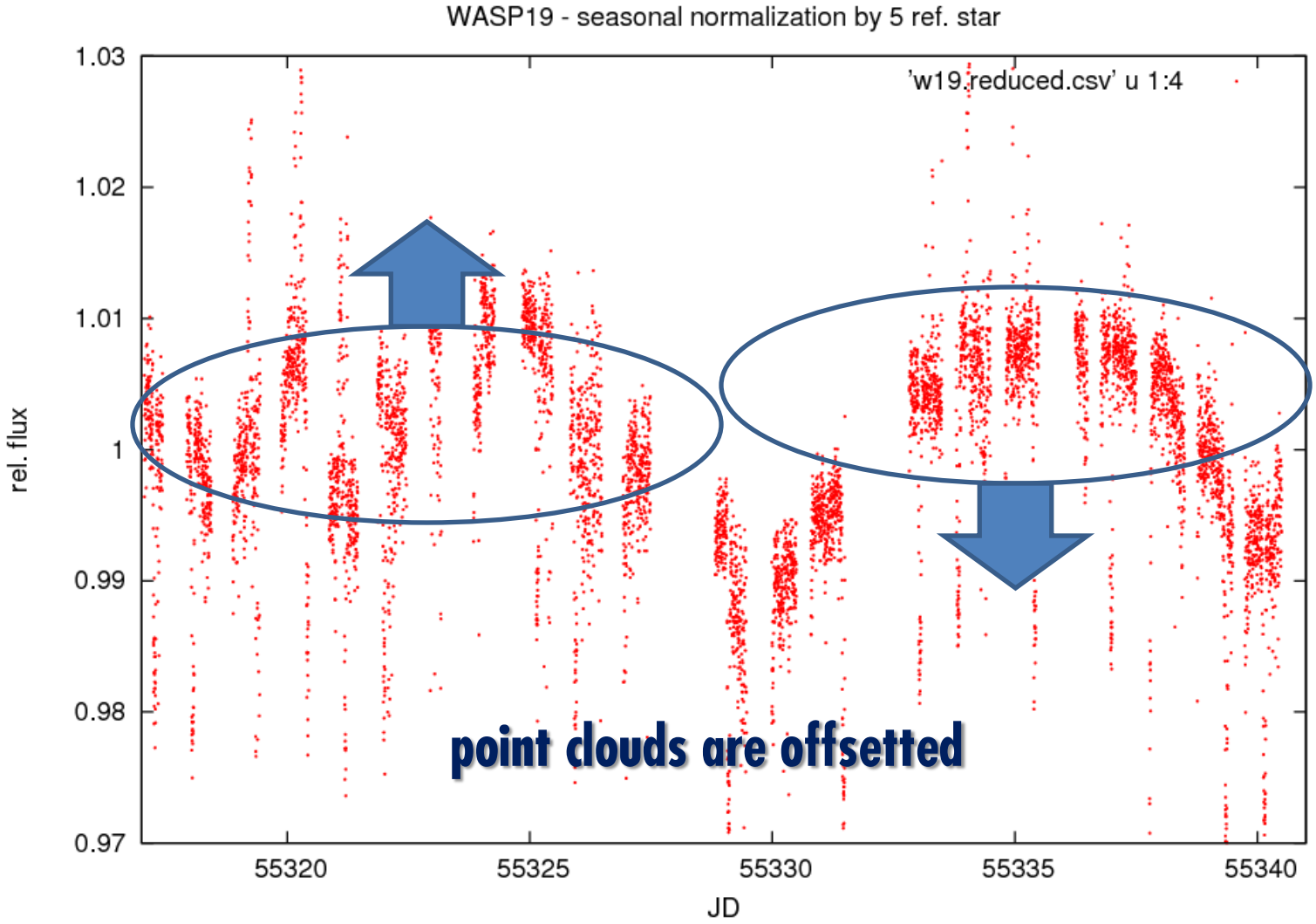
  ➔ Takes into account star variability

  ➔ problem: if we take only one reference star at a time, and compare LC calibrated with different stars, there are variable offsets of the order of about $\lesssim 1\%$

Seasonal normalization (5 ref. stars)

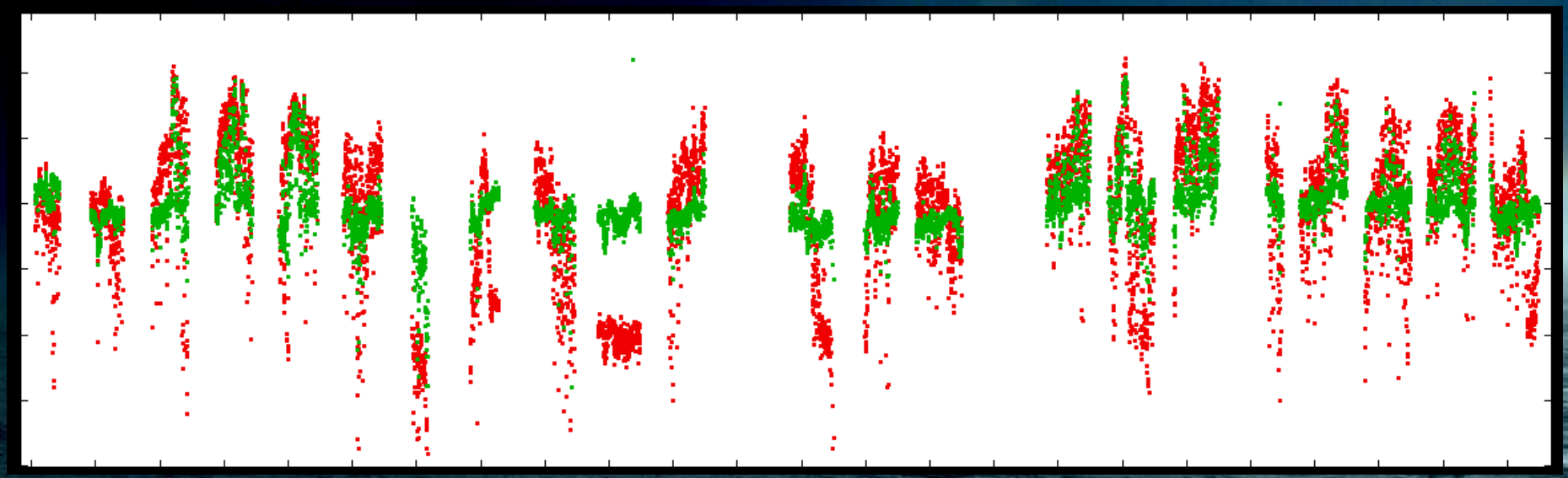


Seasonal normalization (1 ref. star)

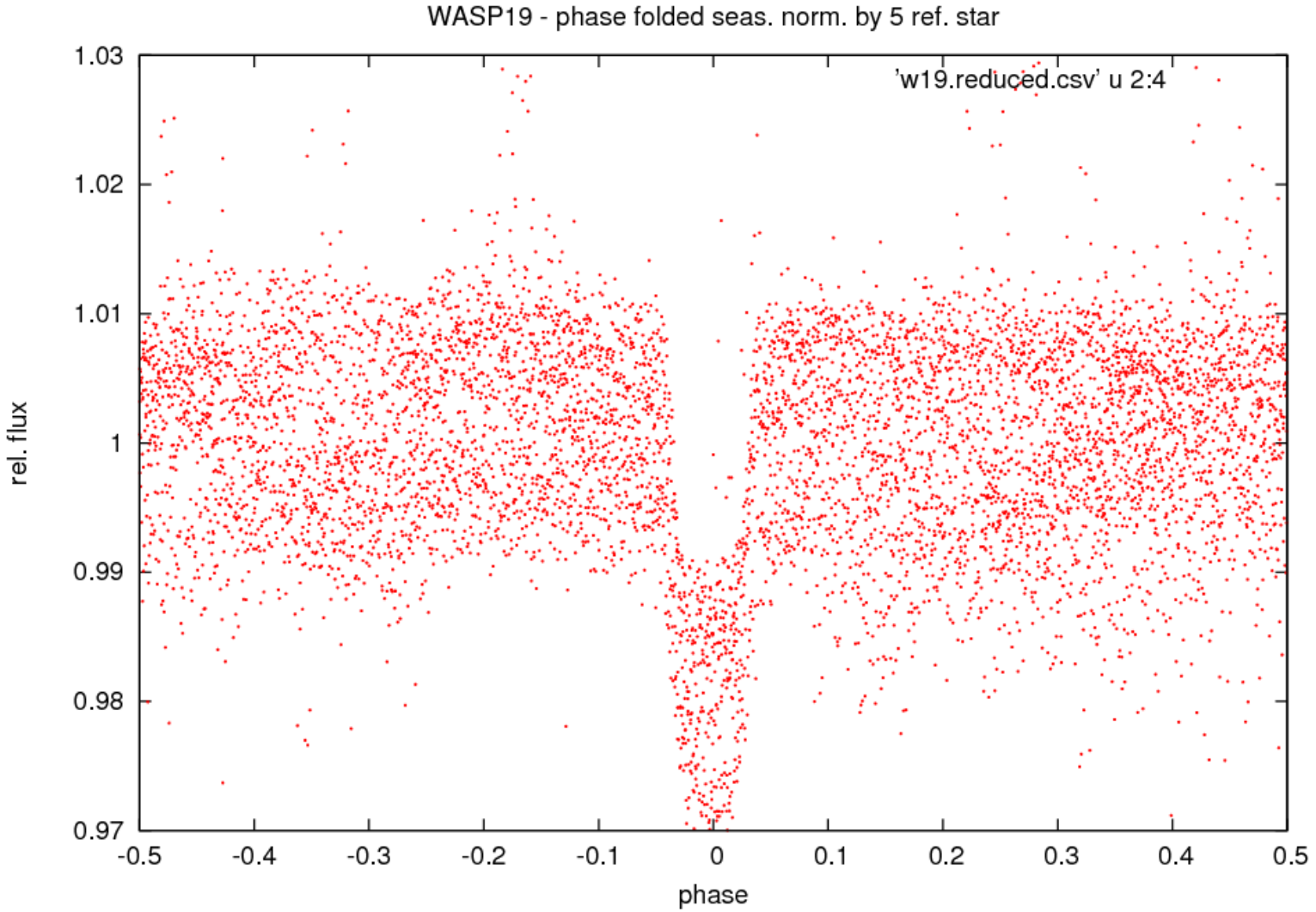


Seasonal normalization (1 ref. star)

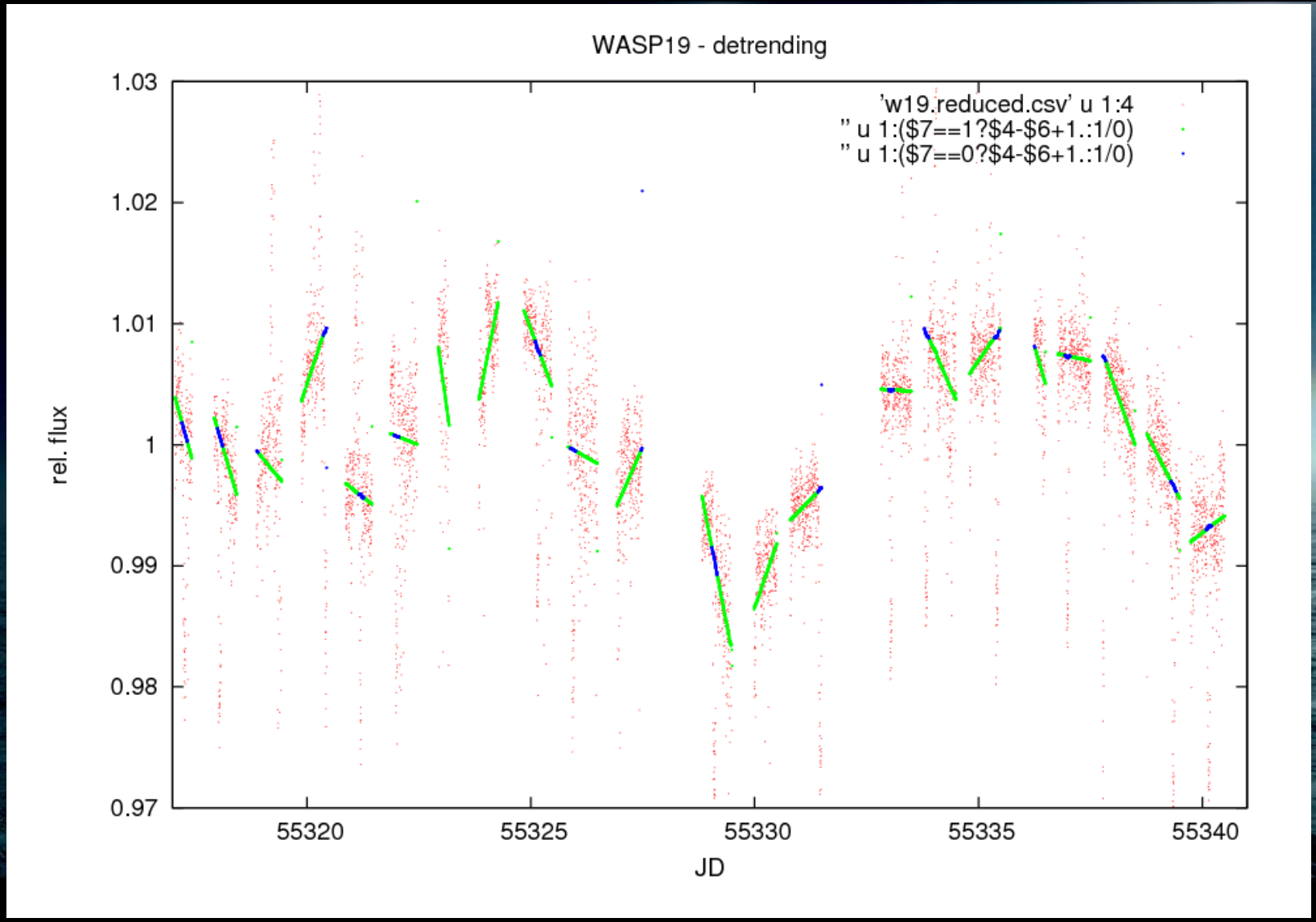
- Red and green are calibrated with a different star for the entire WASP-19 observing period



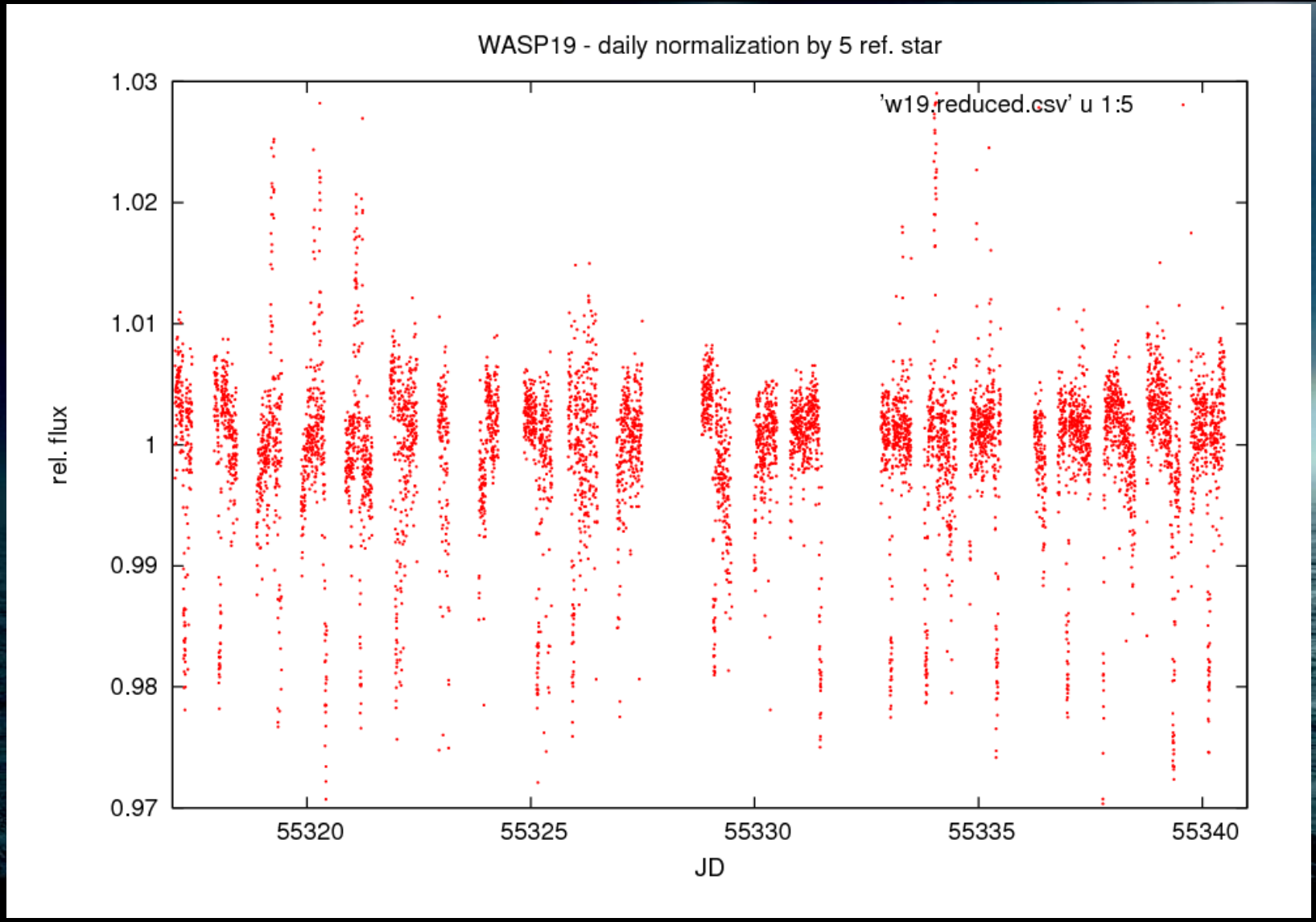
Phase folded (seasonal normalization)



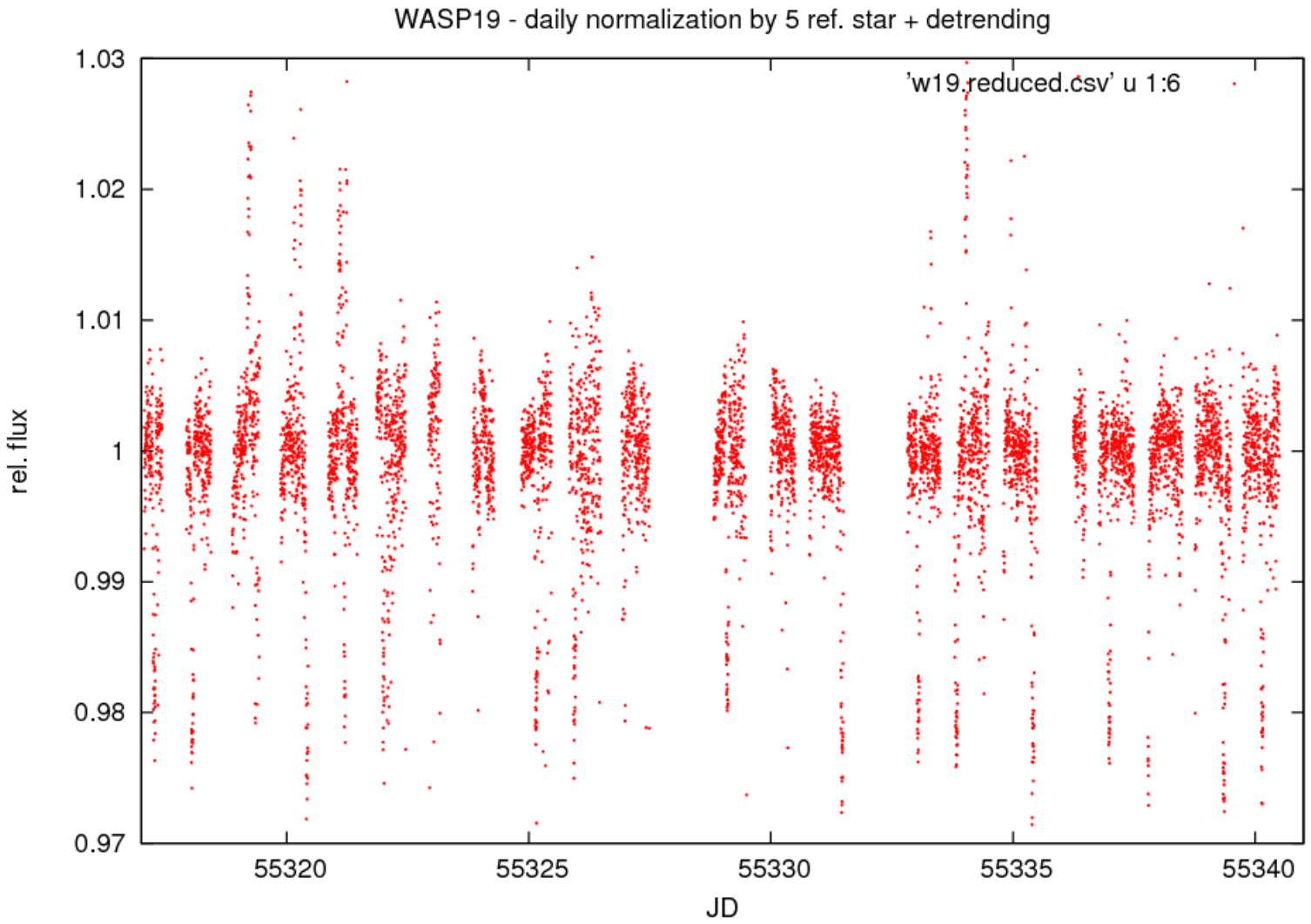
Detrending


WASP19 - detrending
'w19.reduced.csv' u 1:4
'' u 1:($7==1?$4-$6+1.:1/0)
'' u 1:($7==0?$4-$6+1.:1/0)
rel. flux
JD
1.03
1.02
1.01
1
0.99
0.98
0.97
55320
55325
55330
55335
55340

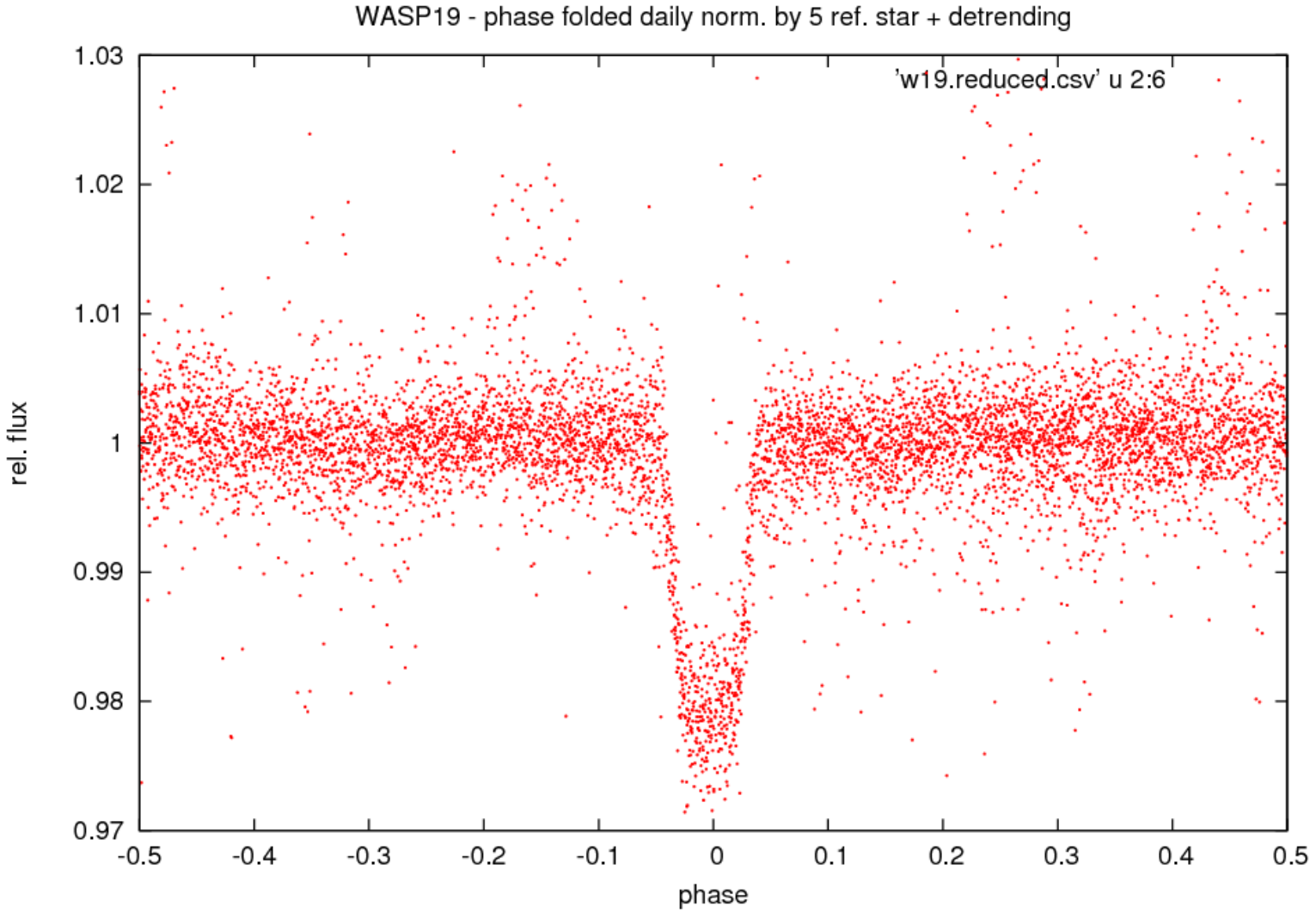
Daily normalization before detrending



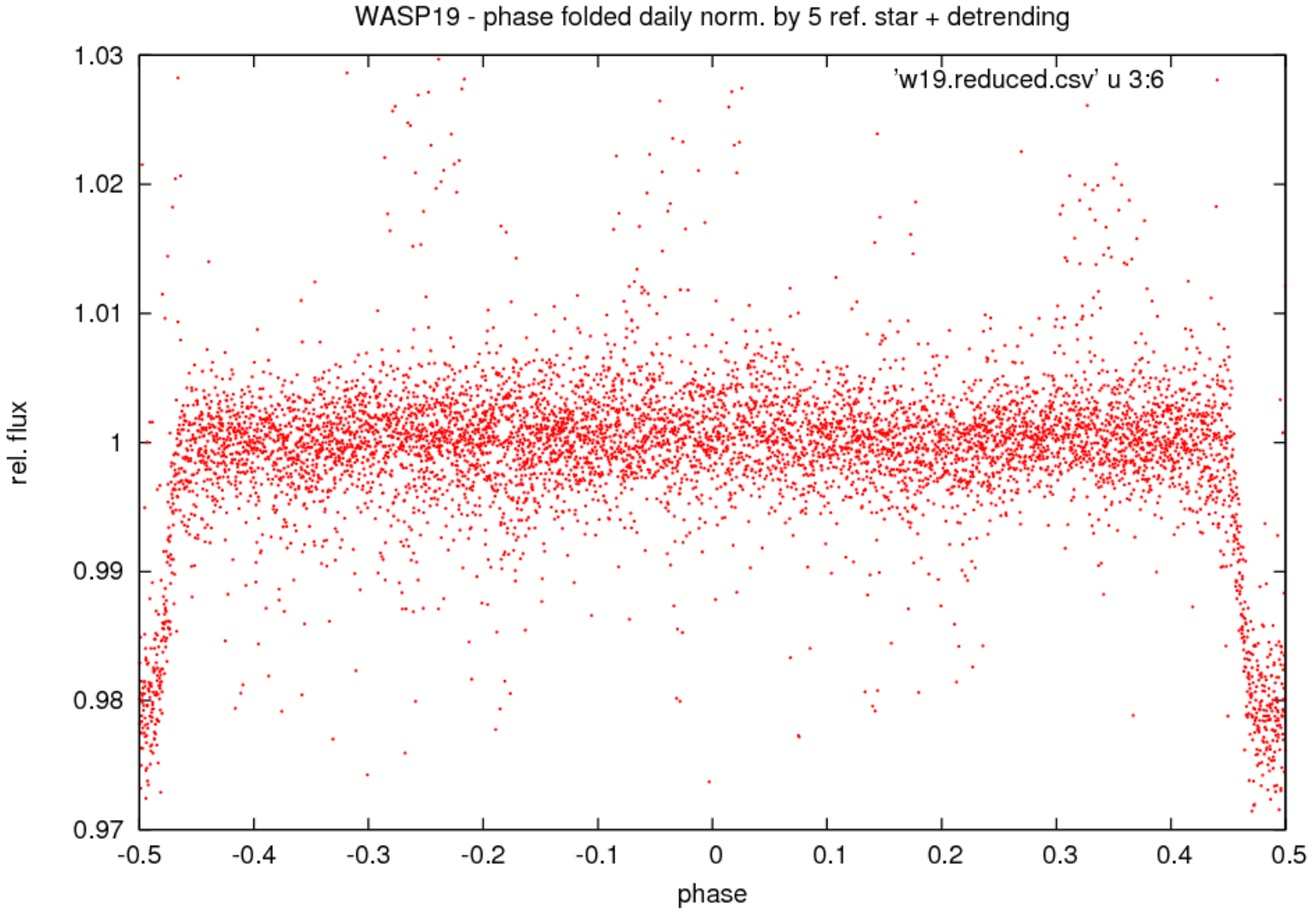
Daily normalization after detrending



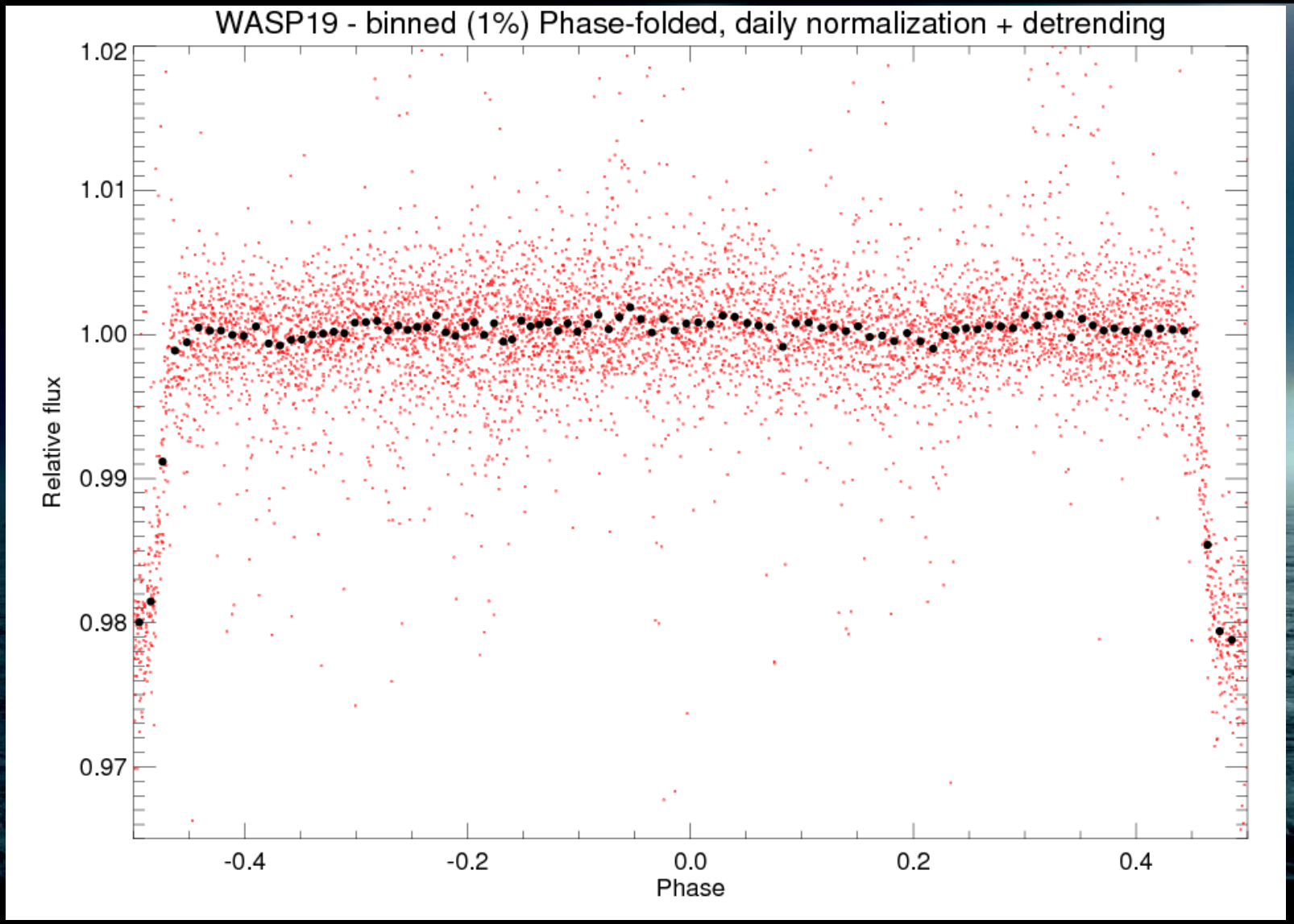
Phase folded (daily normalization + detrending)



Phase folded (daily normalization + detrending)

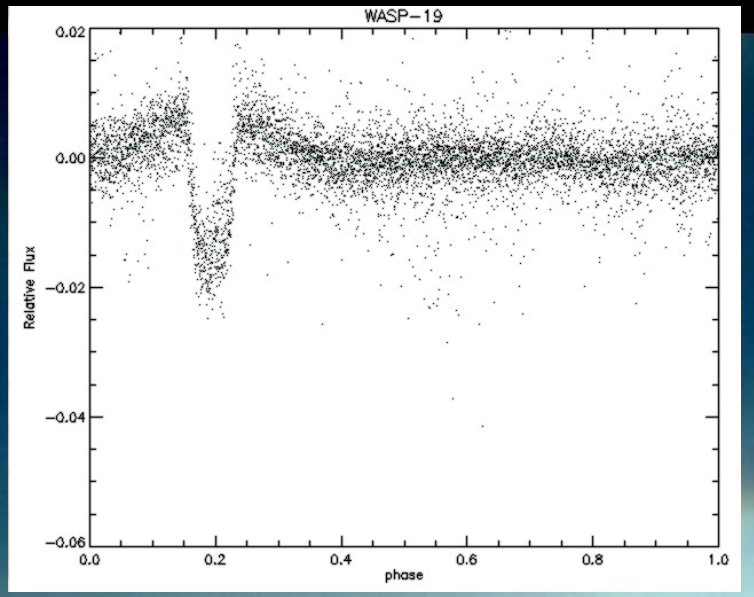


Binned 1% (daily normalization + detrending)



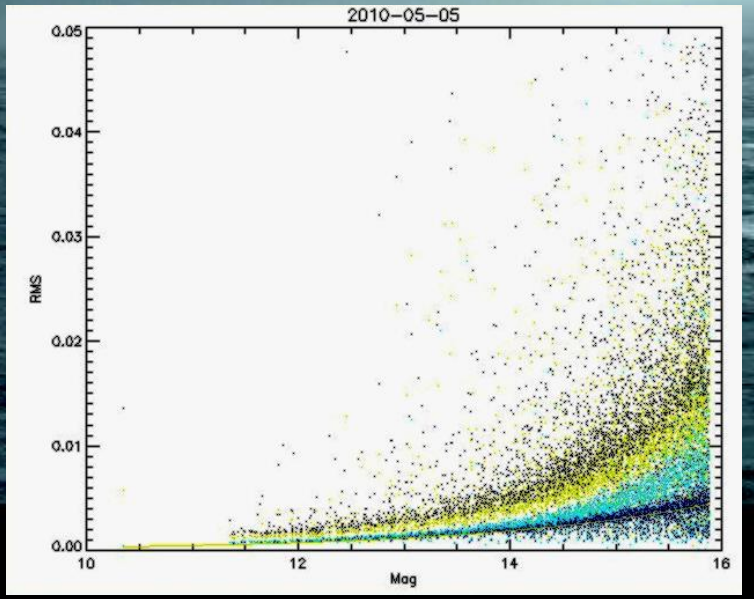
Applying SYSREM

- Daily calib., SYSREM applied on each night



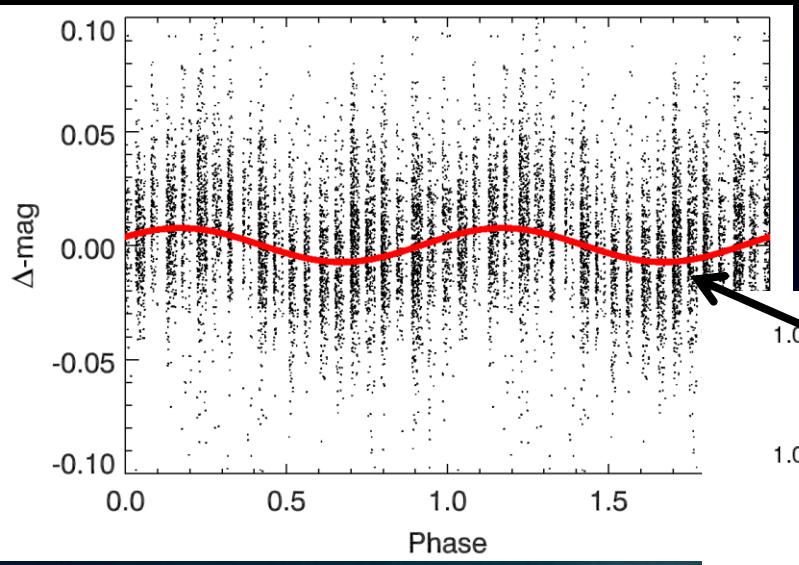
- **Global calibration on raw, uncalibrated data**
  - SYSREM was efficient at removing systematics, but WASP-19 transit was strongly affected

- **On calibrated data**
  - not much gain (< factor 2, yellow dots, 100 iterations)
  - ➔ to be deeper investigated (+Trend Filtering Alg.?)



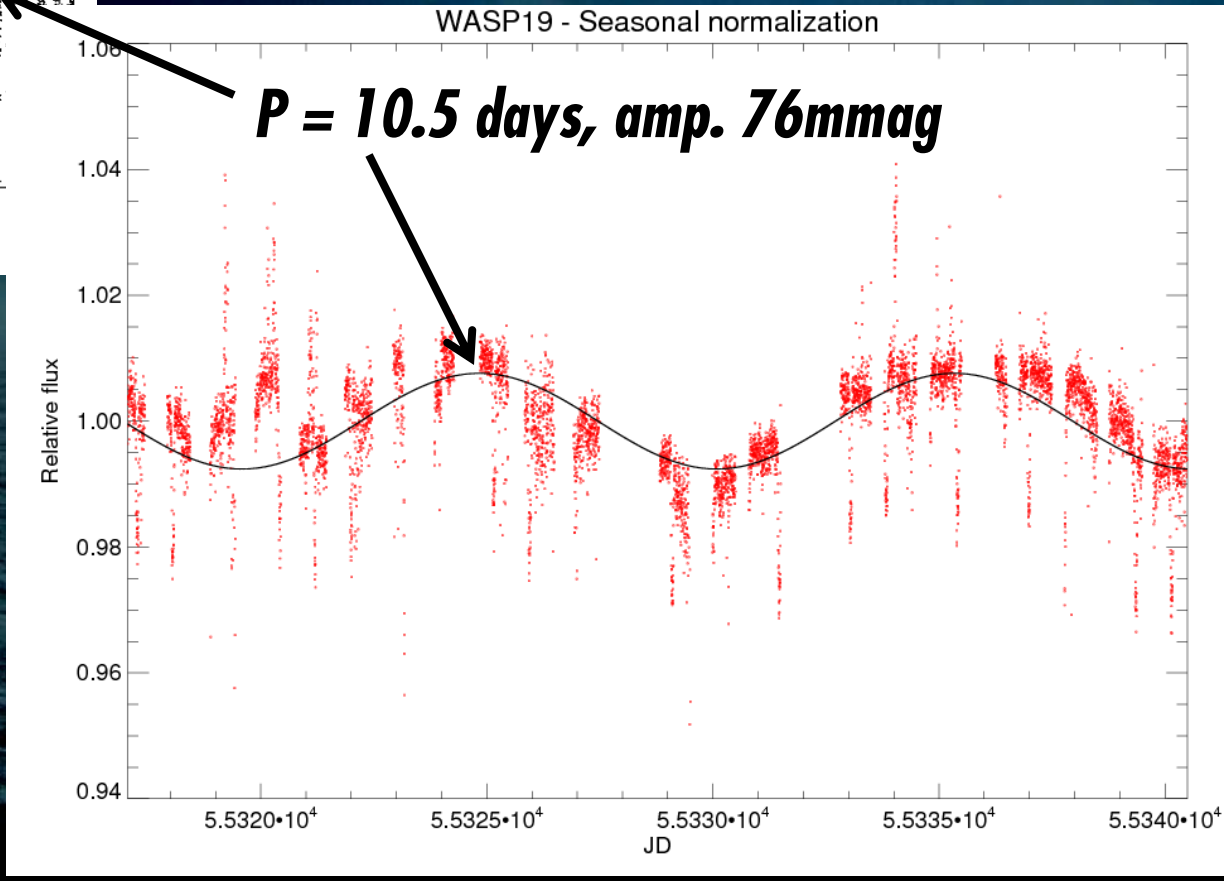
Upper black is measured, lower black is photon noise estimate only, light blue with added background ▶

WASP-19 Variability



◀ Hebbs et al. 2010





Problematic issues

- **Instrument and observations flaws**
  - unexplained ~fixed crater-like structure (modulation?) at the center of the images

    (known issue since Nice tests in 2009)
  - baffling was probably neglected ➔ stray light turns out to be a bit problematic
  - flats strategy and procedure are probably not optimal

    (also a consequence of the above item)

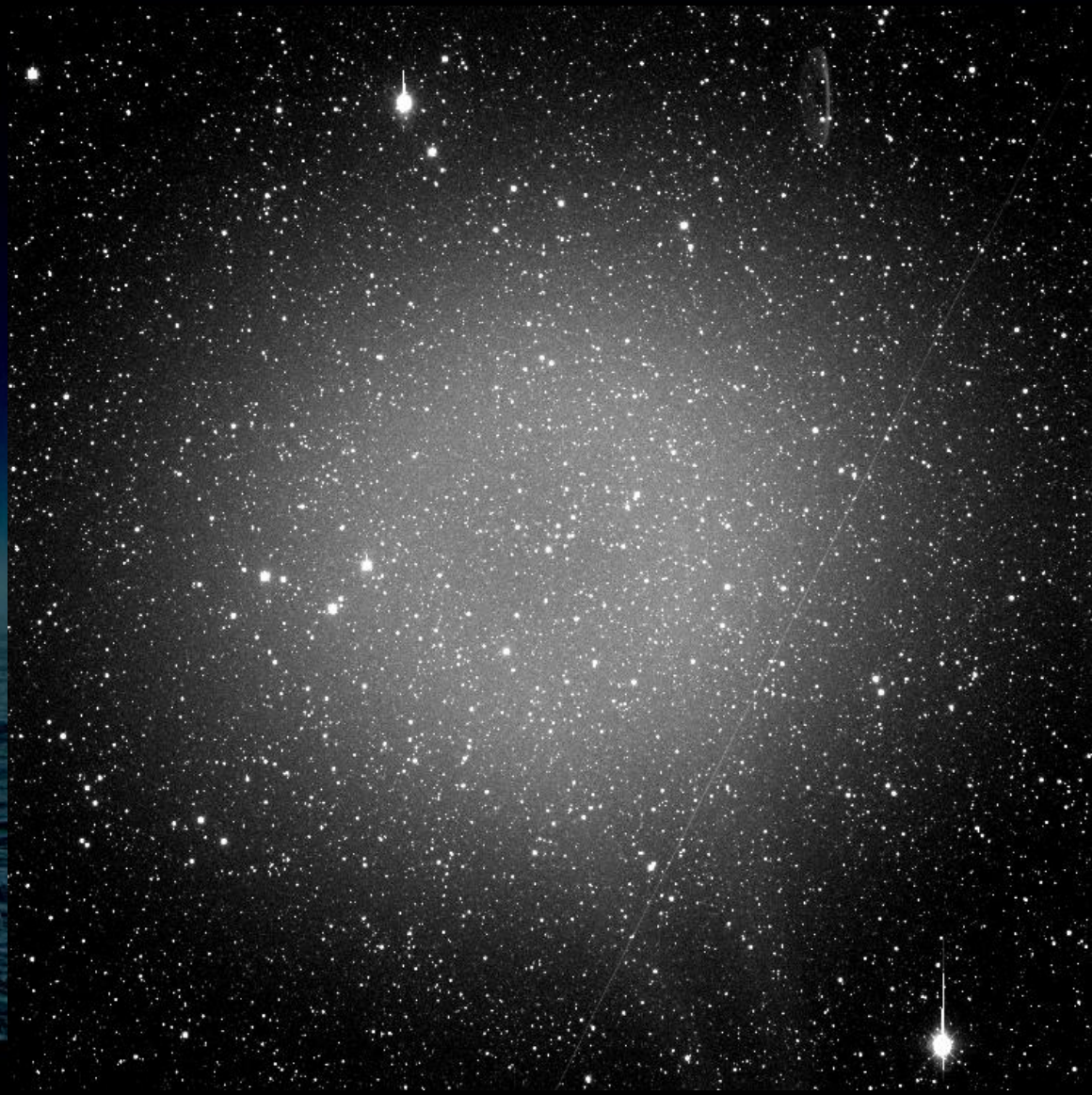
Crater-like structure

- *Amplitude is about 40% edge-to-center (from min. bkg. intensity)*

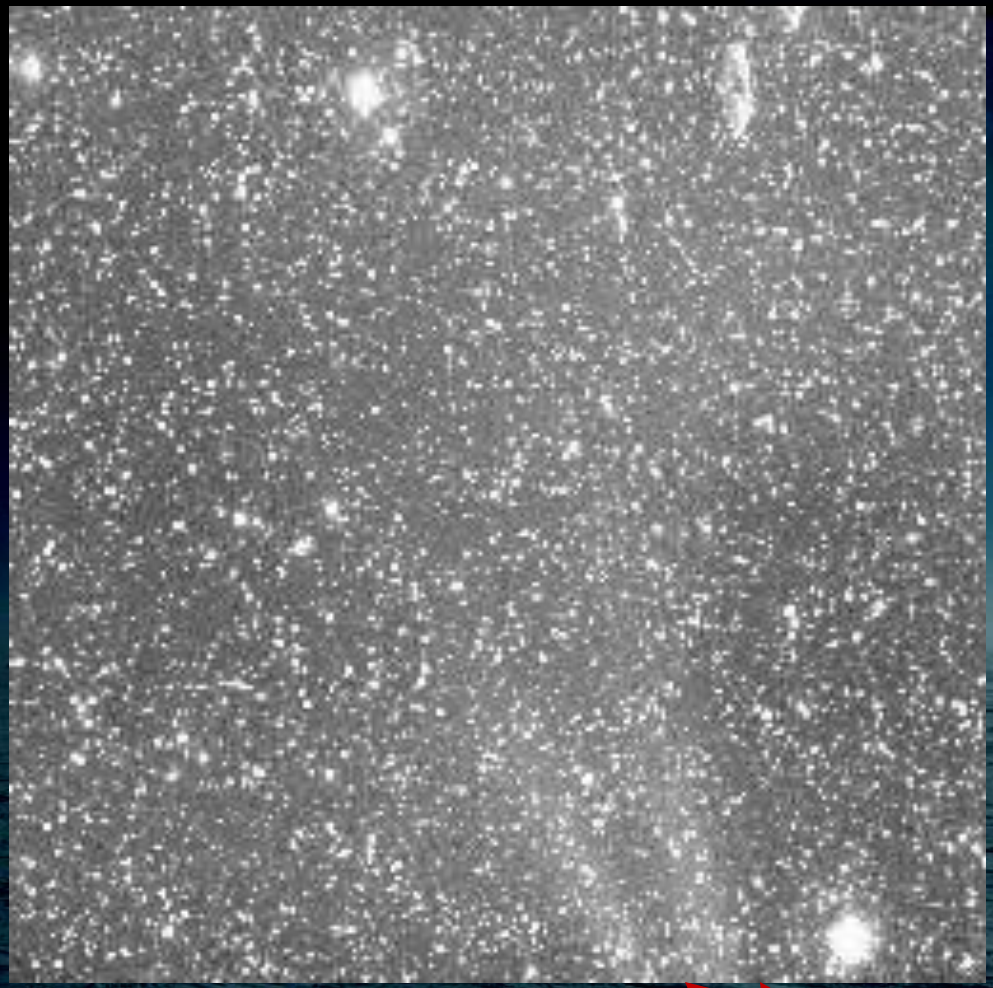
- *Not predicted by optical design*
  - ➔ *not vignetting, not a ghost*
  - ➔ *optical coatings?*

- *Probably a modulation*
  - ➔ *need some additional on-site tests*

- *Fixed pattern?*



Flats



Example of a flat sequence

- *Problem: flats are not done the same way, or even not done systematically each night*

- *A « master flat » is constructed from few best flats during the observation of WASP19*

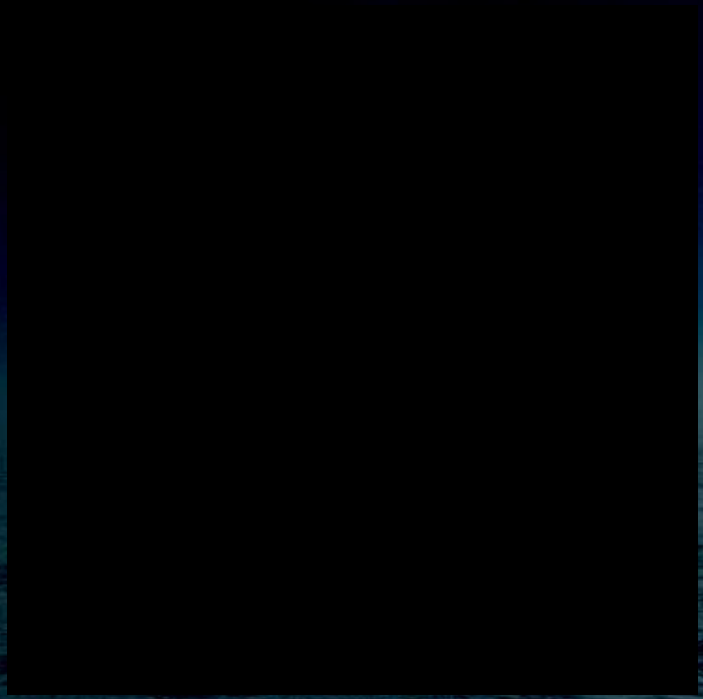
➔ *flats may vary from one night to the other*

Bright streaks

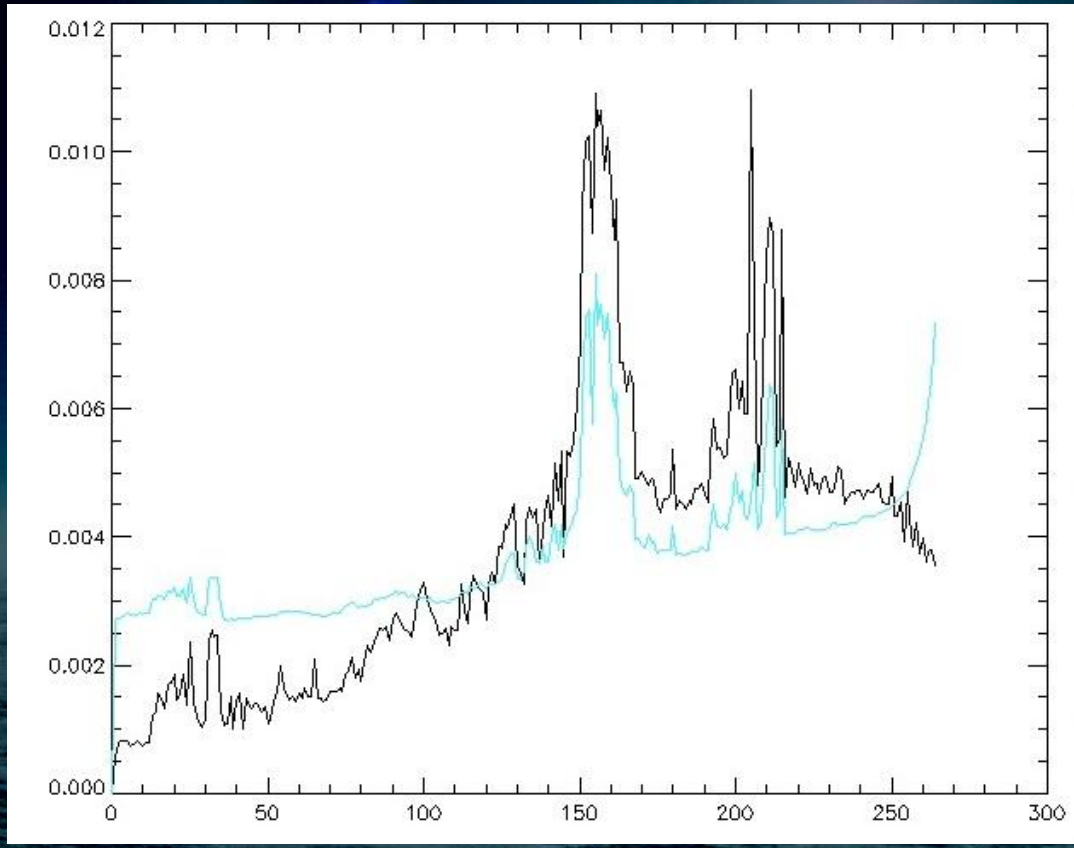
(bright star reflection)

Next steps

Movie showing one night sequence with constant background subtracted ▼



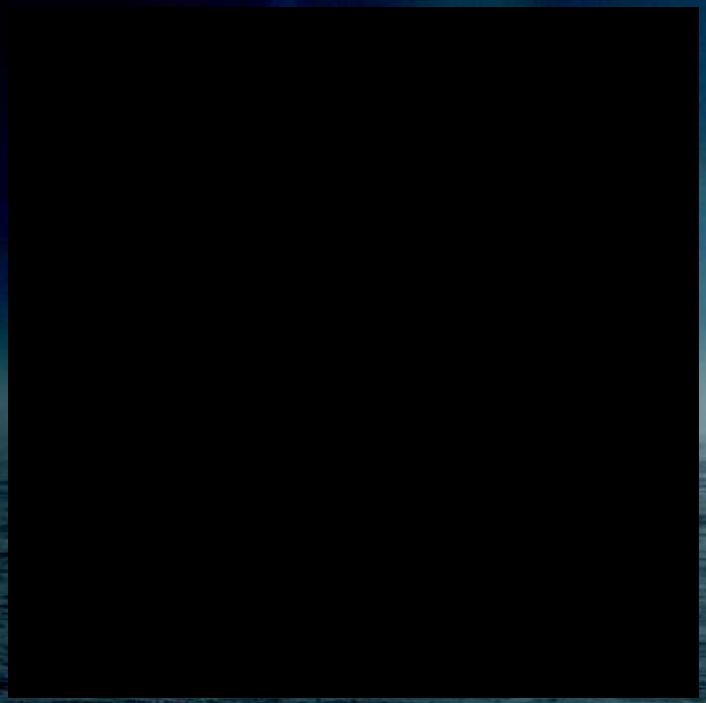
...See the existence of a fixed(?) pattern.



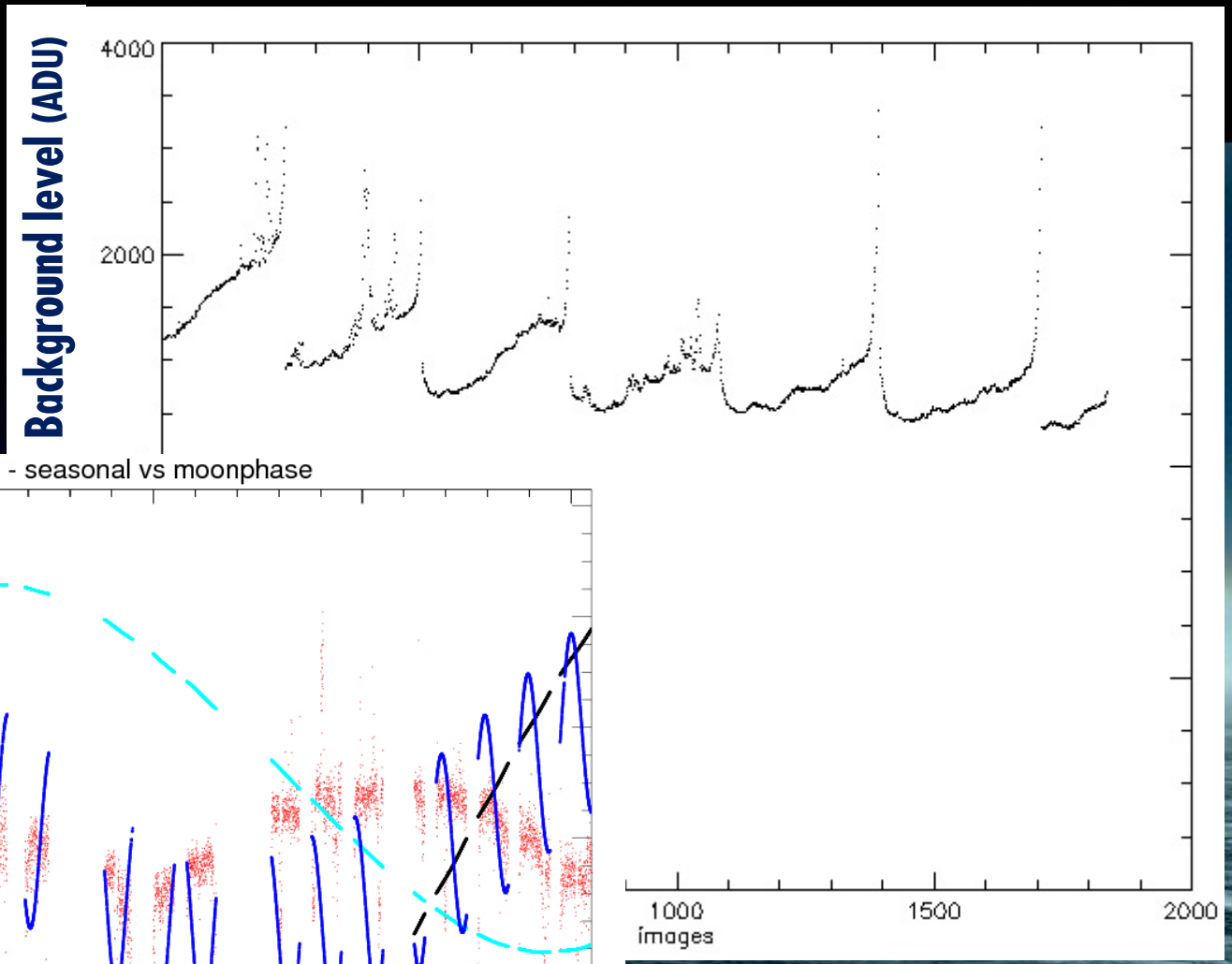
▲ Correlation between image background level and « pattern » intensity

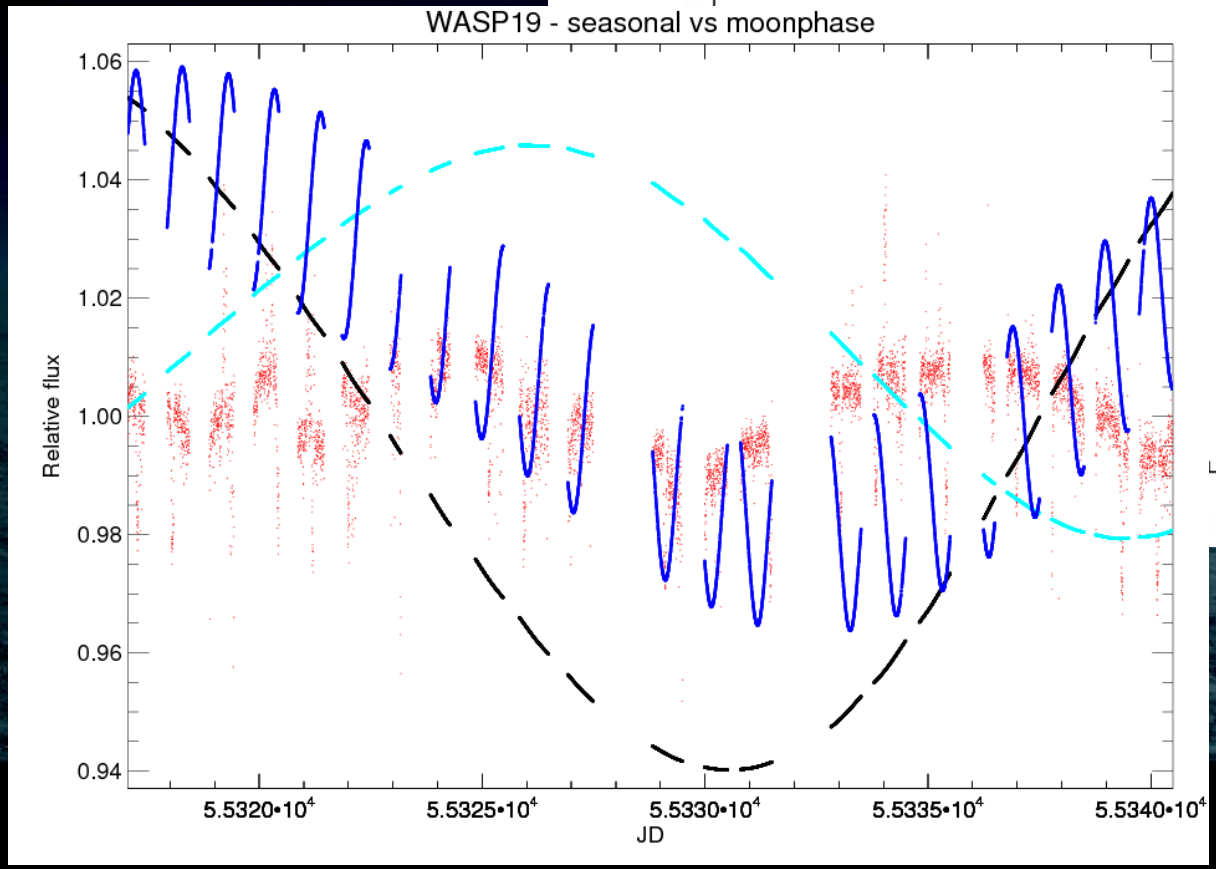
Next steps

Movie showing the same sequence with estimate of the « pattern » subtracted



Next steps


Background level (ADU)
4000
2000
1000
1500
2000
images


WASP19 - seasonal vs moonphase
Relative flux
1.06
1.04
1.02
1.00
0.98
0.96
0.94
5.5320•10^4
5.5325•10^4
5.5330•10^4
5.5335•10^4
5.5340•10^4
JD