Circumstellar matter around RR Lyrae stars

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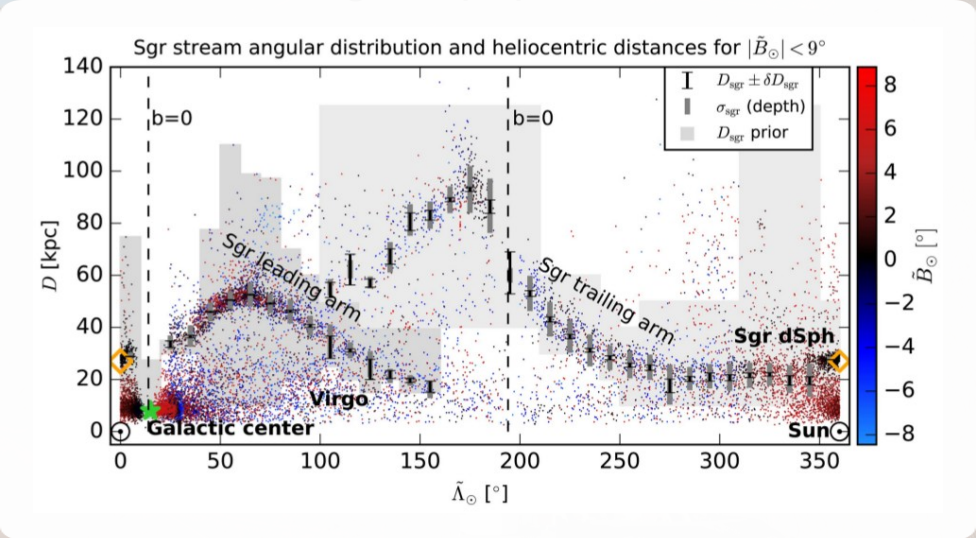
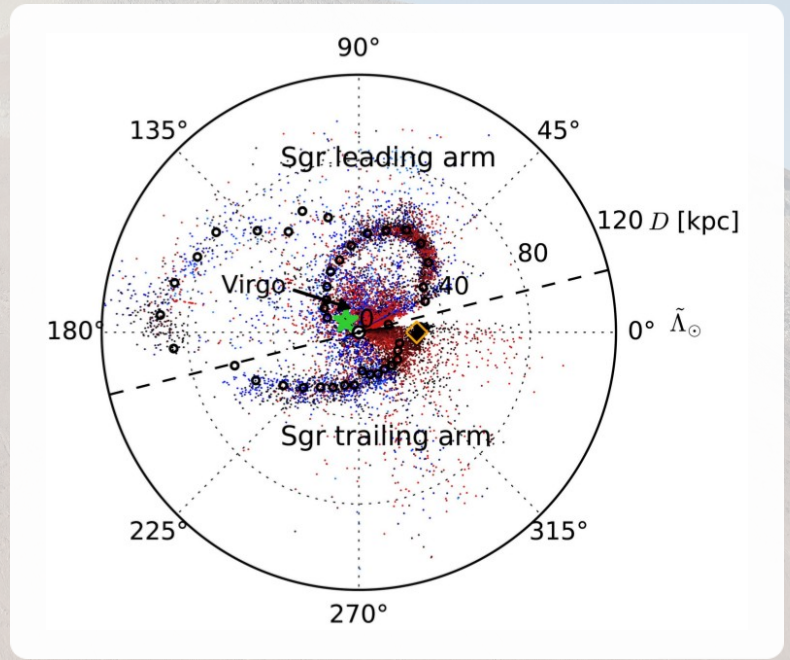
RR Lyrae stars: excellent tracers of Population II

Easy to find:

- bright (40 - 60 L_{Sun})
- characteristic light curve
- tracing old populations





Hernitschek+2017

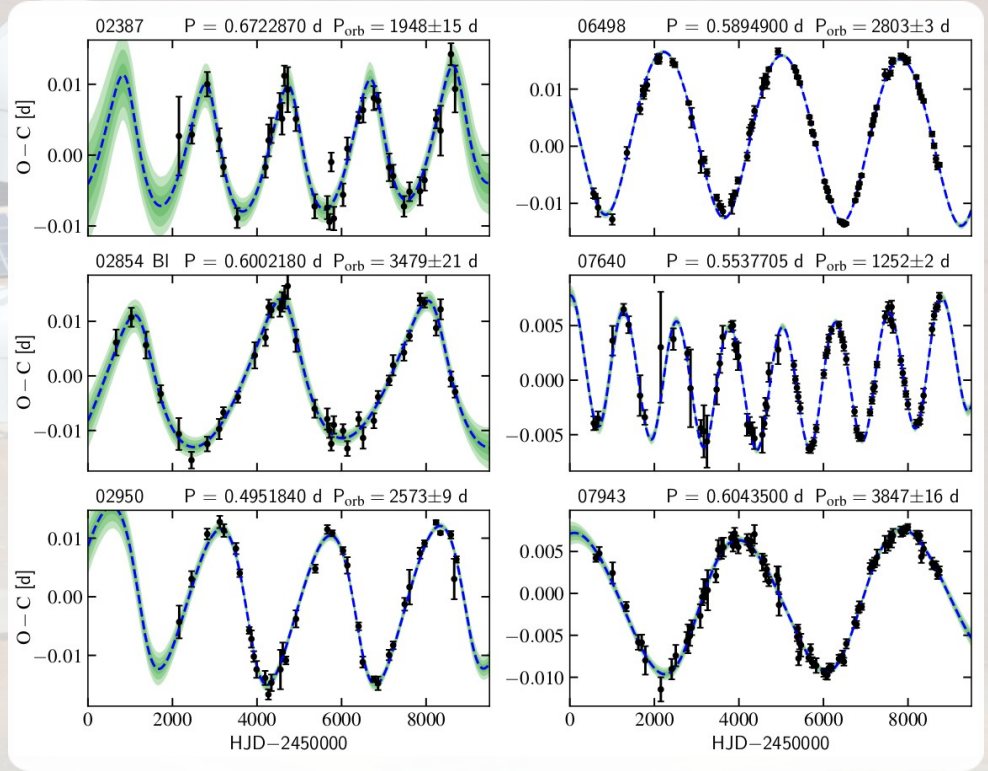
Search for binary RR Lyrae

Visually inspected:

– O-C of 27,480 OGLE RRab

– with LCs (folded and unfolded)

– 87 binary candidates (Hajdu+2021)



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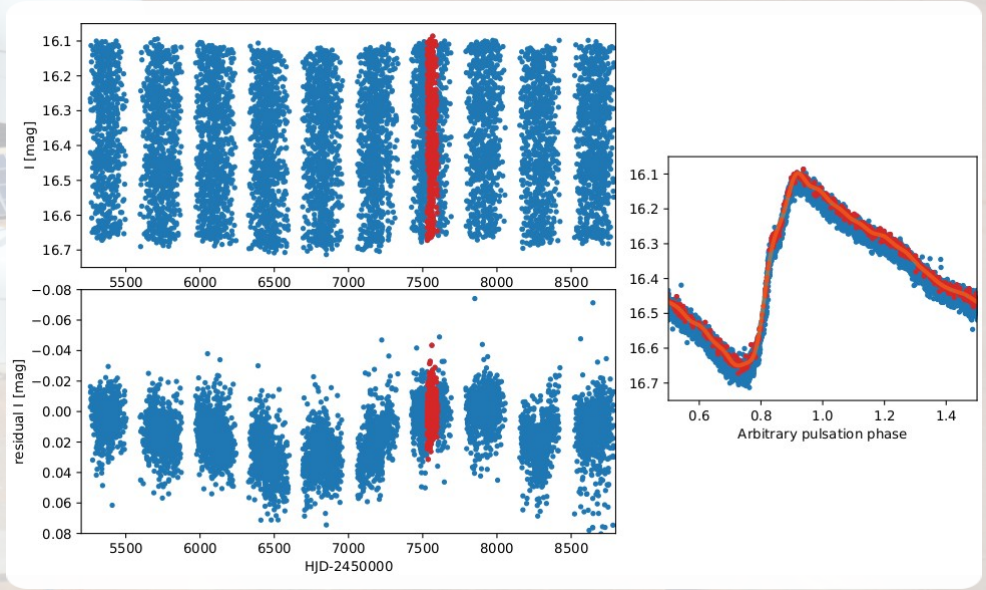
Light-curve anomalies:

– some RR Lyrae change mean brightness with time

OGLE-BLG-RRLYR-33665



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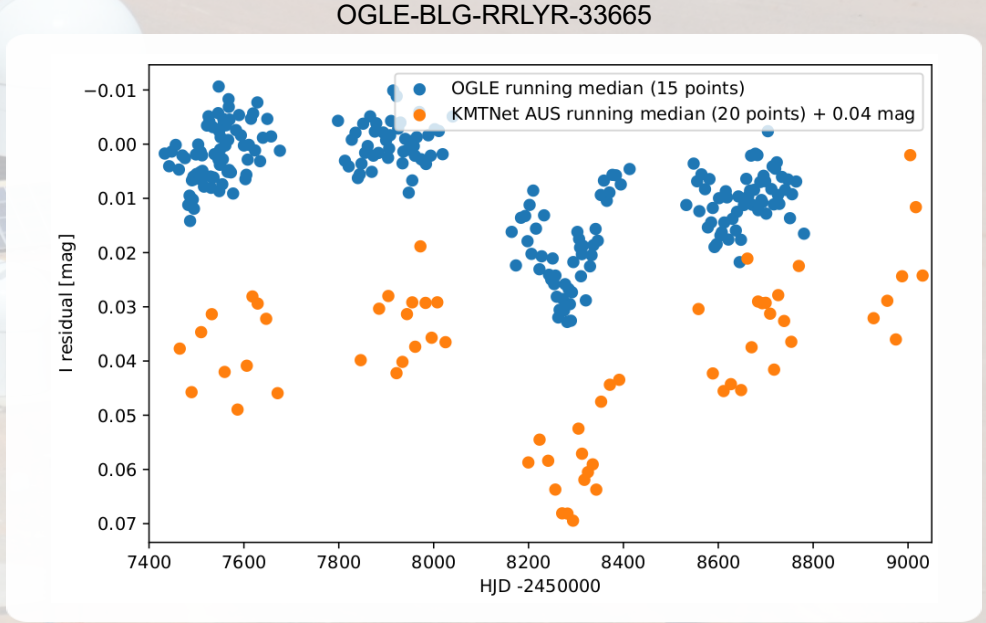

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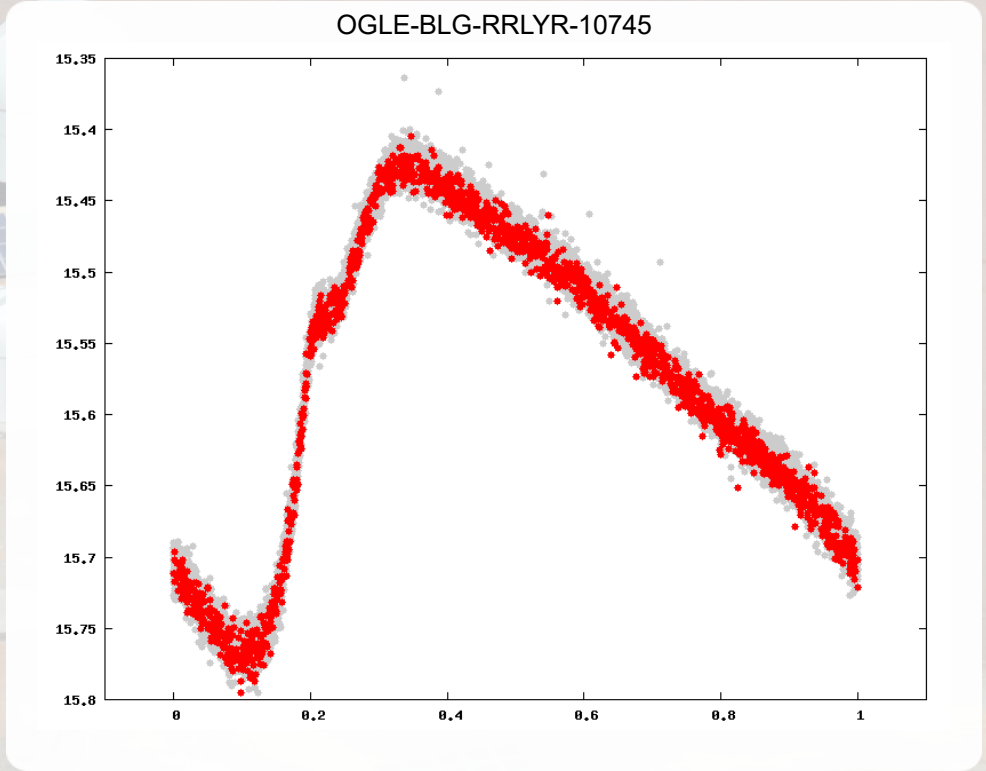
Light-curve anomalies:

– some RR Lyrae change mean brightness with time

– some binary candidates too, and with the period of the binarity



Search for mean magnitude changes

Visually re-inspection:

– same 27,480 OGLE RRab

– focusing on the light curves

– ~250 stars pre-selected for analysis

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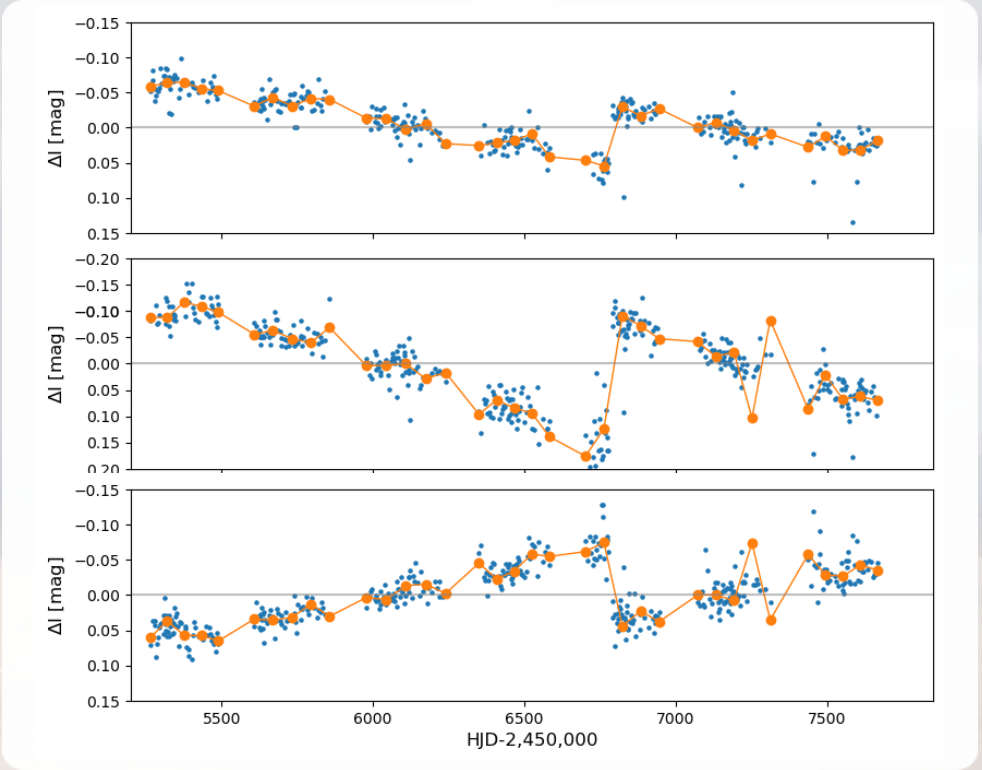
– vetting out many false candidates (blends, high proper motions, many NGC 6441 RRL)



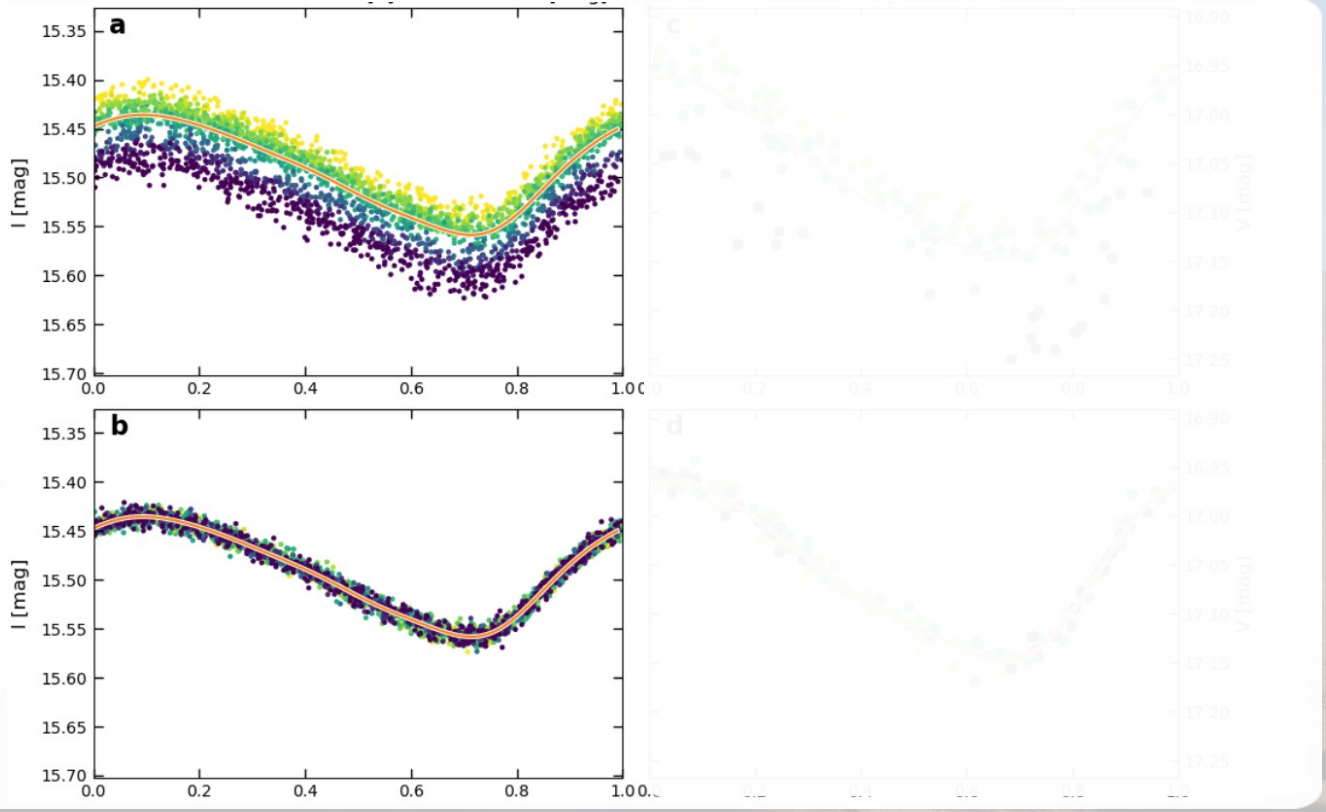
Modified Fourier fitting process

I-band fitting:

– Fourier series

+ variable mean magnitude

OGLE-BLG-RRLYR-12237



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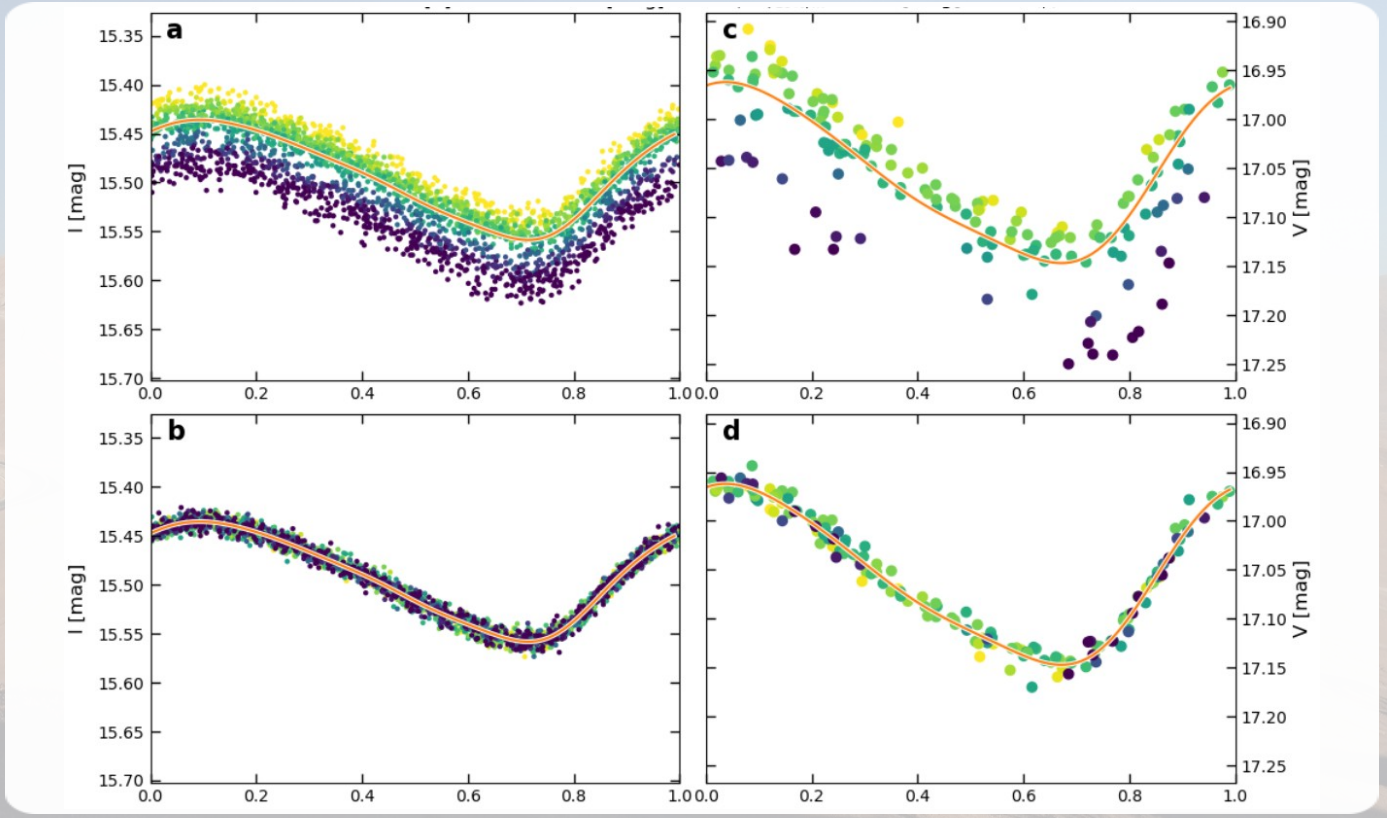
× extra constant



Modified Fourier fitting process

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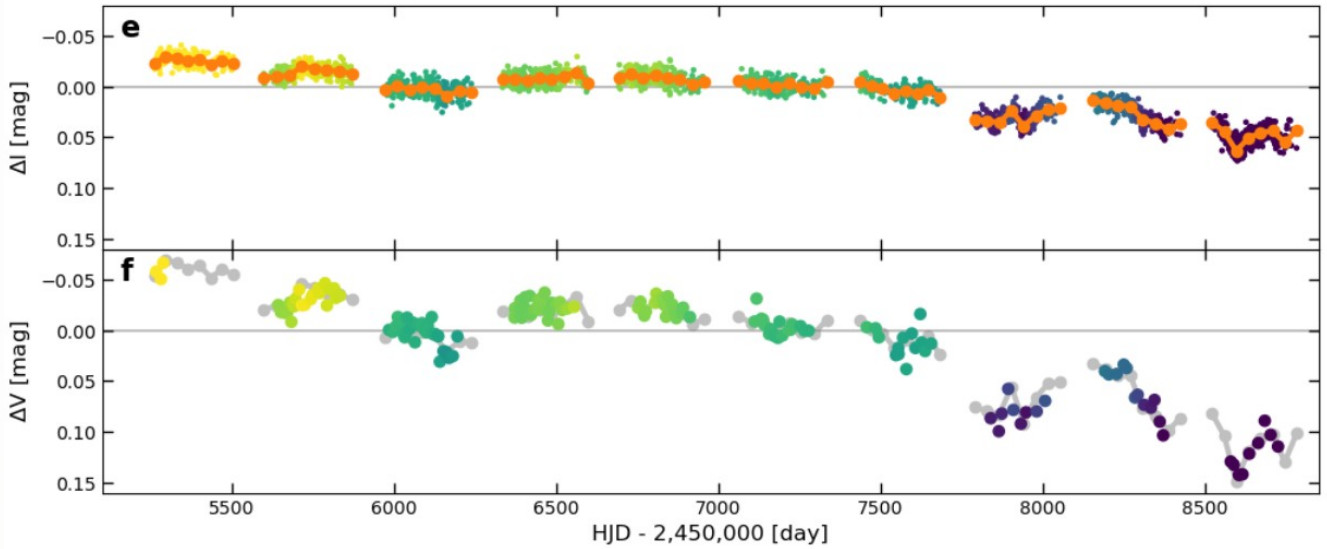
× extra constant
= A(V) / A(I)



Properties of the sample

Prevalence:

– 81 stars (80 RRab, 1 RRc)

– 5 / 81 binary candidates

– only a few stars with Blazhko effect

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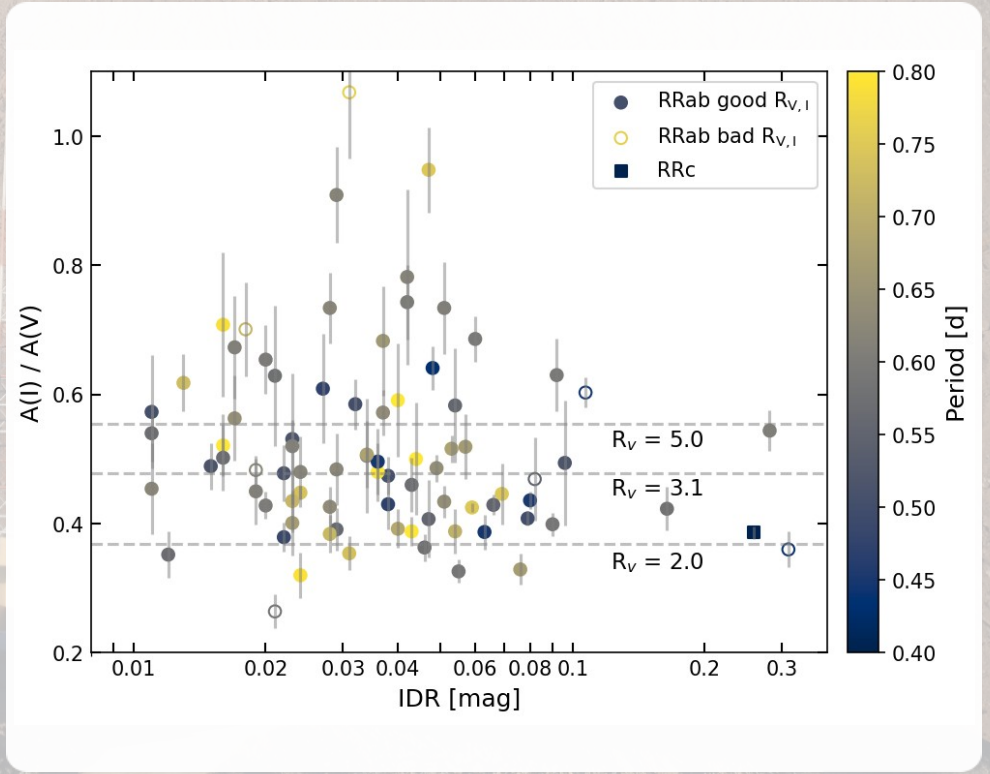
A(I)/A(V) distribution:

– very broad distribution from 0.35 to 0.8, outside normal interstellar extinction range

– supports a circumstellar (probably circumbinary) dusty origin



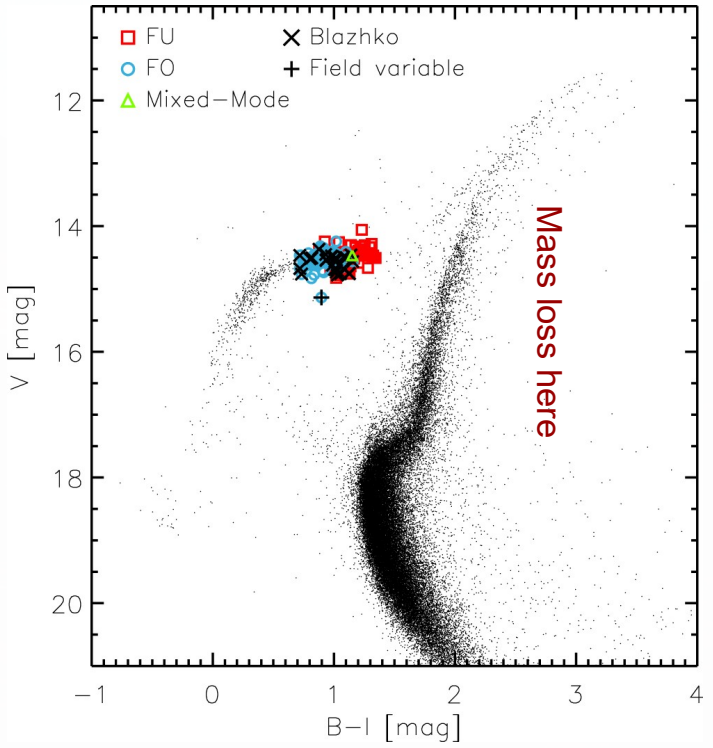
Connection to other kinds of stars

Things to consider:

– present in binary systems, ~ Porb

– circumbinary dust? companion?

– source of dust? RRL itself? WD?



Braga+2016

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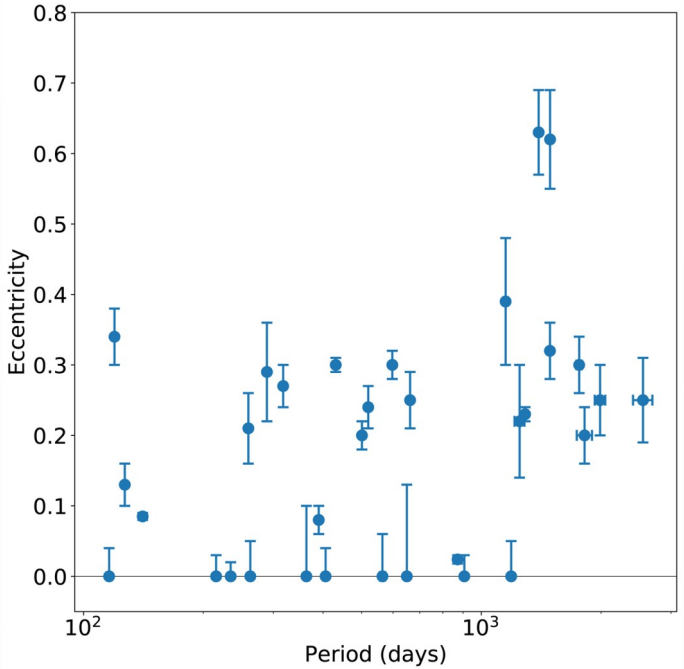
– Porb ~ 100-2500 days

– circumbinary disks

– Lindblad resonance can pump the eccentricity (Glenn-Michael+2020)



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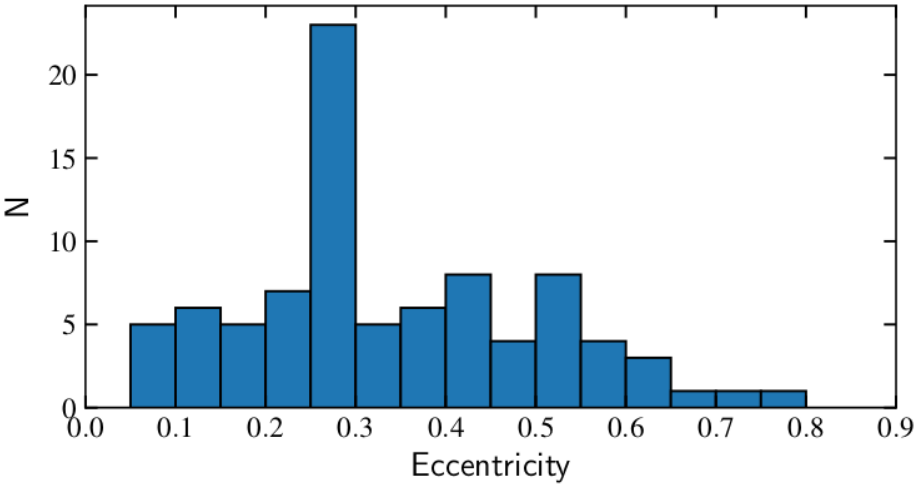
– RR Lyrae: *e* ~ 0.27 excess



Hajdu+2021

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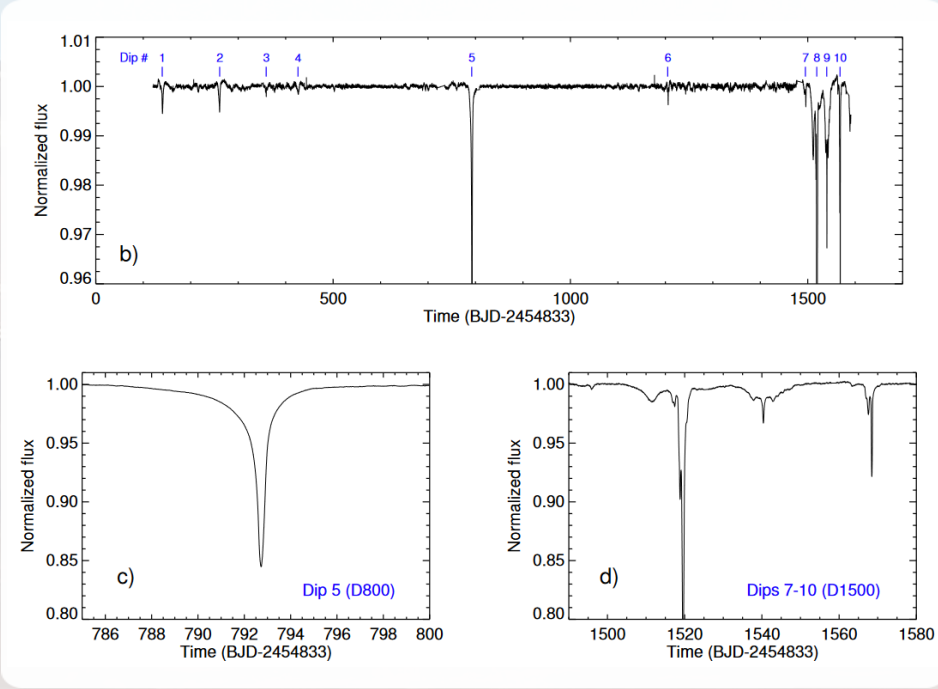
KIC 8462852 (Boyajian's Star):

– mysterious dimmings in Kepler data



Boyajian+2015

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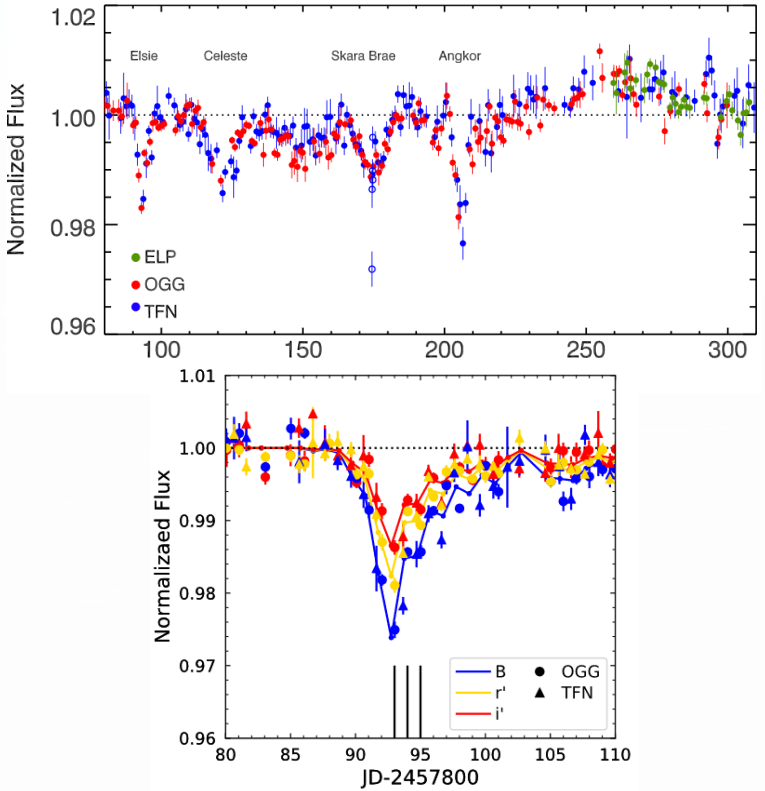

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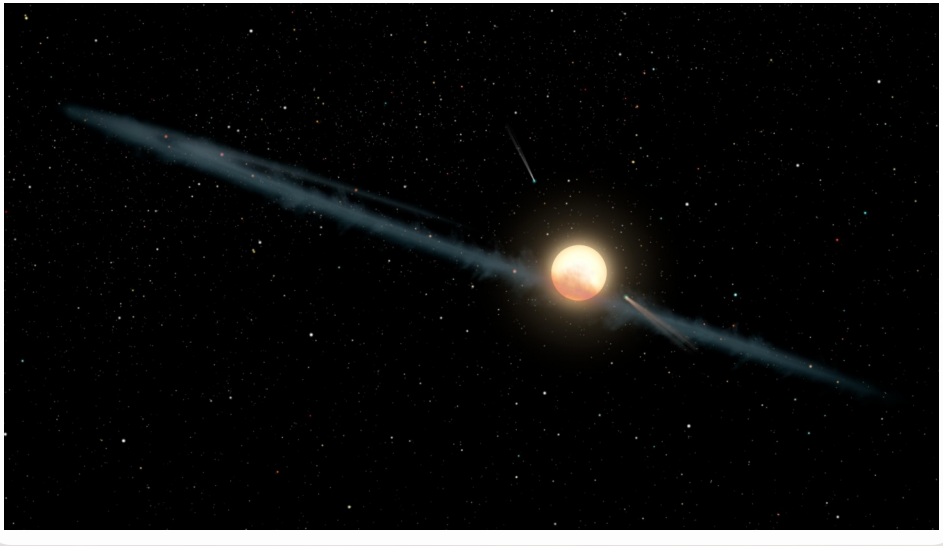
– uneven dust disk?



NASA/JPL-Caltech

Future prospects

Photometric studies needed:

- continued OGLE I-band, more V-band time series
- targeted multiband follow-up of the best stars + mid-IR
- other horizontal branch stars?

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Spectroscopy:

- chromatic Rossiter-McLaughlin effect might be present
- Ca H & K lines, other?

Polarimetry and simulation:

- scattered light might be detectable (time dependence)
- mass loss on RGB, binary evolution of RRL

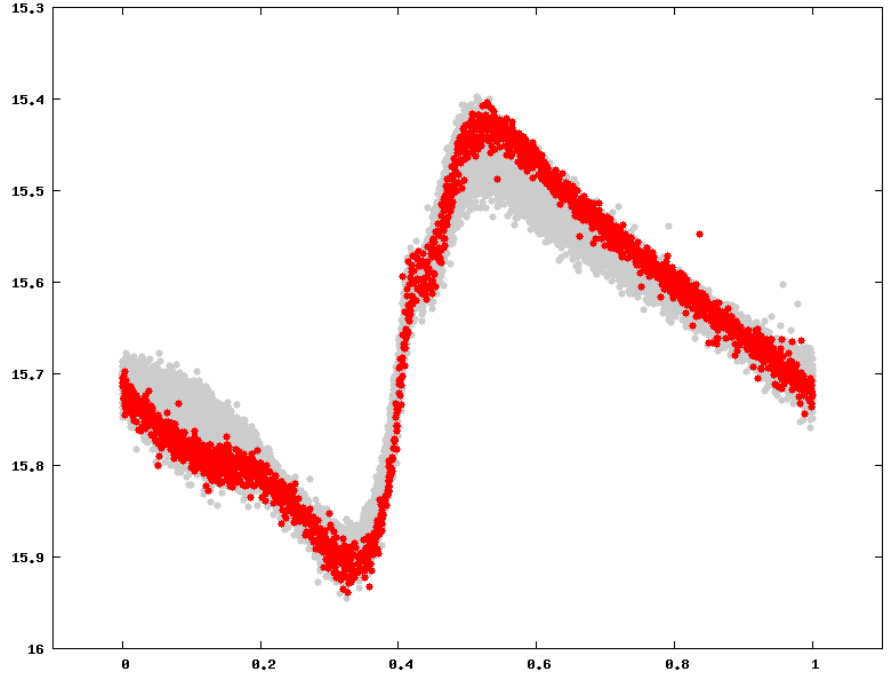
Thank you for your attention!

Some more curious RR Lyrae

OGLE-BLG-RRLYR-08752:

– binary candidate, 2 Blazhko modes

+ mean magnitude change (w/ Porb)



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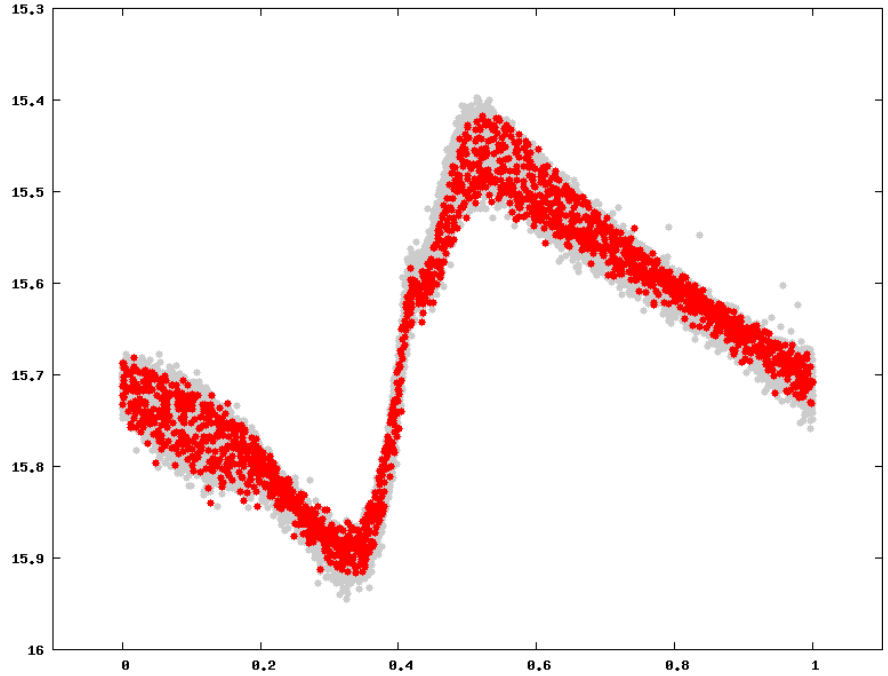

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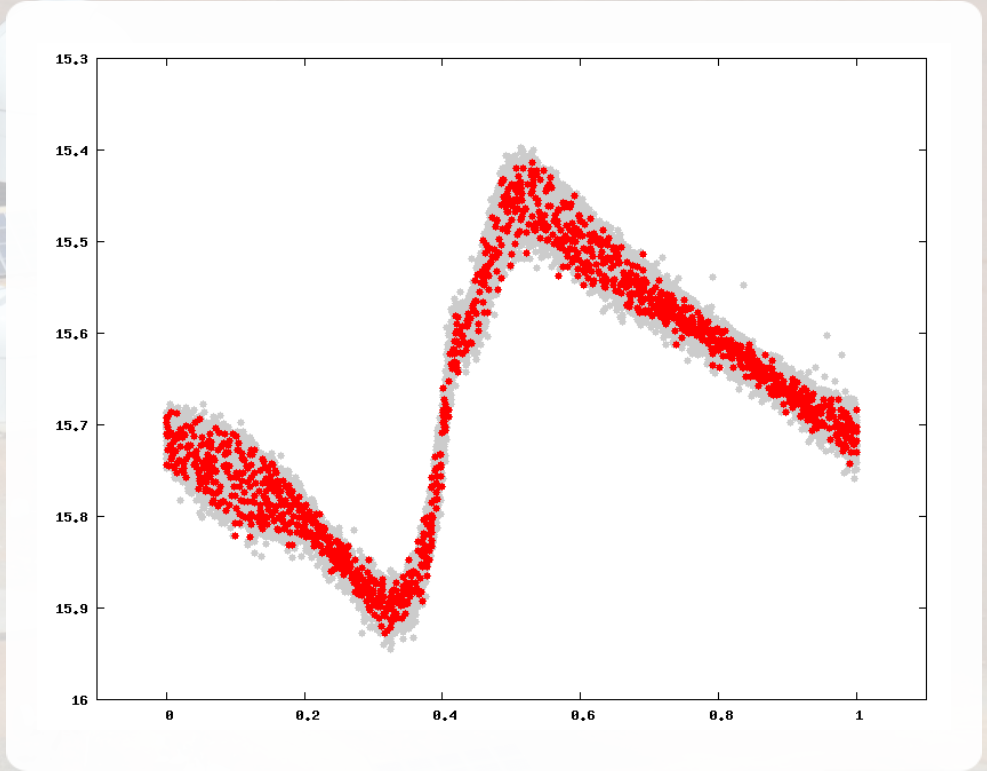

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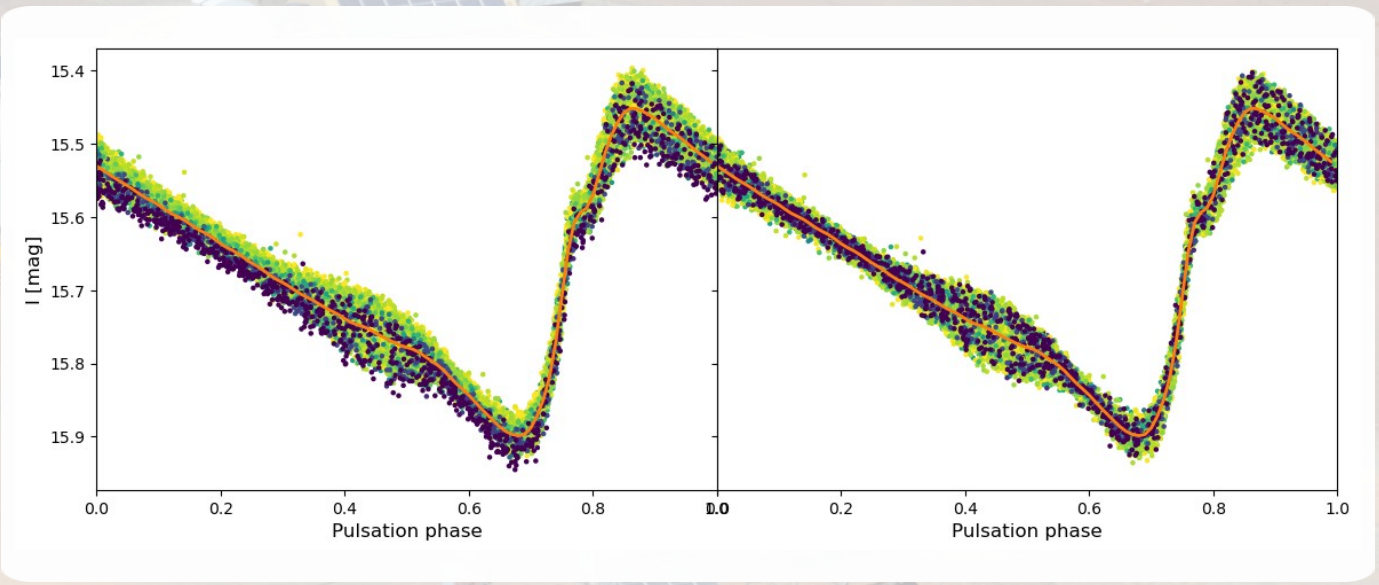

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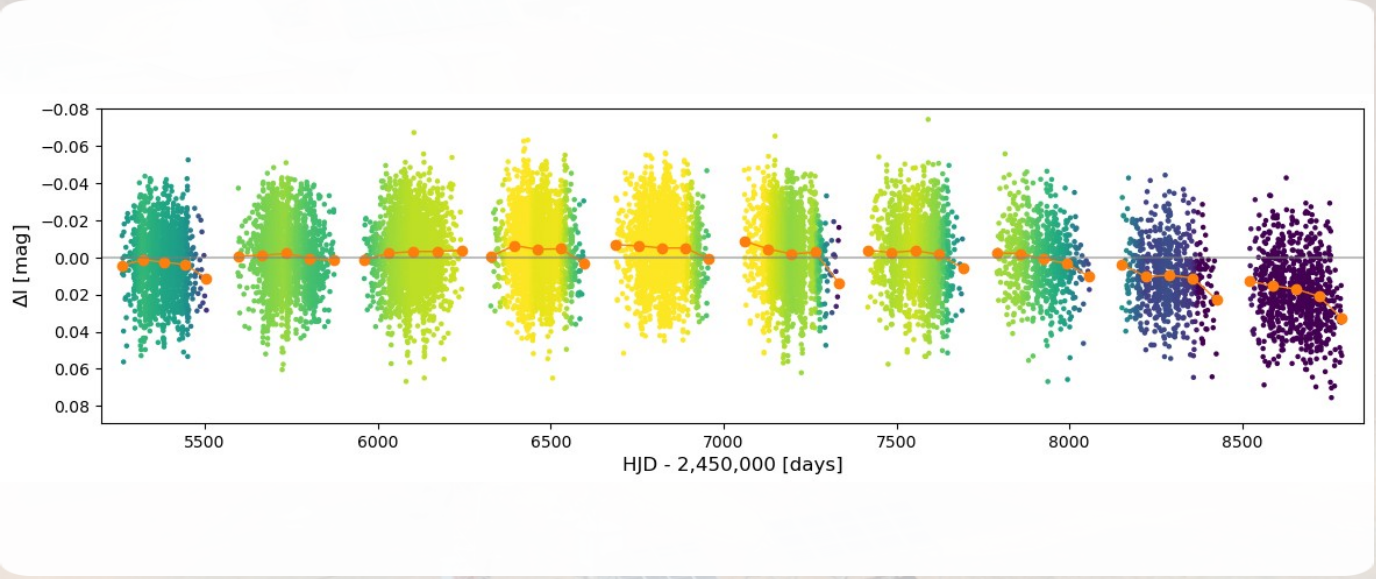

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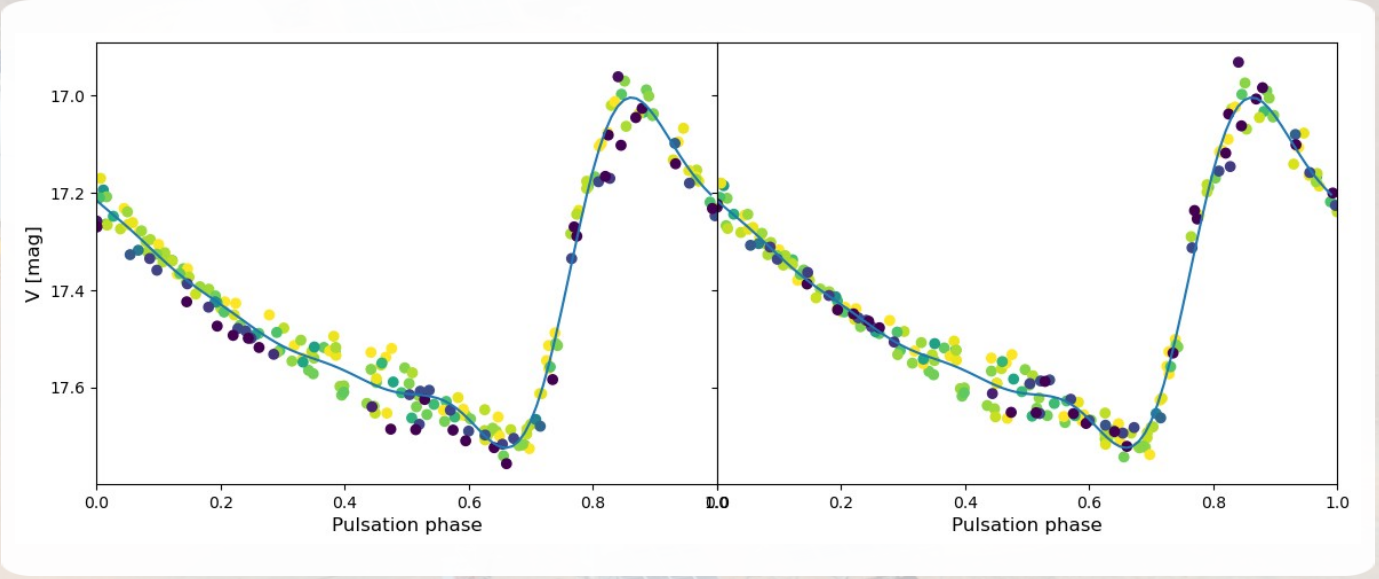

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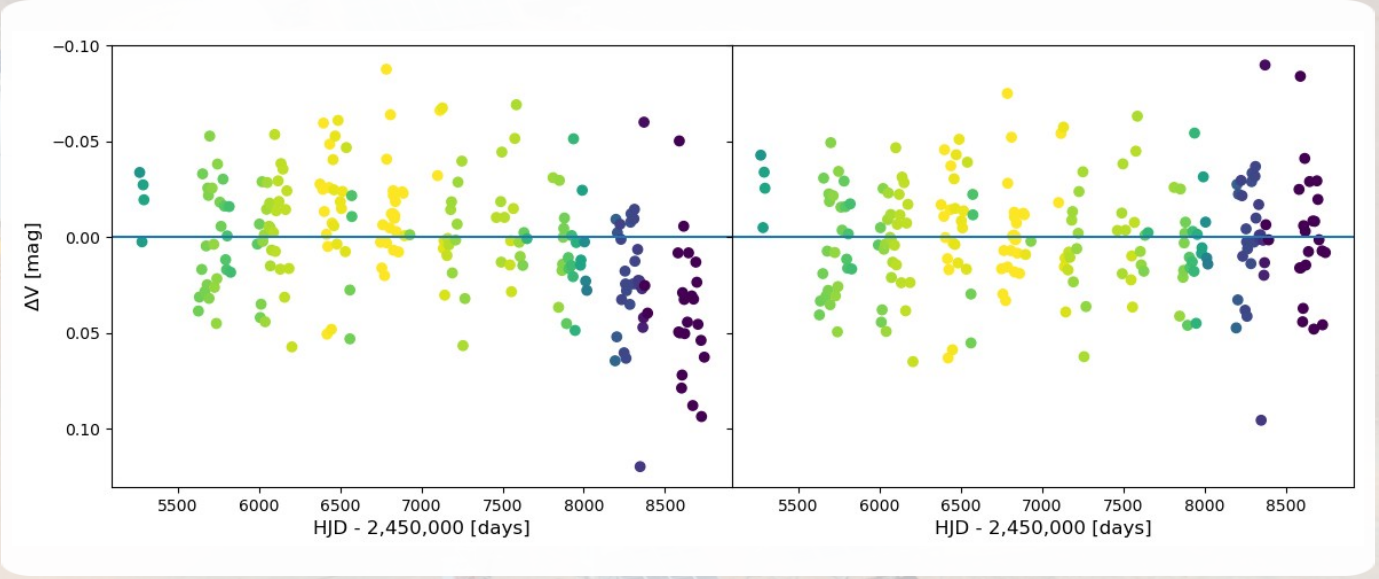

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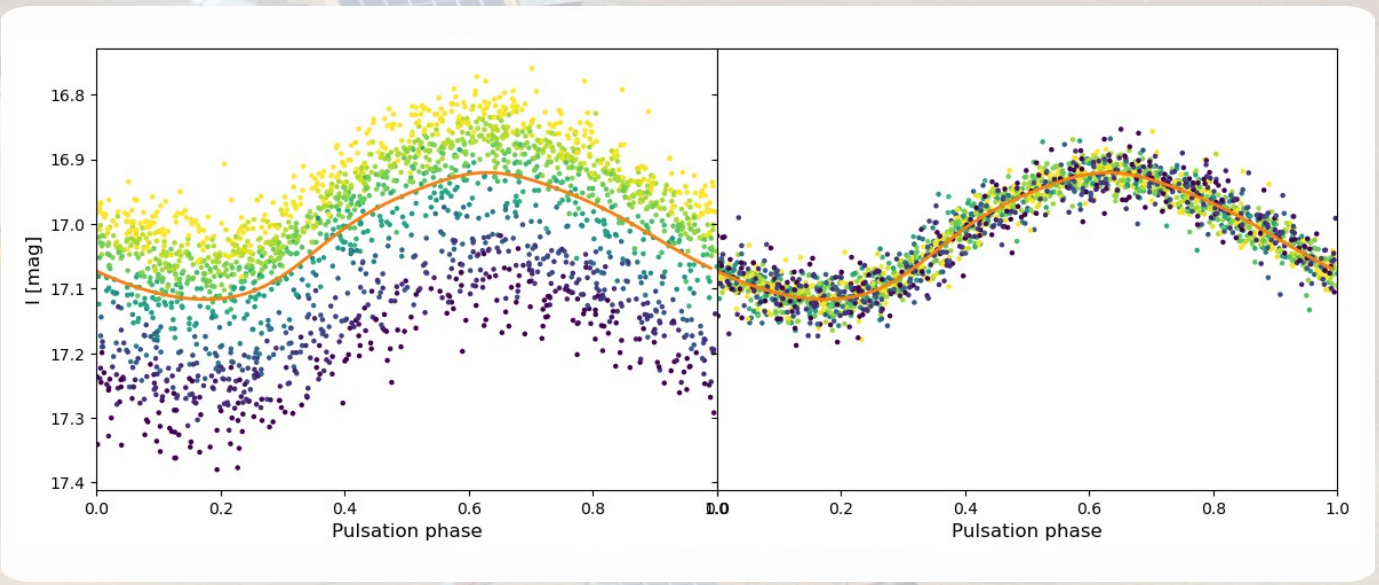
OGLE-BLG-RRLYR-34373:

– RRc with variable mean magnitude noted in the OGLE catalog



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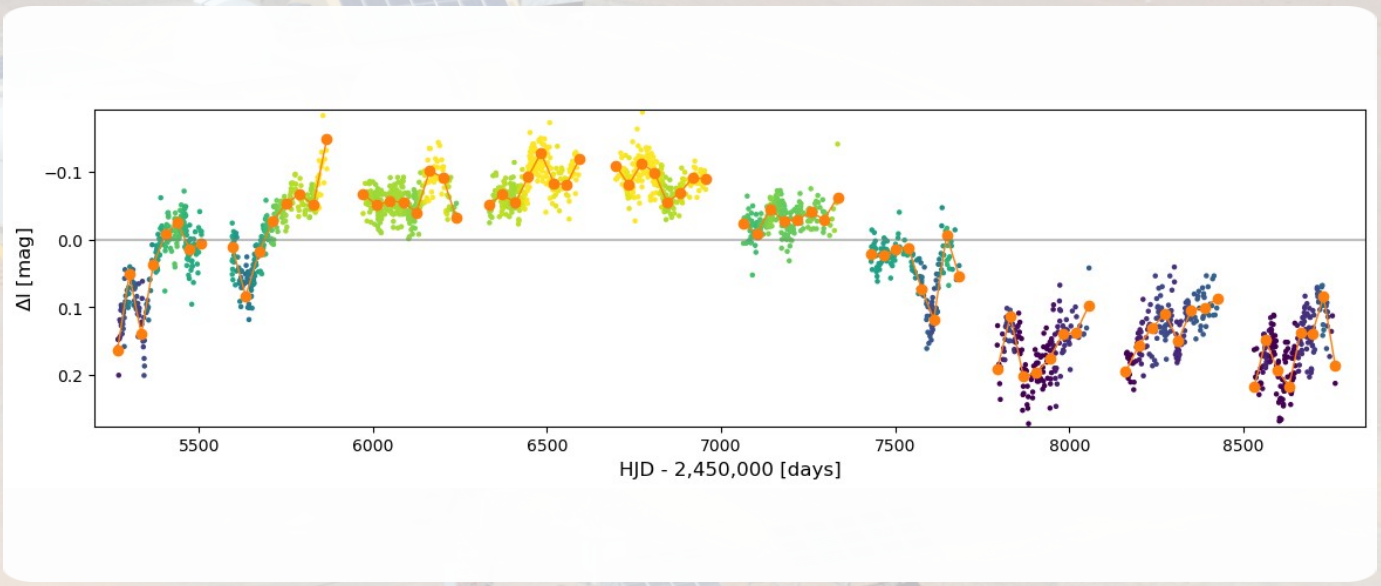

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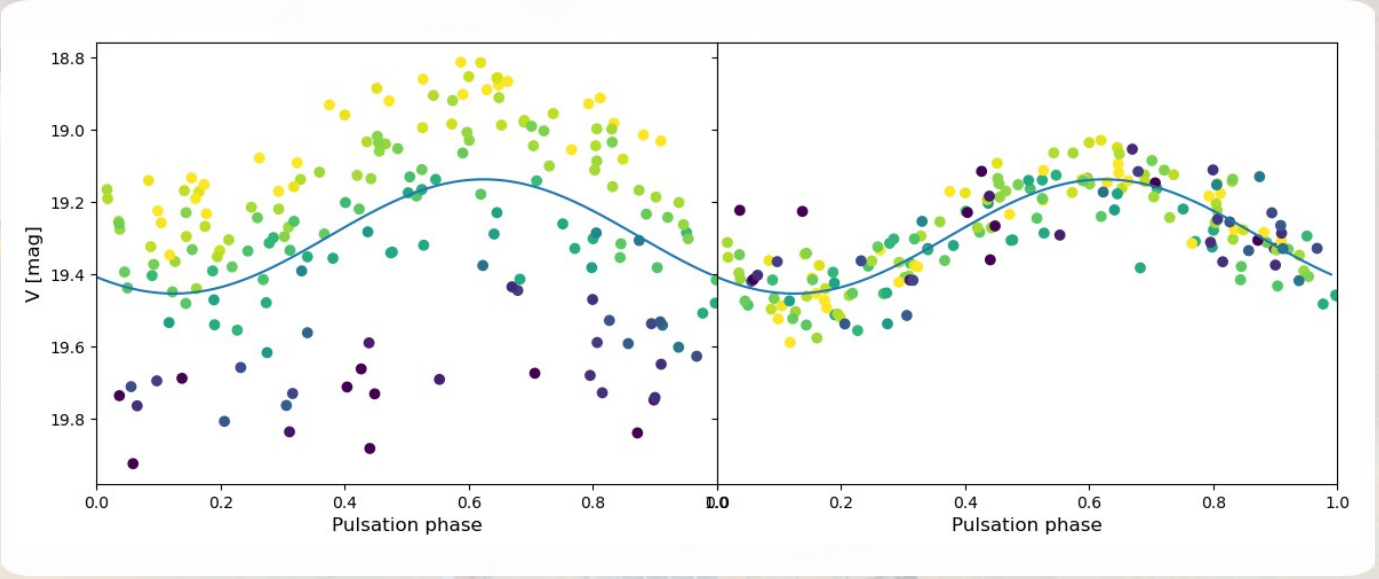

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