Annual report - Circumstellar matter around RR Lyrae stars

Gergely Hajdu

Academic activities 2025

– member of the Araucaria project

– 6 publications as co-author

– 3 manuscript accepted for publication,
1 as first author in A&A (topic of talk)

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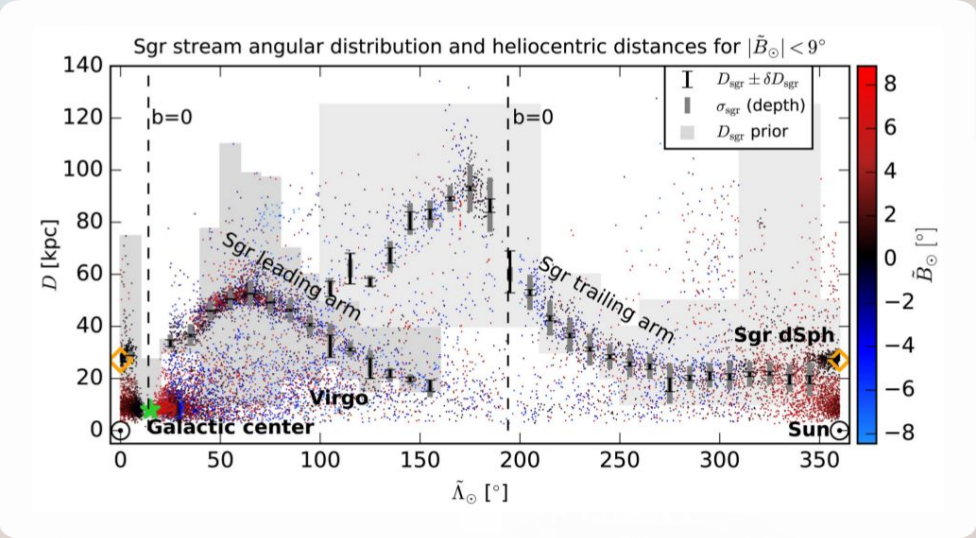
– 2 trips to the Cerro Murphy Observatory

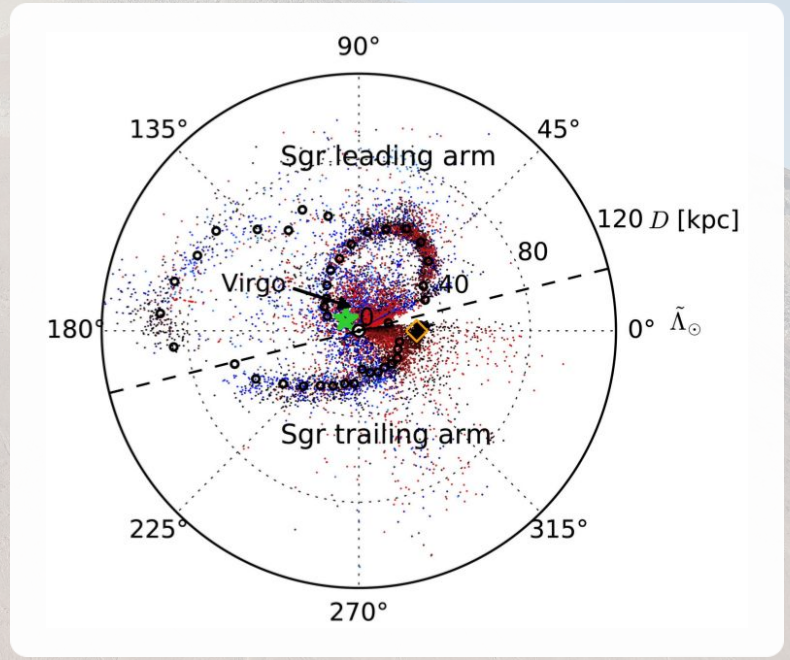
– 1 master co-advised: defended thesis
June 18, started PhD in Rome

RR Lyrae stars: excellent tracers of Population II

Easy to find:

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





Hernitschek+2017

RR Lyrae stars with variable mean brightness

Visually inspected:

– O-C of 27,480 OGLE RRab

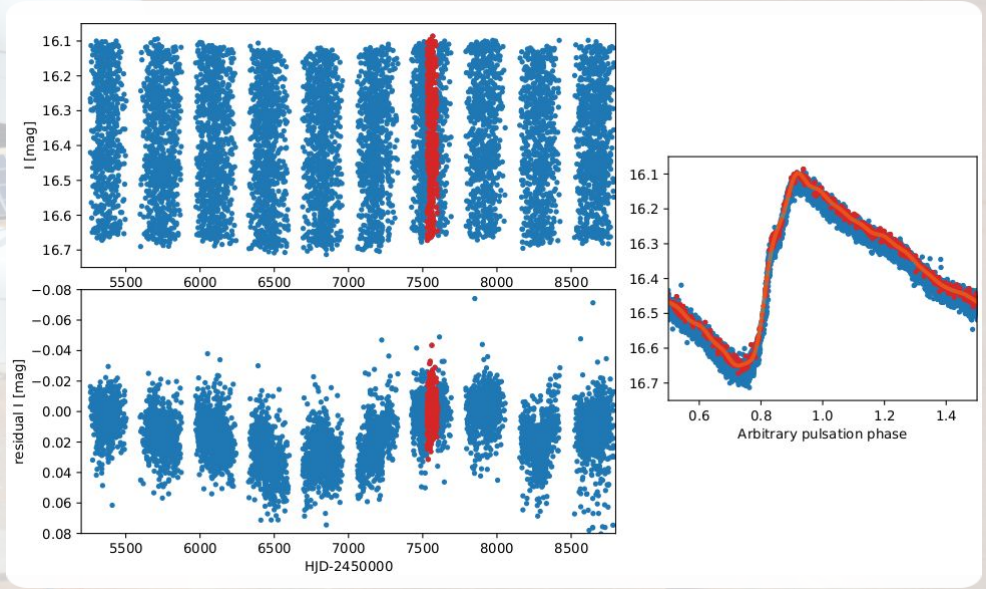
– with LCs (folded and unfolded)

– 87 binary candidates (Hajdu+2021)

Light-curve anomalies:

– some RR Lyrae change mean brightness with time

OGLE-BLG-RRLYR-33665

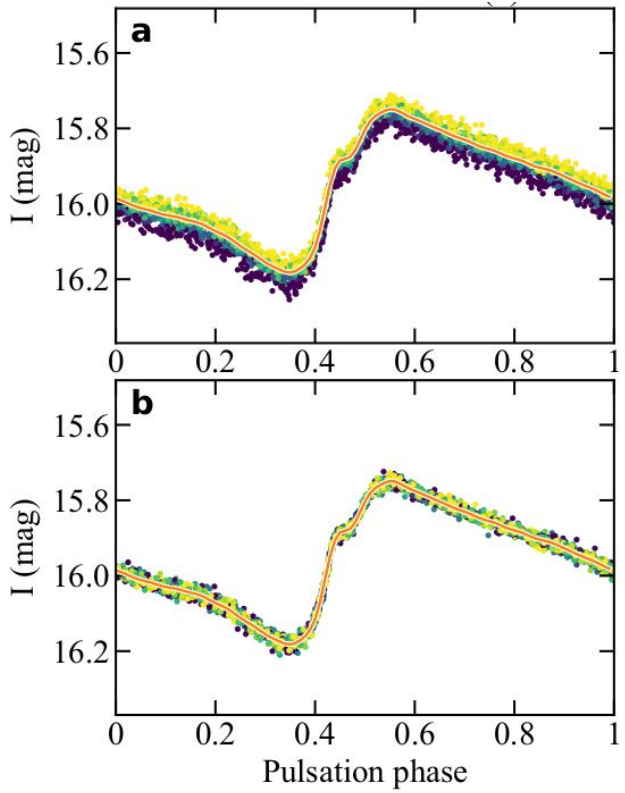


Modified Fourier fitting process

I-band fitting:

– Fourier series + variable mean magnitude

OGLE-BLG-RRLYR-12793



Modified Fourier fitting process

I-band fitting:
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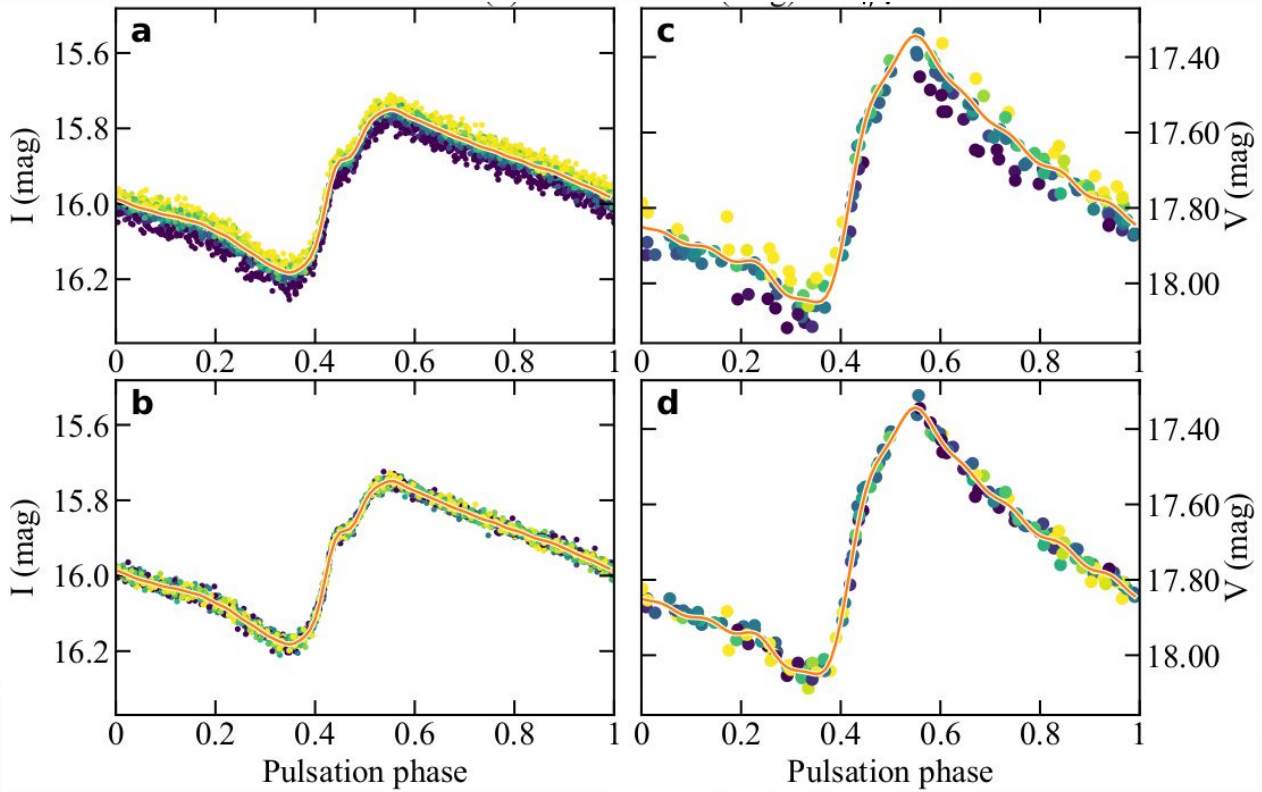
V-band fitting:
– Fourier series
+ I-band mean magnitude
× extra constant

OGLE-BLG-RRLYR-12793



Modified Fourier fitting process

I-band fitting:
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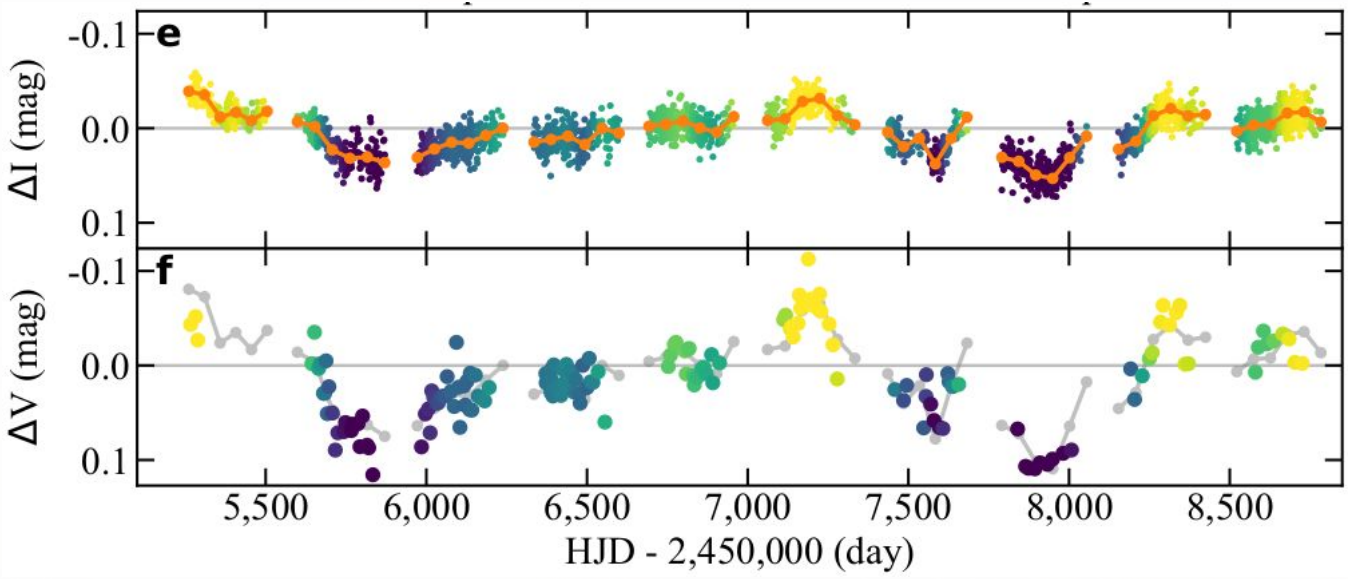
V-band fitting:
– Fourier series
+ I-band mean magnitude
× extra constant
= A(V) / A(I)



Properties of the sample

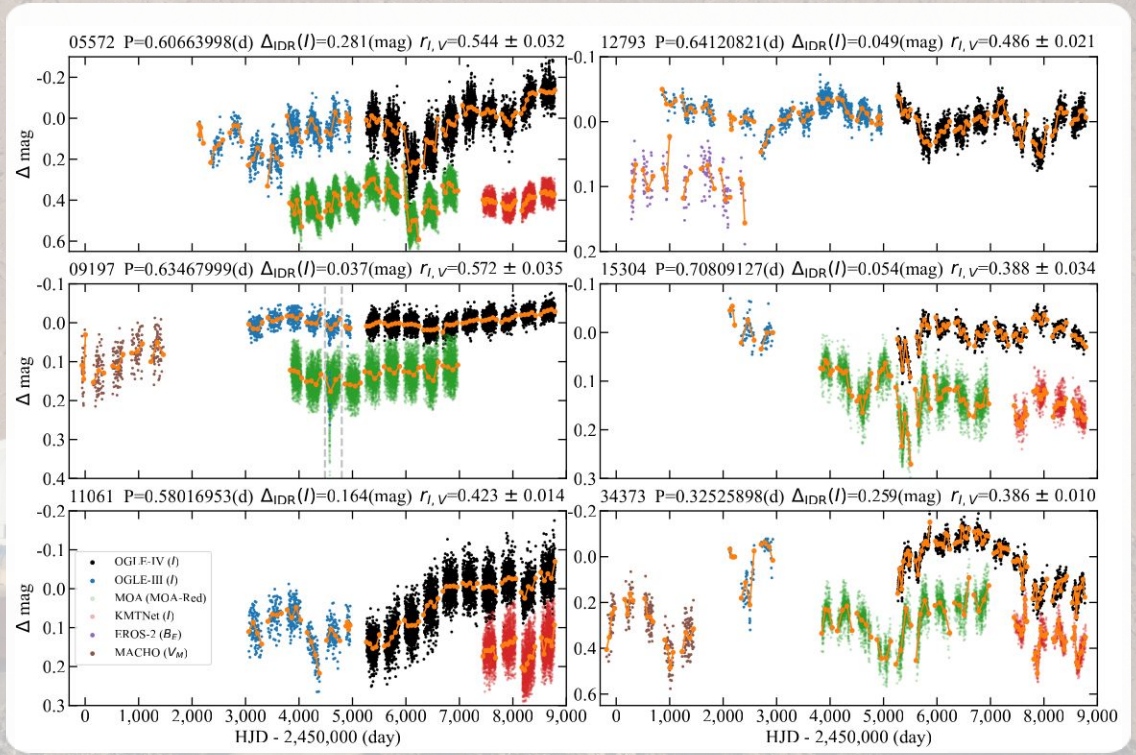
Prevalence:

– 72 stars (71 RRab, 1 RRc)

– 5 / 72 binary candidates

Comparison of light curves from different surveys:

– all surveys show the same behavior for the same stars



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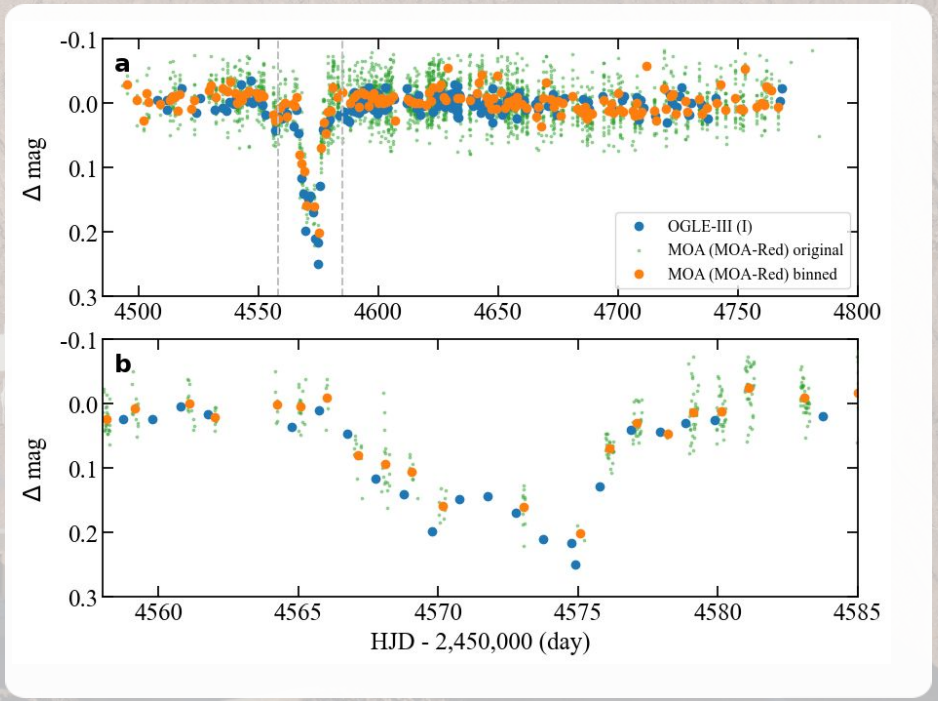
– eclipse event for 09197 is confirmed by MOA data!



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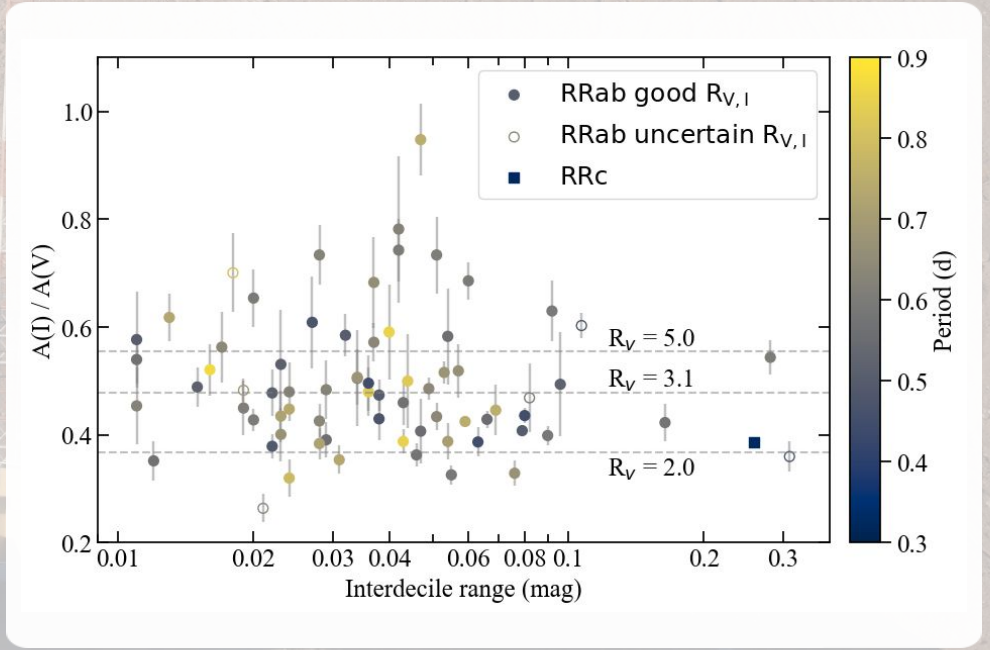
A(I)/A(V) distribution:

– broad distribution from 0.35 to 0.8, wider than “normal” extinction

– supports a circumstellar (probably circumbinary) dusty origin

– moderate dust masses ~ 10^{18} kg



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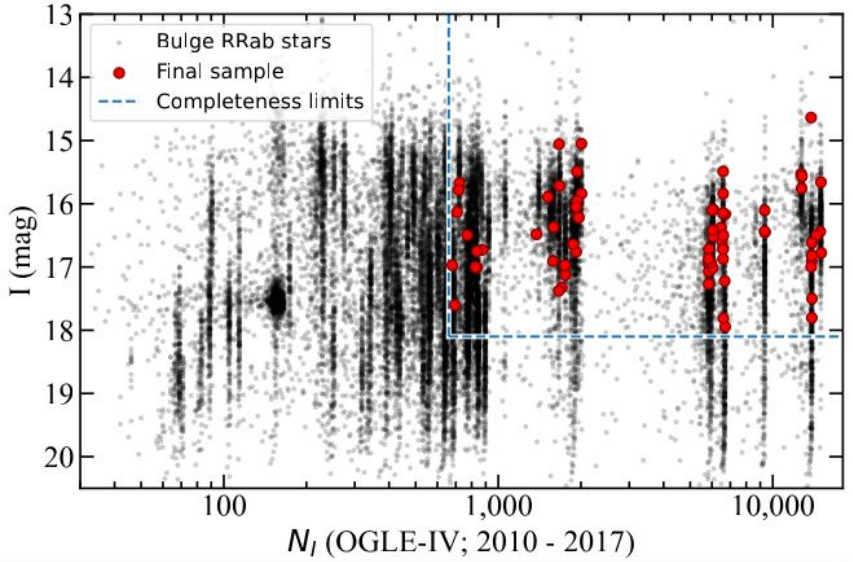
– incidence rate ~0.9%



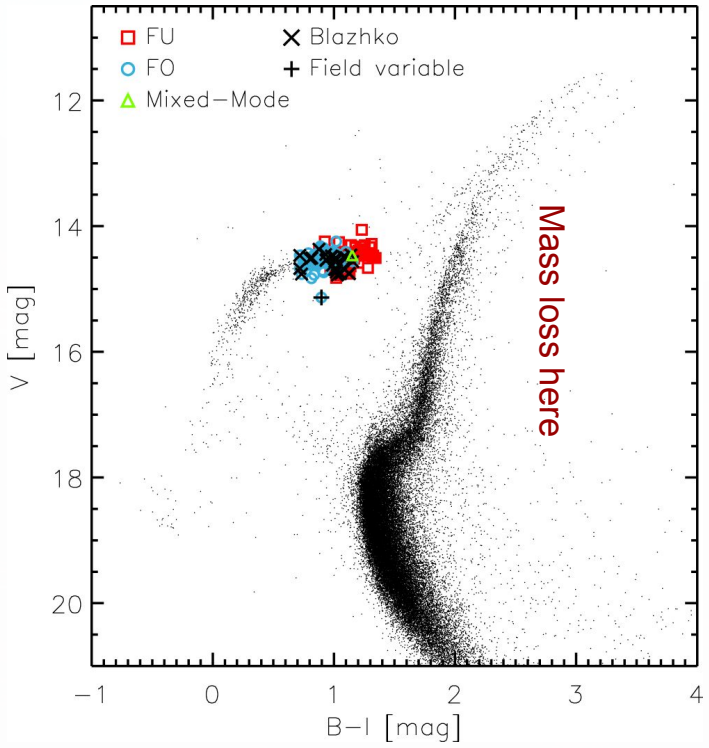
Connection to other kinds of stars

Things to consider:

– present in binary systems, ~ Porb

– circumbinary dust? companion?

– source of dust? RRL itself? WD?



Braga+2016

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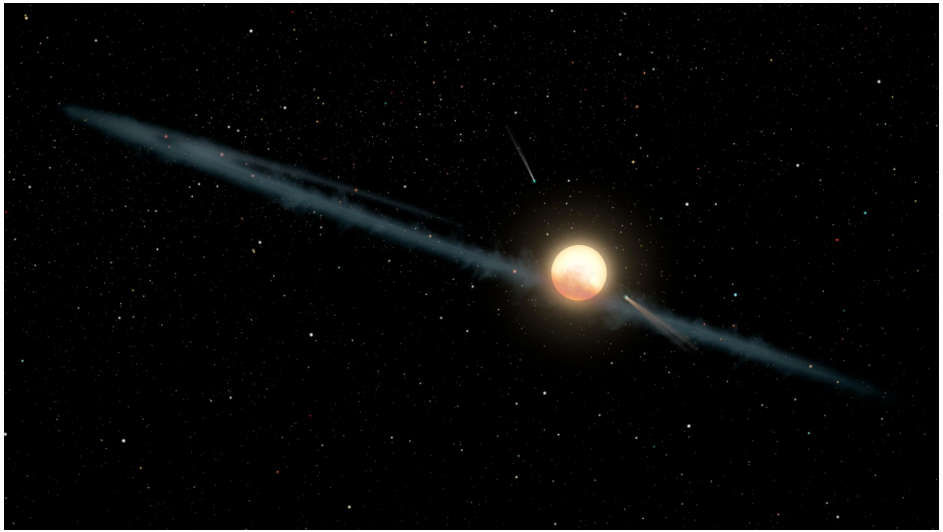
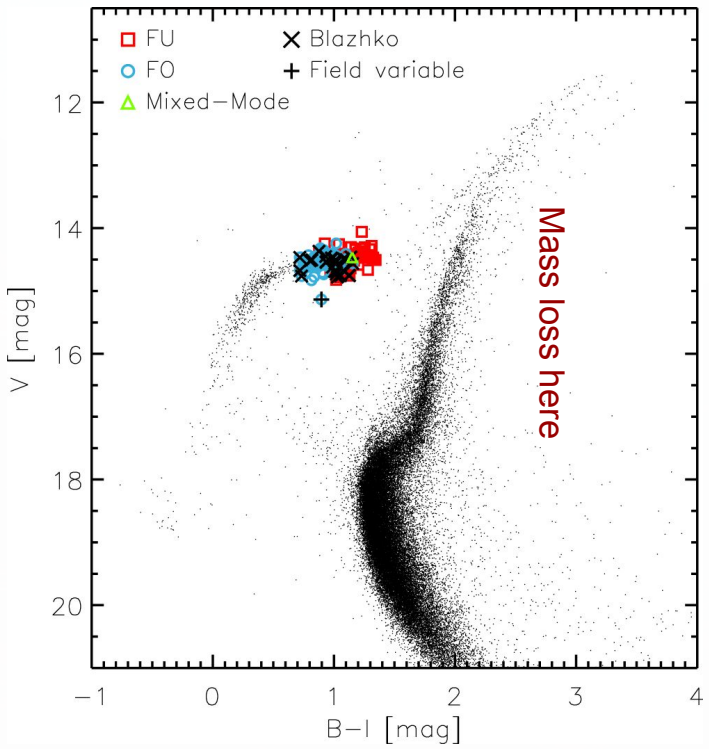


NASA/JPL-Caltech



Braga+2016

Spectral energy distributions

SED model:

– DUSTY spherical model

– BB 6200K, inner dust temperature 800K (~4AU)

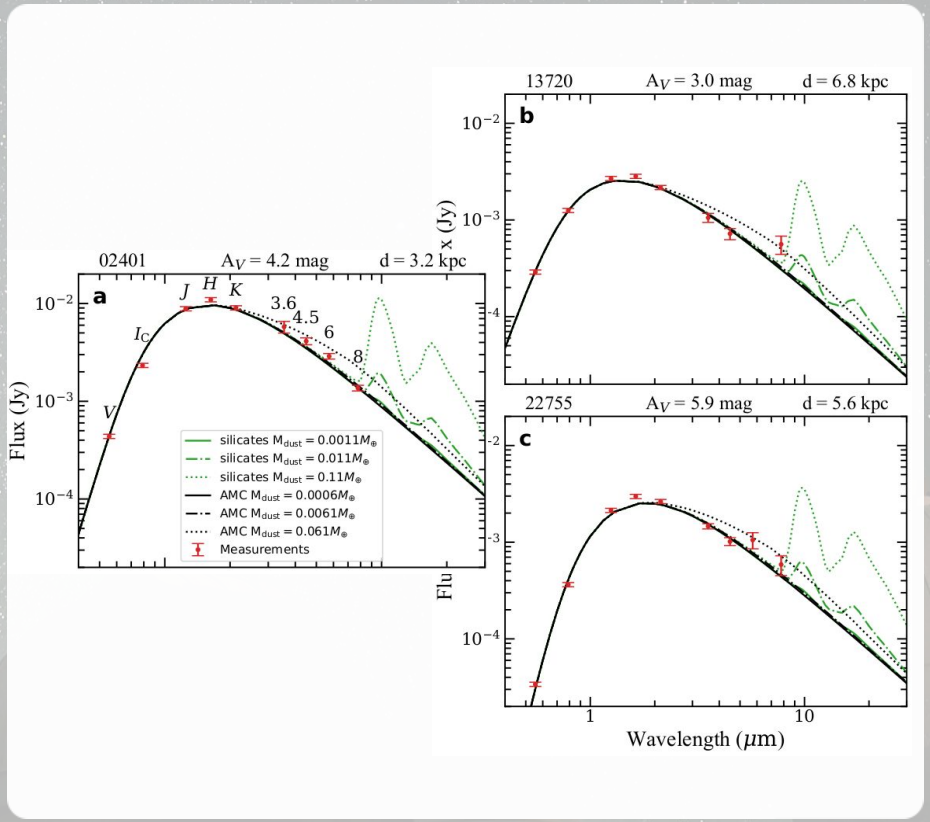
– AMC and silicate models

Observations:

– brightness and crowding limited (Spitzer, WISE)

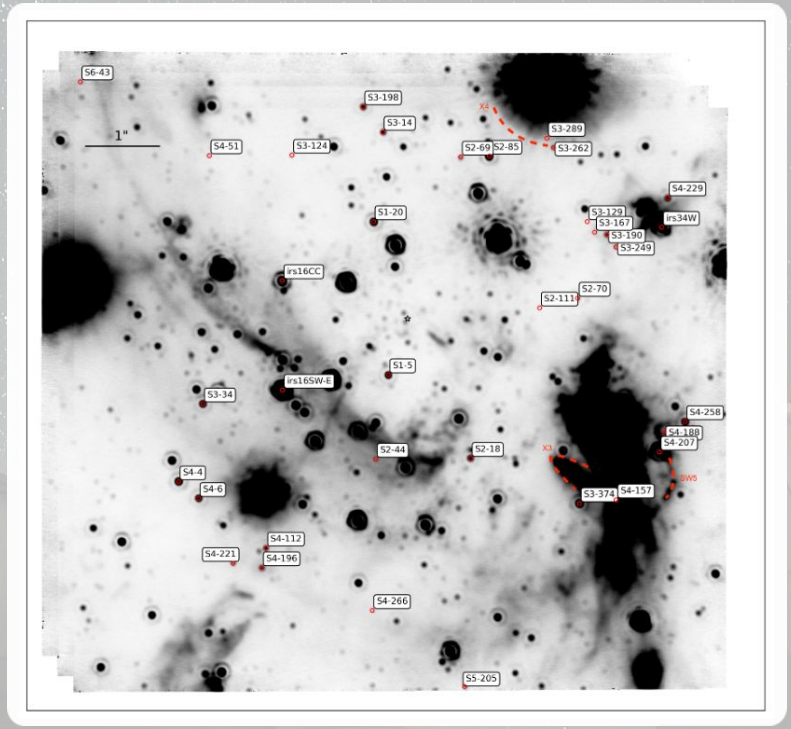
– only 3 stars detected at 8um (GLIMPSE)

– no sign of IR excess



Alternative explanation

– variable interstellar extinction
– recently claimed for the Galactic center region (Haggard+2024)
– dust concentrated in arcs



Haggard+2024

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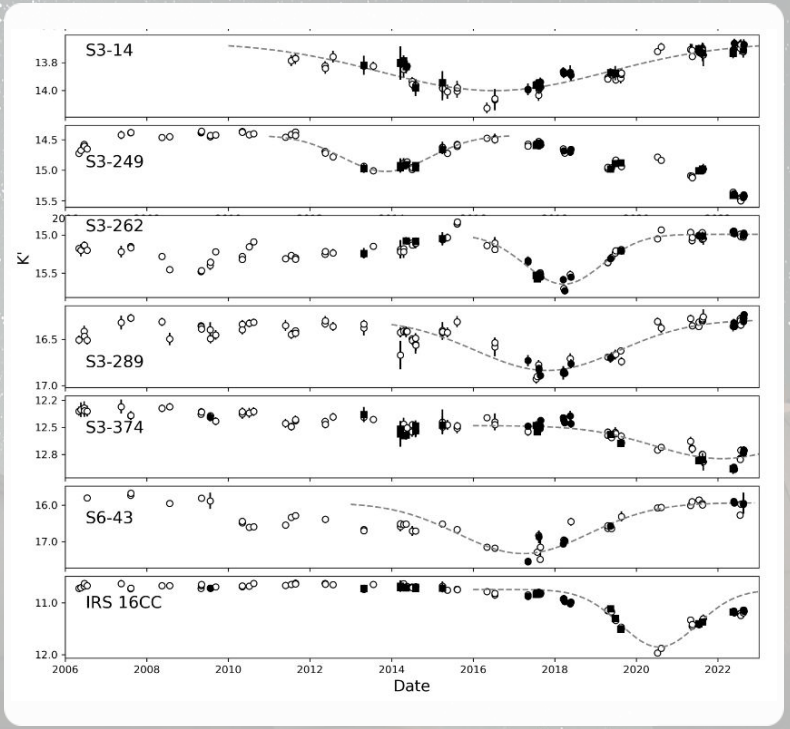
– dust concentrated in arcs
+
– large proper motion of stars
=
– variable extinction
– PM difference between dust and bulge RR Lyrae ~200 km/s



Haggard+2024

Additional clues

OGLE Galactic bulge RRL sample:

– strongly correlated parameters

– some RRL in the foreground, our sample does not follow the bulge RRL

– proper motions markedly different compared to bulge RRL

→ halo interloper population?
RV data missing (10/71)