

Annual report - Circumstellar matter around RR Lyrae stars

Gergely Hajdu

Academic activities 2024

- member of the Araucaria project
- main organizer of the Journal Club at CAMK:
Nov. 2022 - Dec. 2024



Academic activities 2024

- member of the Araucaria project
- main organizer of the Journal Club at CAMK:

Nov. 2022 - Dec. 2024

- 7 publications as co-author (2 as second author)
- 1 manuscript submitted to NA
- 2 conferences:

Dust Devils, Tucson, Arizona, USA

RRL conference, Marrakesh, Morocco

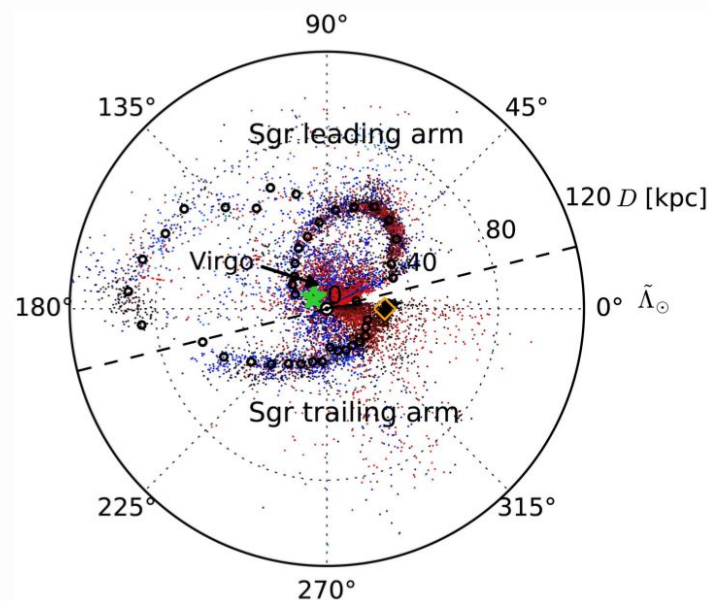
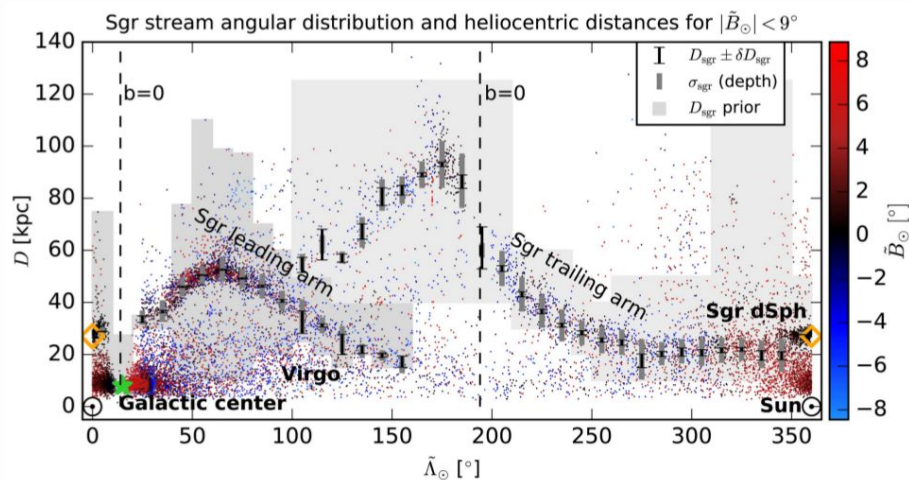
- 1 trip to the Cerro Murphy Observatory
- 1 master student co-advised



RR Lyrae stars: excellent tracers of Population II

Easy to find:

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



Hernitschek+2017

RR Lyrae stars with variable mean brightness

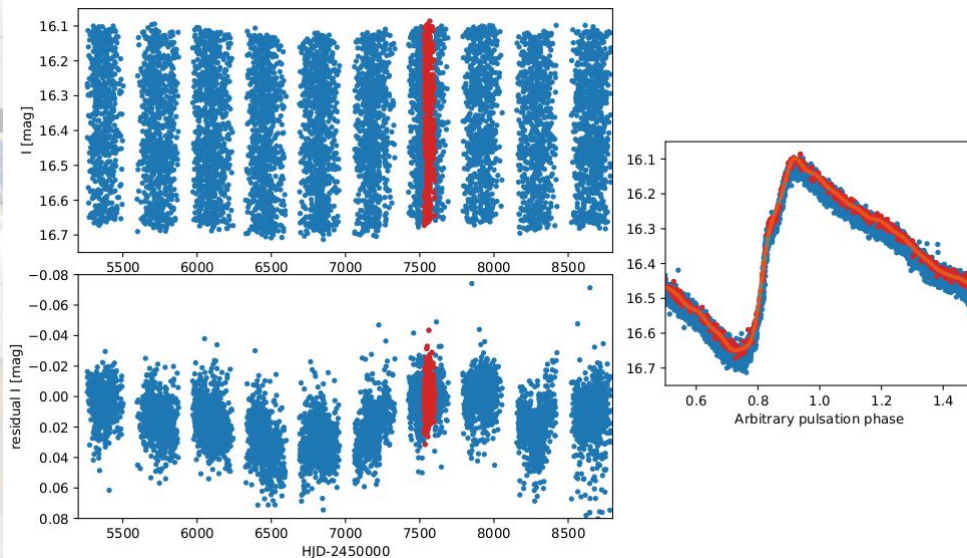
Visually inspected:

- 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

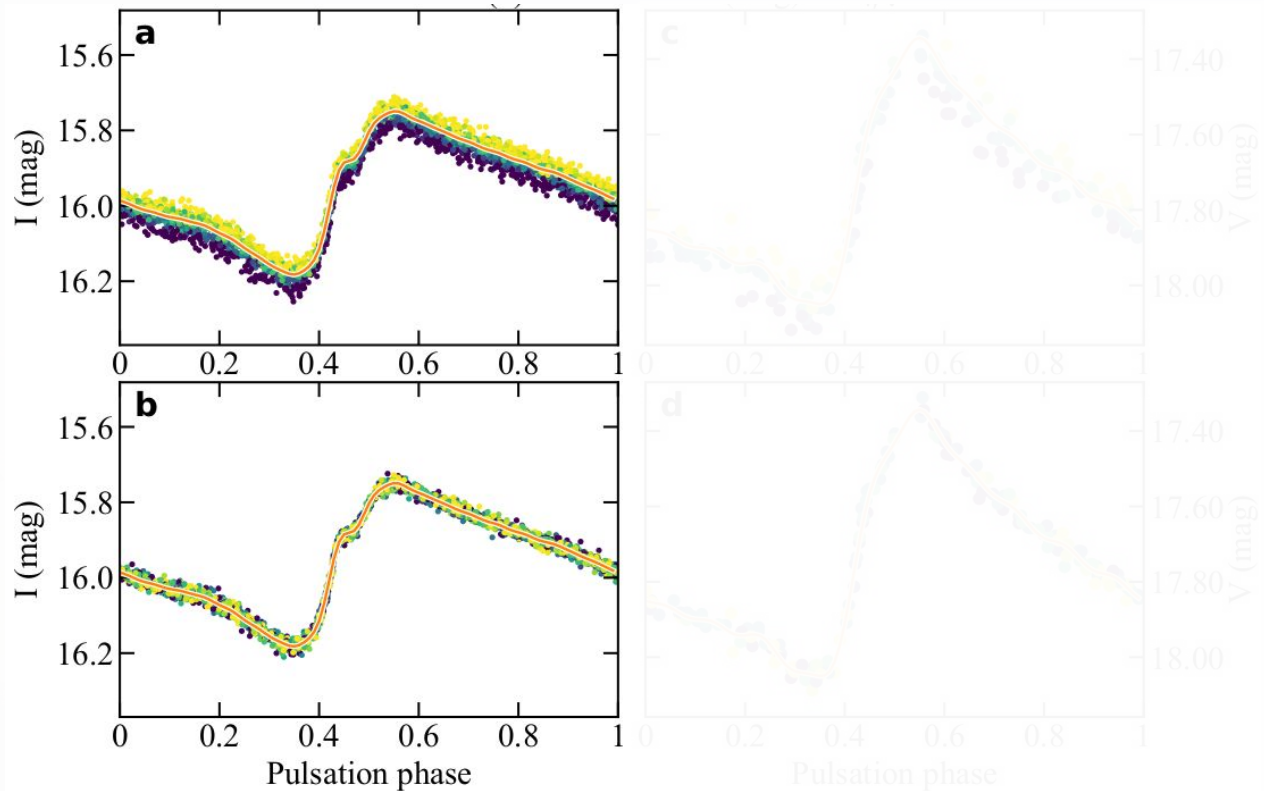


Modified Fourier fitting process

OGLE-BLG-RRLYR-12793

I-band fitting:

- Fourier series
- + variable mean magnitude



Modified Fourier fitting process

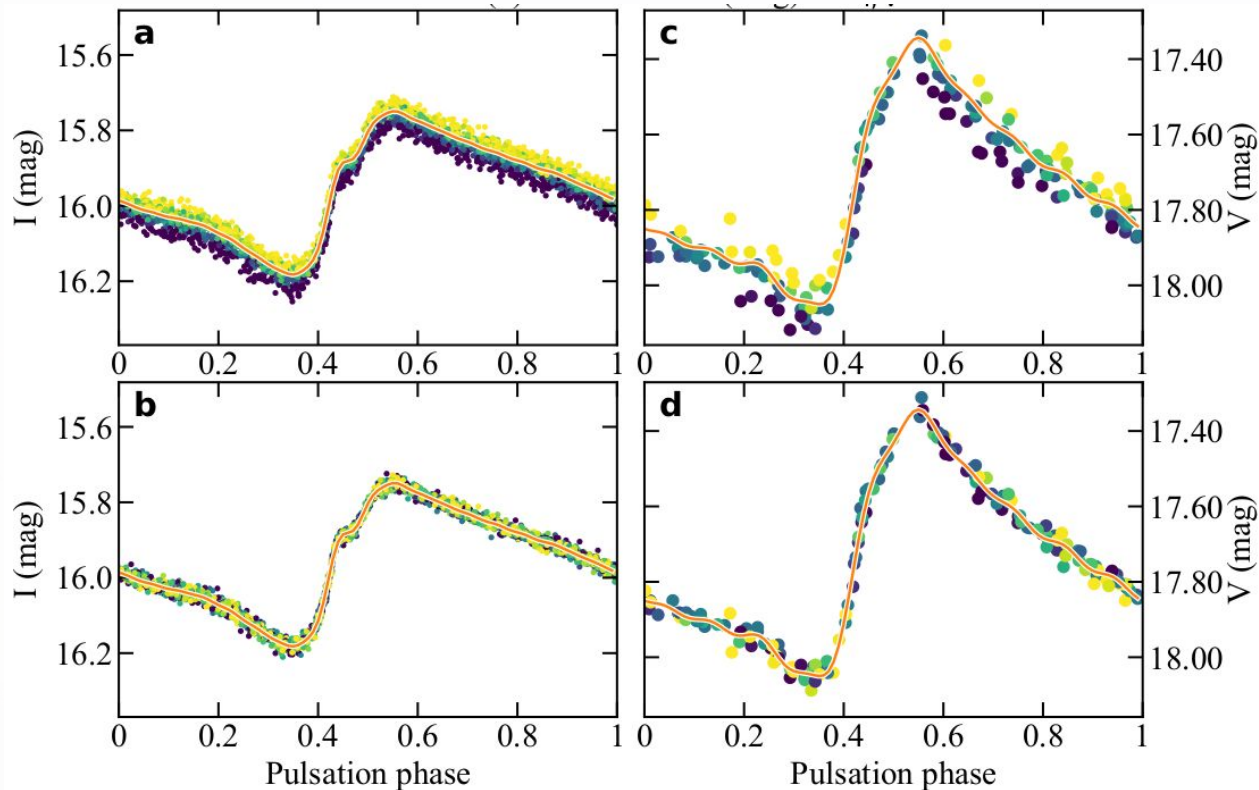
OGLE-BLG-RRLYR-12793

I-band fitting:

- Fourier series
- + variable mean magnitude

V-band fitting:

- Fourier series
- + I-band mean magnitude
- × extra constant



Modified Fourier fitting process

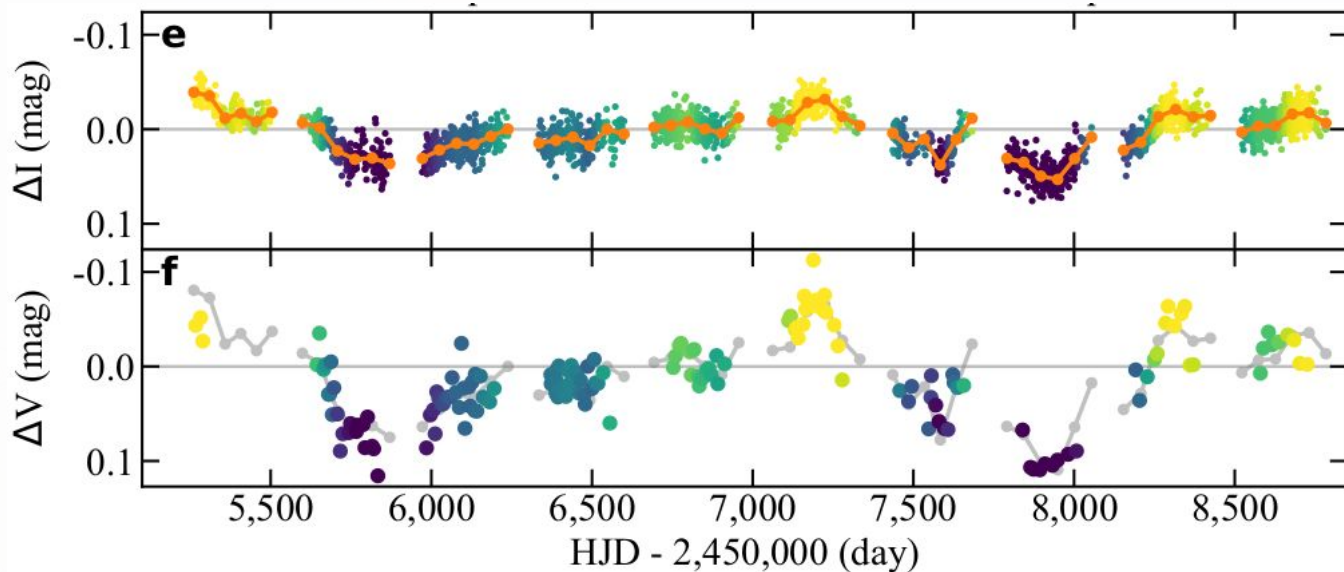
OGLE-BLG-RRLYR-12793

I-band fitting:

- Fourier series
- + variable mean magnitude

V-band fitting:

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



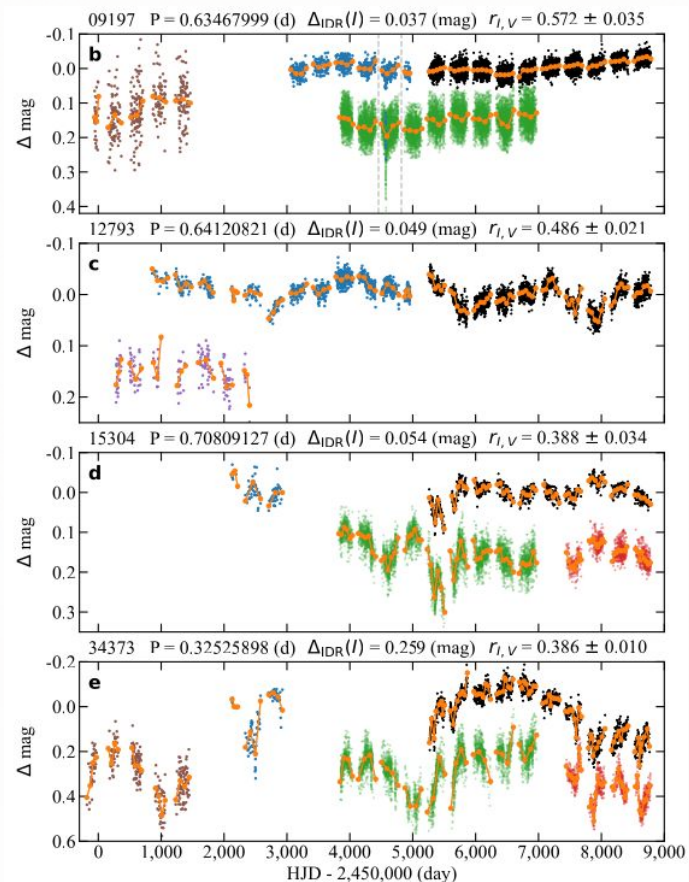
Properties of the sample

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



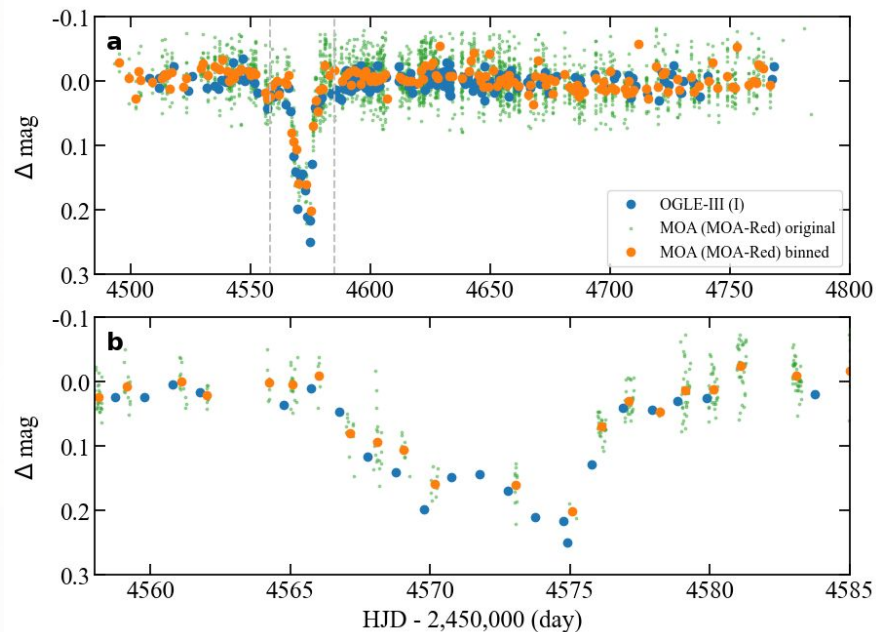
Properties of the sample

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
- eclipse event for 09197 is confirmed by MOA data!



Properties of the sample

Prevalence:

- 72 stars (71 R Rab, 1 R R C)
- 5 / 72 binary candidates

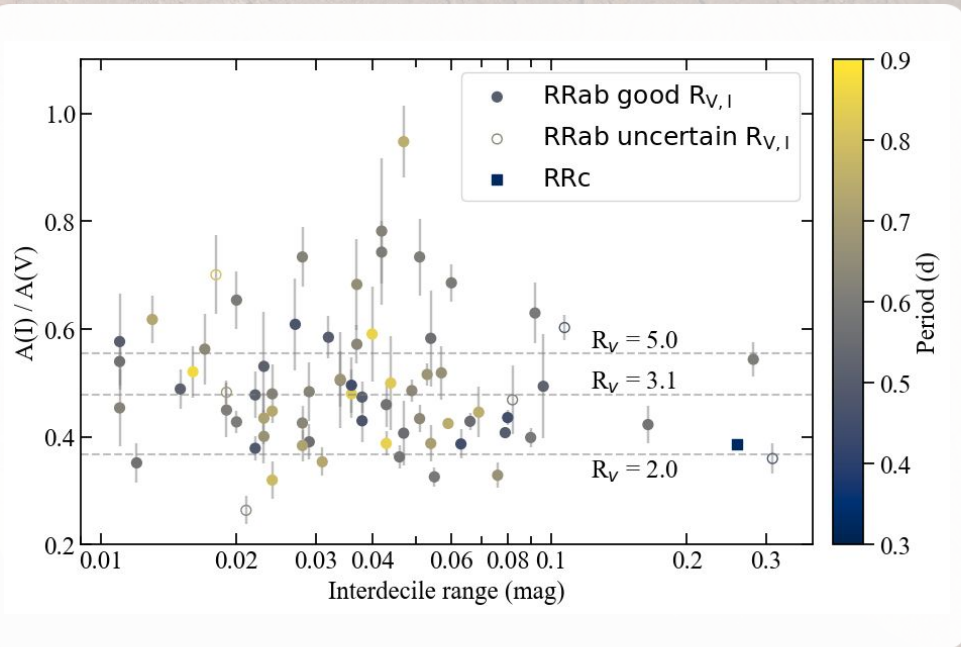
A(I)/A(V) distribution:

- broad distribution from 0.35 to 0.8, wider than “normal” extinction
- supports a circumstellar (probably circumbinary) dusty origin
- moderate dust masses

(a: $\sim 1.3 \times 10^{18}$ kg)

(c: $\sim 6.7 \times 10^{17}$ kg)

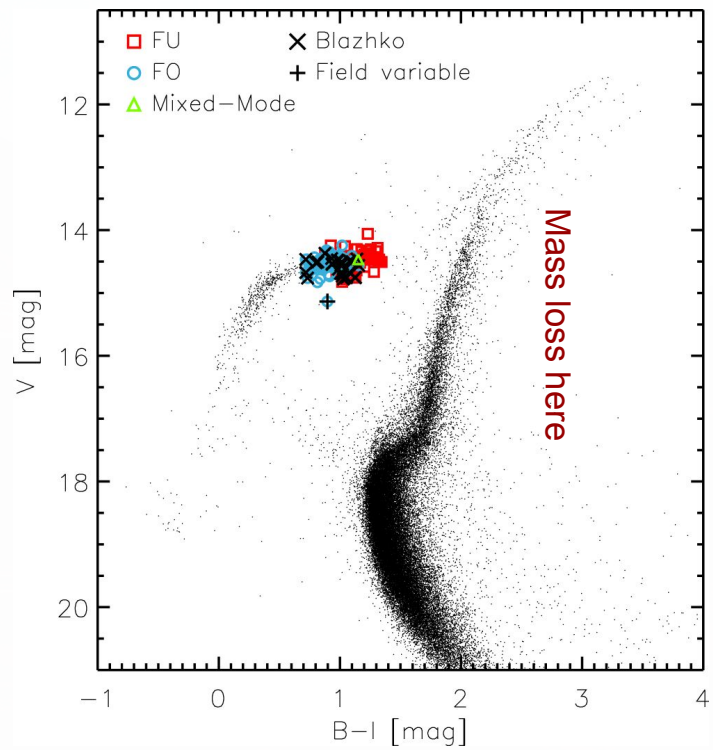
(e: $\sim 1.1 \times 10^{18}$ kg)



Connection to other kinds of stars

Things to consider:

- present in binary systems, $\sim P_{orb}$
- circumbinary dust? companion?
- source of dust? RRL itself? WD?

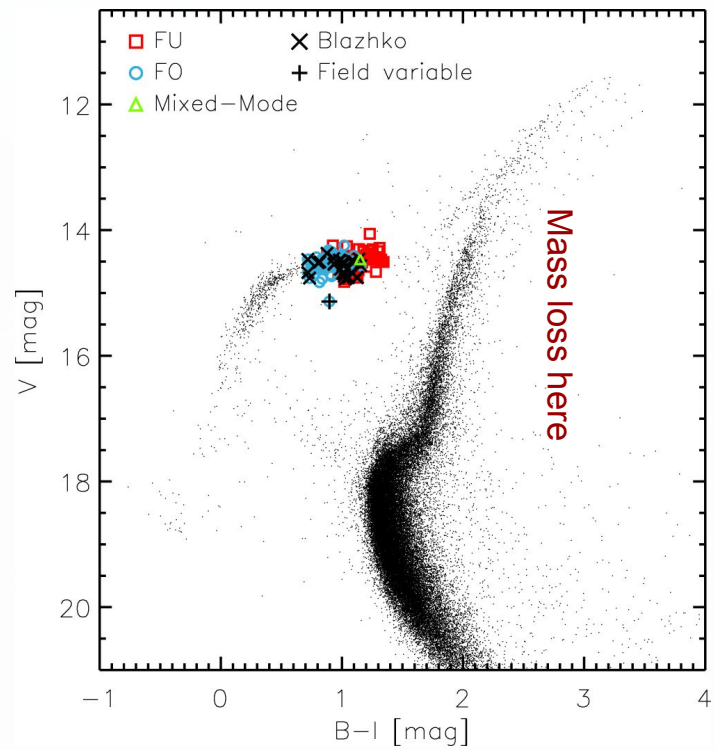
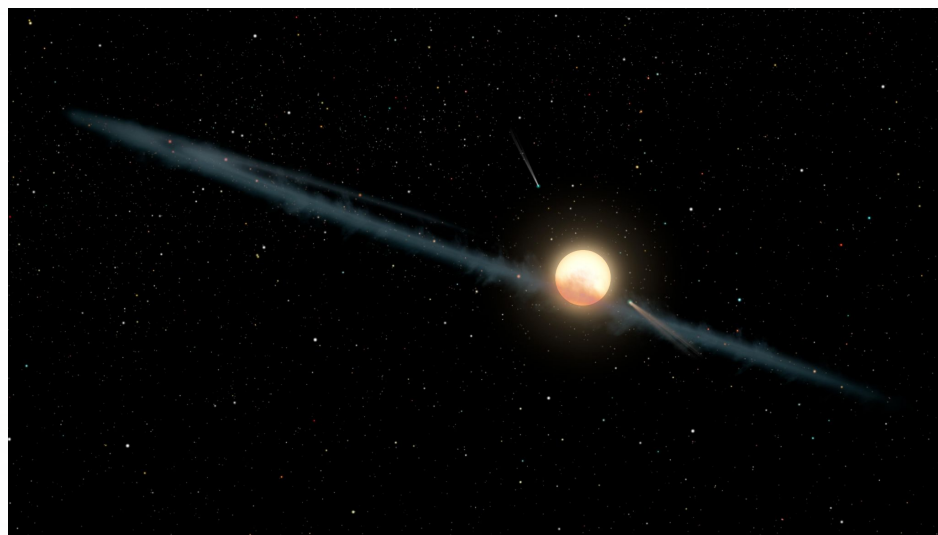


Braga+2016

Connection to other kinds of stars

Things to consider:

- present in binary systems, $\sim P_{orb}$
- circumbinary dust? companion?
- source of dust? RRL itself? WD?



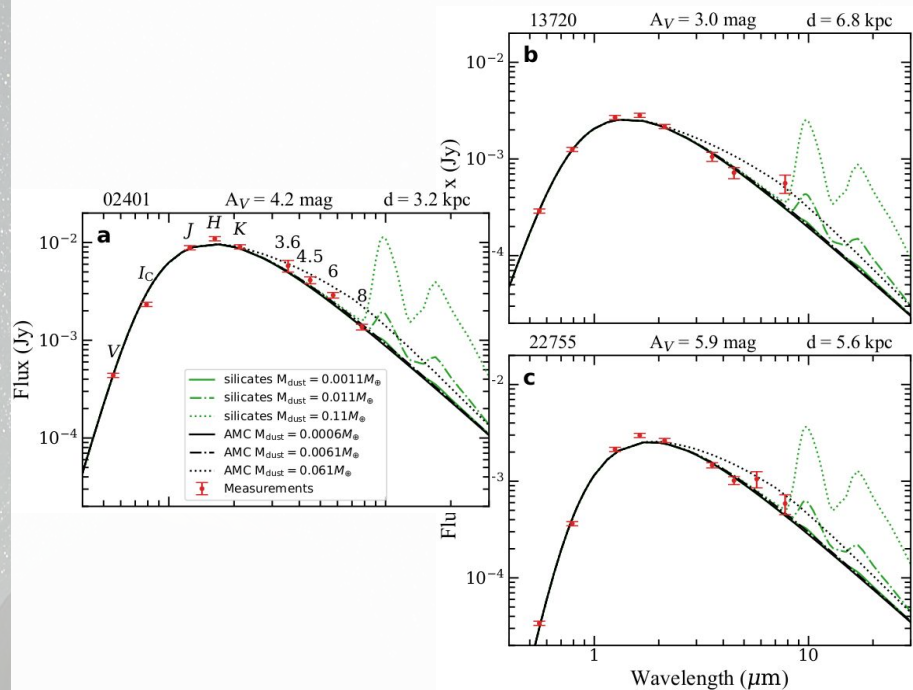
Spectral energy distributions

SED model:

- DUSTY spherical model
- BB 6200K, inner dust temperature 800K (~4AU)
- AMC and silicate models

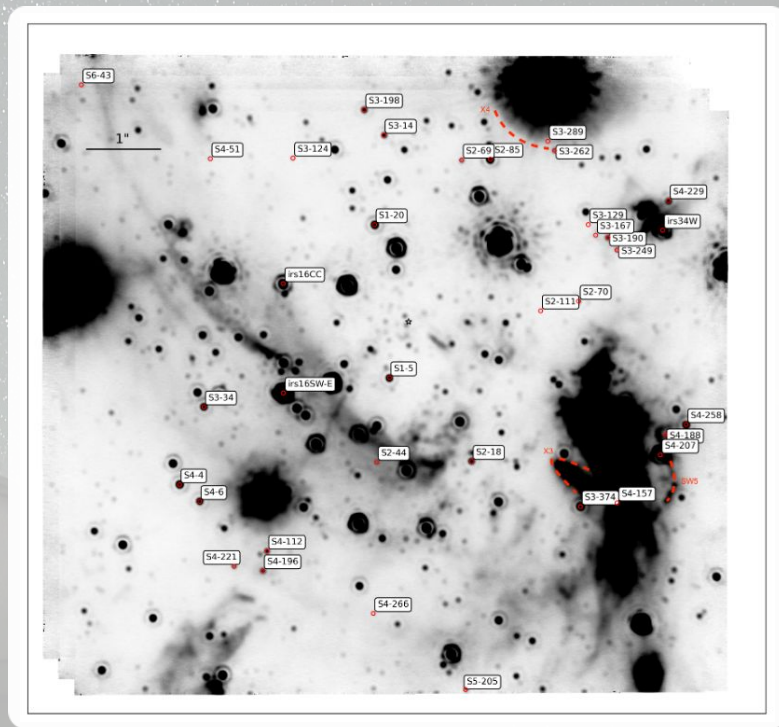
Observations:

- brightness and crowding limited (Spitzer, WISE)
- only 3 stars detected at 8um (GLIMPSE)
- no sign of IR excess



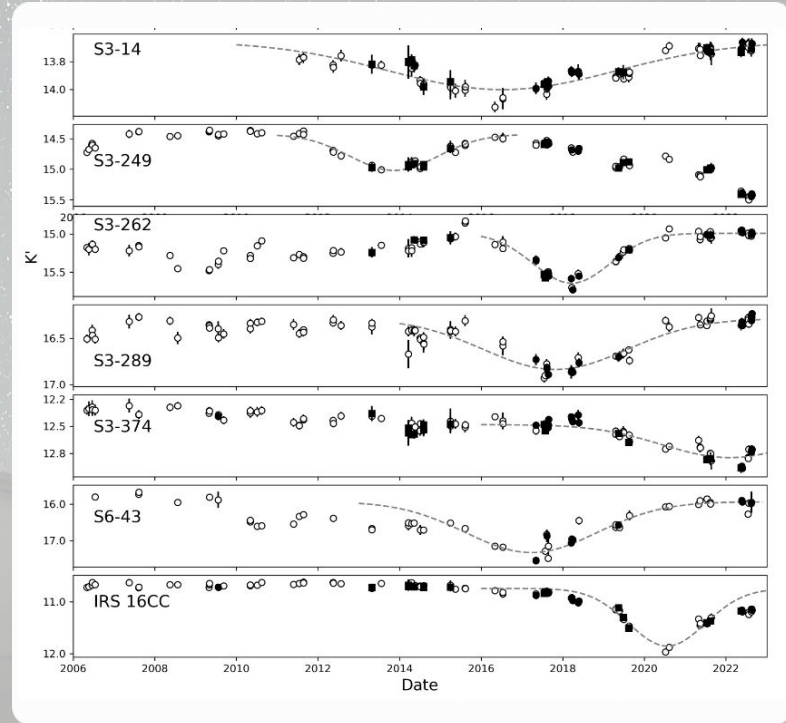
Alternative explanation

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



Alternative explanation

- variable interstellar extinction
- recently claimed for the Galactic center region (Haggard+2024)
- dust concentrated in arcs
- +
– large proper motion of stars
- =
- variable extinction
- PM difference between dust and bulge RR Lyrae ~ 200 km/s



Additional clues

OGLE Galactic bulge RRL sample:

- huge mess: 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)

