

# A-Stars of the Hyades

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2024 CHARA Science Meeting, Tucson, AZ

# The Hyades

Closest Open Cluster to the Sun  
(at 47 pc)

Open Clusters are Great!

Similar...

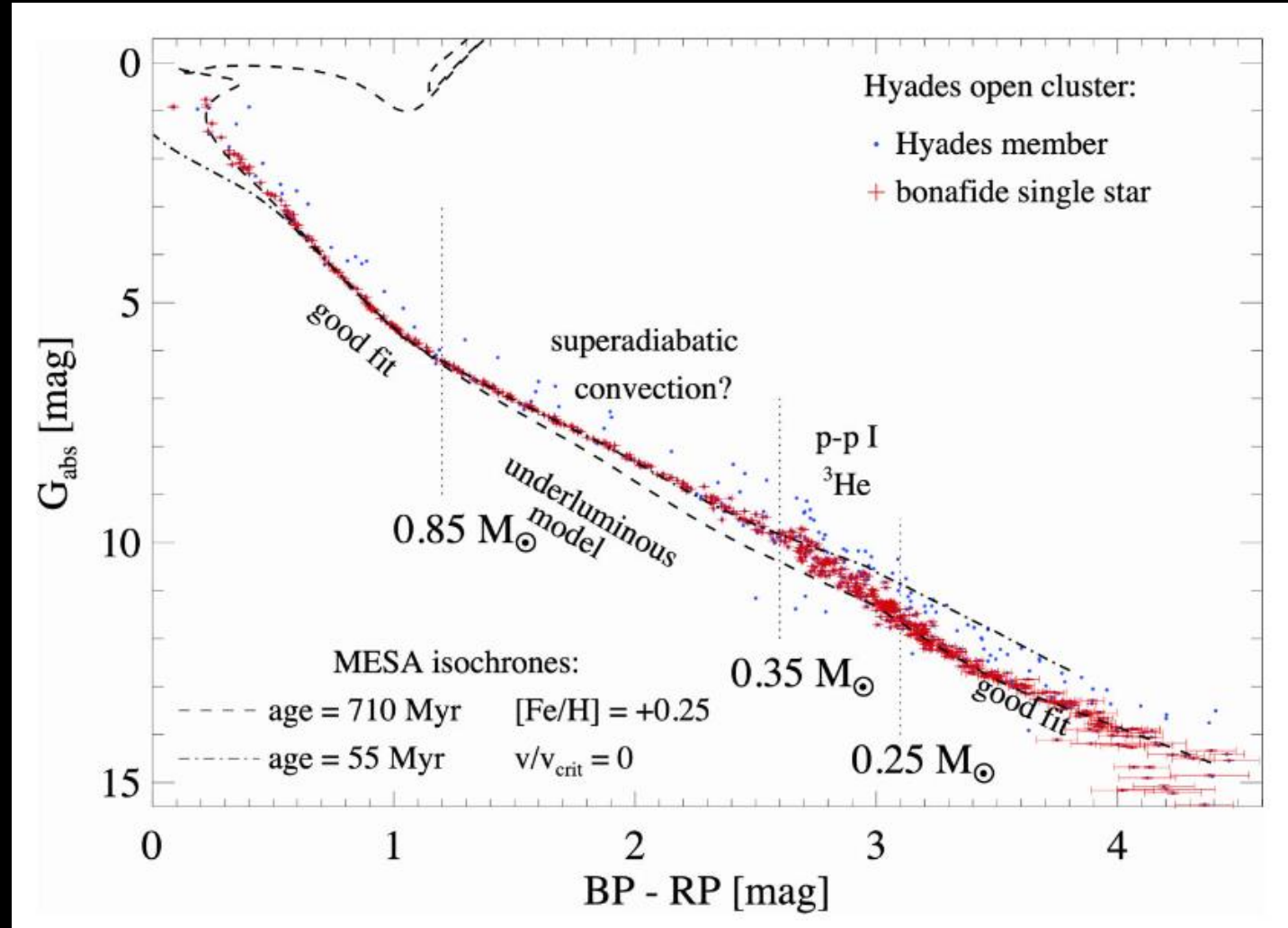
Age

Metallicity

Distance

Hyades Age Estimates Vary

600-800 Myr



Brandner et al. (2023)



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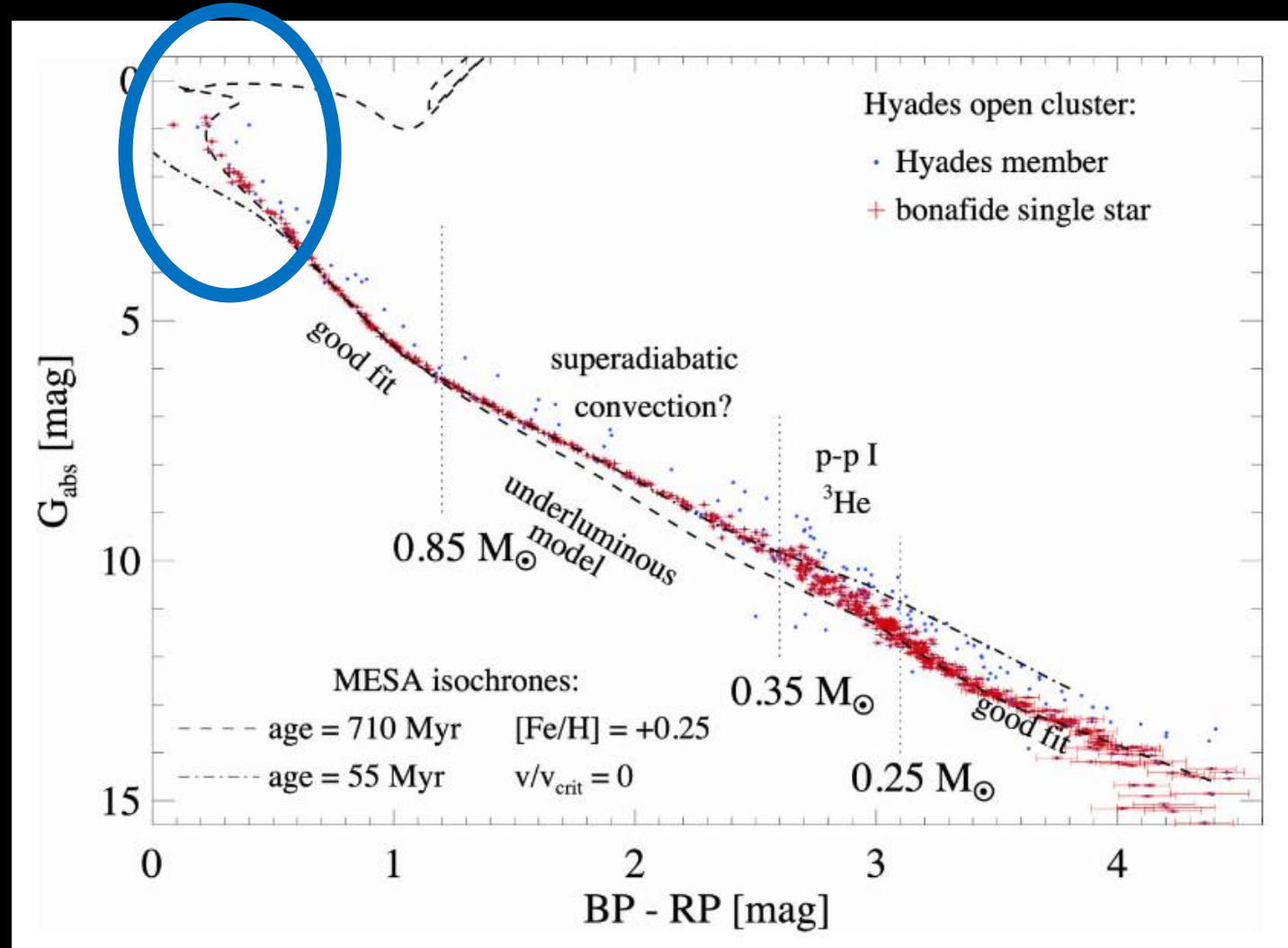
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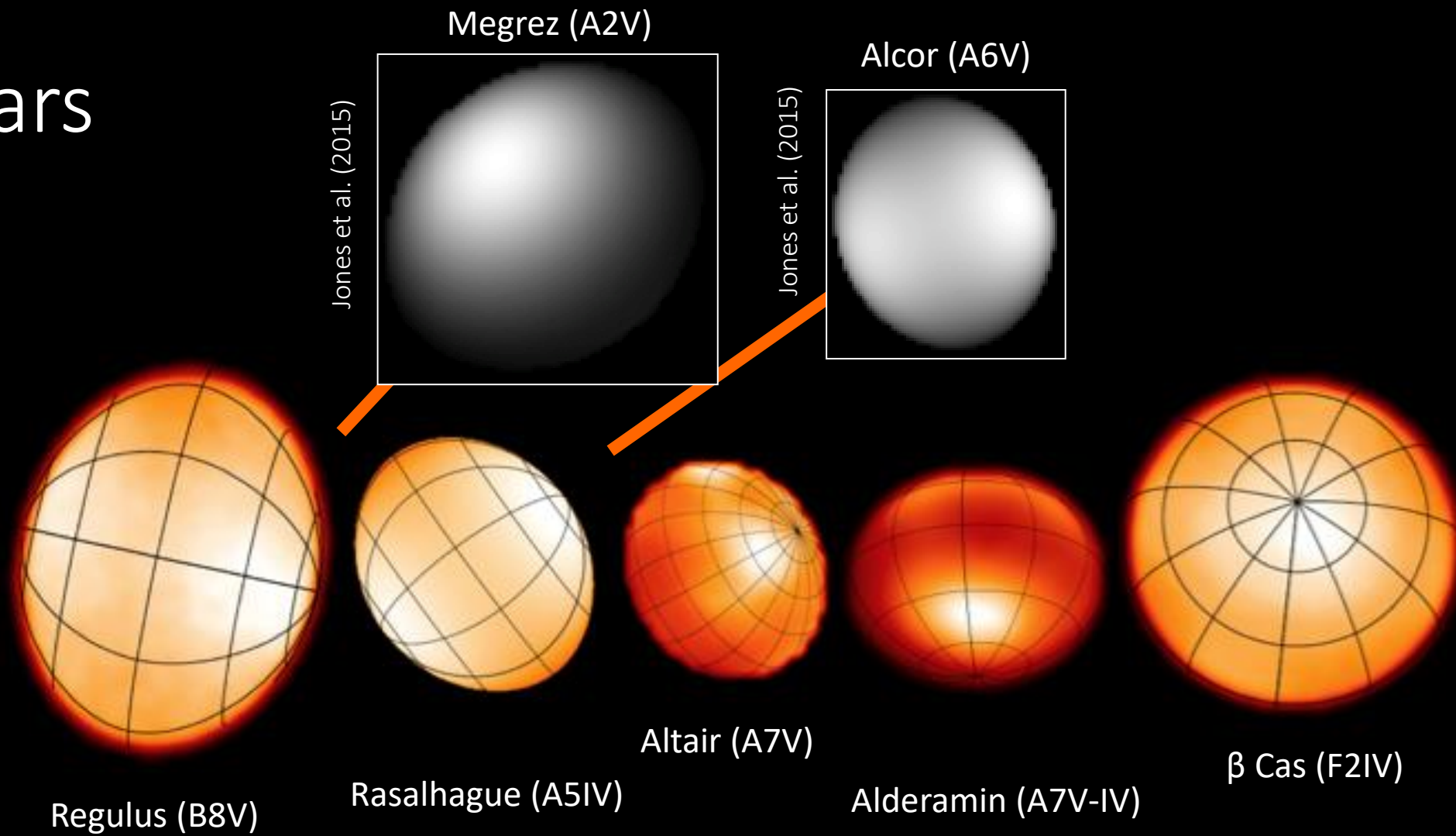
A-Stars are at the MS Turnoff



Brandner et al. (2023)



# A-Stars



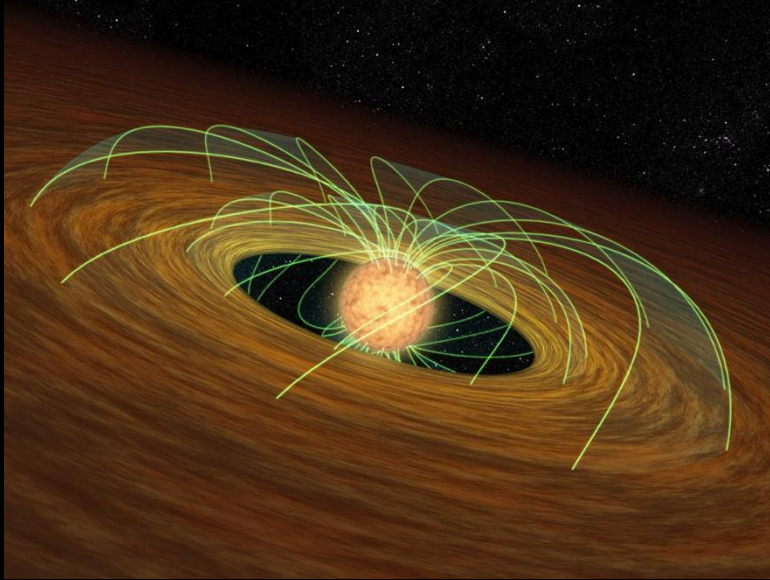
Rapid Rotation –  $v \sin i > 150 \text{ km/s}$



Monnier et al. 2007; Zhao et al. 2009; Che et al. 2011

2  $R_{\text{sun}}$

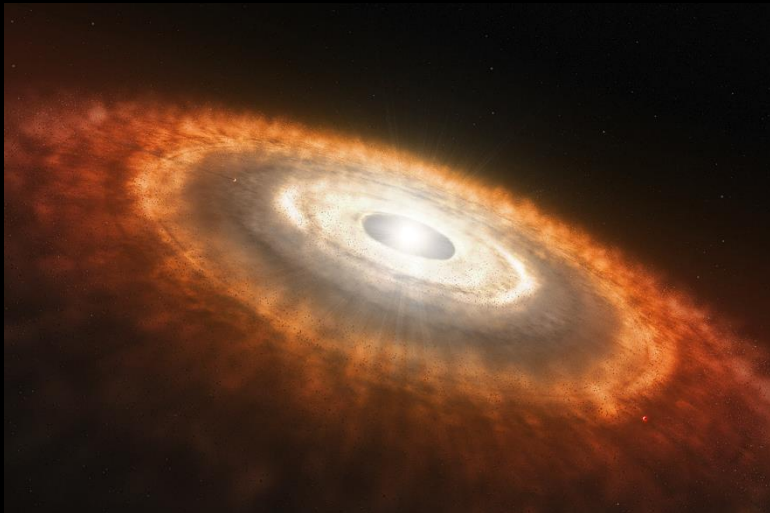
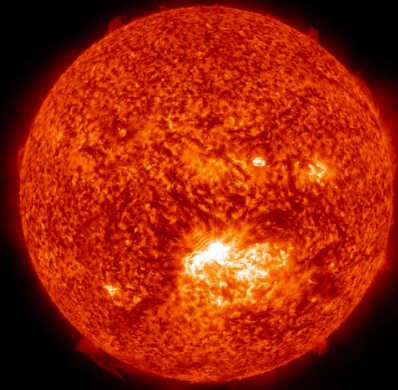
# What Causes Rapid Rotation?



Magnetic Field



Slow Rotation



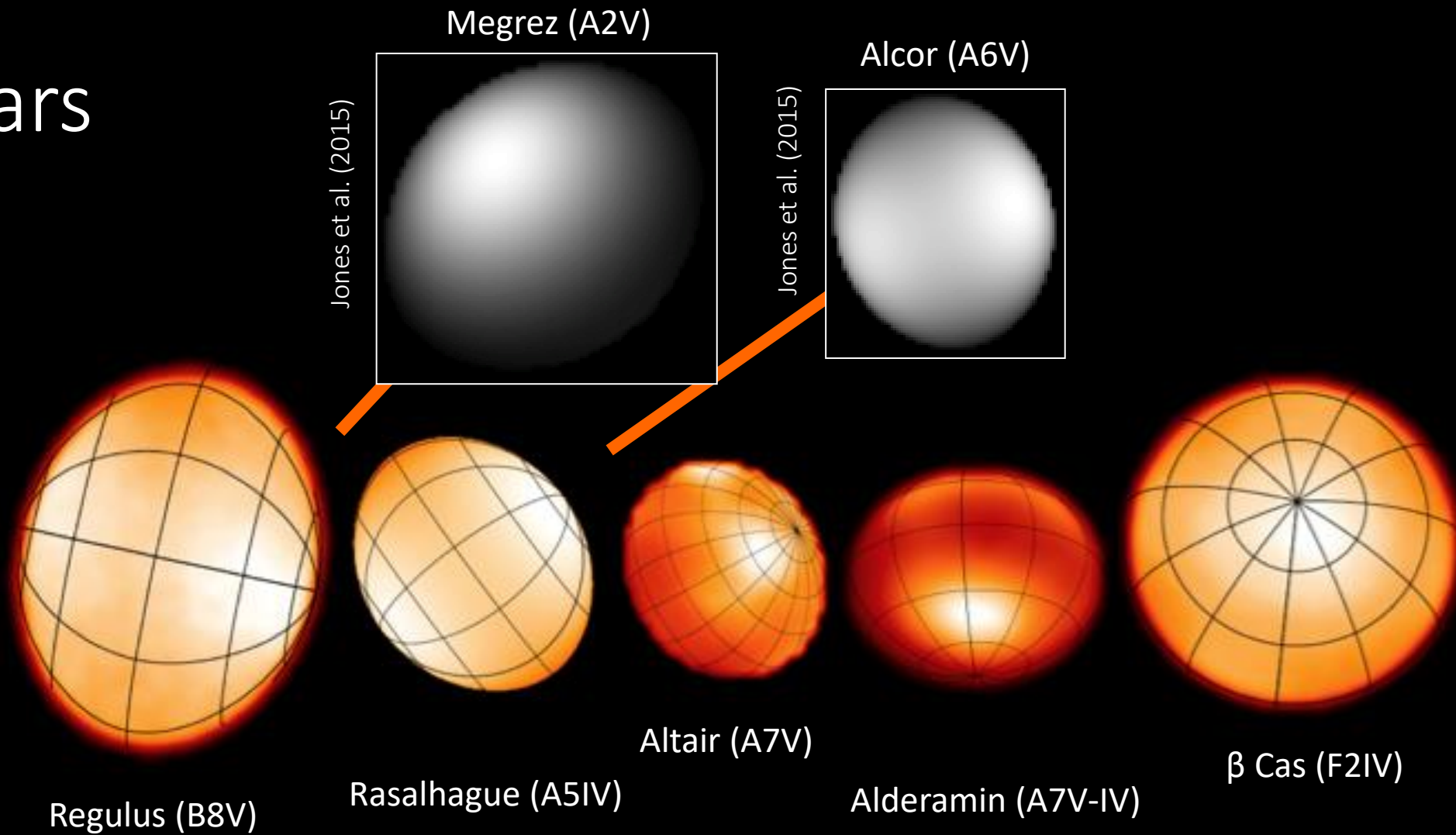
No Magnetic Field



Rapid Rotation



# A-Stars

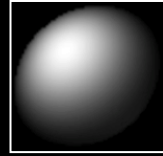


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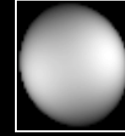


# A-Stars

Megrez (A2V)



Alcor (A6V)



Regulus (B8V)



Rasalhague (A5IV)



Altair (A7V)



Alderamin (A7V-IV)



$\beta$  Cas (F2IV)

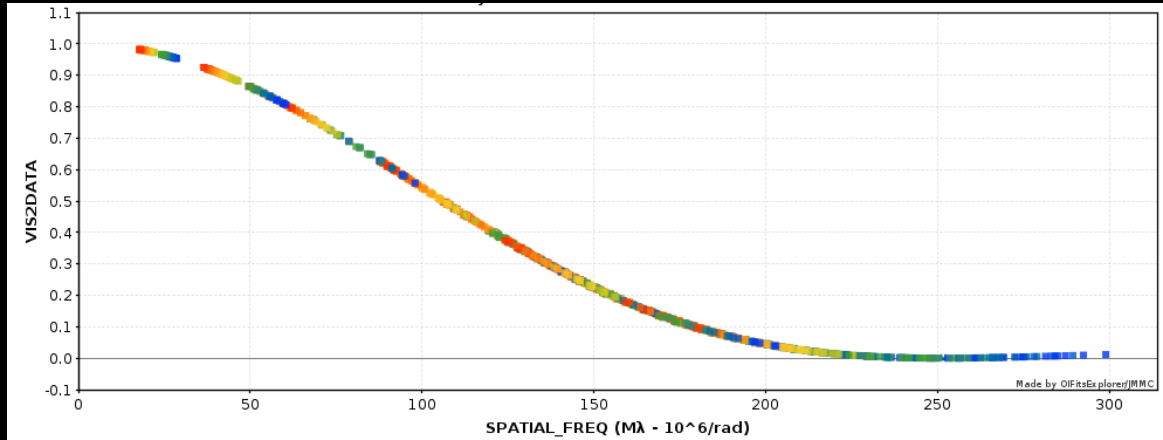


1 mas (ish)



# A-Stars – Imaging vs. Modeling

Imaging



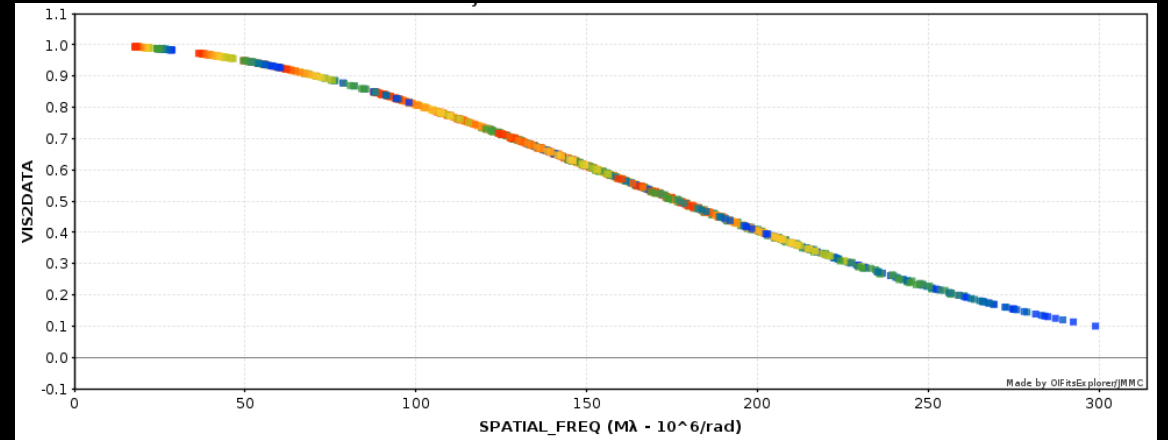
You need (at least):

- > 1 mas (in H-band) or > 0.5 mas (in R-band)
- $\geq 4T$  & closure phases

You get:

- Size
- Shape
- Inclination
- Gravity Darkening

Modeling



You need (at least):

- > 0.5 mas (in H-band) or > 0.2 mas (in R-band)
- Multiple 2T obs
- Grav. Dark. Prescription
- Photometric Fluxes

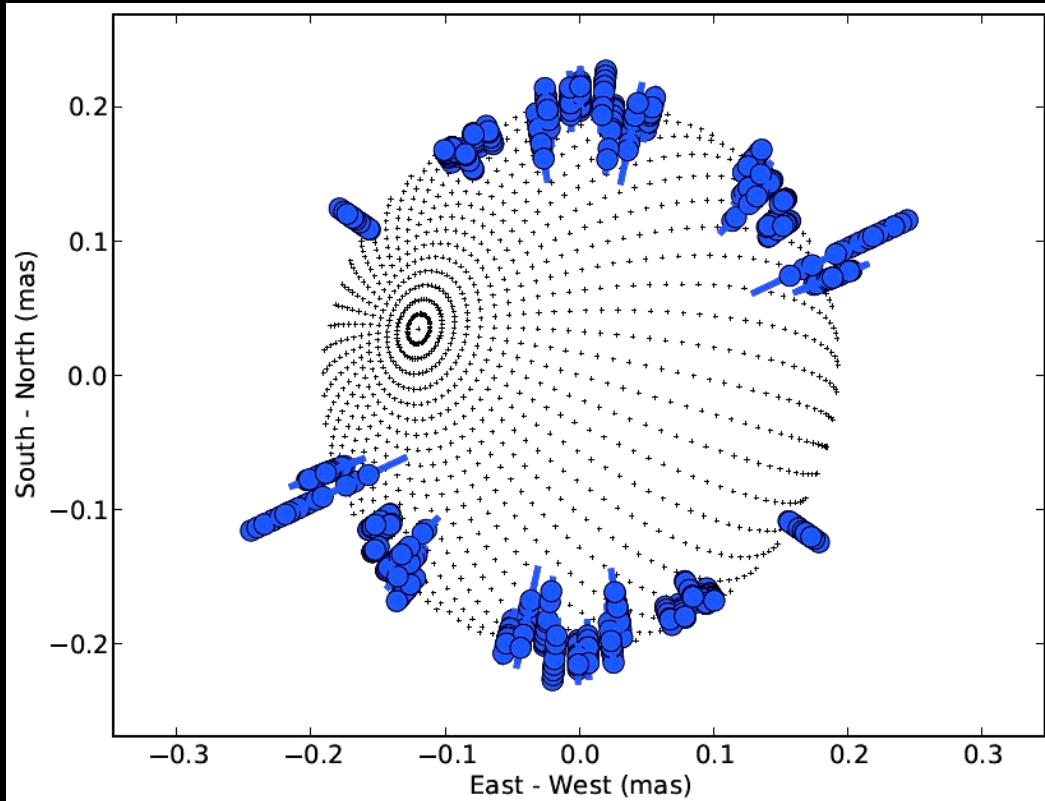
You get:

- Size
- Shape
- Inclination (more or less)
- More stars!



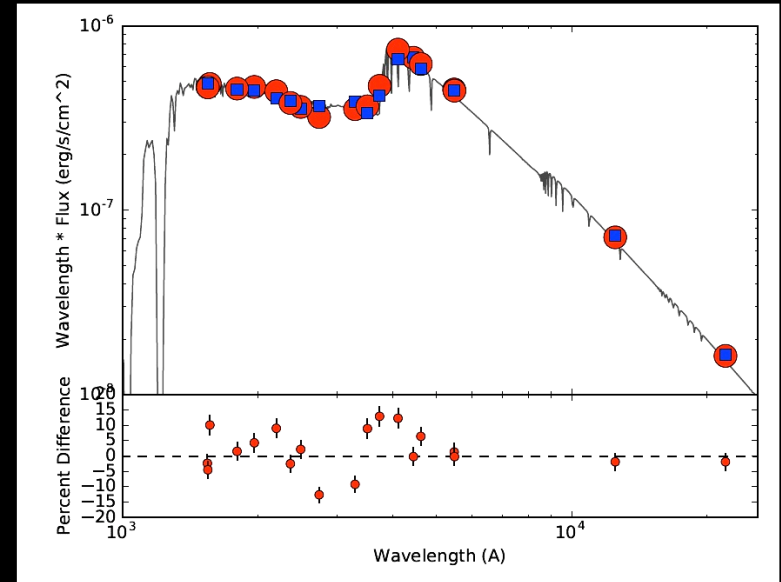


# A-Stars – Oblate Star Model

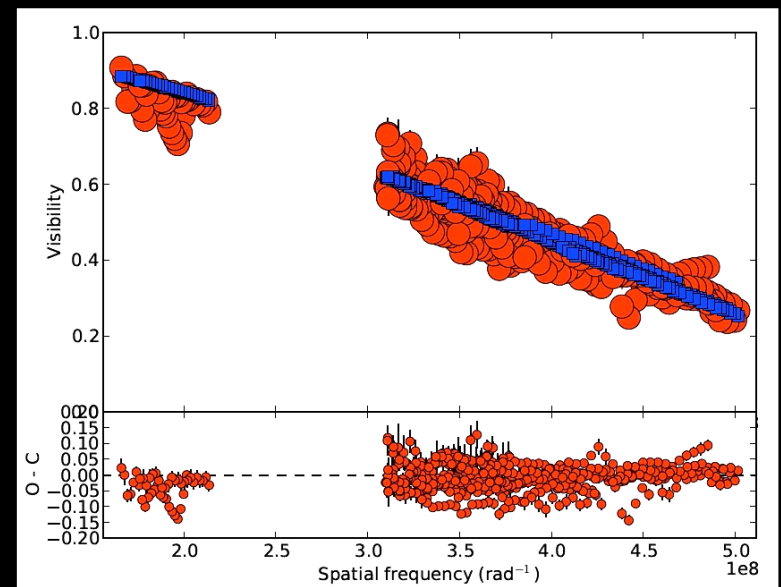


$\kappa$  And from Jones et al. (2016)  
Not in Hyades, but good example of the technique

Photometry from Literature

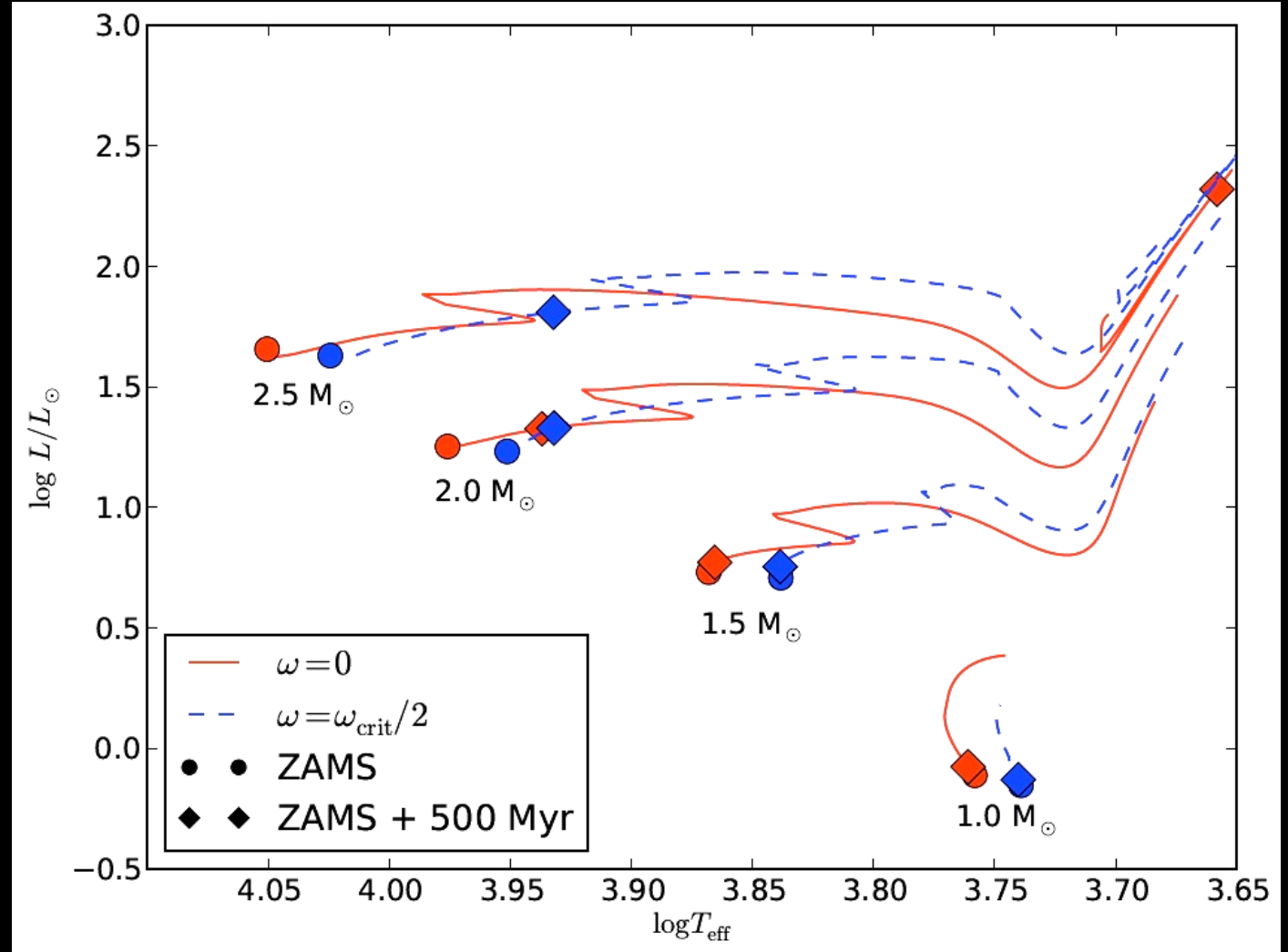


Visibilities from CHARA



# A-Stars – Ages

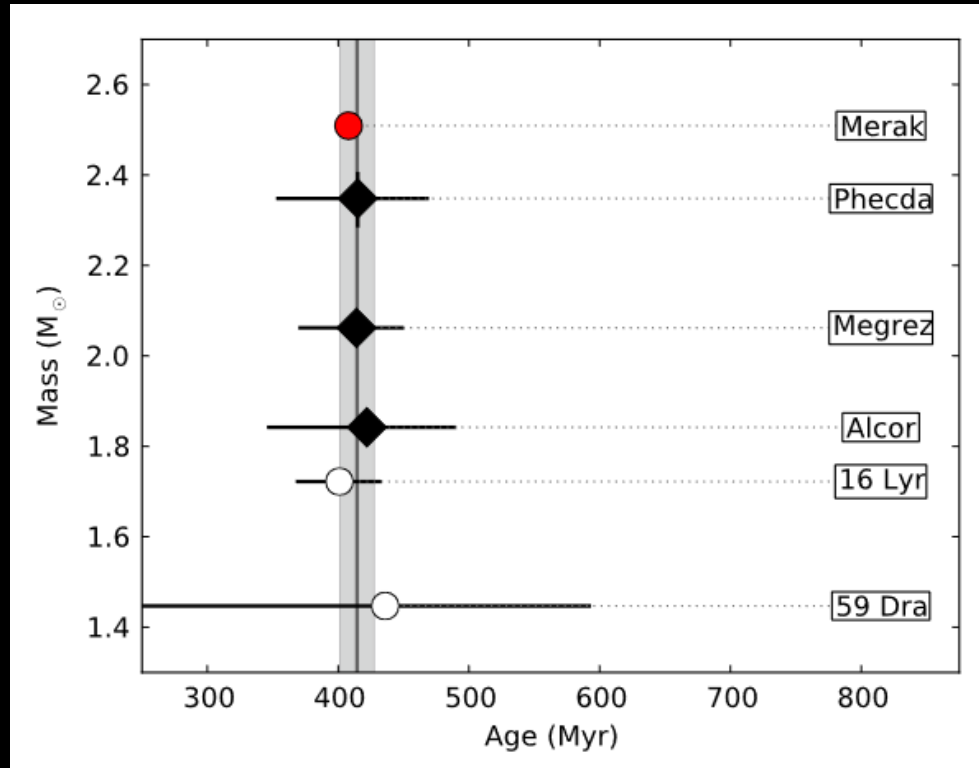
- **RR Model Output Parameters**
  - Total Luminosity
  - Average Radius
  - Equatorial Rotation Velocity
- **Comparison with Evolution Models**
  - Age
  - Mass
  - Initial Rotation Rate



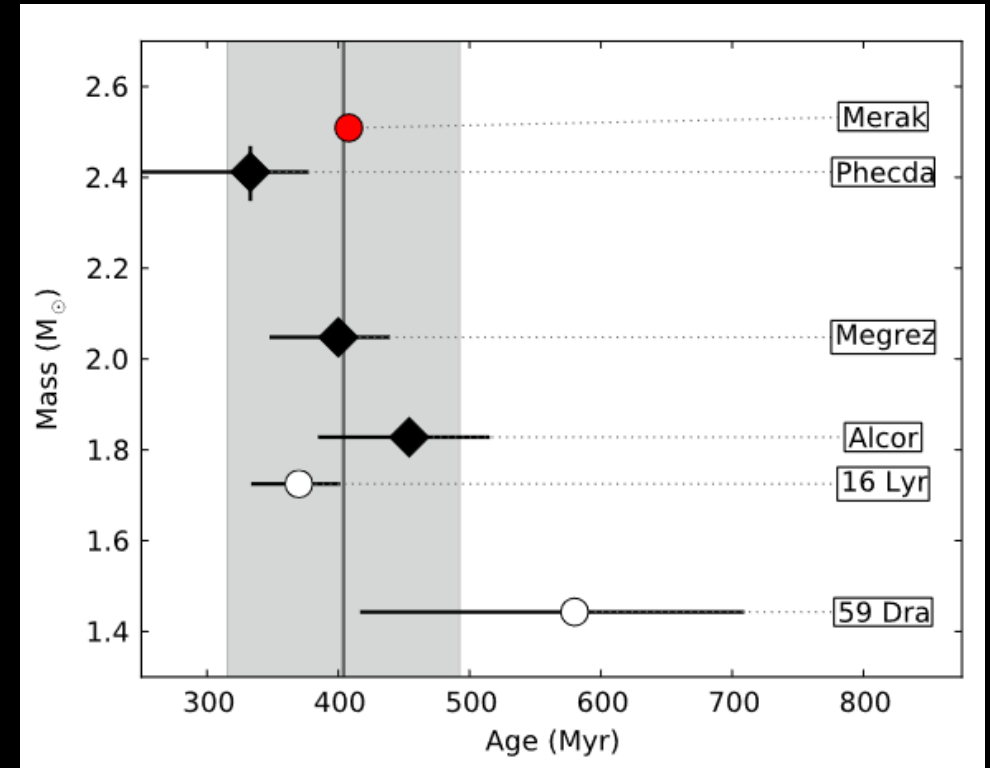
# A-Stars – Ages

## Test Case: Ursa Major Moving Group

Gravity Darkening: von Zeipel law –  $\beta = 0.25$



Gravity Darkening: Espinosa Lara & Rieutord –  $\beta = \beta(\omega)$



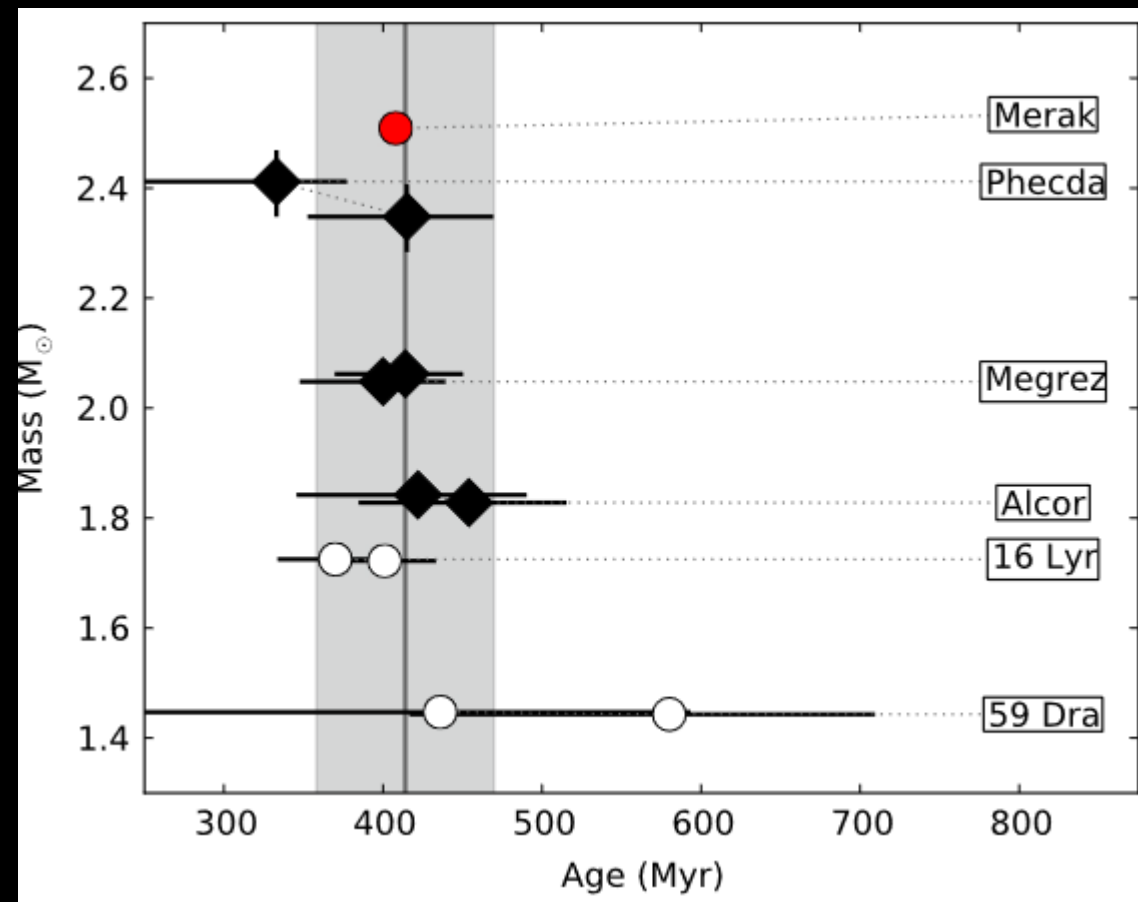
Jones et al. 2015



# A-Stars – Ages

Test Case: Ursa Major Moving Group

Gravity Darkening: Both

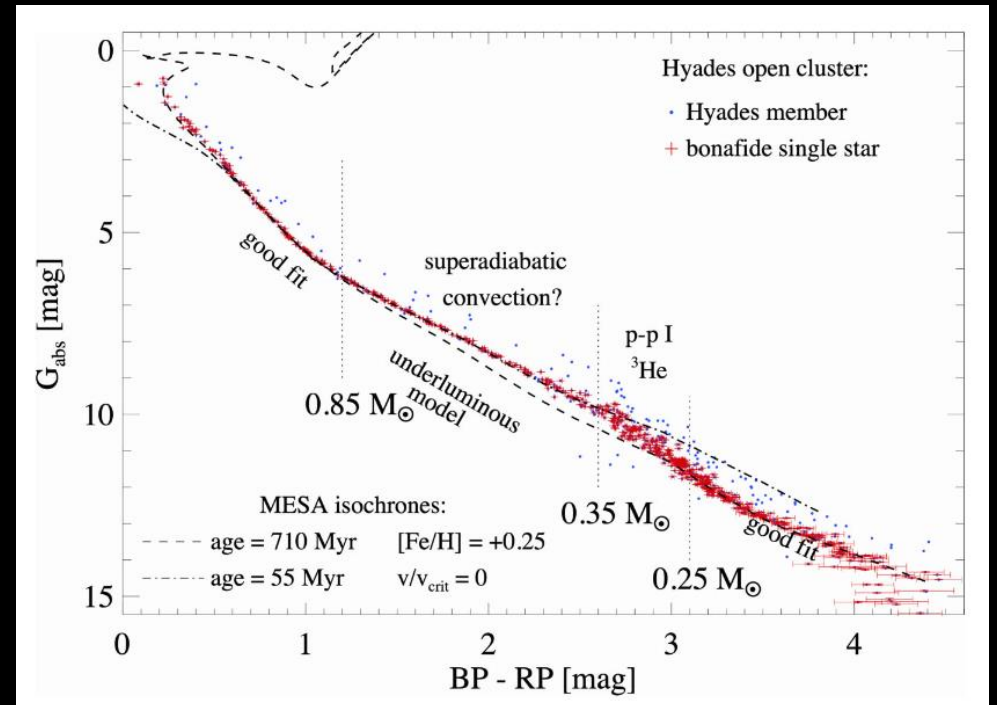


**Age**  
 $414 \pm 23$  Myr

Jones et al. 2015



# A-Stars of the Hyades

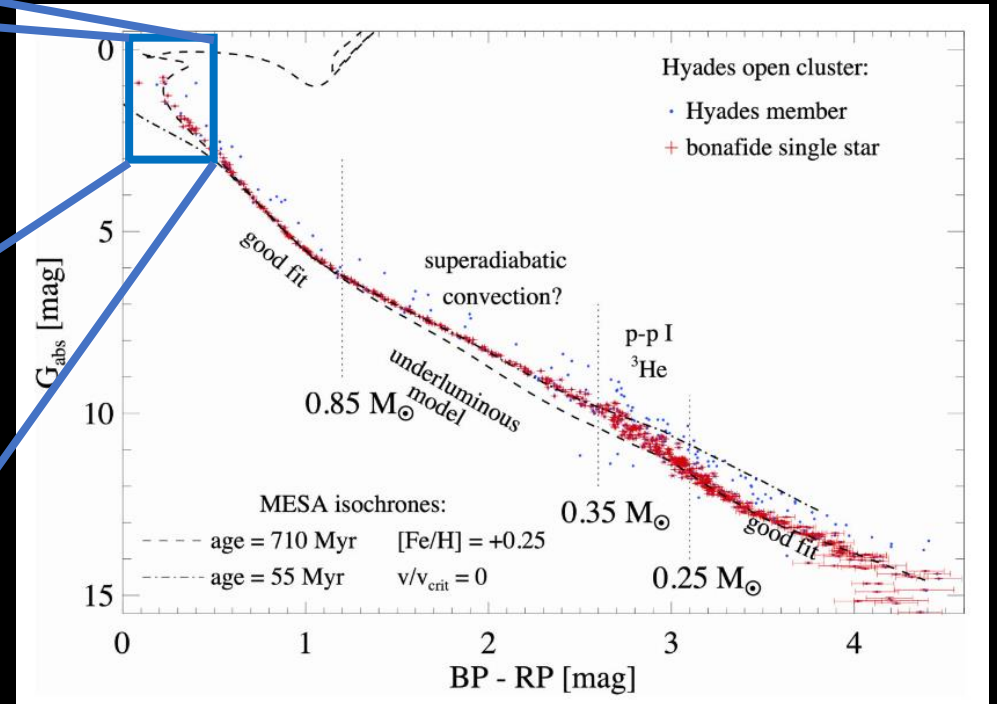
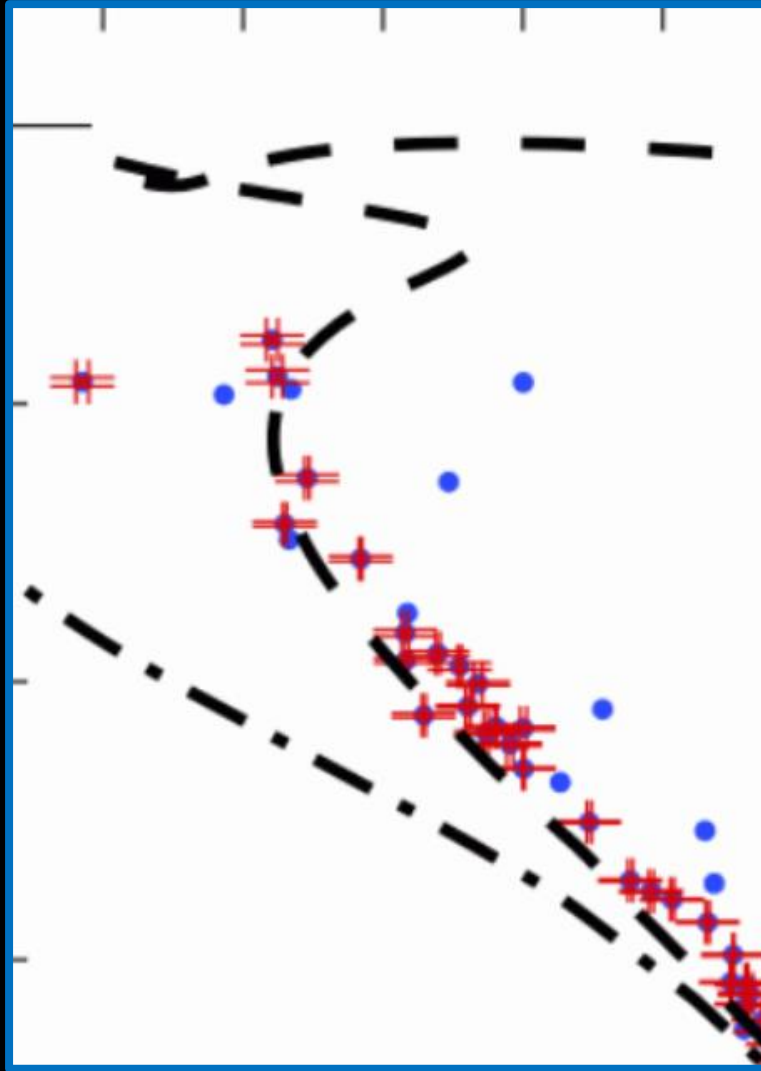


Brandner et al. (2023)



Oh hey! That's the name of the talk!

# A-Stars of the Hyades

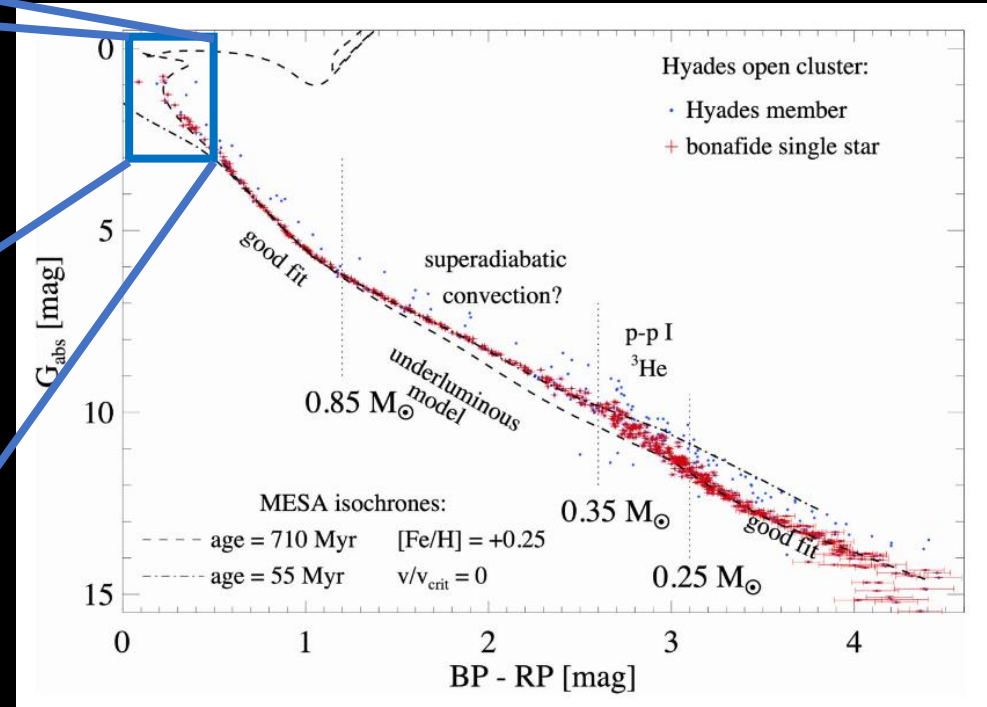
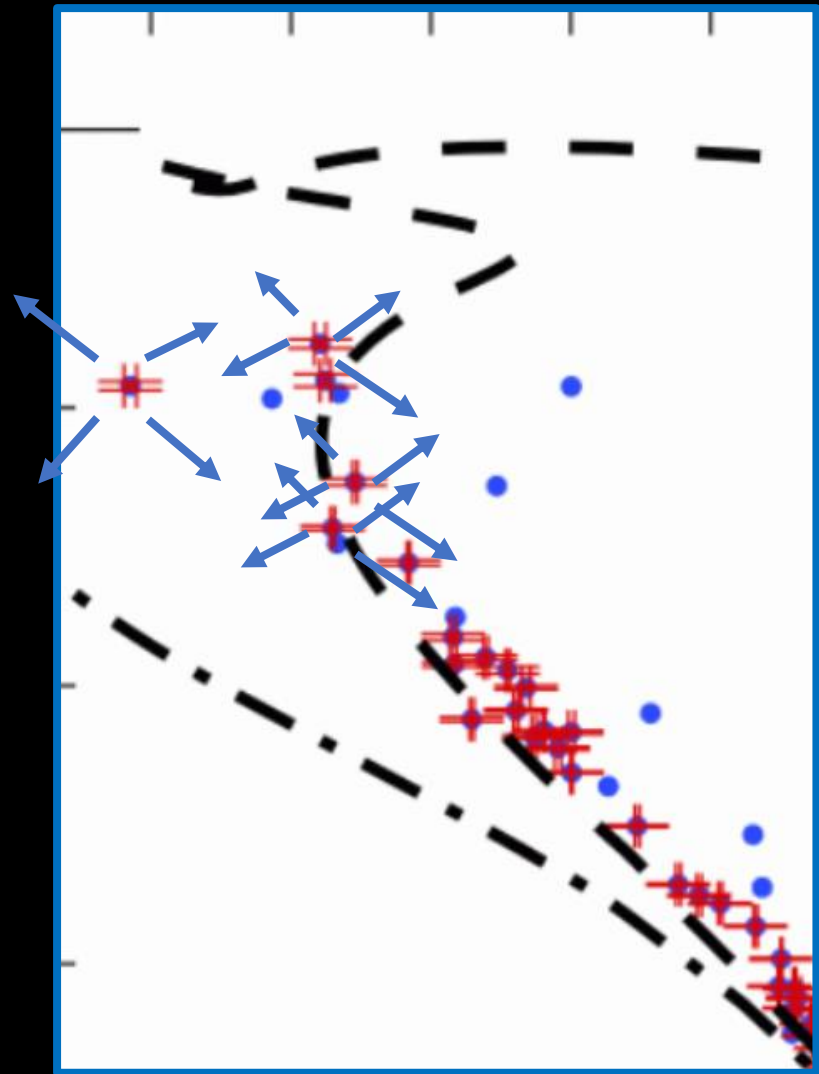


Brandner et al. (2023)

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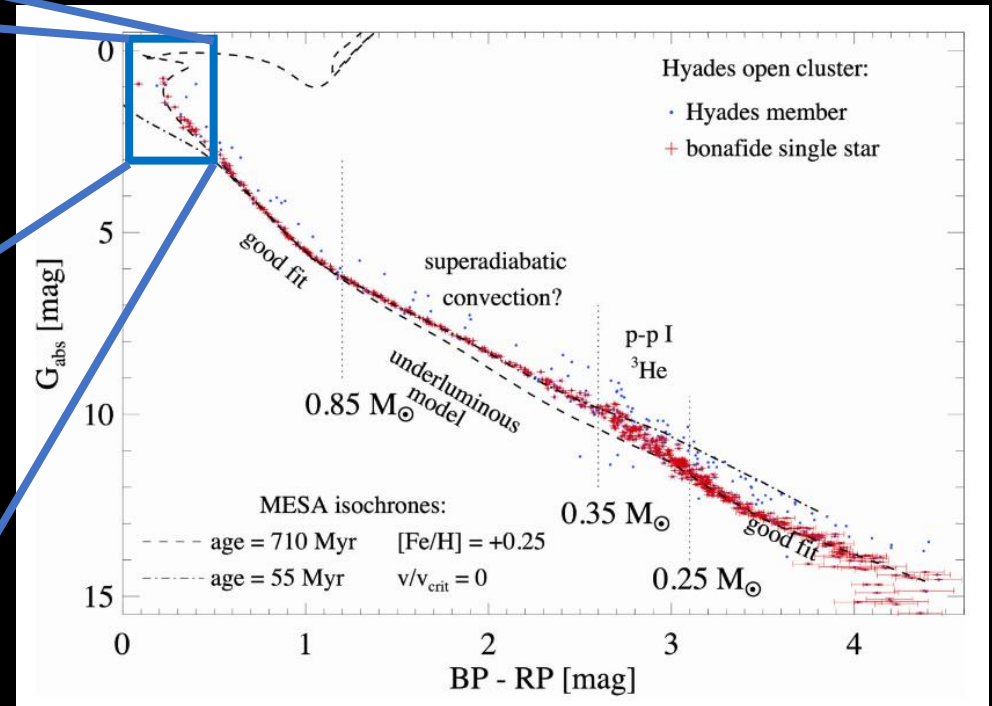
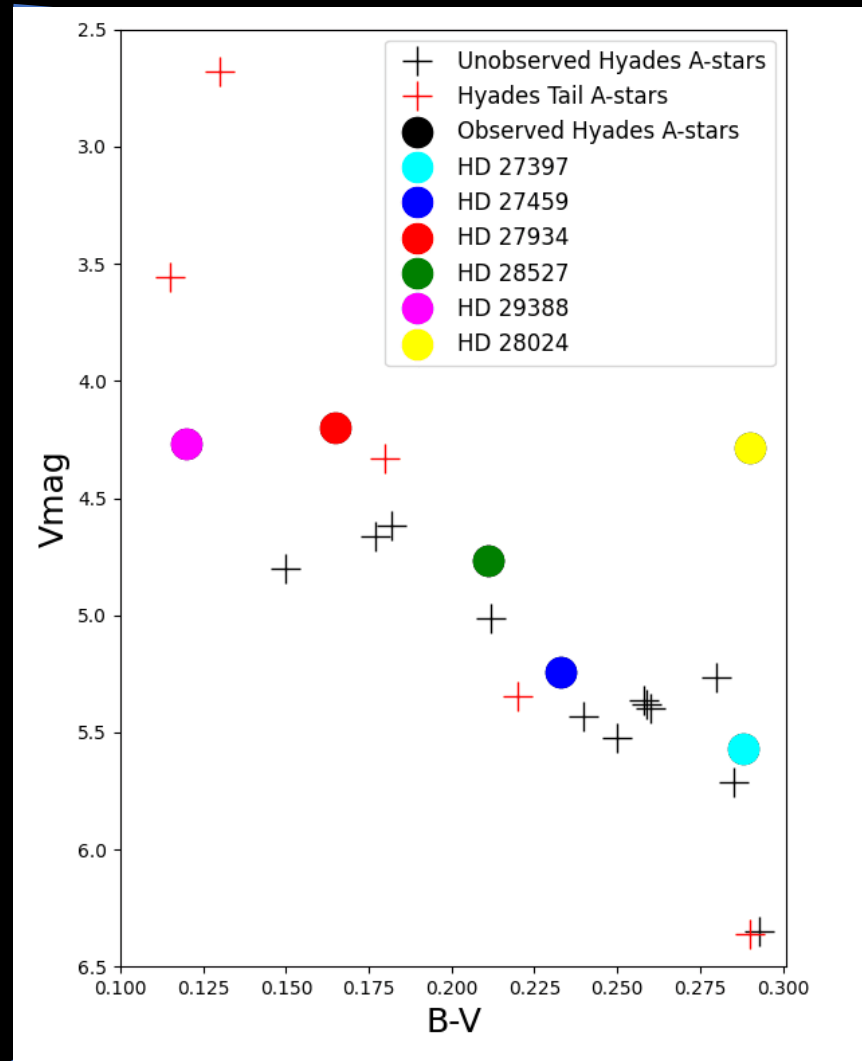


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# A-Stars of the Hyades – Our Sample



ish

Brandner et al. (2023)

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# A-Stars of the Hyades – Our Sample



## Sample Criteria:

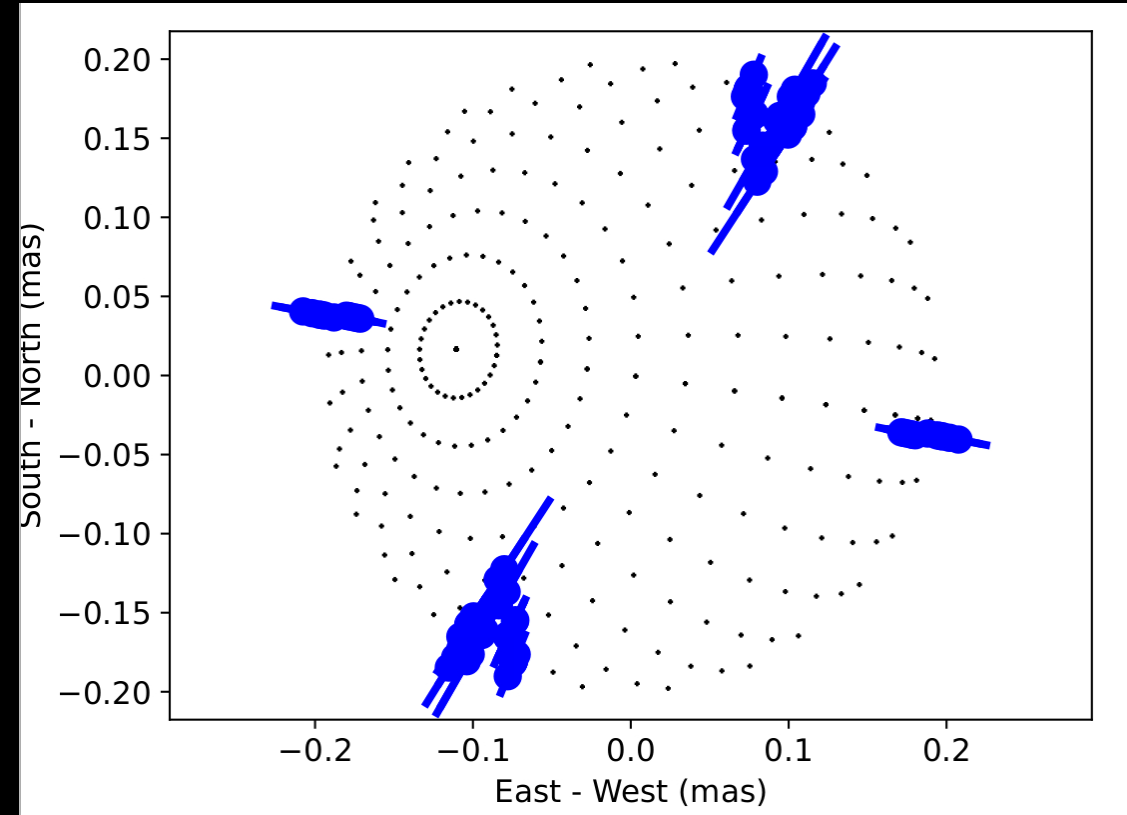
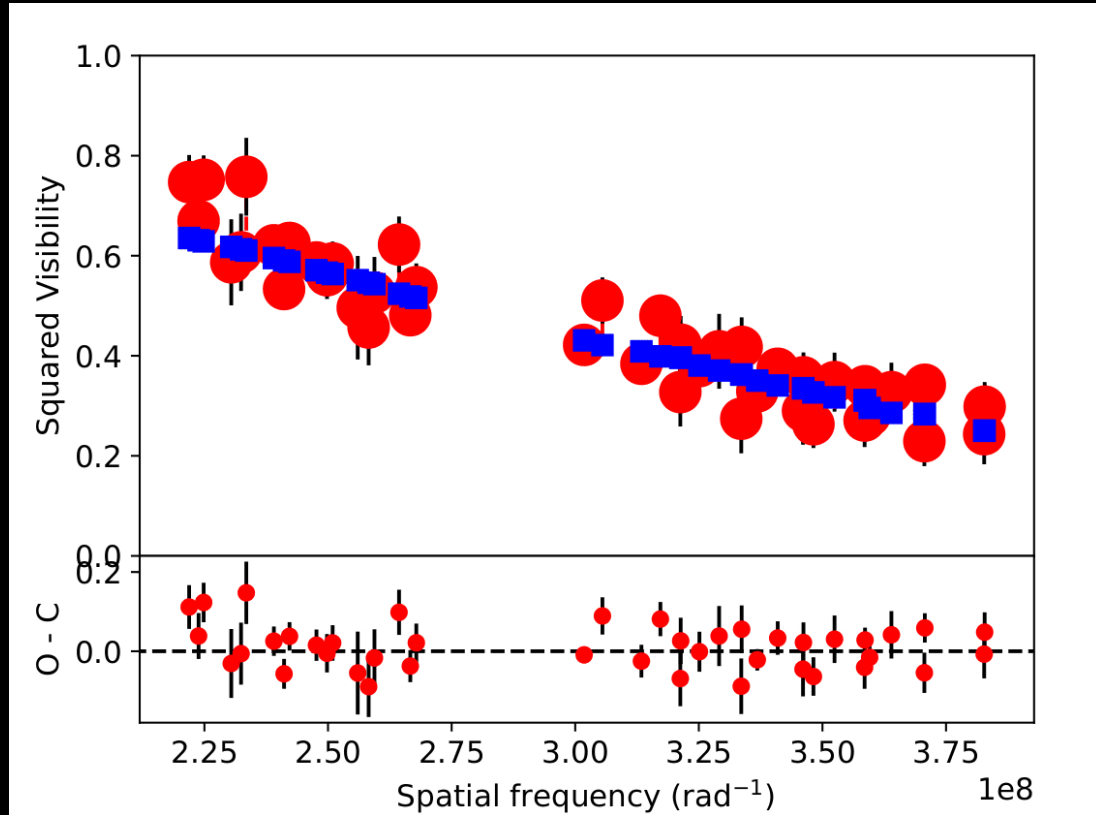
- Hyades Member
- A- Star ( $B-V < 0.31$ )
- No close, bright companions

Sample Status	Core	Tail	Total
Complete	6	0	6
Partial/Unreduced	9	4	13
No Data	3	1	4
Total	18	5	23

“Complete” = Multiple observations  
on at least 3 baselines

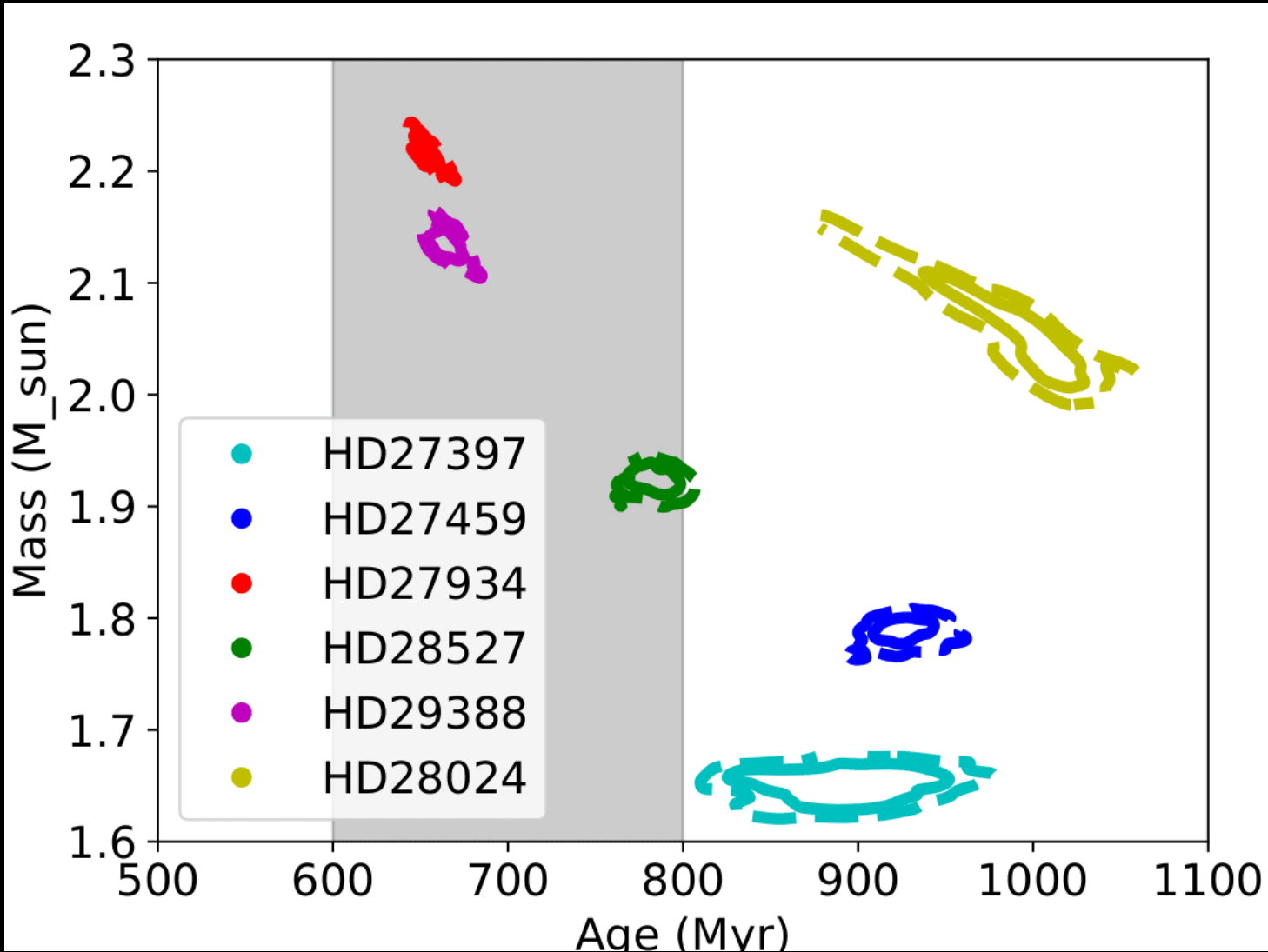


# Example Visibilities – HD 27397



# Age of the Hyades

Initial Ages – Not so good



Lit ages:

600 – 800 Myr

Our spread:

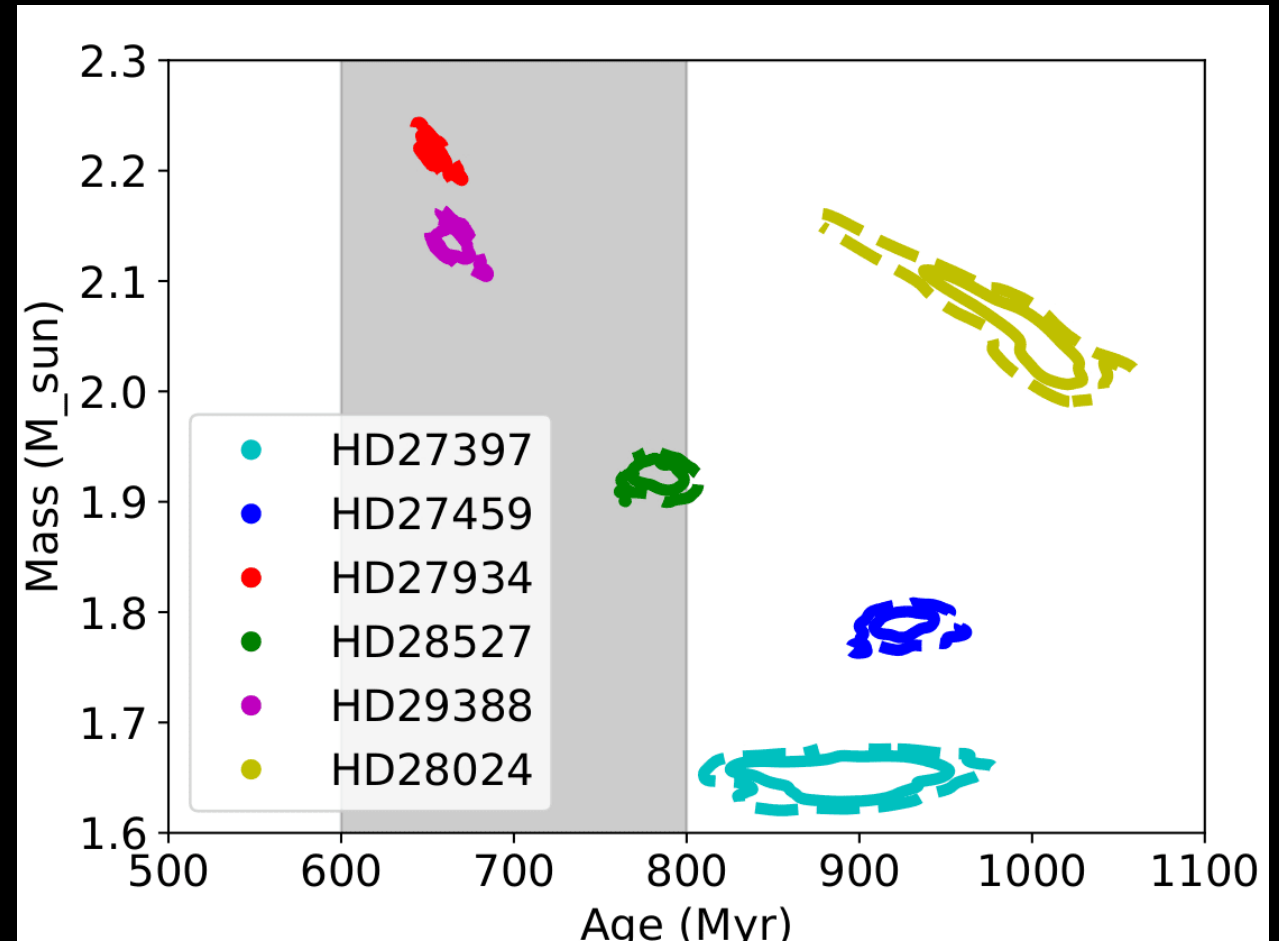
640 – 1000 Myr

# Age of the Hyades

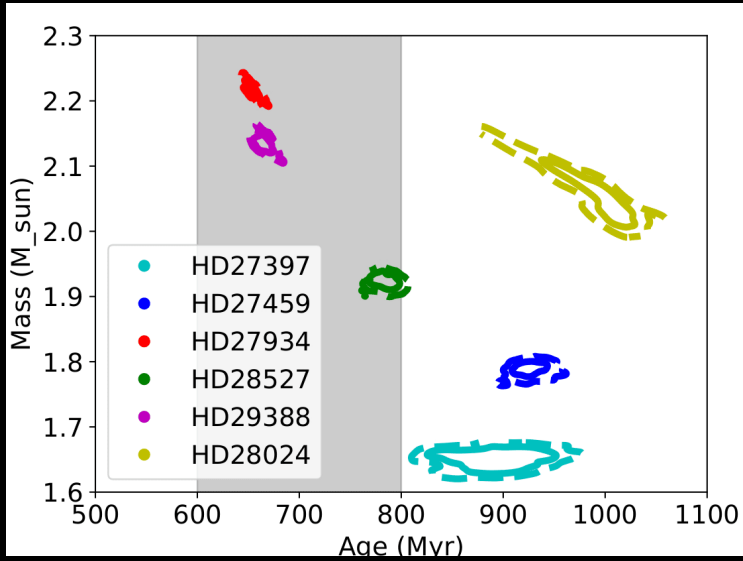
Initial Ages – Not so good

How to address the discrepancies:

- “complete” != complete
  - solution = SPICA
- Better SEDs
  - solution = AAVSO/APASS ?
- More observations
  - solution = dryer & calmer winters

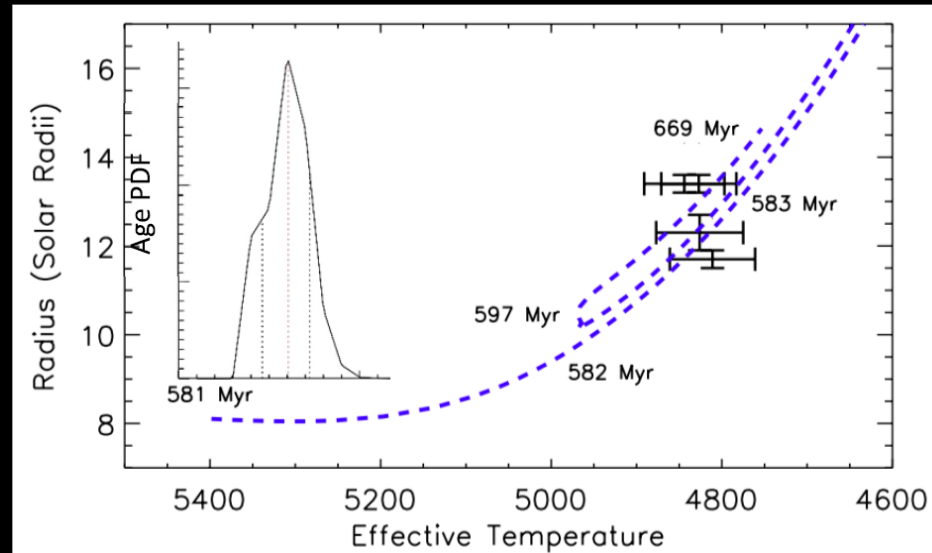


# Nailing Down the Age of the Hyades

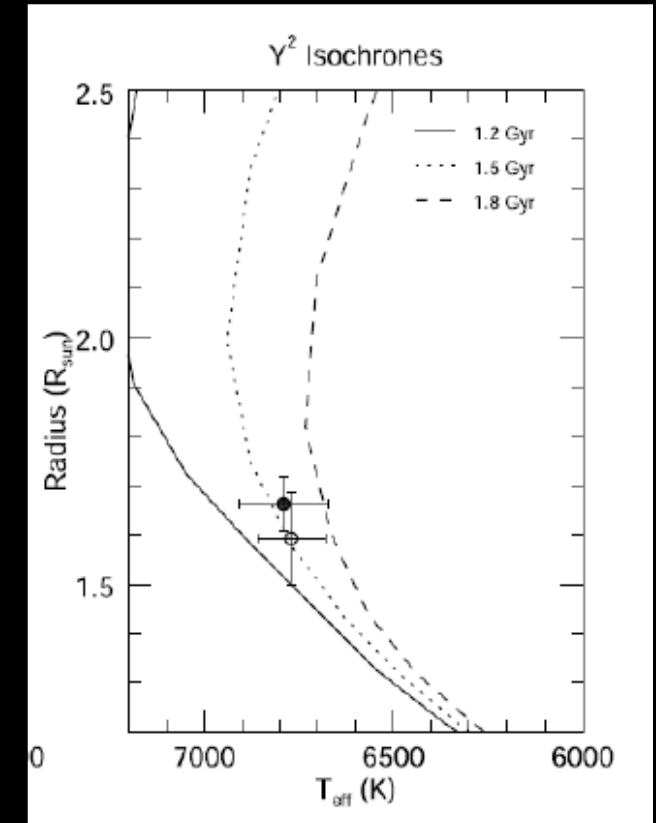


A-Stars

Giants  
with Russel White



Binaries  
with Gail Schaefer



Lester et al. (2020)  
Demonstrating age dating technique for binaries

