How Metallicity Effects the Rotation of Low Mass Stars

JORDAN RILEY

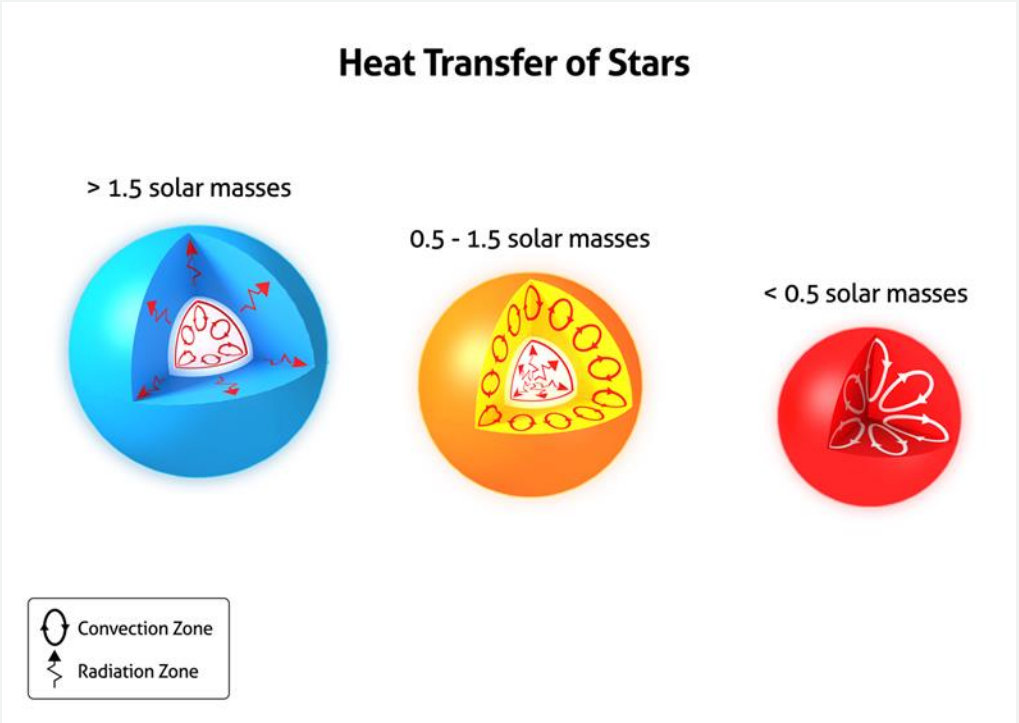
MENTOR: DR. SEAN MATT

ACKNOWLEDGEMENTS: DR. LOUIS AMARD, DAVID GRACIA, LUKE GARCIA, STEPHANIE HALL, RESHMA REBA ALEXANDER, AND JENNA BRUSTAD

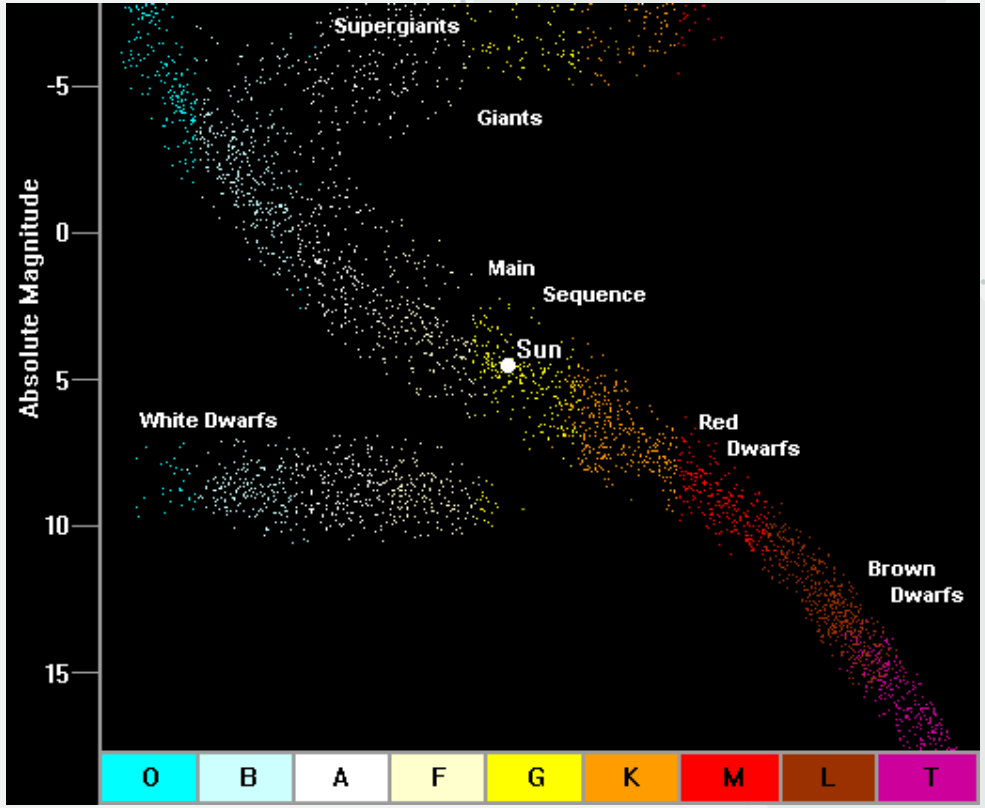
Homer L. Dodge Department of Physics and Astronomy

Background

- Low Mass Stars < 1.4 M⊙
  - F through M

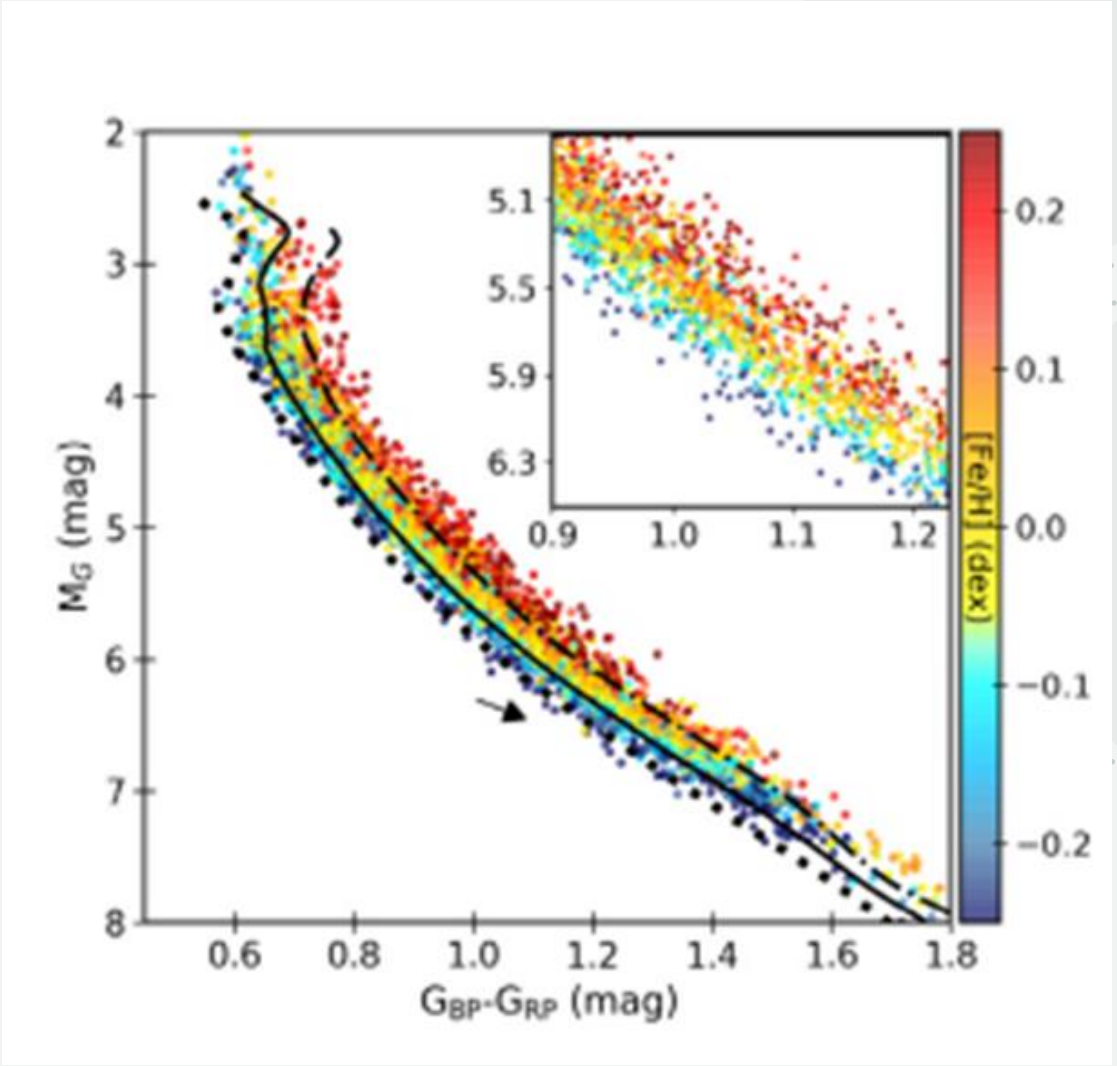


Spectral Class - Unfolded Universe (weebly.com)



Metallicity effect on Temperature

- Metallicity within a Star [Fe/H]
  - Chemical Composition
  - [Fe/H] > 0 High
  - [Fe/H] = 0 Solar
  - [Fe/H] < 0 Low



Amard (2020)

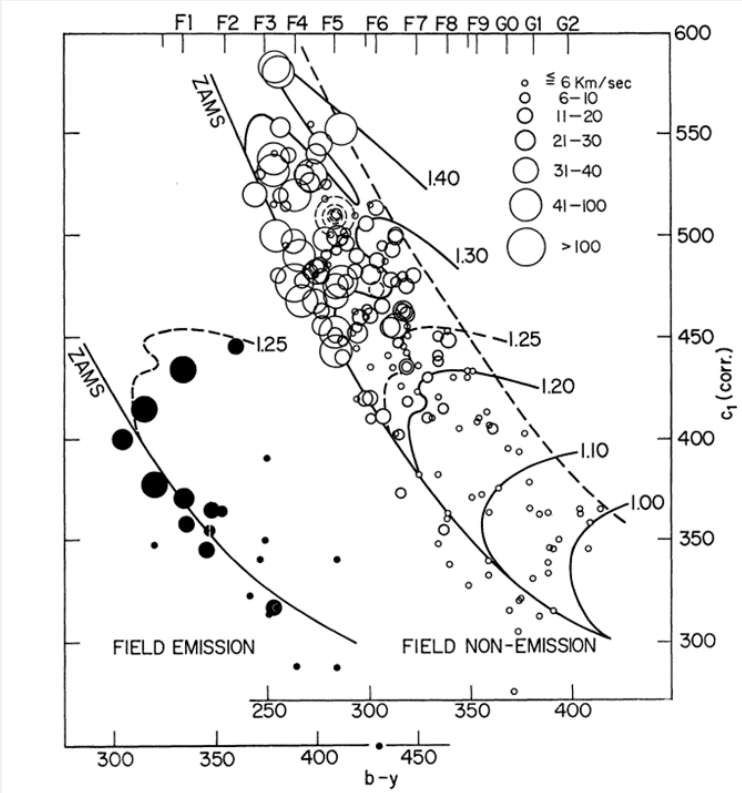
Metallicity effect on Rotation

- Right

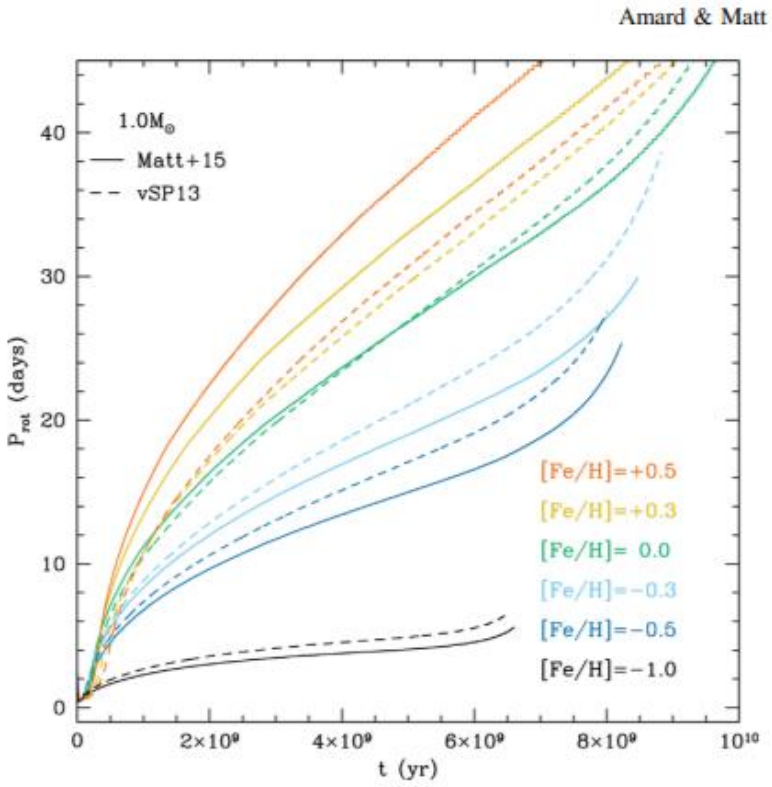
  - Models ran from 2 different stellar-wind-torque formulation

- Left

  - Kraft Break



Kraft (1967)



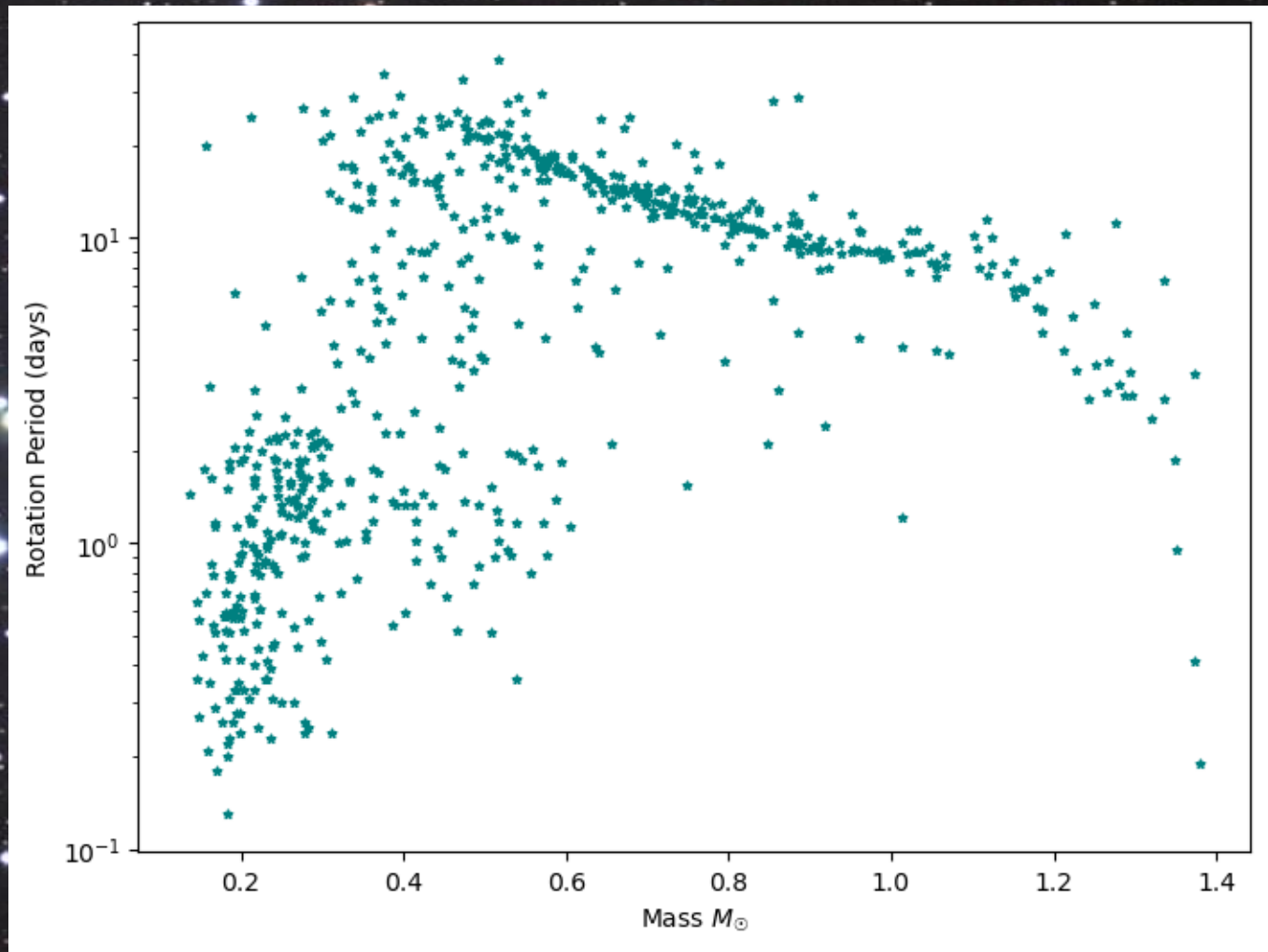
Amard (2020)

http://www.astrosurf.com/gap47/

Observational Data: Praesepe Cluster

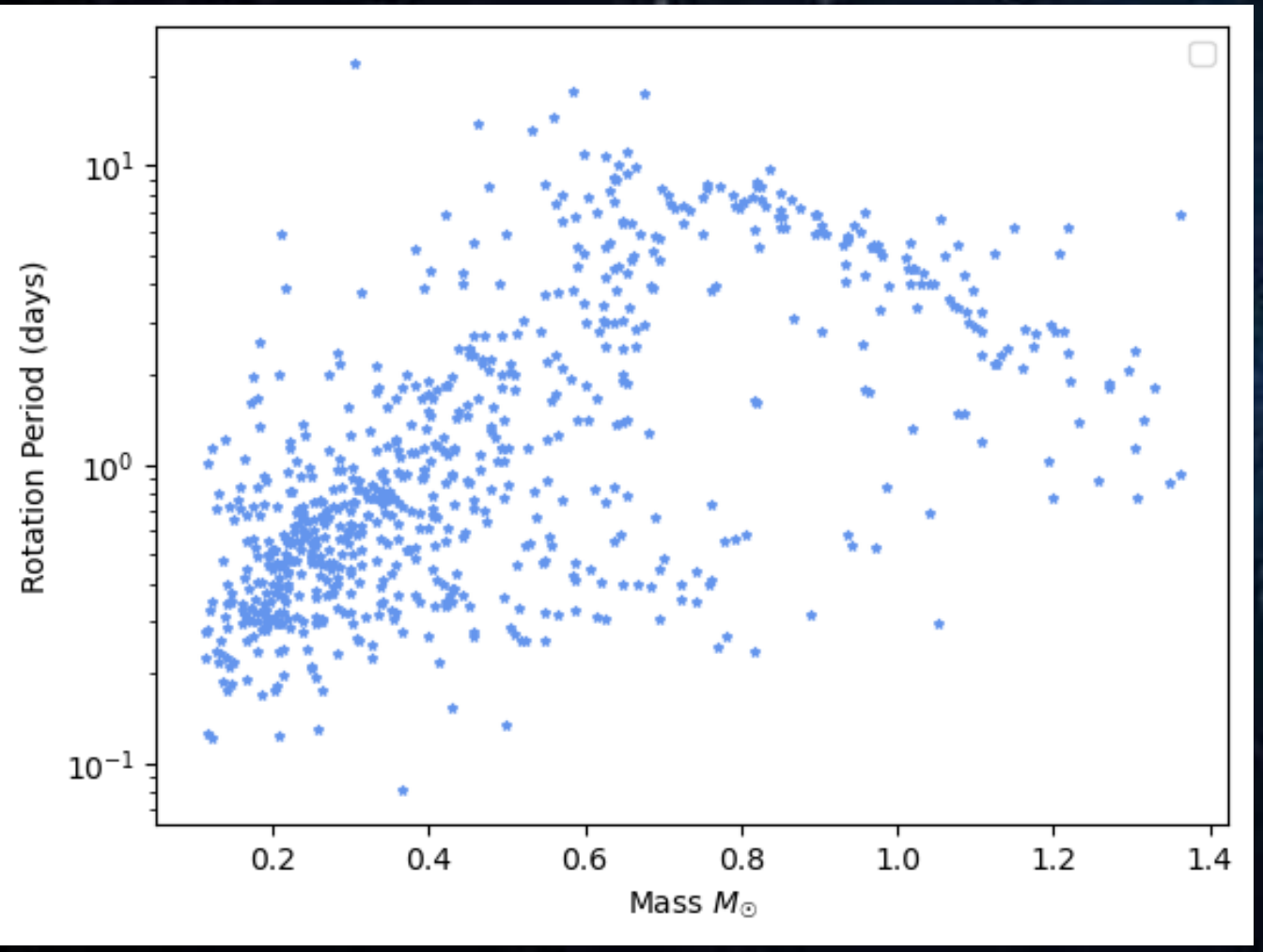
Data from Breimann 2021

- Age ~ 680 Myr
- Nearly Solar Metallicity



Observational Data: Pleiades Cluster

Data from Breimann 2021



- Age ~ 150 Myr
- Nearly Solar Metallicity

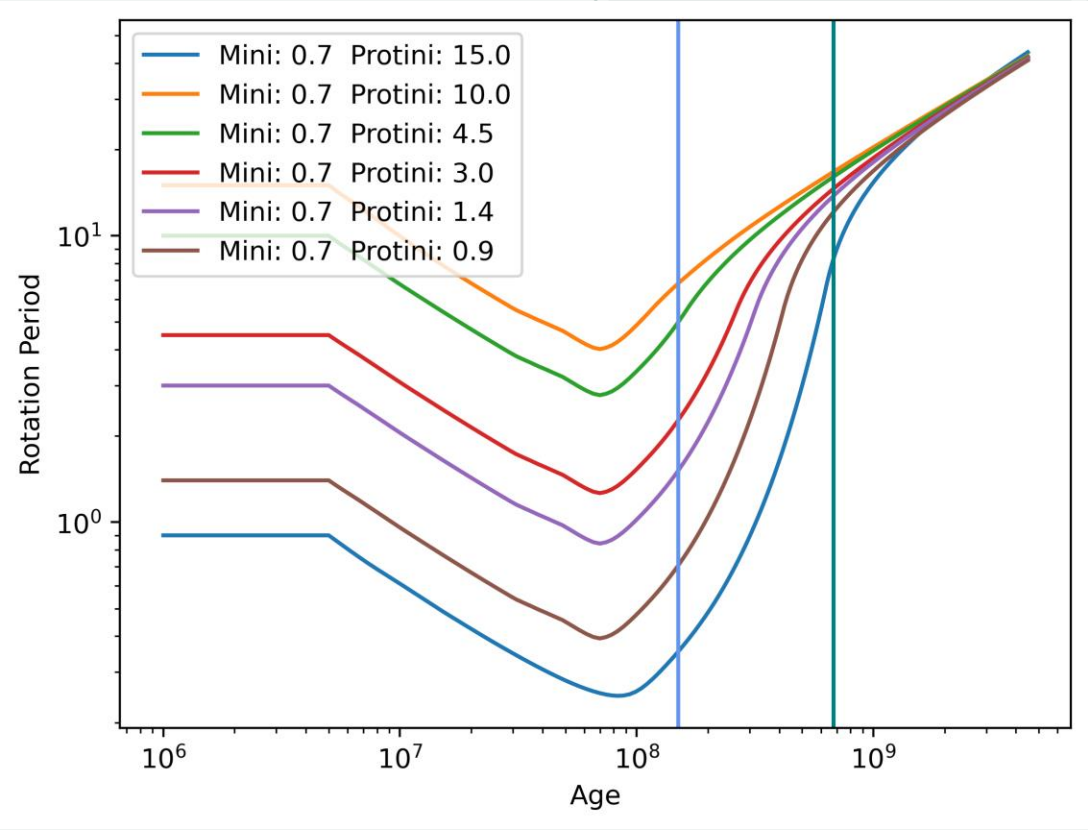
dizzyStars

- Inputs

- Initial mass, initial rotation periods, metallicity, stellar evolution models, turnover timescales, disc treatment, magnetized wind torque, etc.

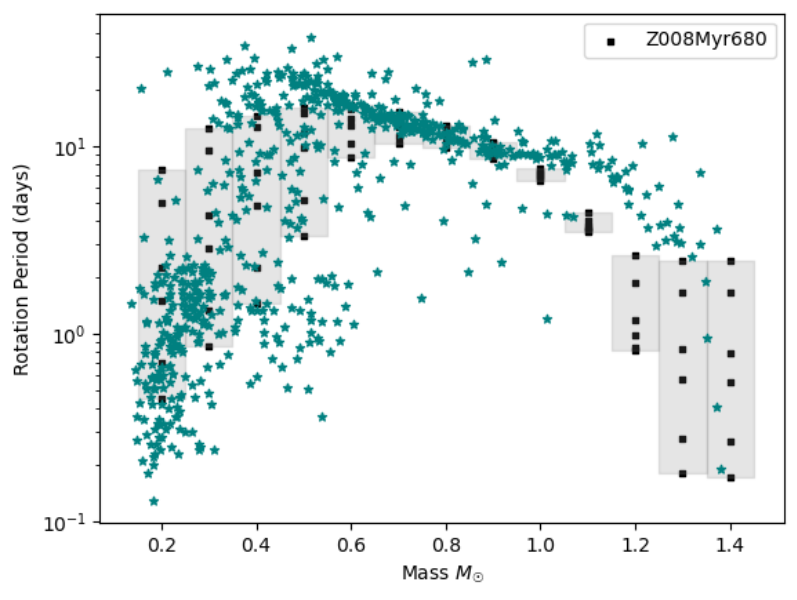
- Output

-Rotation rate as a function of time



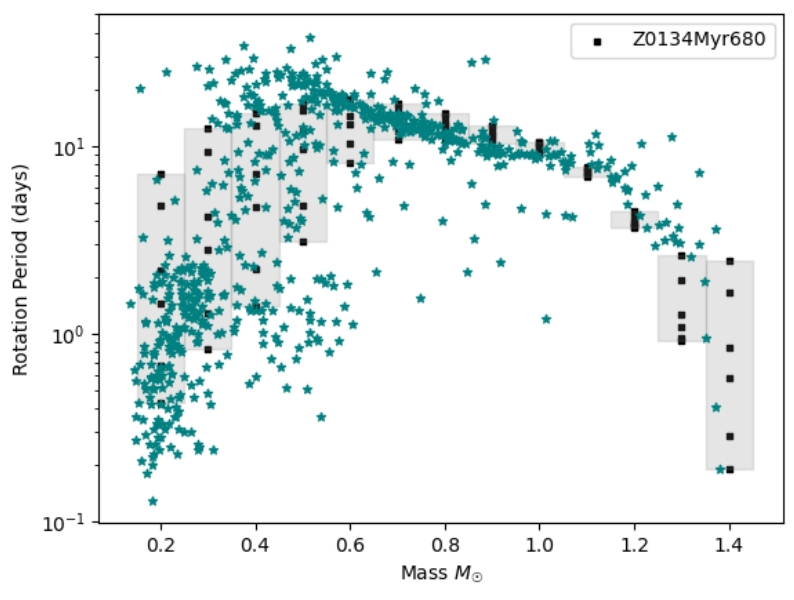
Results & Analysis

- Different metallicities at the same age with Praesepe



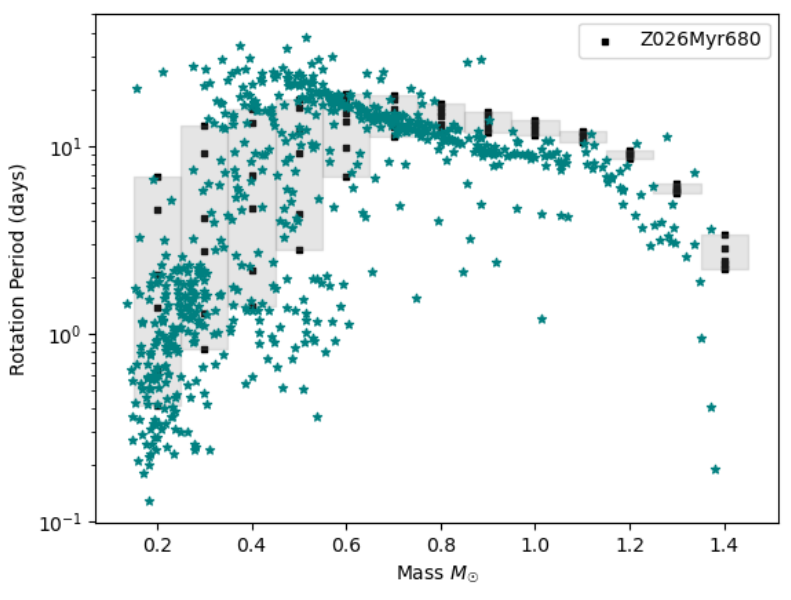
[Fe/H] = -0.3

Low



[Fe/H] = 0

Solar



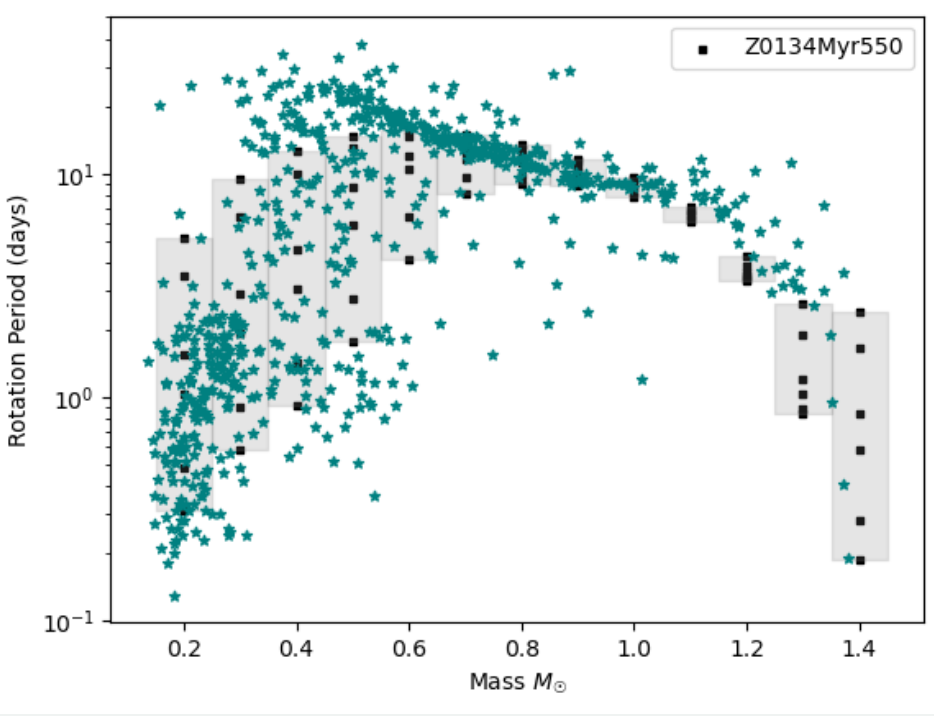
[Fe/H] = 0.3

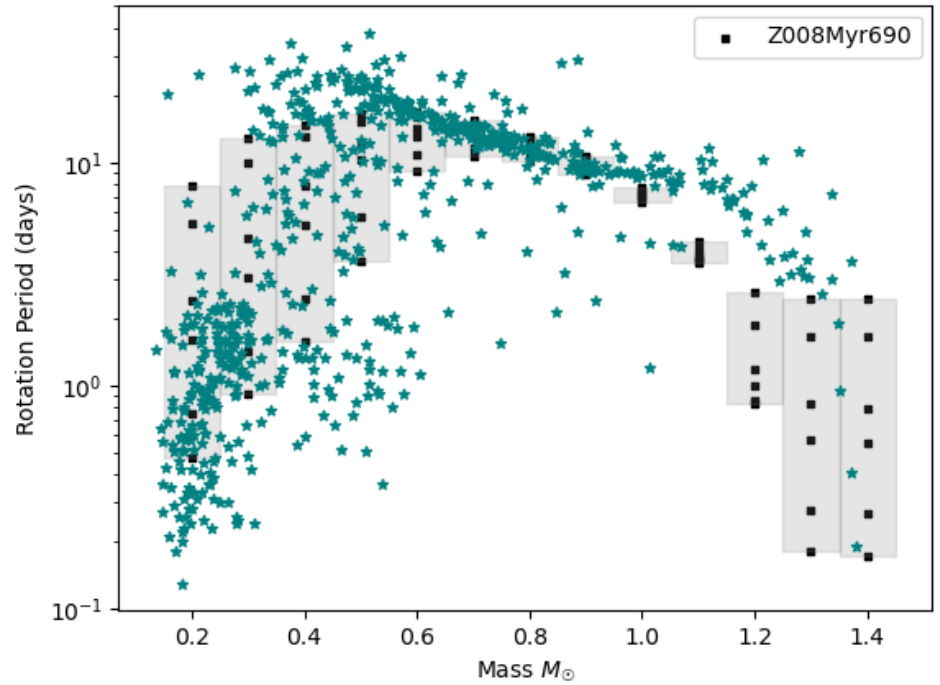
High

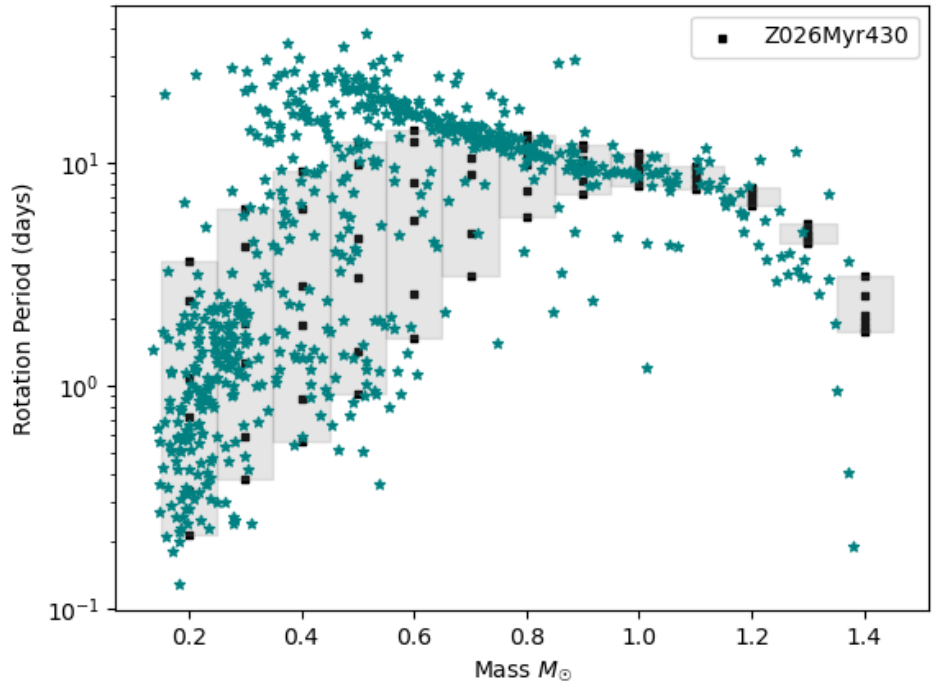
Results & Analysis

- Different metallicities at the best fit age

Praesepe



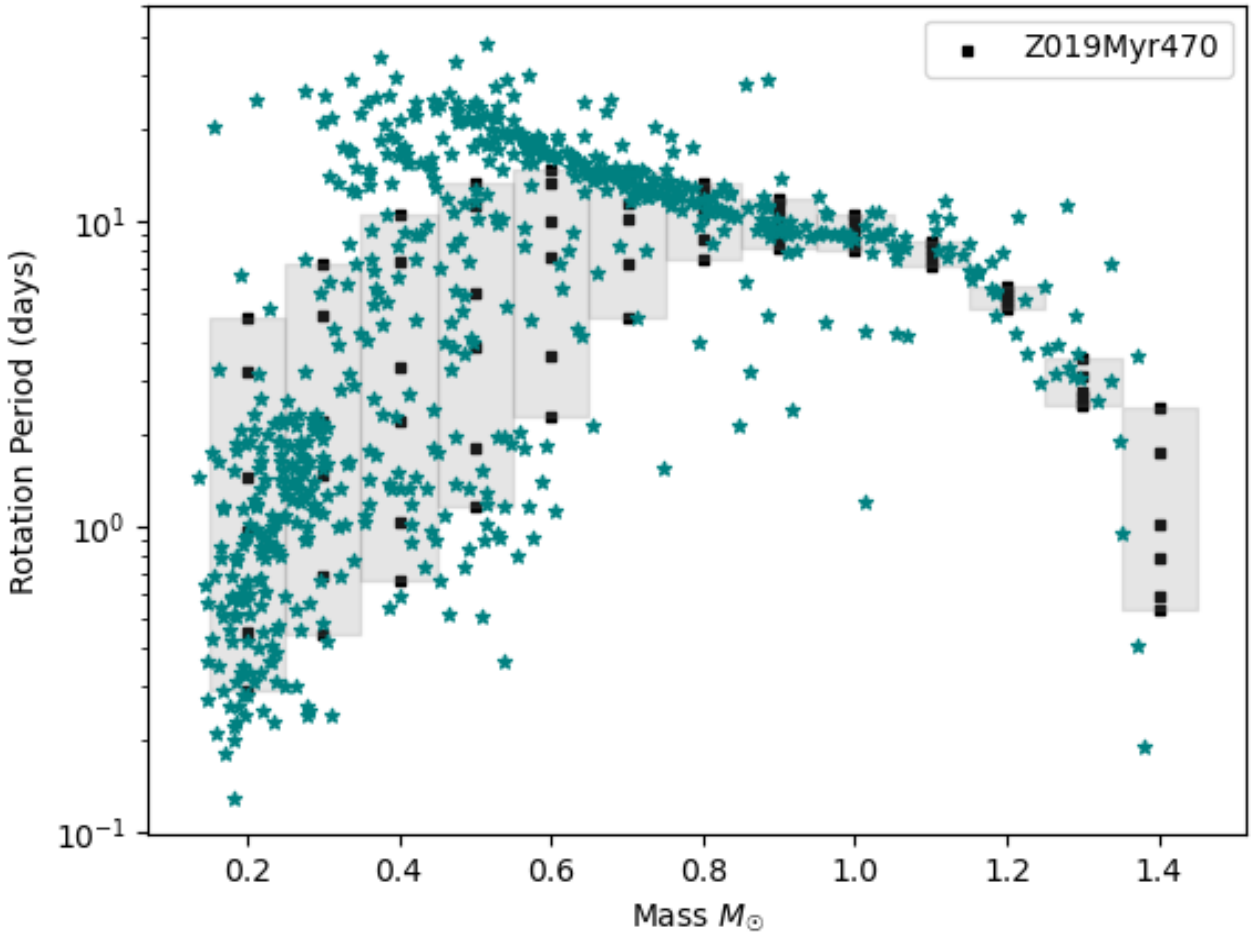


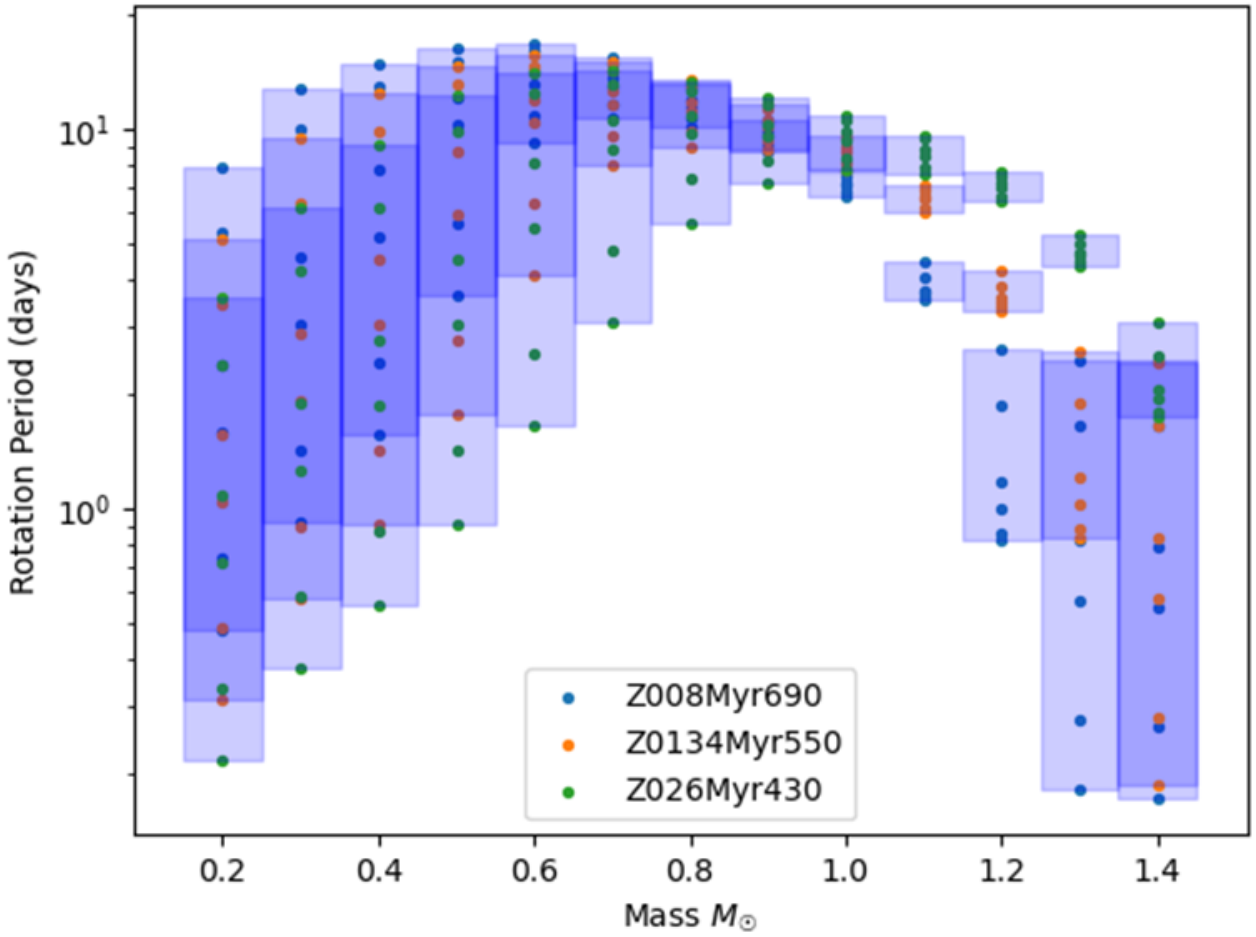


Homer L. Dodge Department of Physics and Astronomy

Results & Analysis

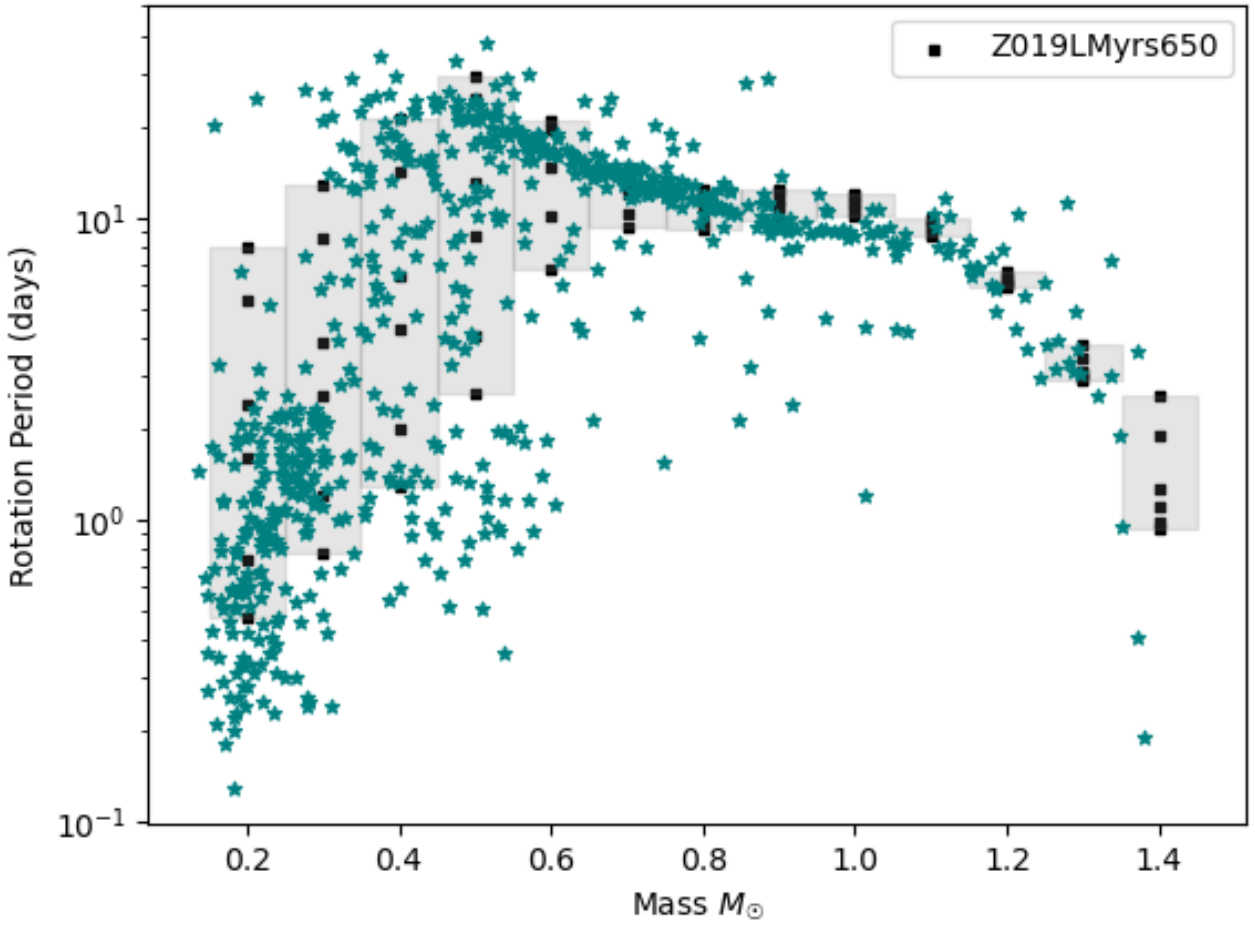
- Best fit metallicity to Praesepe

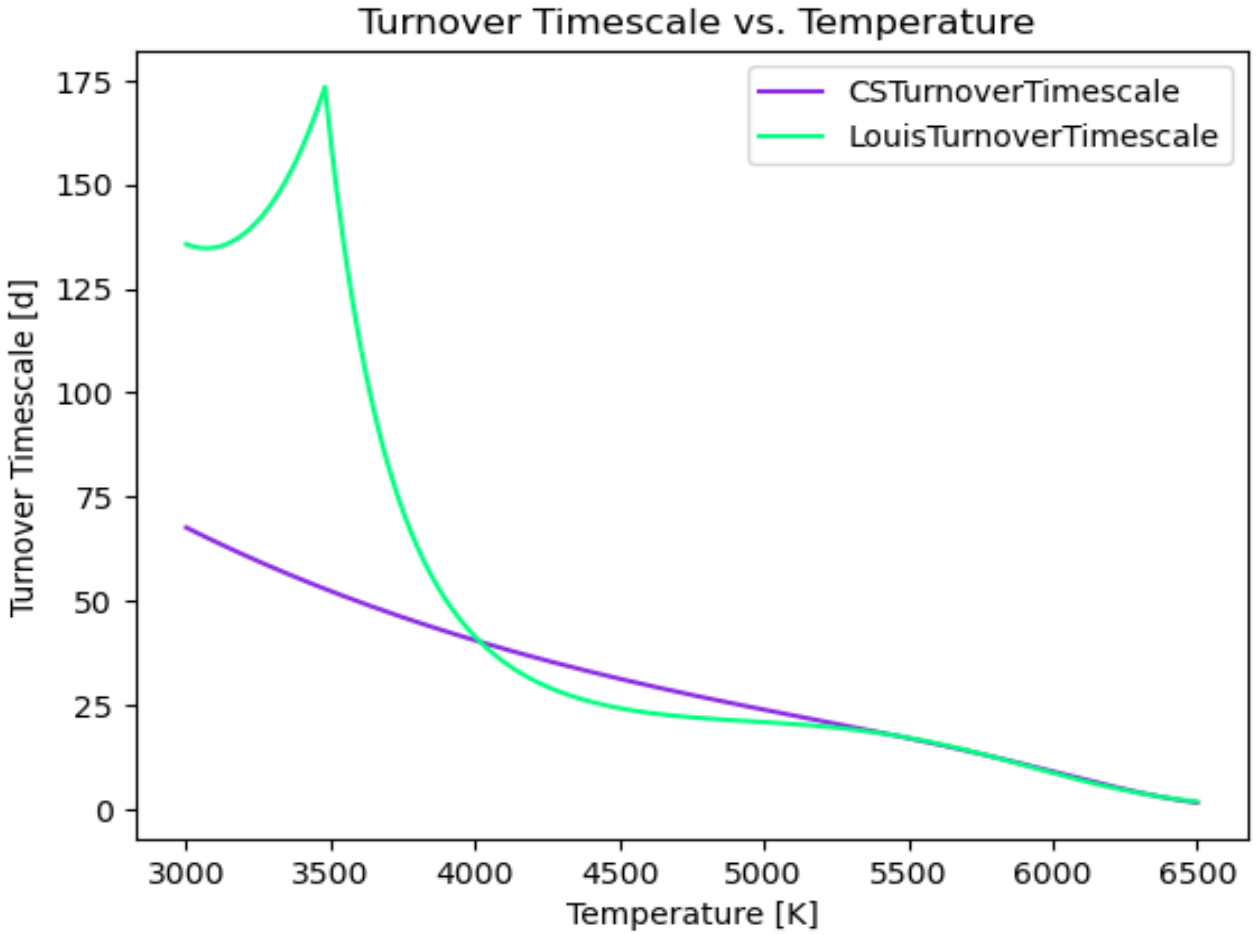




Results & Analysis

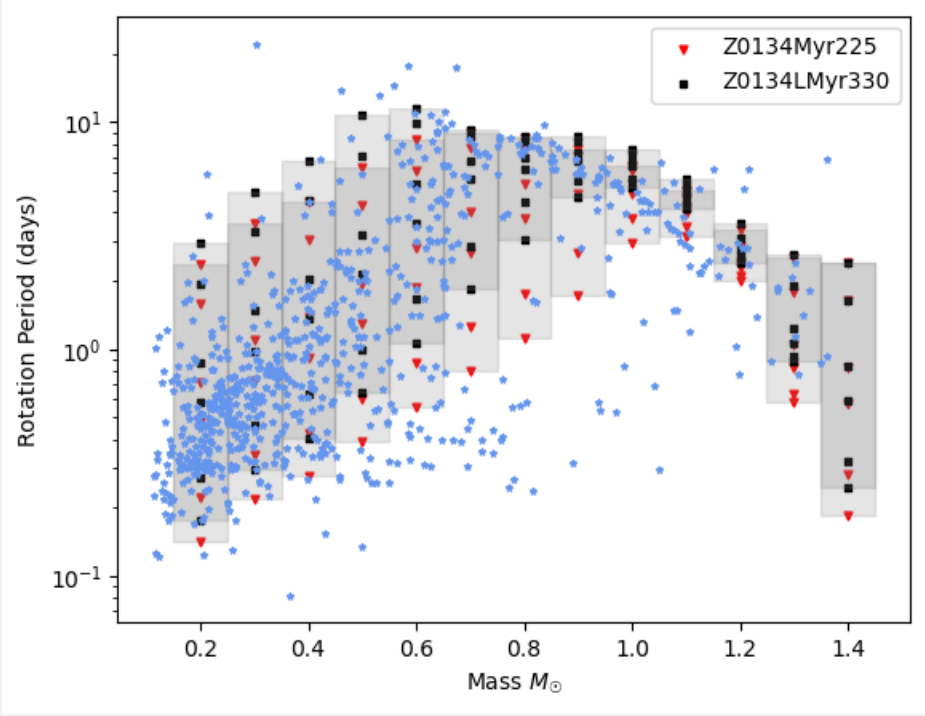
- Changing the turnover timescale



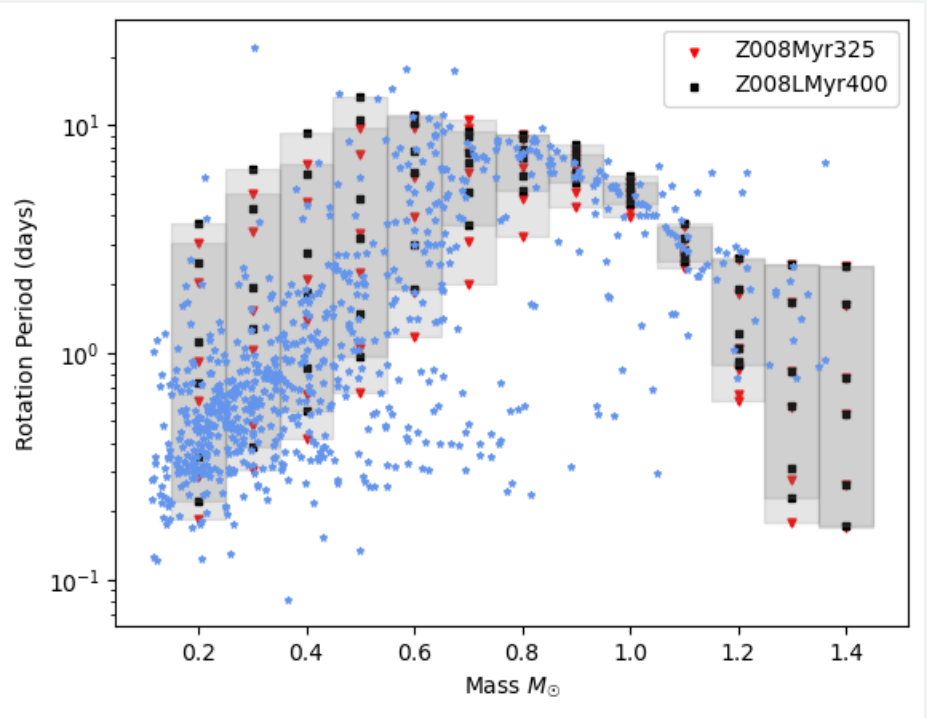


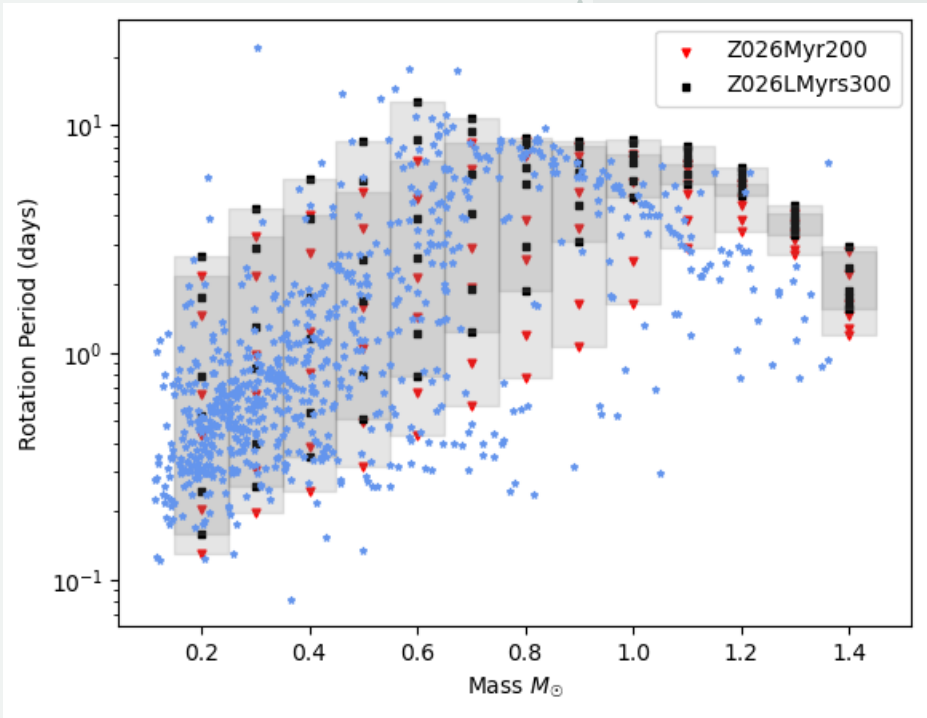
Results & Analysis

- Same analysis with a younger cluster



Pleiades





Upcoming Plans

- Better understand how metallicity affects rotation
  - Compare plots against other cluster data
  - Continue to improve the models
- Collaborate with a colleague from Columbia
- Refine my Python skills

APOD: 2018 January 18 - Blue Comet in the Hyades (nasa.gov)


Questions?

Citations

- Amard, Louis and Sean P. Matt. “The Impact of Metallicity on the Evolution of the Rotation and Magnetic Activity of Sun-like Stars.” *The Astrophysical Journal* 889 (2020): n. pag.
- Louis Amard, Julia Roquette, Sean P Matt, Evidence for metallicity-dependent spin evolution in the *Kepler* field, *Monthly Notices of the Royal Astronomical Society*, Volume 499, Issue 3, December 2020, Pages 3481–3493, https://doi.org/10.1093/mnras/staa3038
- Breimann, Angela A. et al. “Statistical Fitting of Evolutionary Models to Rotation Rates of Sun-like Stars.” *The Astrophysical Journal* 913 (2021): n. pag.