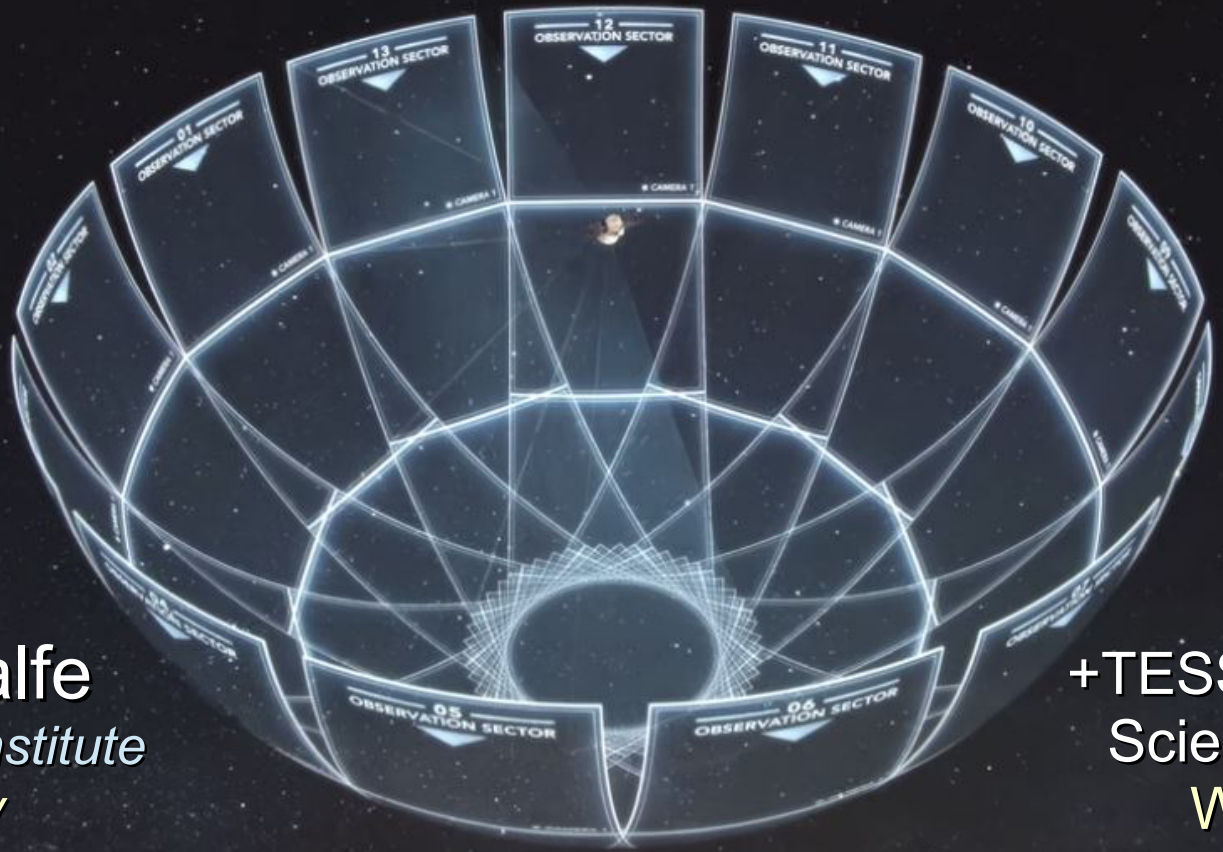
Deciphering Rotation and Activity Variations in 94 Aqr with TESS



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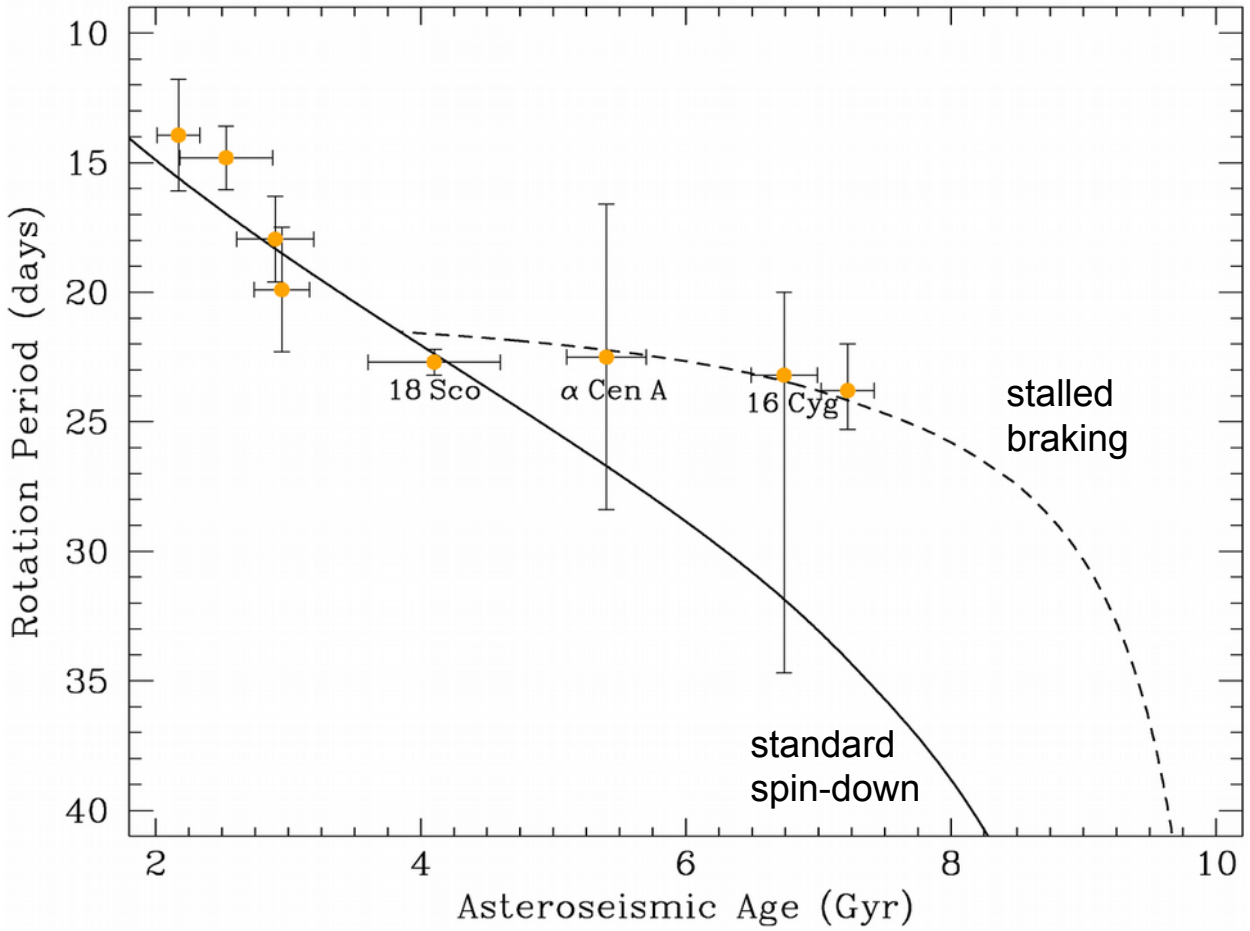
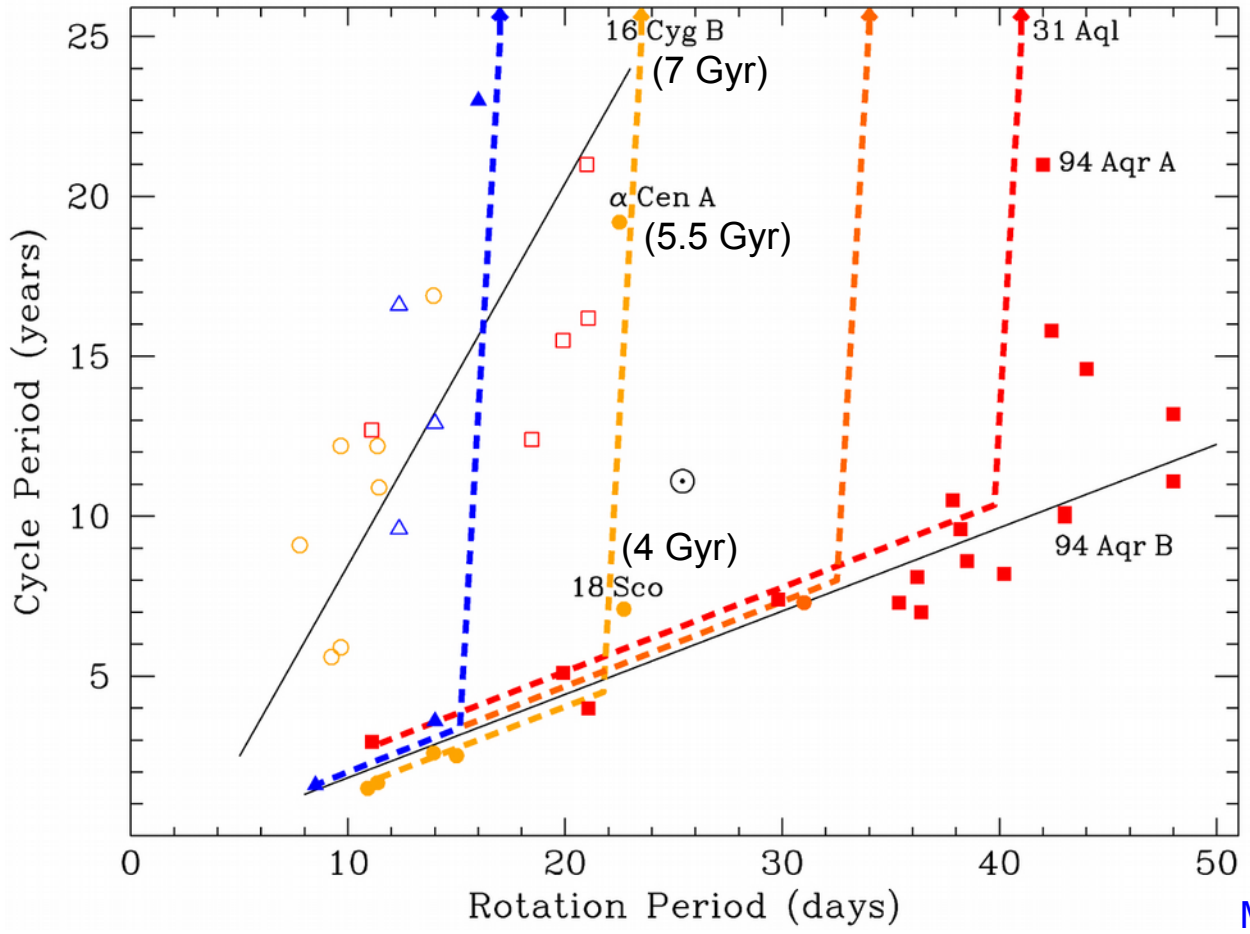
+TESS Asteroseismic
Science Consortium
Working Group 2

Spin-down stalls near middle-age

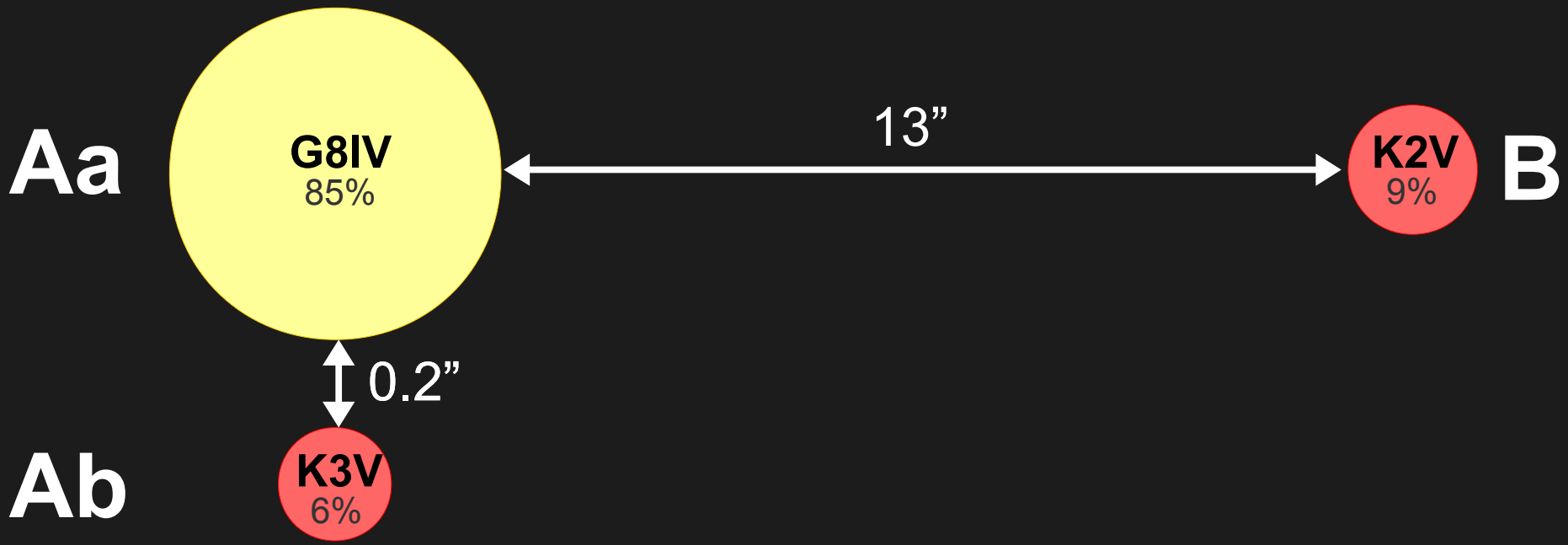


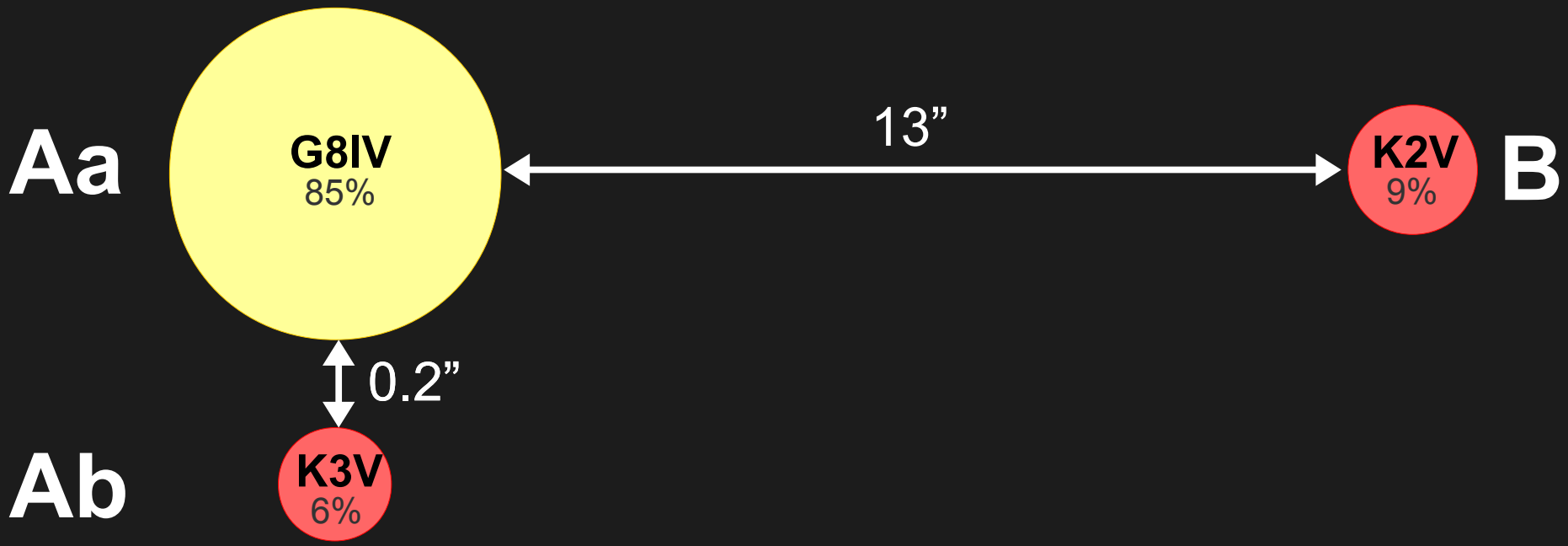
van Saders+ (2016, Nature)

Activity cycle grows longer and weaker

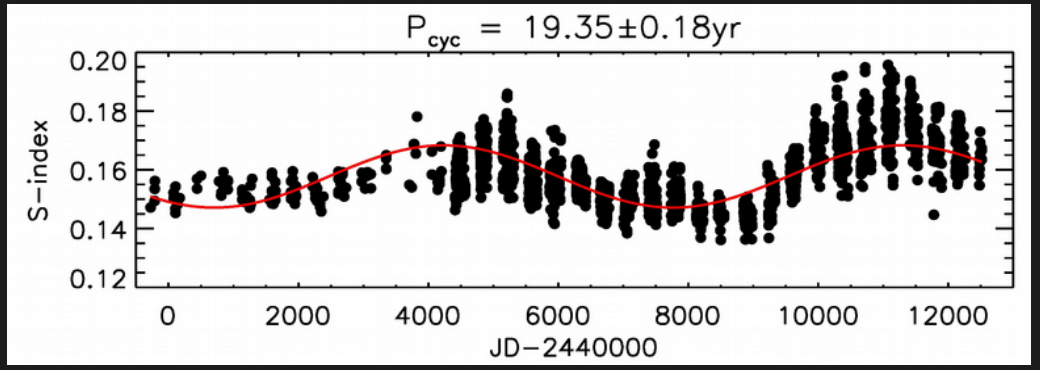


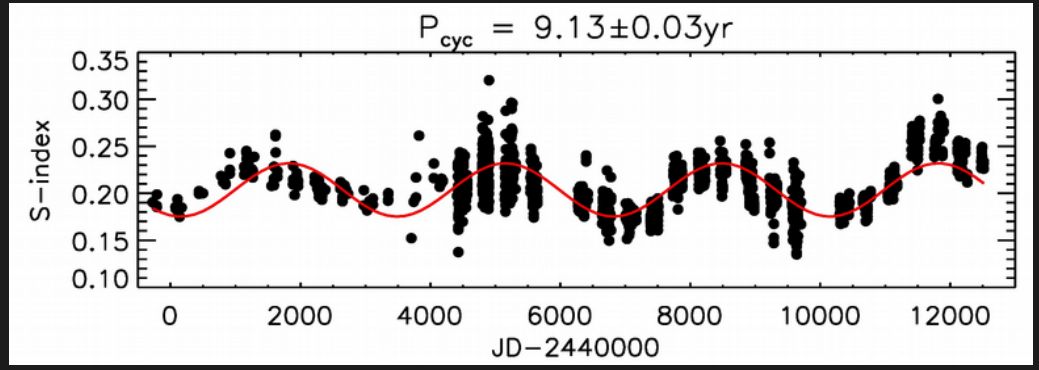
Metcalfe & van Saders (2017)

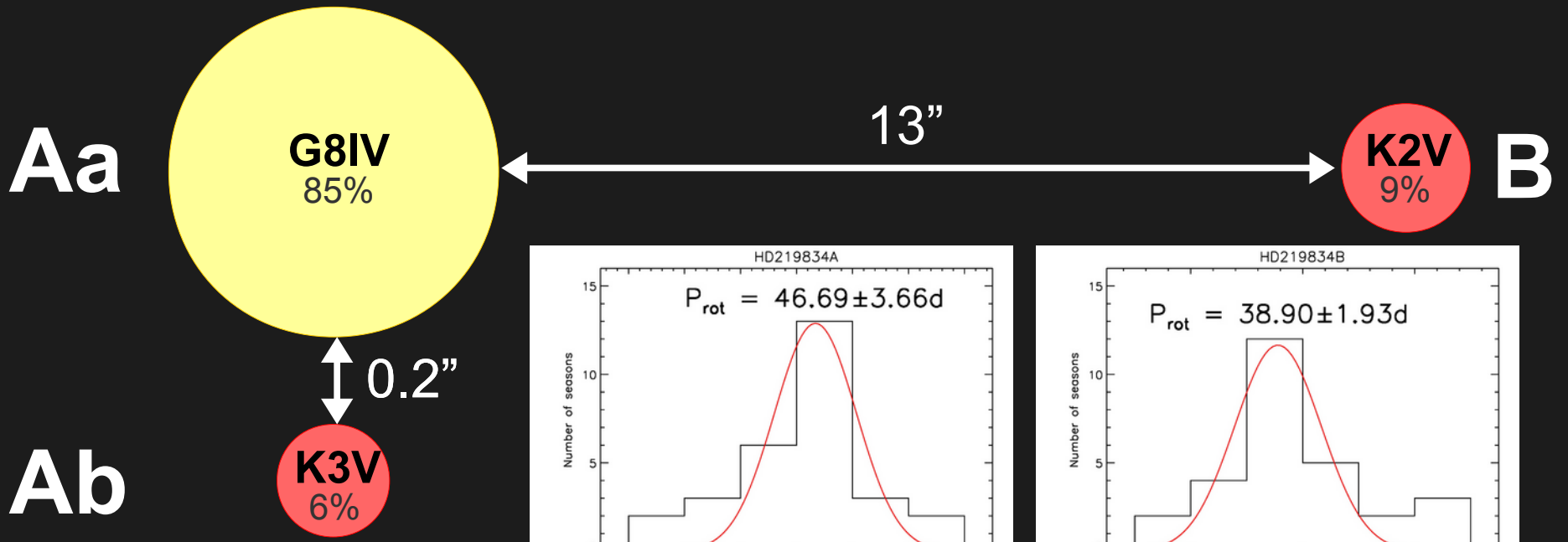

Aa
G8IV
85%
13”
K2V
9%
B
0.2”
Ab
K3V
6%



T. Reinhold / R. Egeland







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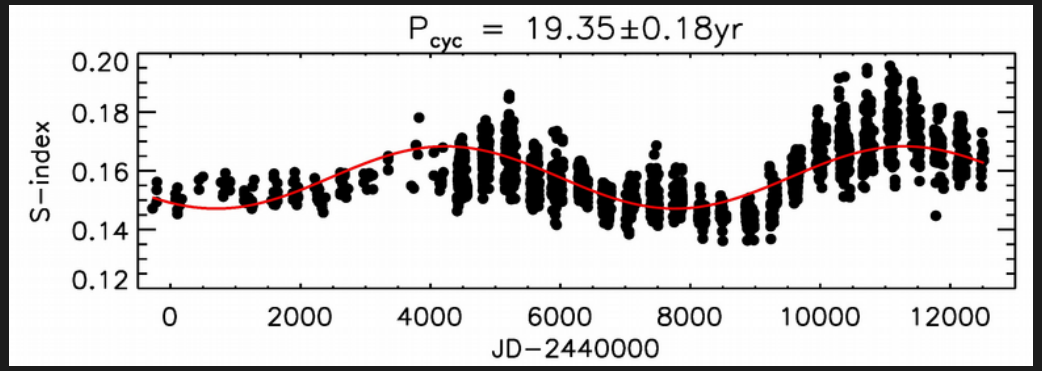
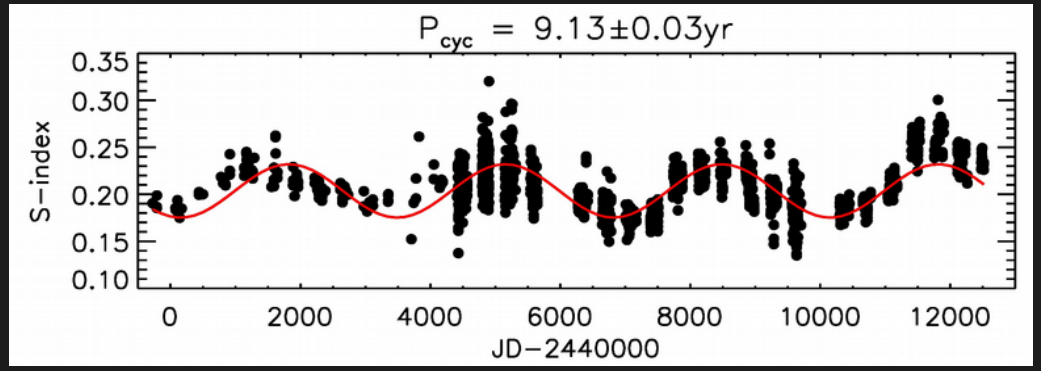
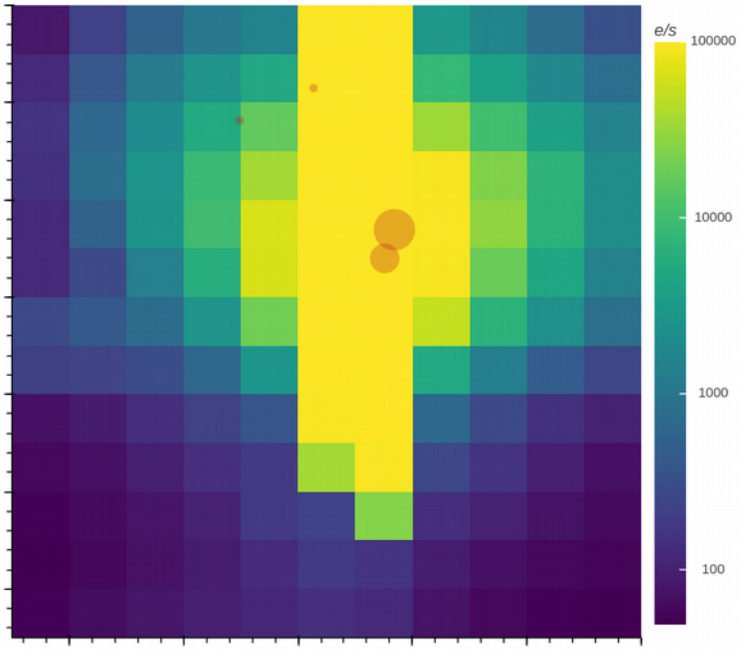
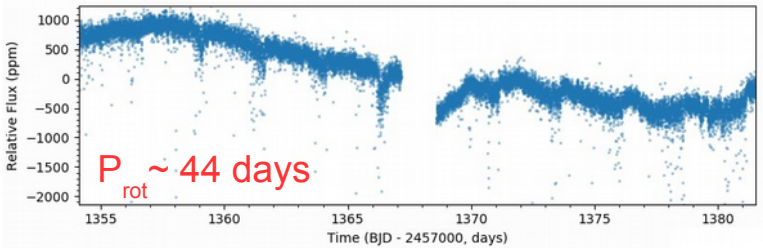




Asteroseismic properties from TESS



⬆ D. Buzasi M. Lund / R. Handberg ⬇

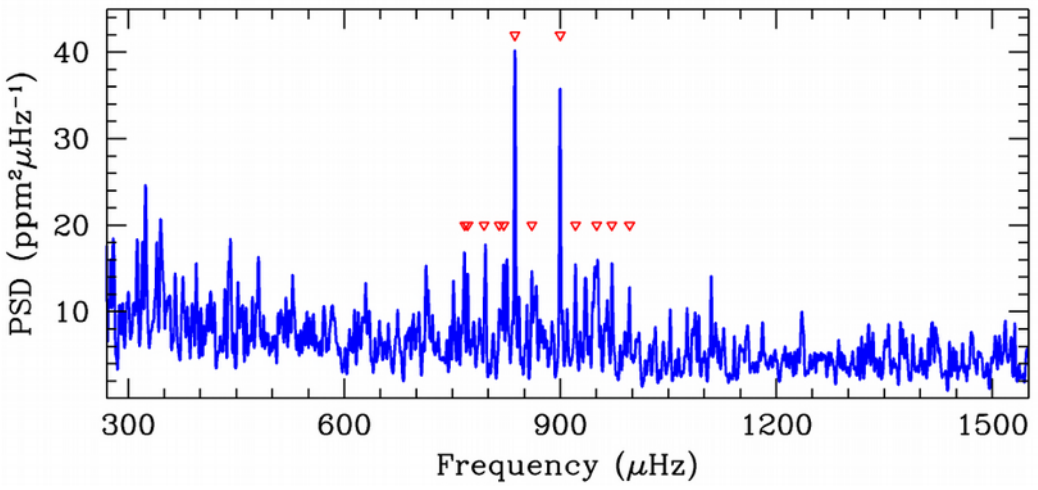


$R = 2.06 \pm 0.05\ R_{sun}$

$M = 1.22 \pm 0.02\ M_{sun}$

Age = 6.2 ± 0.4 Gyr

⬇ D. Huber / P. Gaulme + S. Basu ⬆

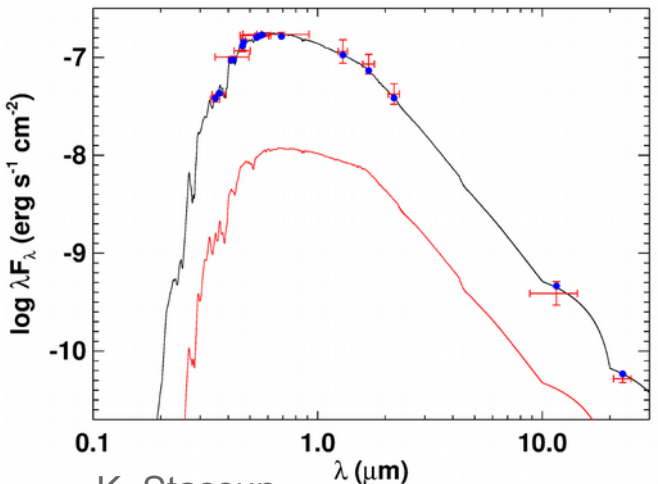


Asteroseismic properties are accurate

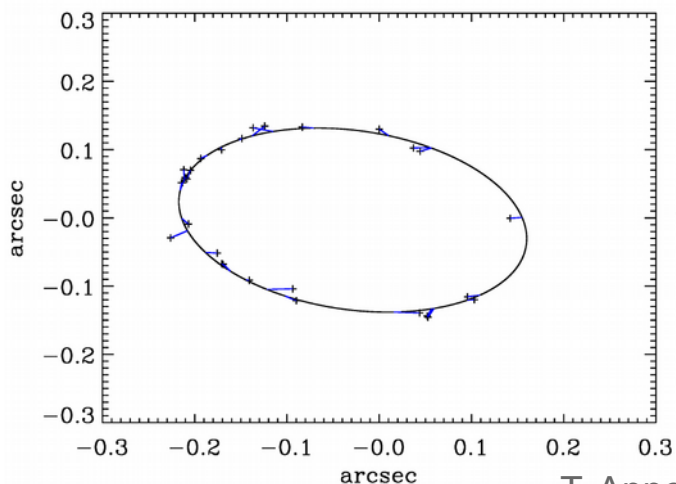
Spectral Energy Distribution → R = 2.05 ± 0.04 R_{sun}

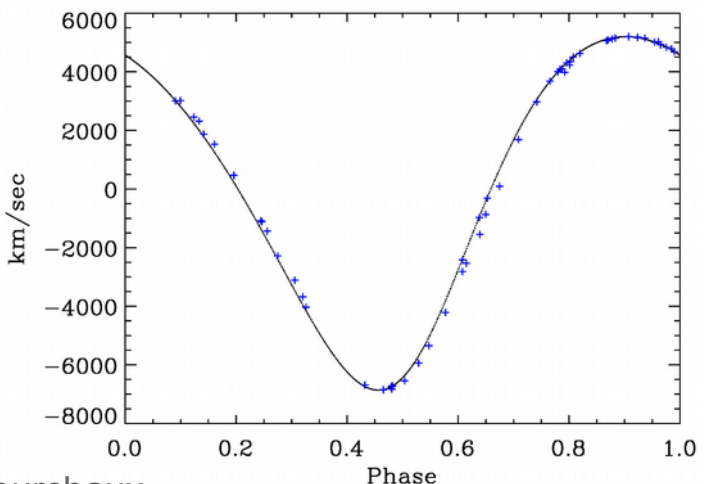
Binary Orbit (astrom.+ RVs) → M = 1.24 ± 0.08 M_{sun}

Gyrochronology of 94 Aqr B → Age = 6.3 ± 0.6 Gyr



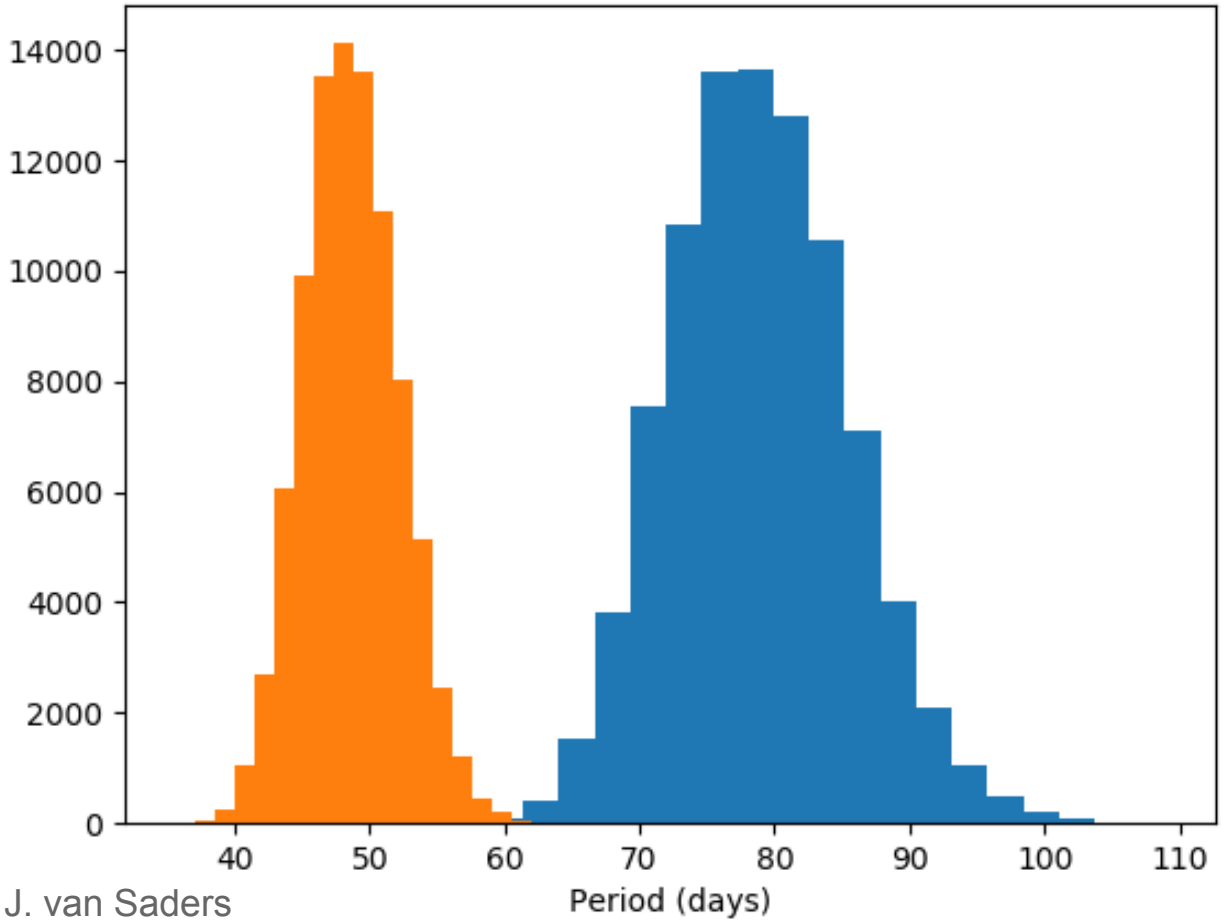
K. Stassun





T. Appourchaux

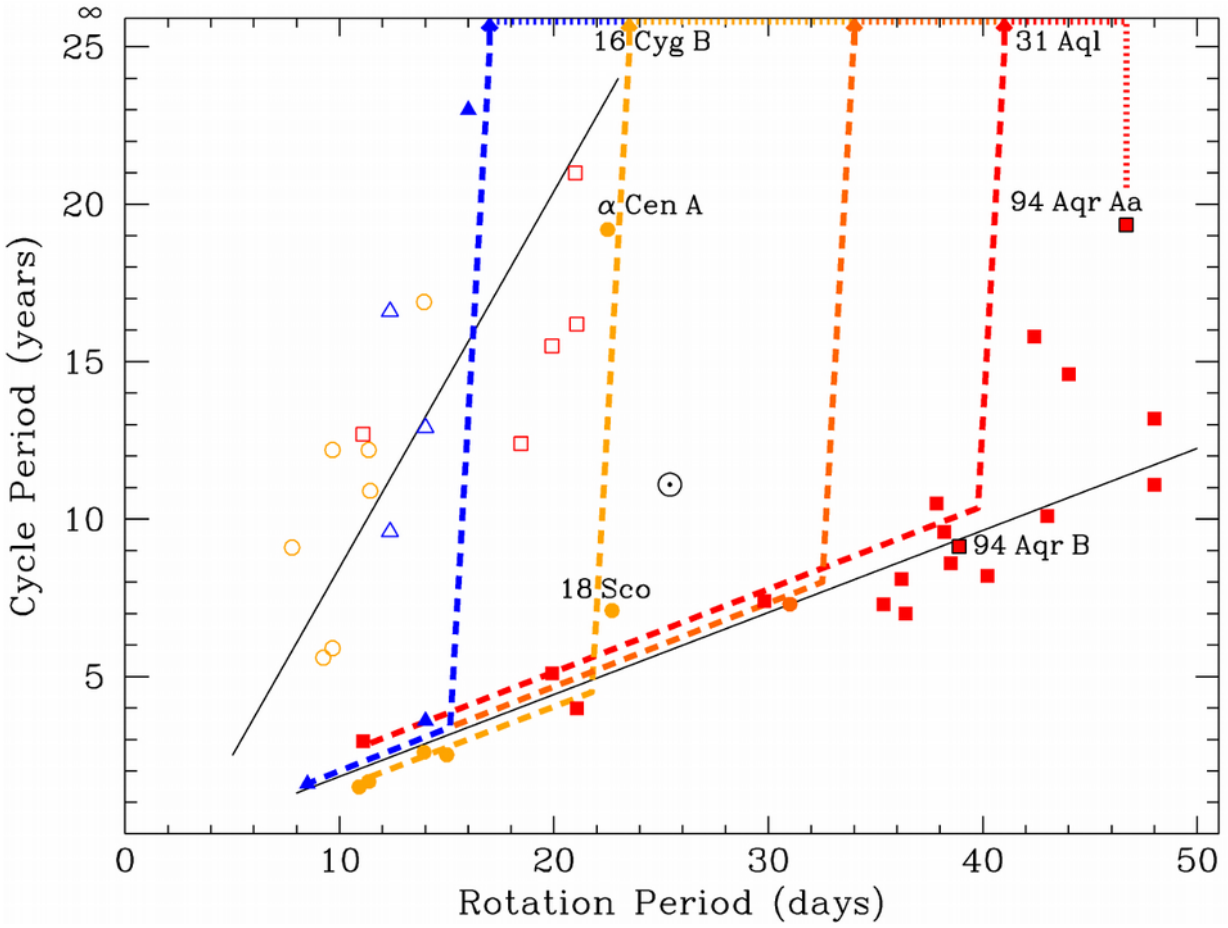
Rotation modeling requires stalled braking



J. van Saders

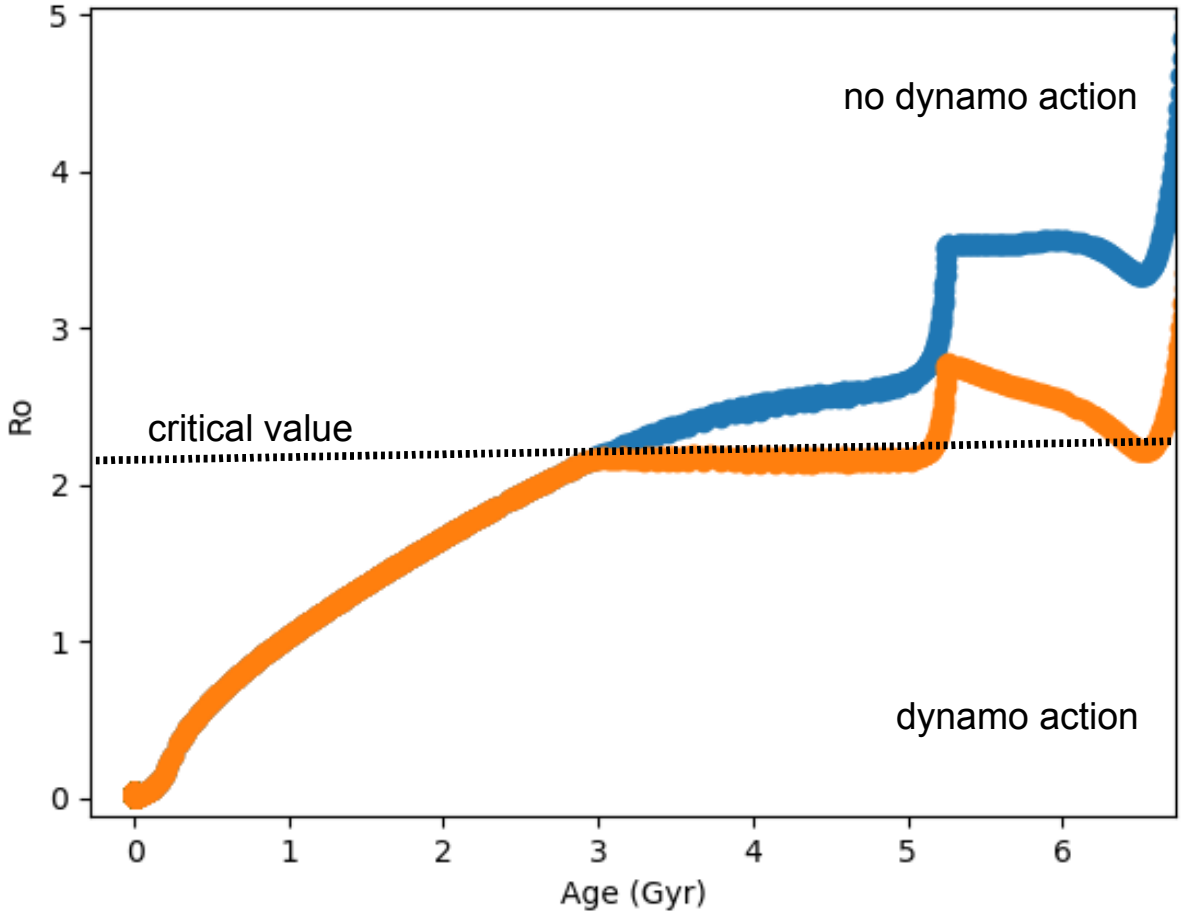
- Given stellar properties of subgiant, predict current rotation period (47 ± 4 d)
- Stalled magnetic braking beyond stellar middle-age yields: P_{rot} = 48 ± 4 days
- Standard spin-down for complete main-sequence yields: P_{rot} = 78 ± 7 days

Subgiant has a “born-again dynamo”



- Subgiant mass suggests that it was an F-type star on the main-sequence
- After losing any original cycle, rotation slowed as it expanded and cooled
- Convection zone became deeper, longer timescale reinvigorated the dynamo

Subgiant has a “born-again dynamo”



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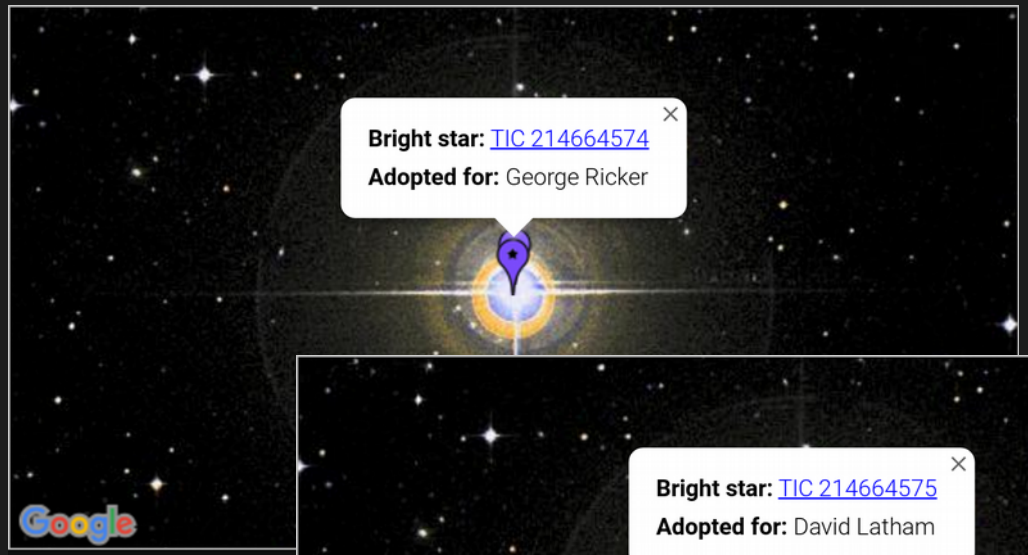
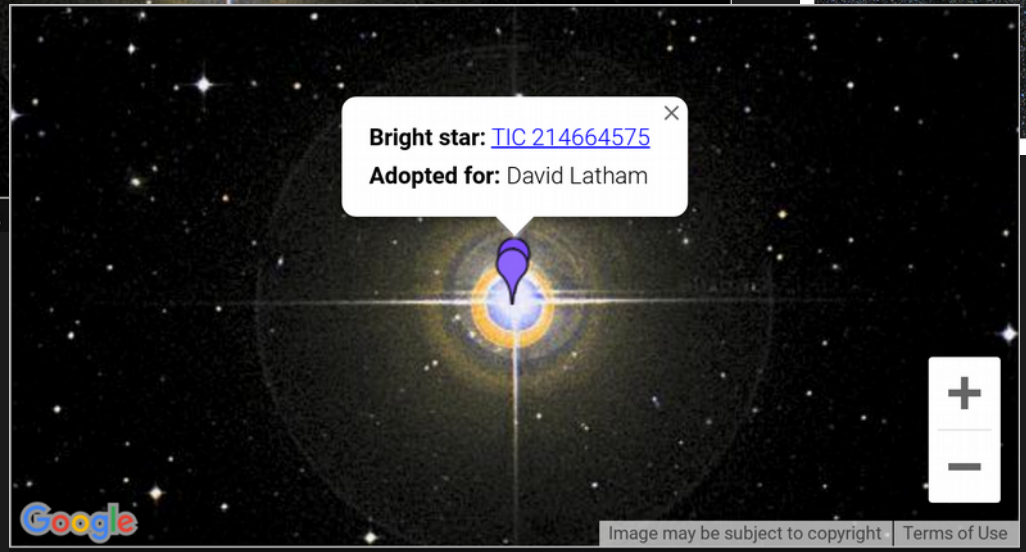
Summary of conclusions

- Rotation and cycle periods from Mount Wilson data can be attributed to the subgiant based on amplitude
- Asteroseismic properties from TESS are consistent with SED (radius), binary orbit (mass), and gyro (age)
- Evolution models only reproduce rotation period with stalled magnetic braking – standard spin-down fails
- After stalled braking and cycle shutdown on the main sequence, subgiant exhibits a “born-again dynamo”

tess.adoptastar.org



Constellation: Aquarius



Constellation: Aquarius [23h19m6.5s, -13°27'18"]