Testing Gyrochronology with Kepler: Stellar Period-Age Relations for Realistic Populations

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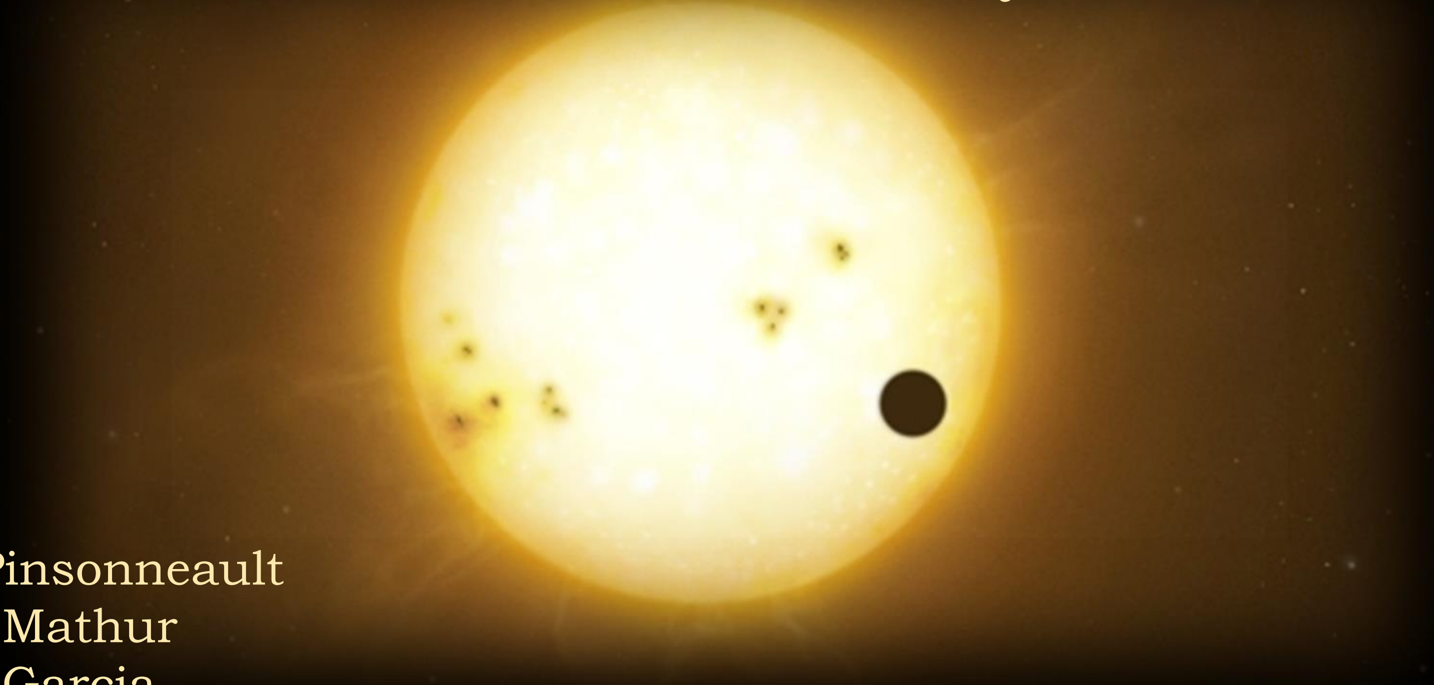
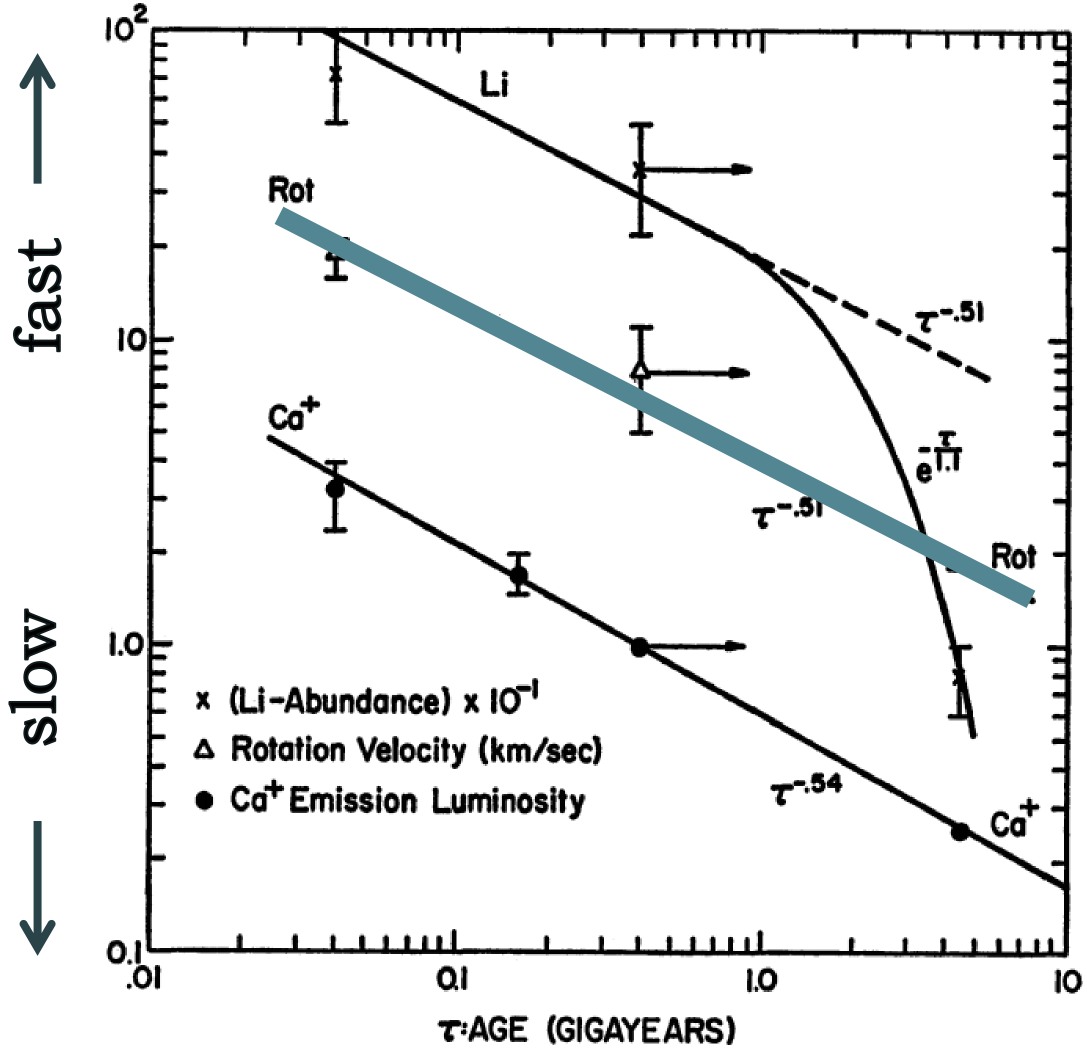


Marc Pinsonneault
Savita Mathur
Rafael Garcia
Tugdual Ceillier

Period-Age Relationship

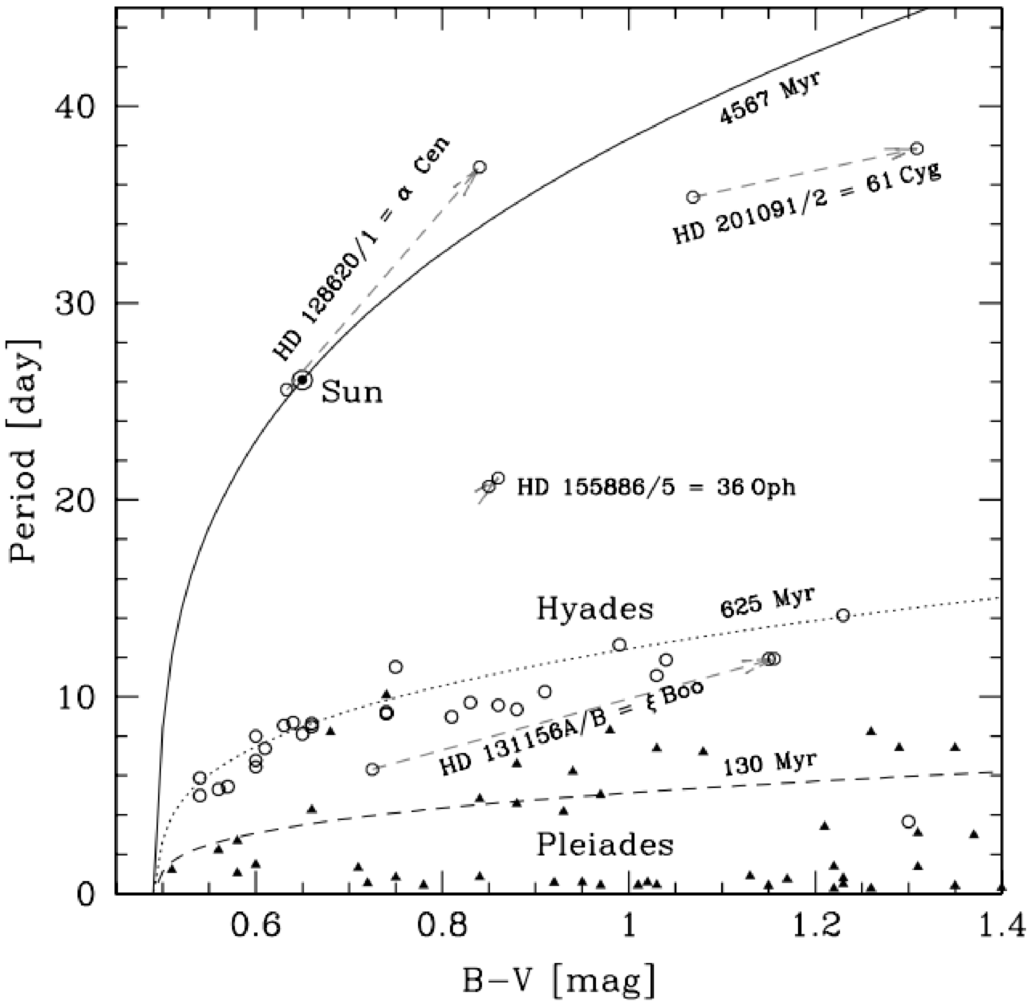


$$v_{rot} \propto t^{-\frac{1}{2}}$$

Basis for "gyrochronology" (Barnes 2007)

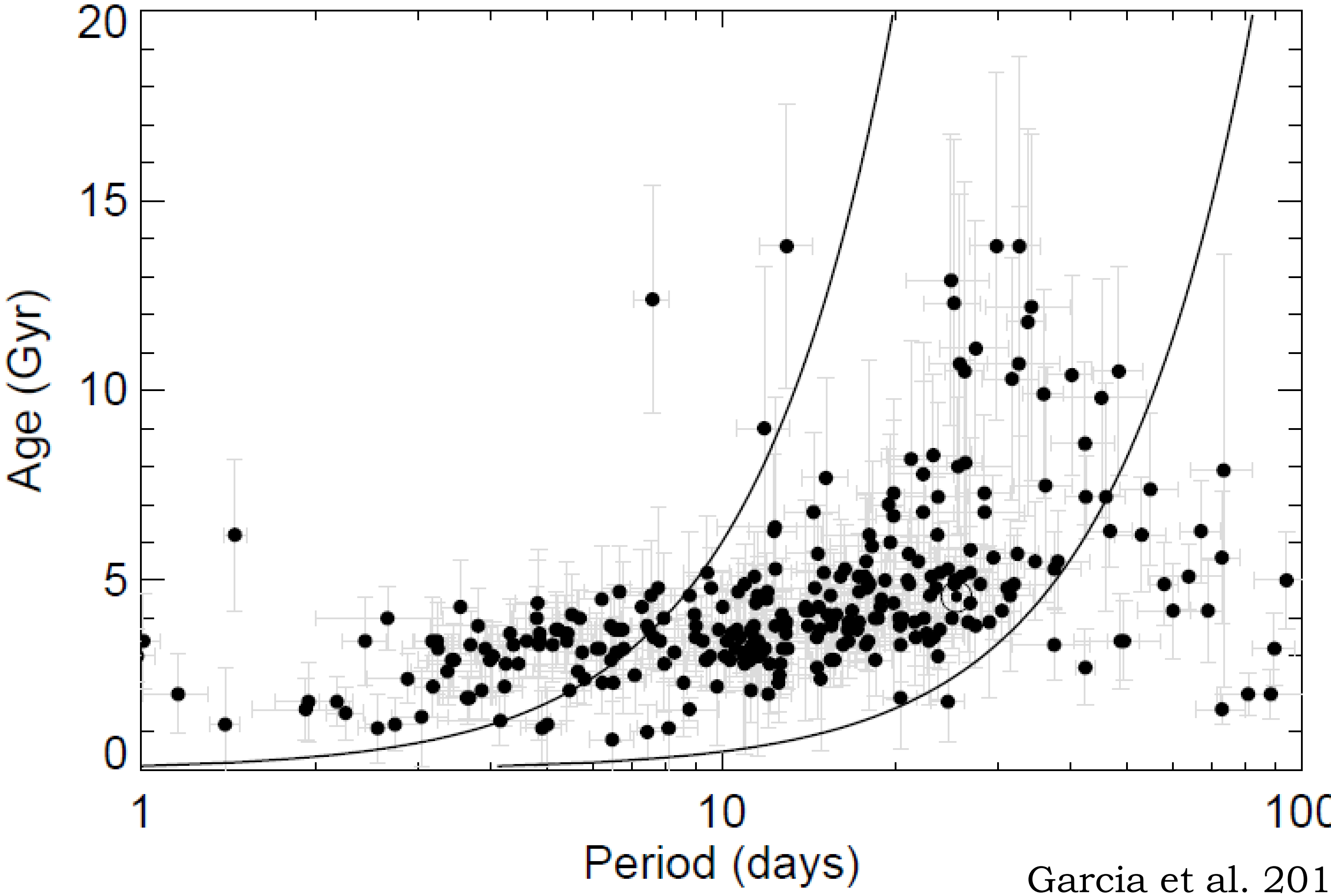
Skumanich 1972

Gyrochronology from the Ground



Mamajek & Hillenbrand 2008

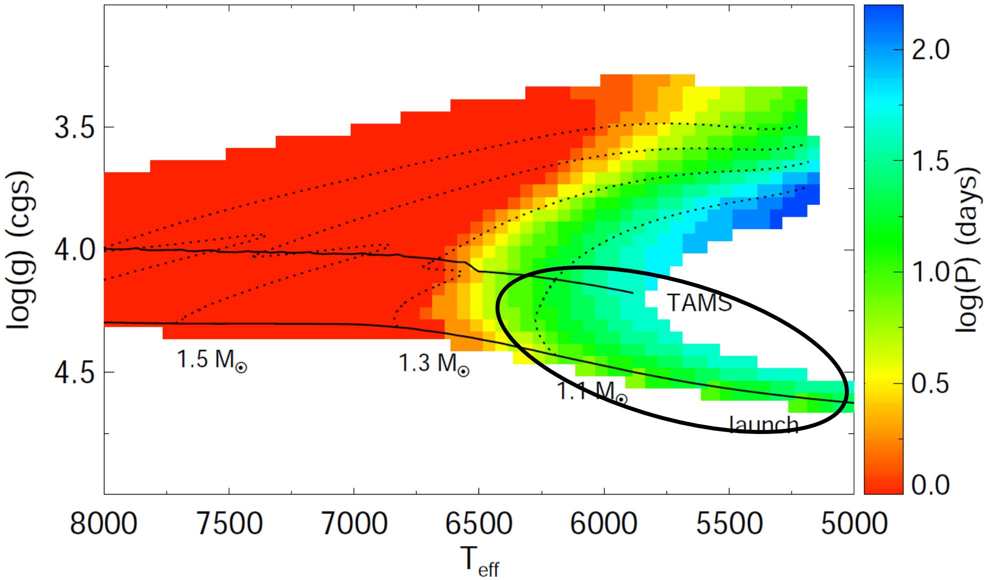
Kepler Asteroseismic Sample



Garcia et al. 2014

Chaplin et al. 2014

Theoretical Expectations



Three regimes:

Cool Dwarfs: Relationship between period and age is present and calibrated in the literature. Spin down goes roughly as $P \propto \sqrt{t}$

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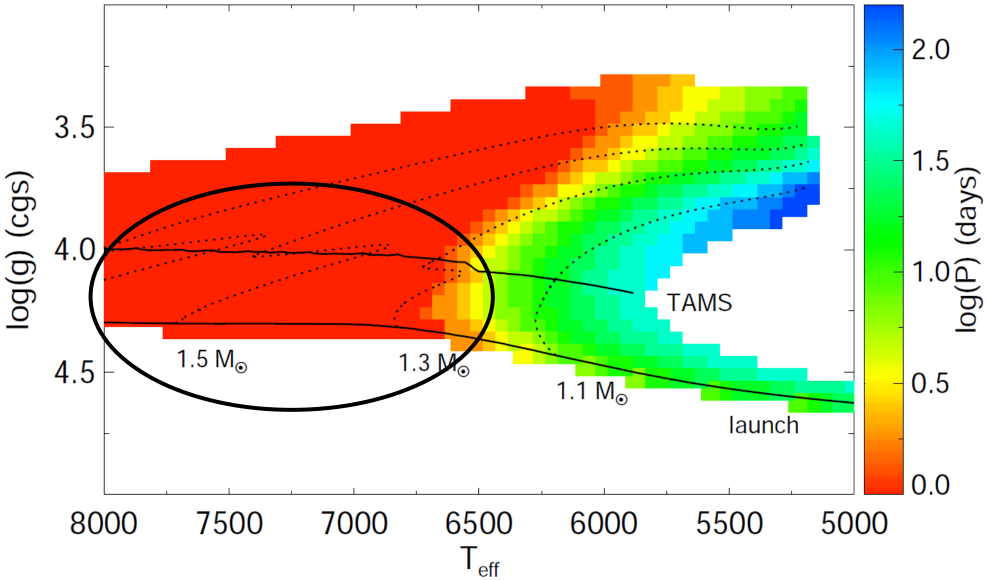

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Hot Stars: Born above the Kraft break, do not undergo magnetic breaking due to thin surface convection zones

van Saders & Pinsonneault 2013

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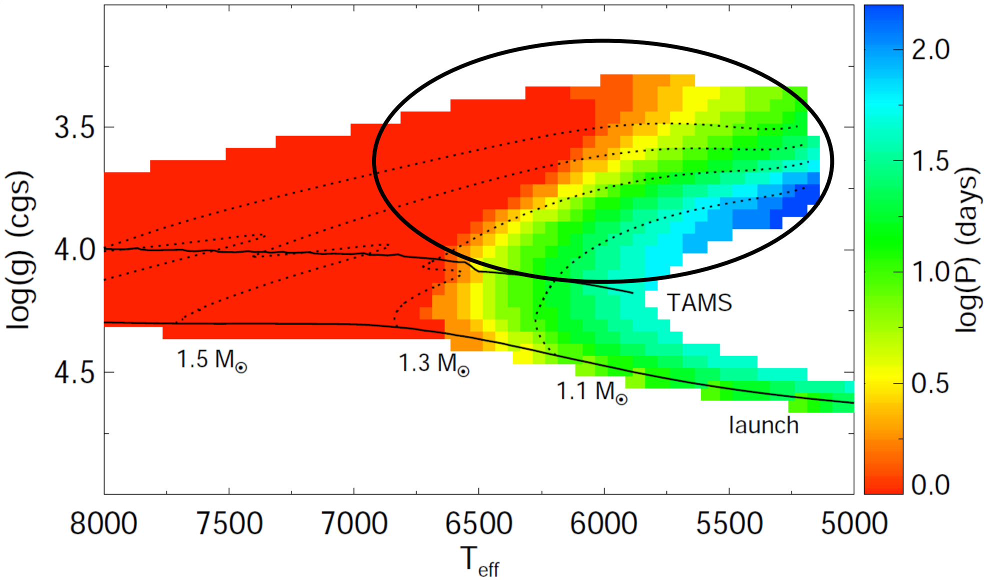

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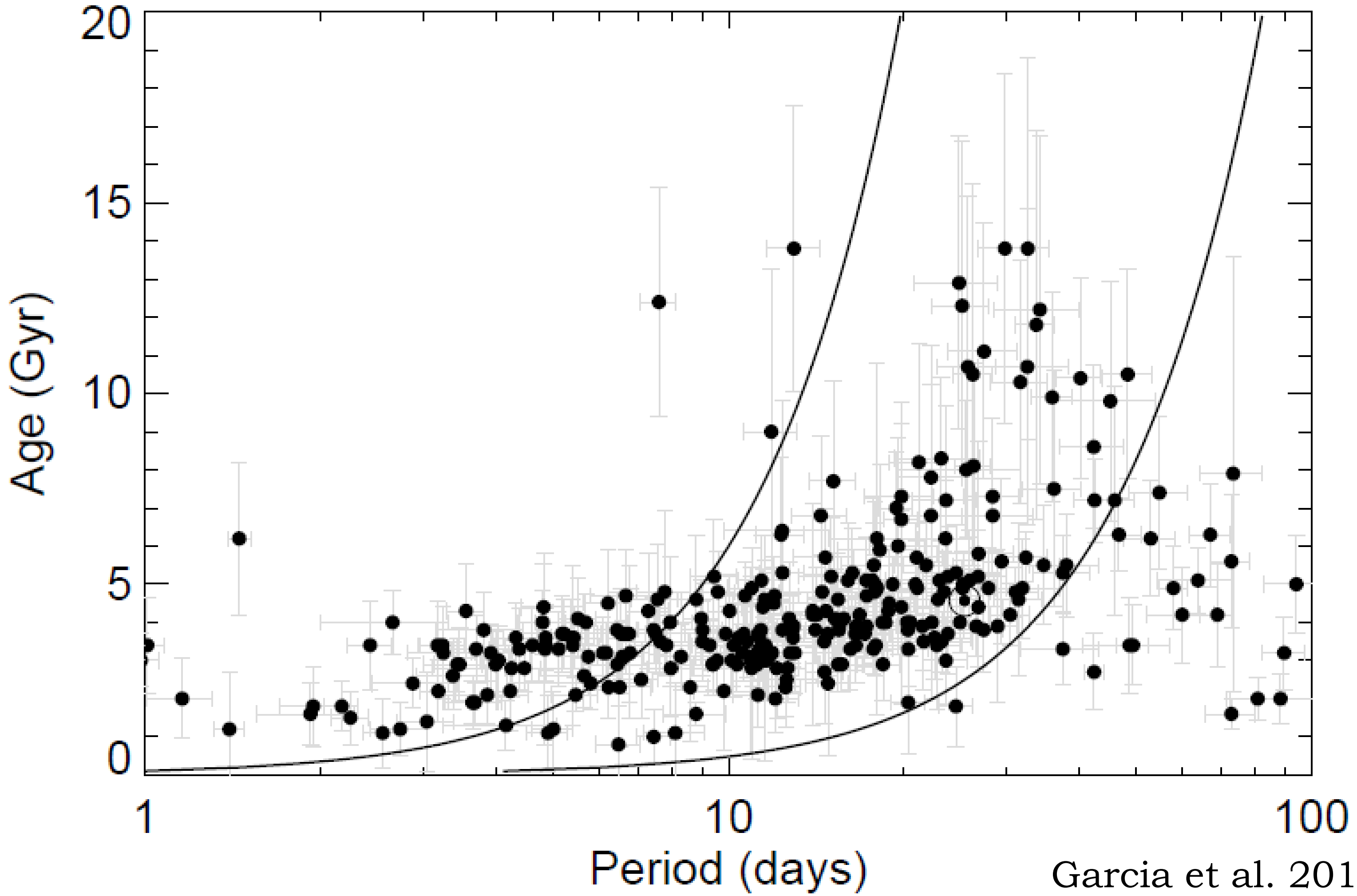
Cool Dwarfs: Relationship between period and age is present and calibrated in the literature. Spin down goes roughly as $P \propto \sqrt{t}$

Hot Stars: Born above the Kraft break, do not undergo magnetic breaking due to thin surface convection zones

Evolved Stars: Rotational evolution dominated by physical expansion of the star and additional magnetic braking (even for stars born above the Kraft break)

van Saders & Pinsonneault 2013

Kepler Asteroseismic Sample



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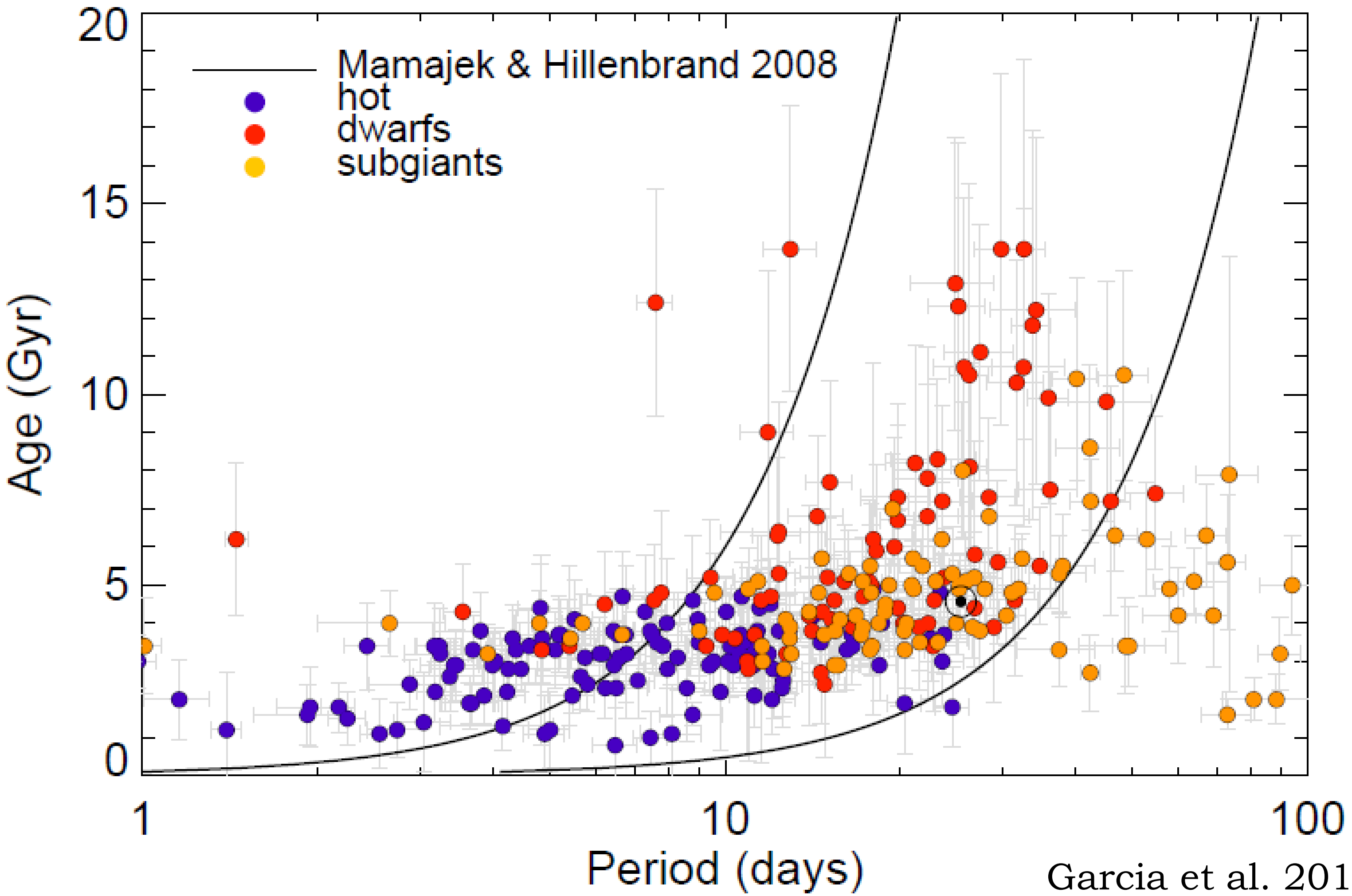

Garcia et al. 2014
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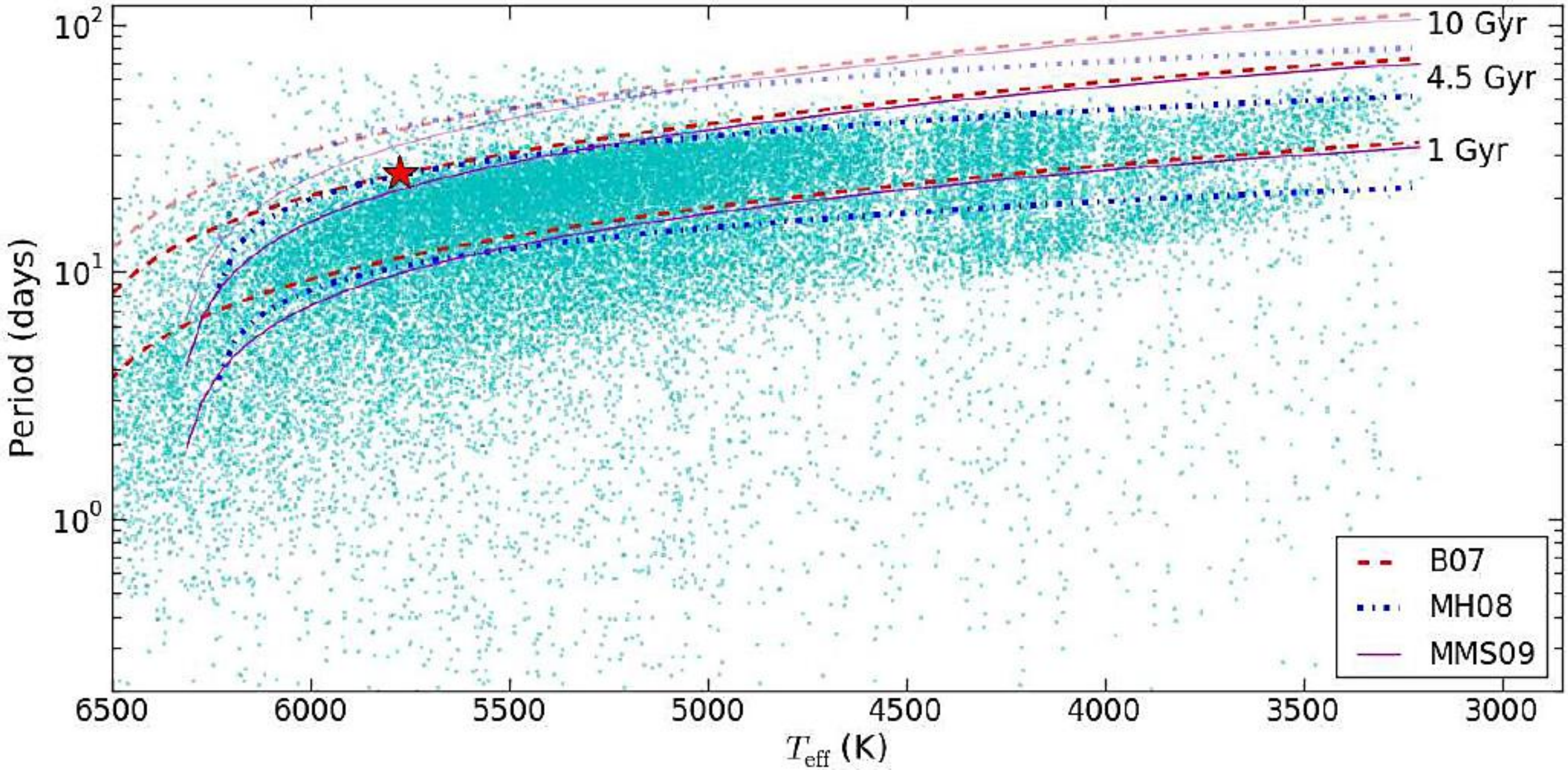
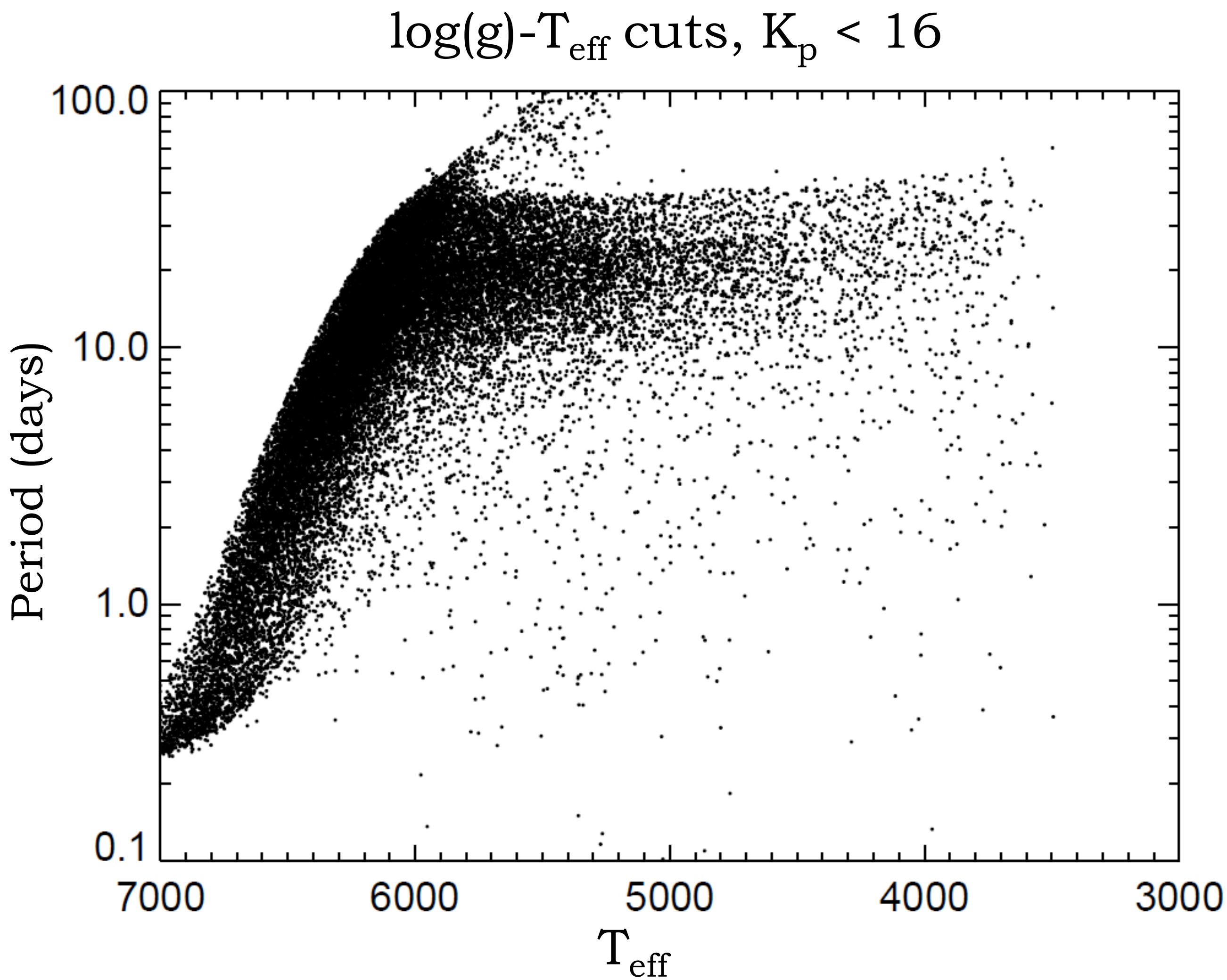
Large Rotation Samples



McQuillan et al. 2014

Forward Modeling



TRILEGAL galaxy model, courtesy of Mauro Barbieri

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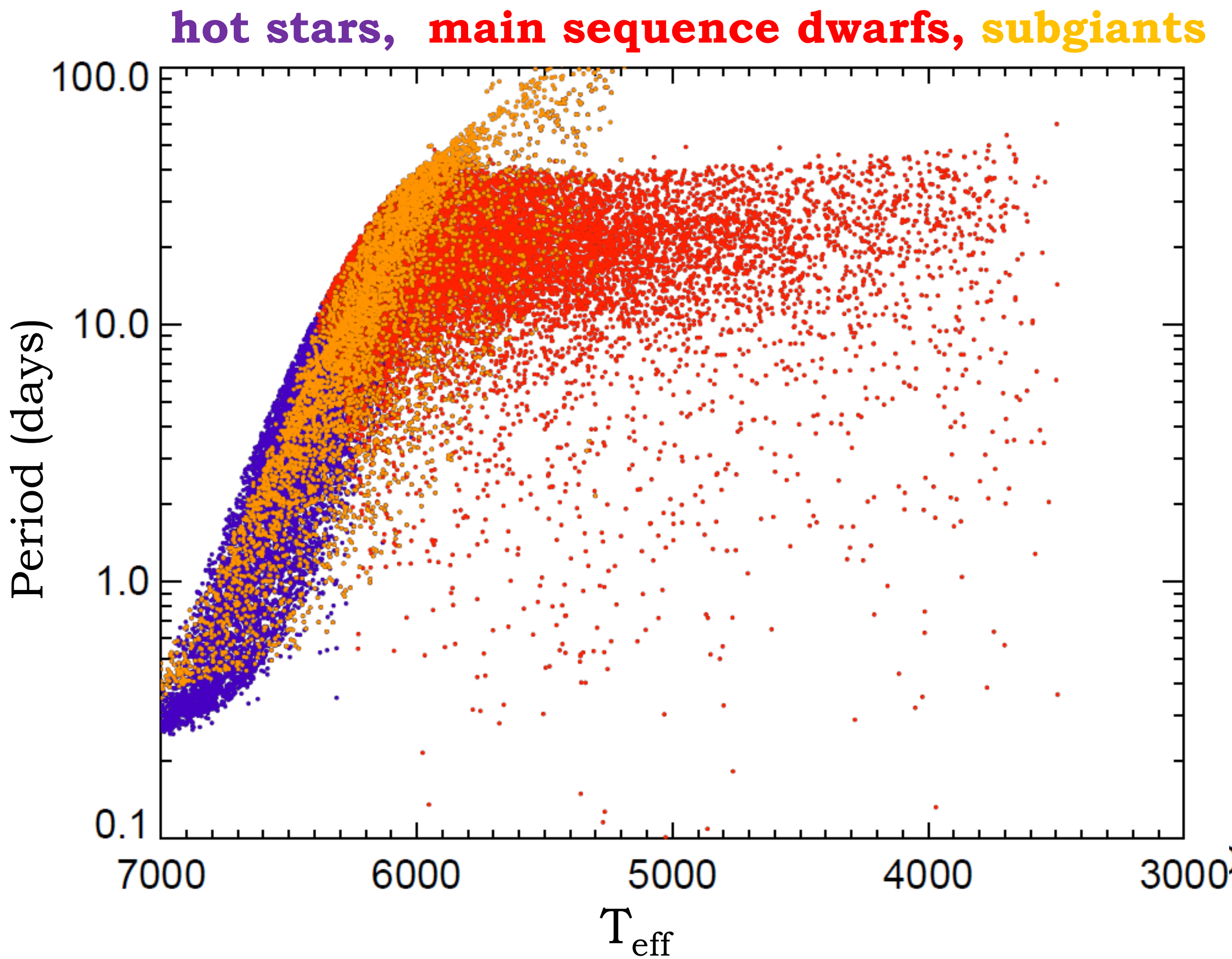

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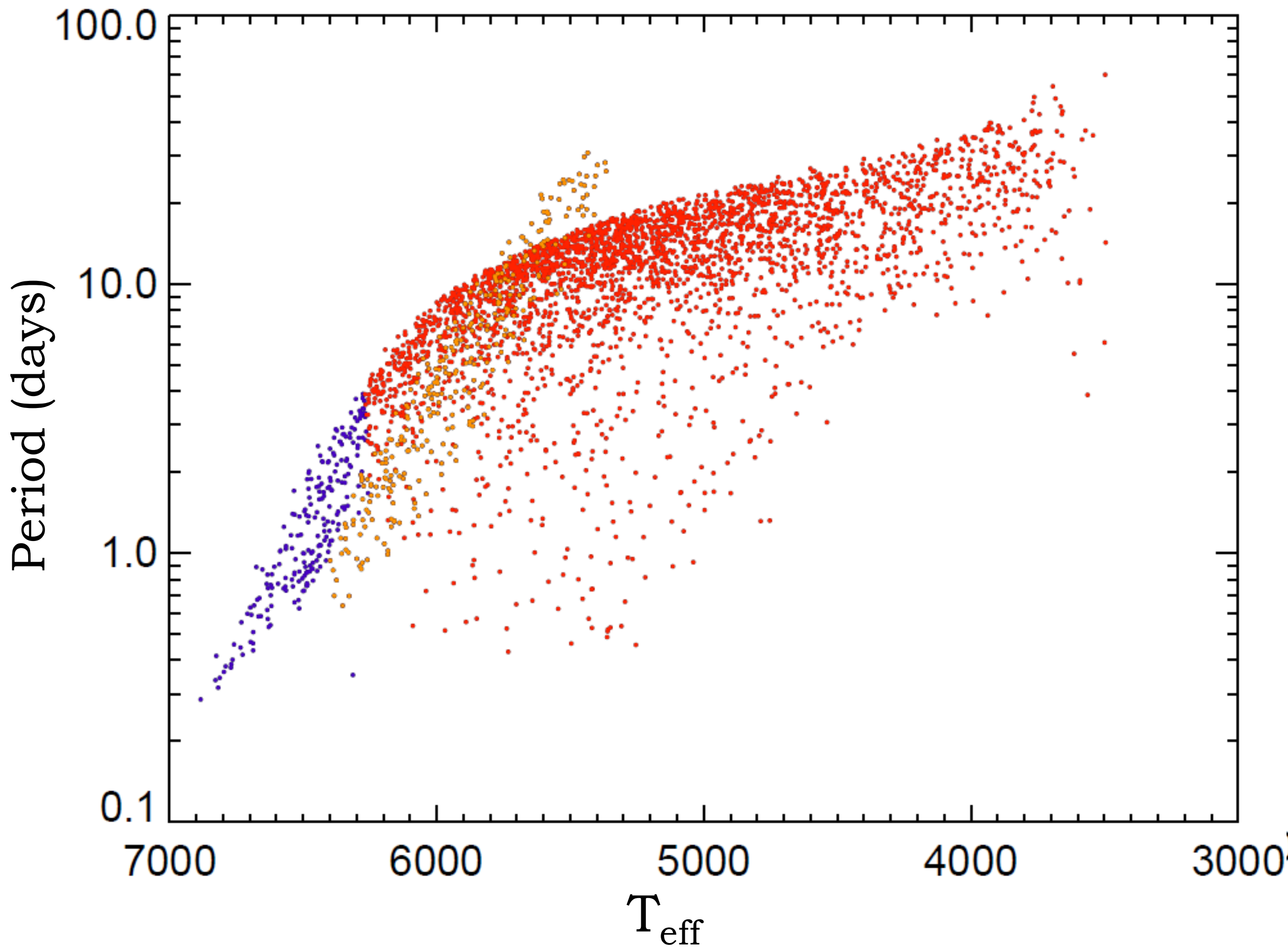
Forward Modeling

log(g)-T_{eff} cuts, K_p < 16, Rossby cut ($\log(R_{per})$ > 3.0)



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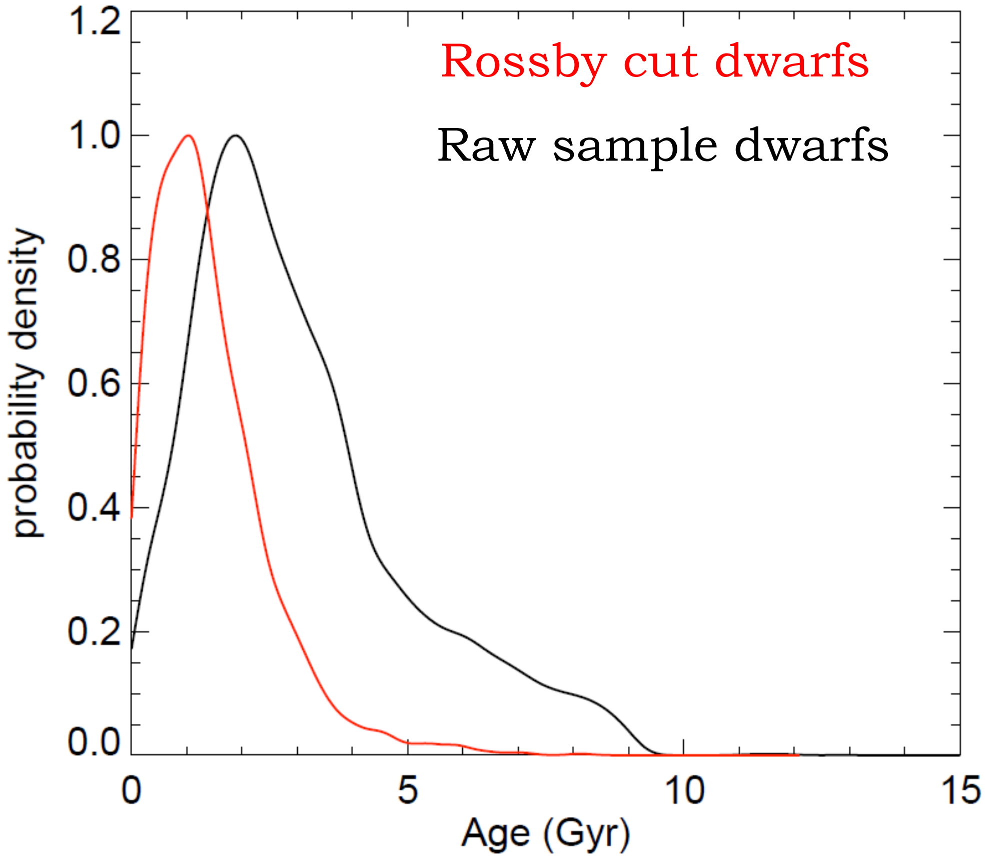
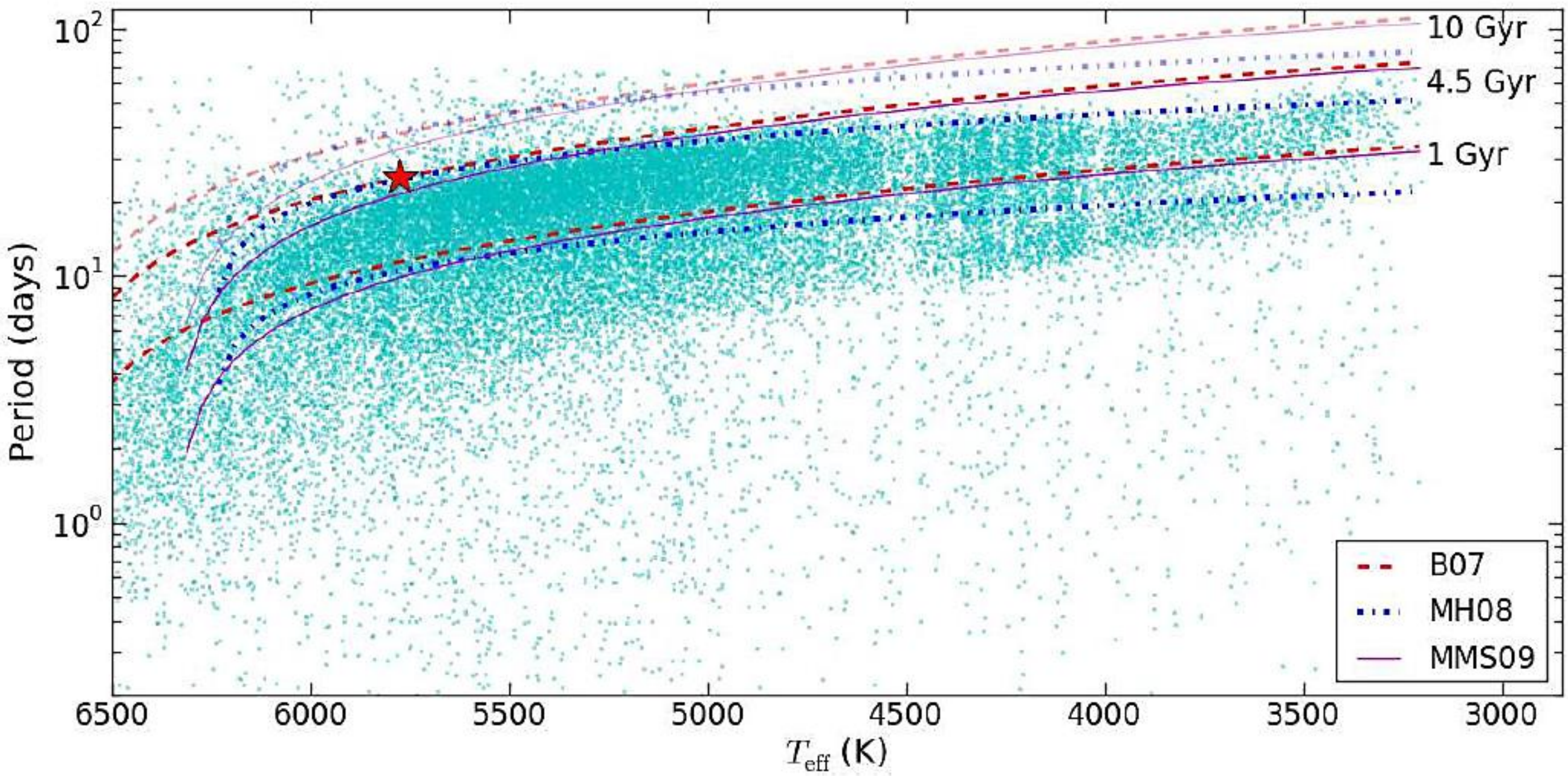


Biases the sample towards younger objects!

Rotation data



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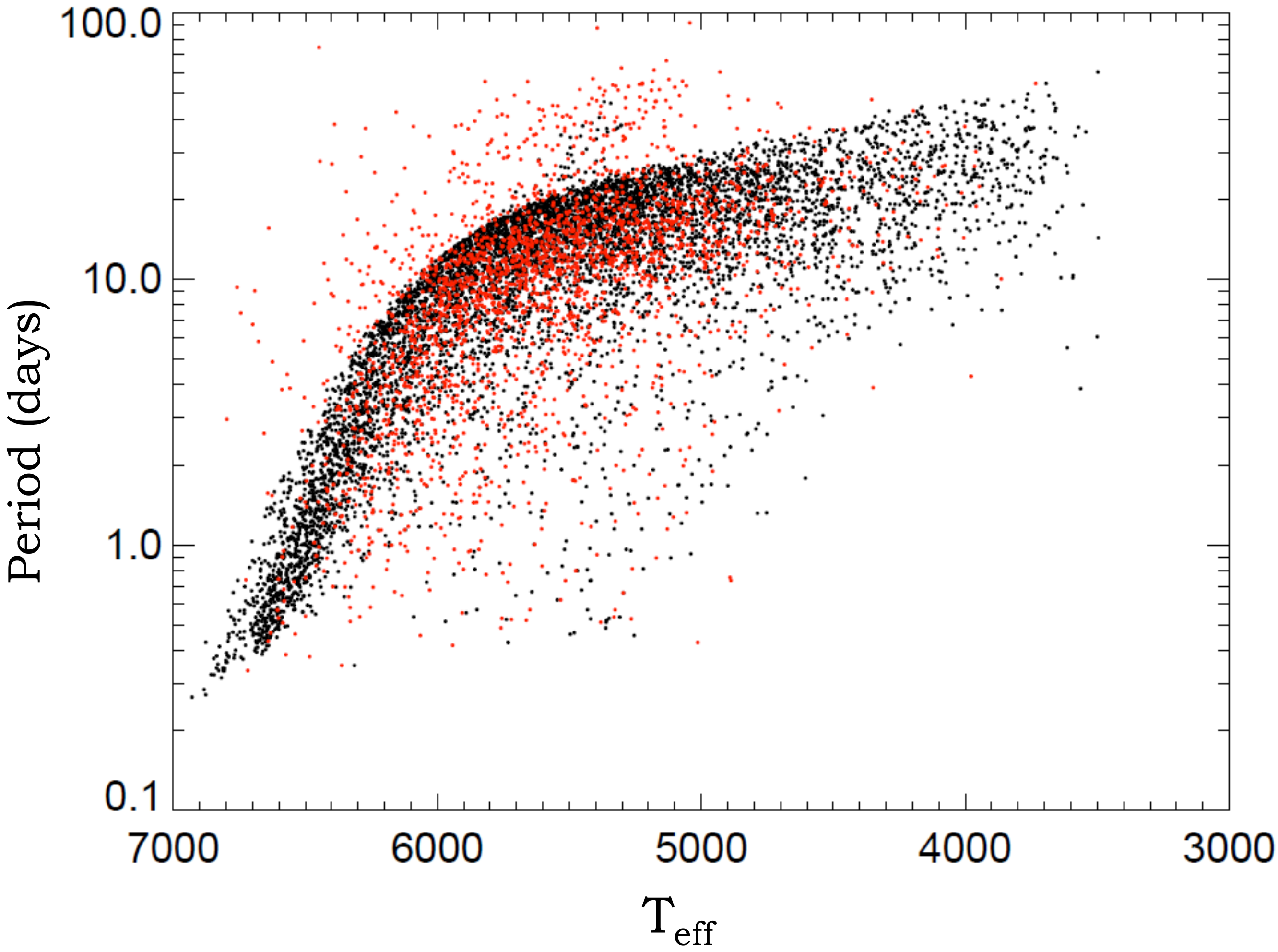
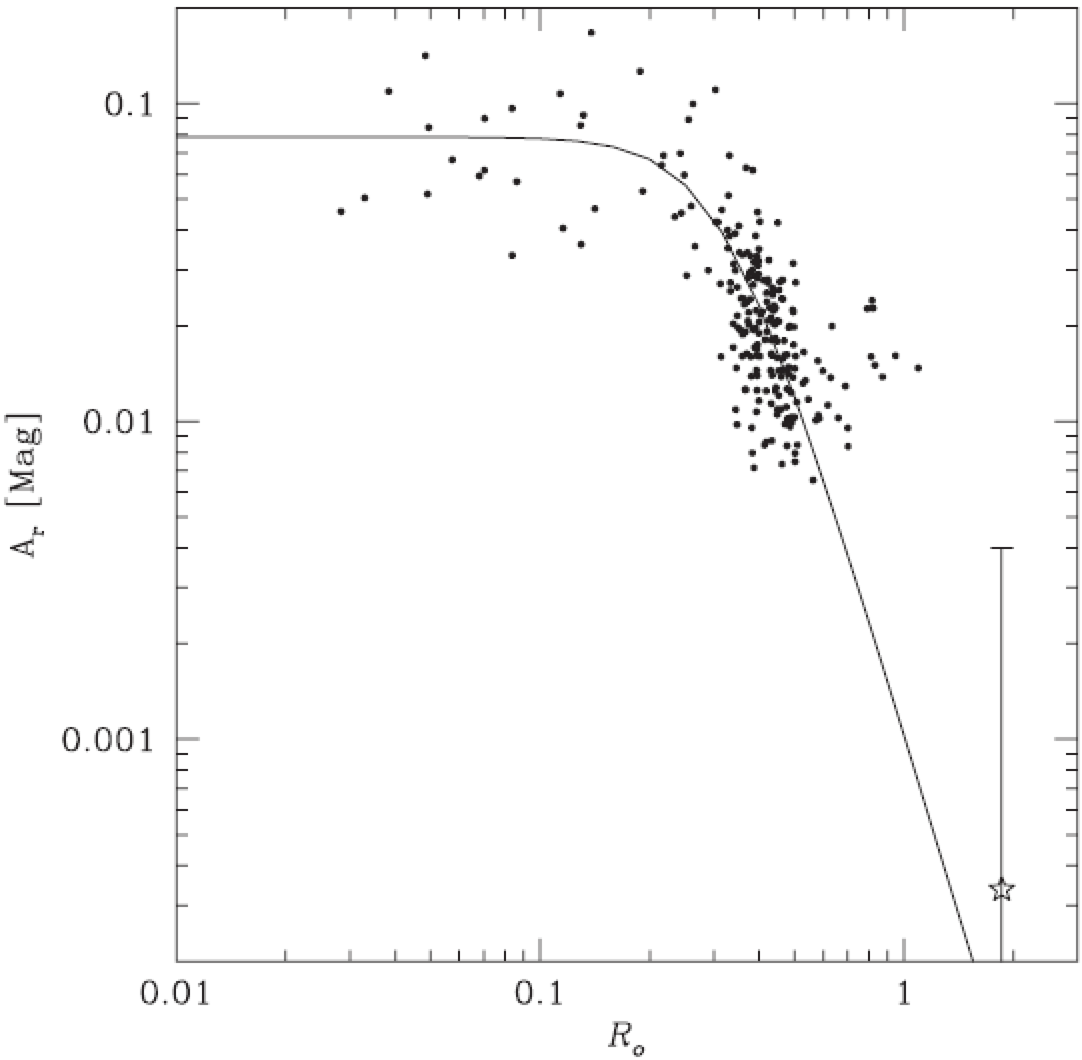
The Impact of Blending



Conclusions

Sample biases directly influence the ages and stellar populations accessible with gyrochronology

Gyrochronological calibrators must be drawn carefully, because the sample is "polluted" with stars that have no (or different) period-age relationships



Hartman et al. 2009

$$A_r = \frac{0.078 \pm 0.008}{1 + \left(\frac{R_O}{0.31 \pm 0.02}\right)^{3.5 \pm 0.5}},$$