

Rotation and magnetism in fully-convective M dwarfs in the Solar Neighborhood

Elisabeth R. Newton

J. Irwin, D. Charbonneau, Z.K. Berta-Thompson,
J.A. Dittmann, P. Berlind, M. Calkins, J. Mink, A.A. West

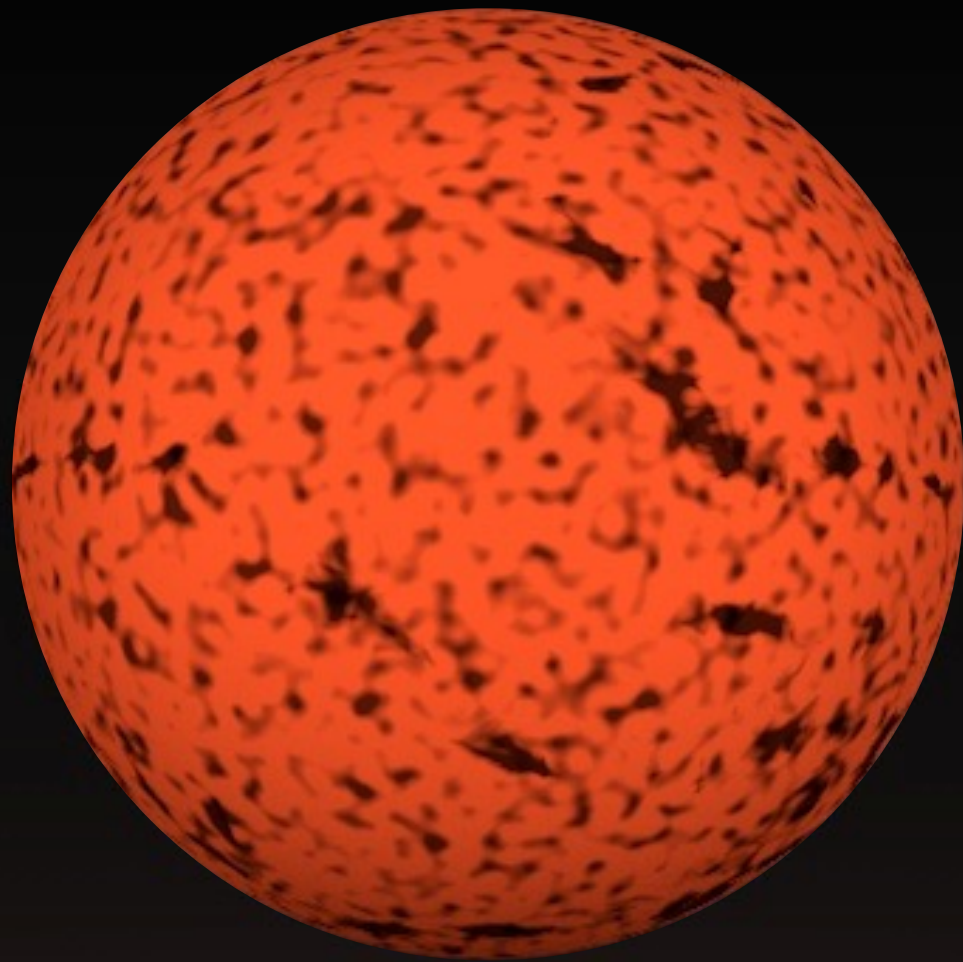


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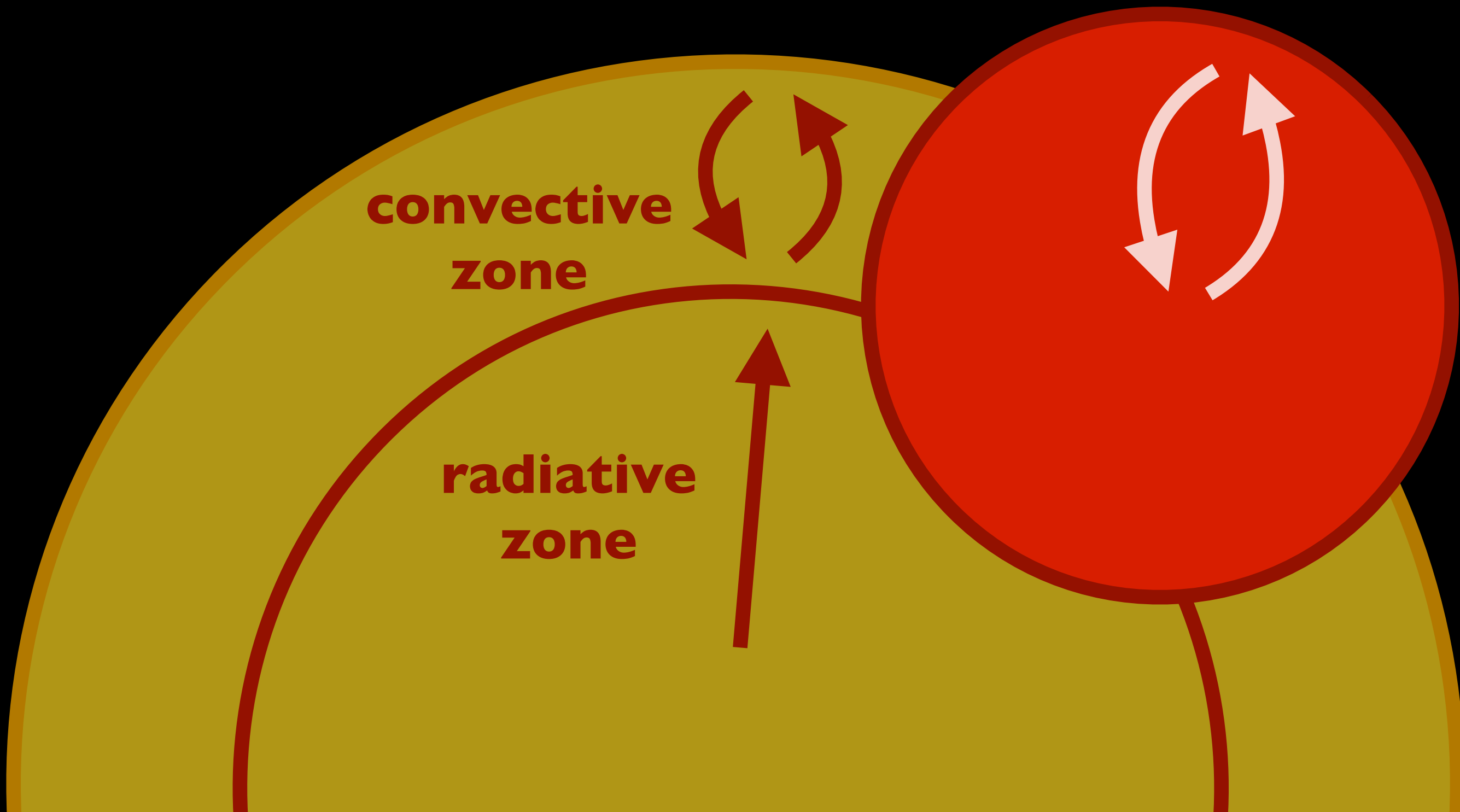


Fully convective M dwarfs:

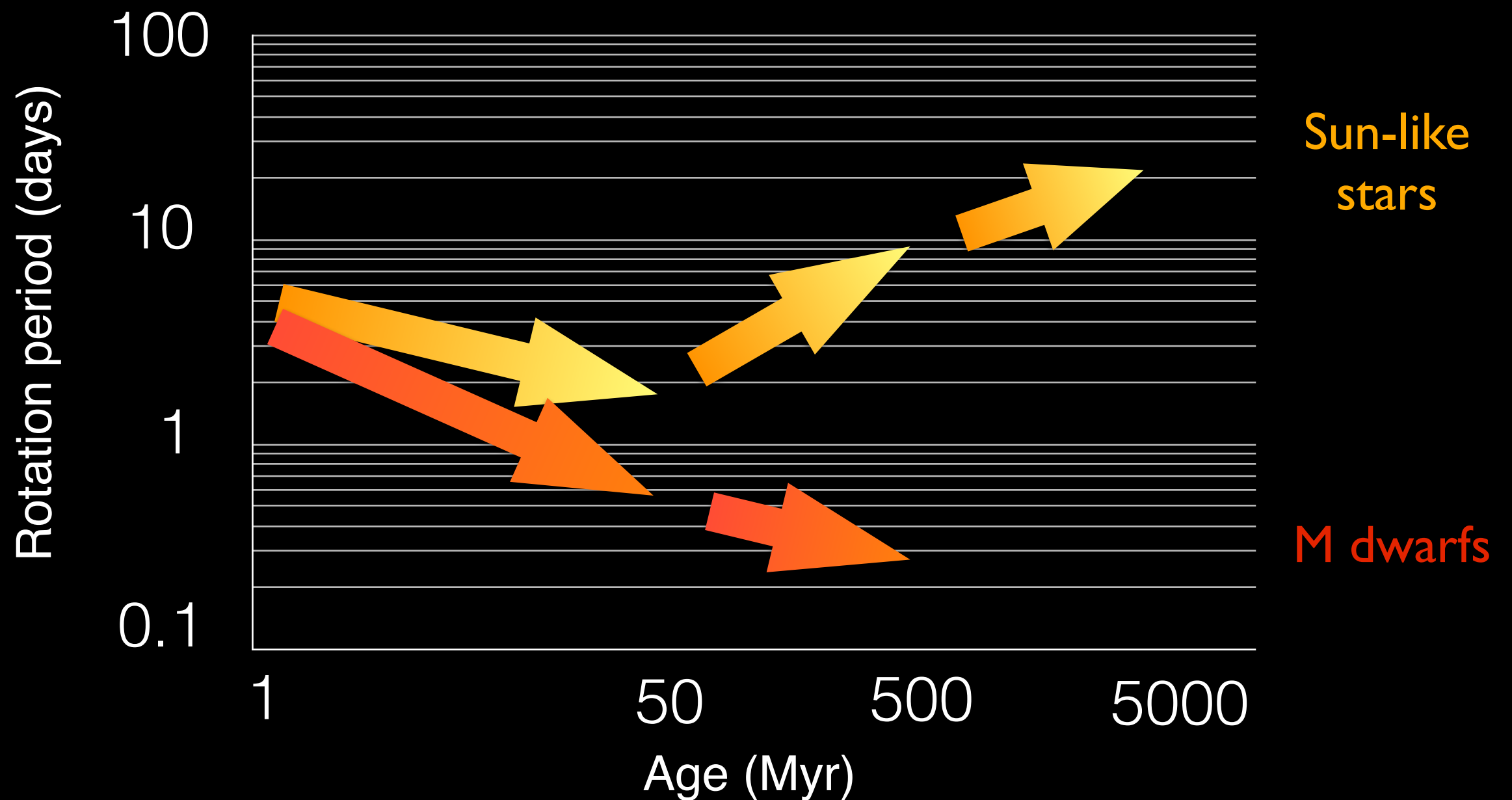
What governs the evolution of their spin?

What drives their magnetic dynamo?

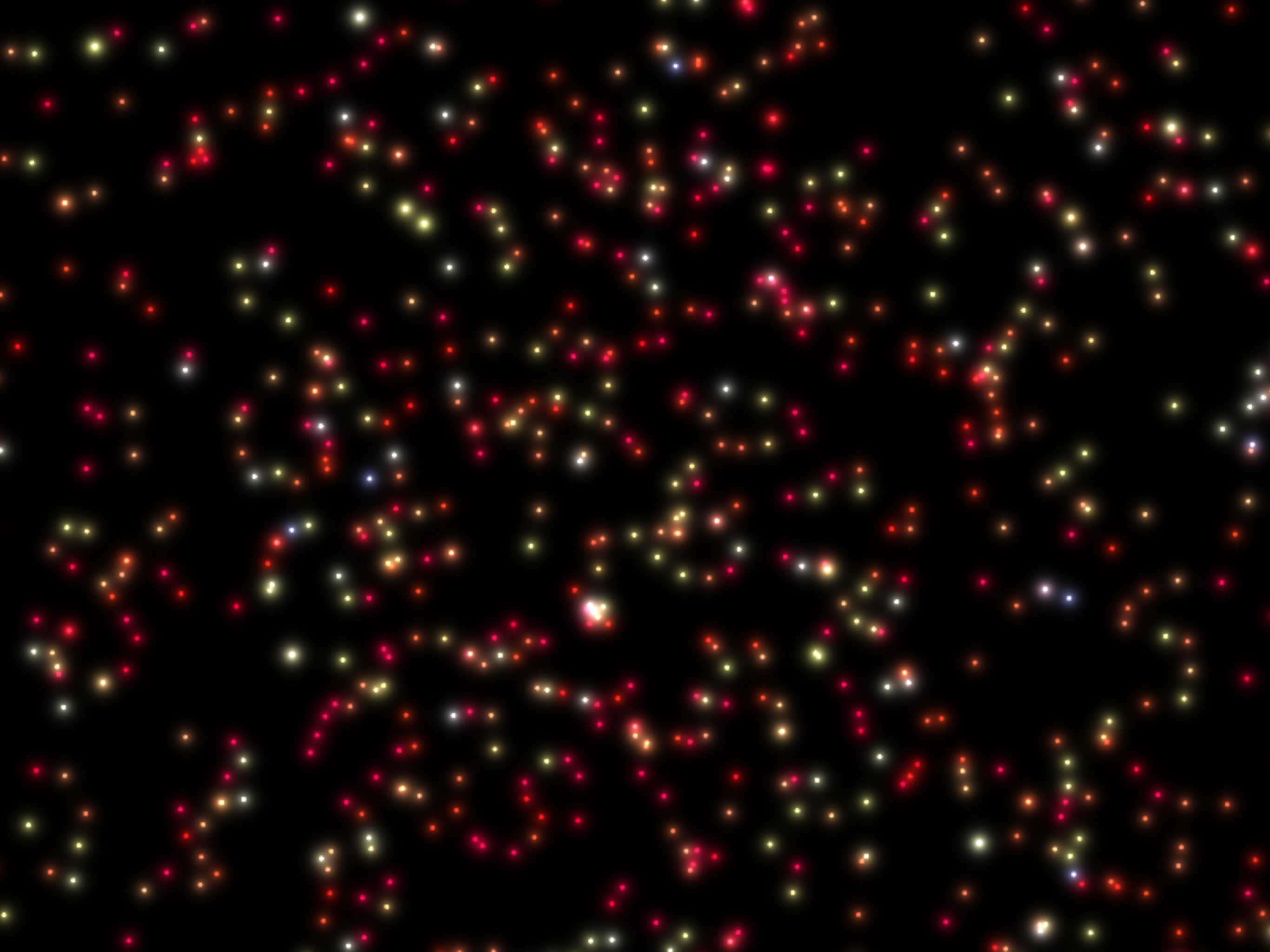
The M dwarf challenge: convective interiors



Angular momentum evolution is mass dependent



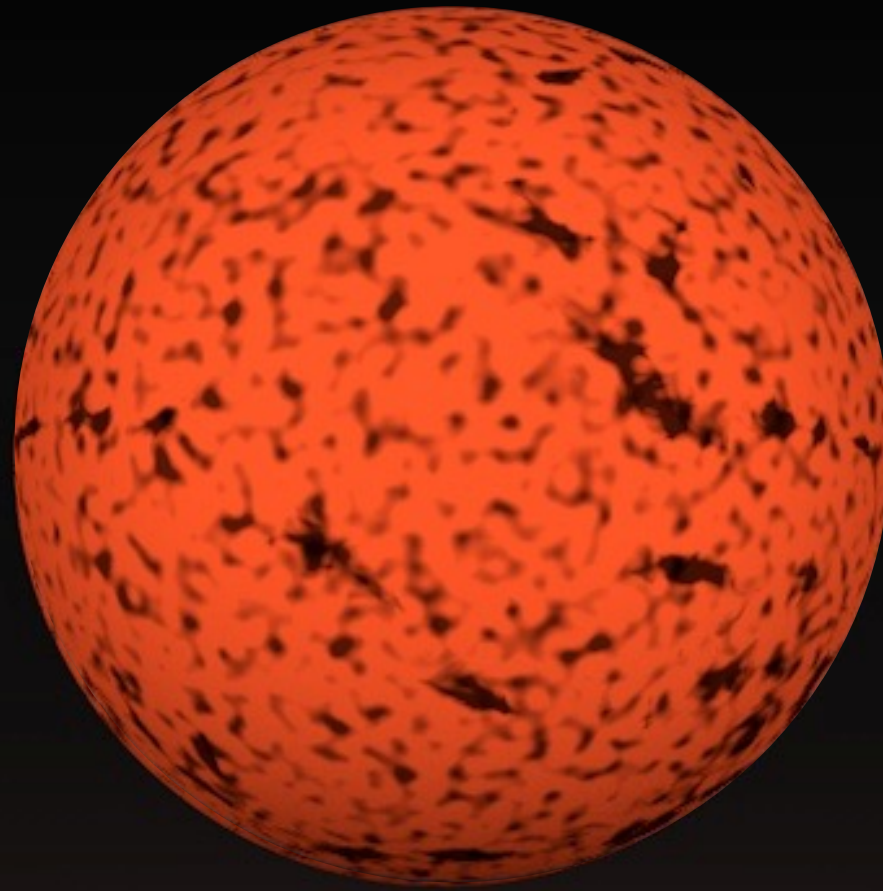
c.f. Irwin & Bouvier (2009)



Measure

rotation
periods

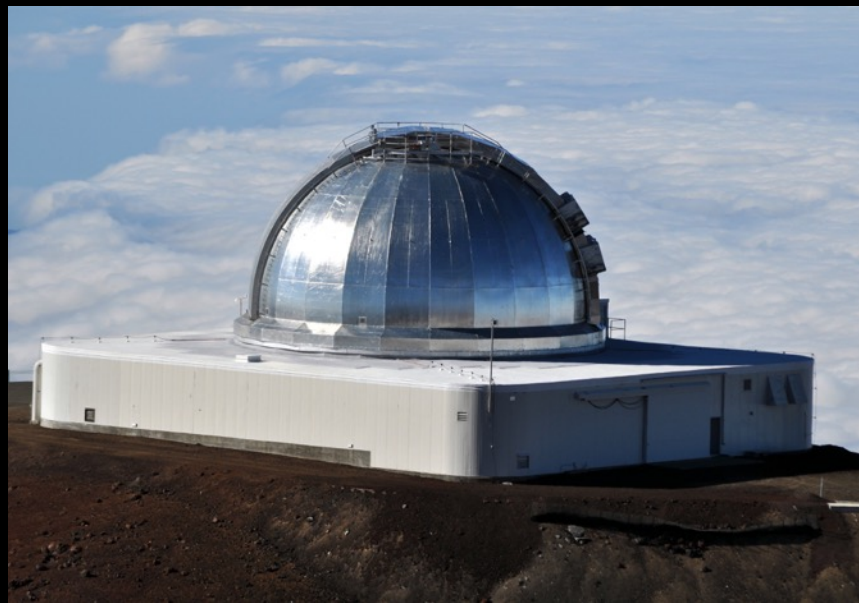
magnetic
activity



Investigate

spin-down
time

period-activity
relation



NIR spectroscopy *with IRTF/SpeX*

Stellar characterization
25 nights, PI: E. Newton



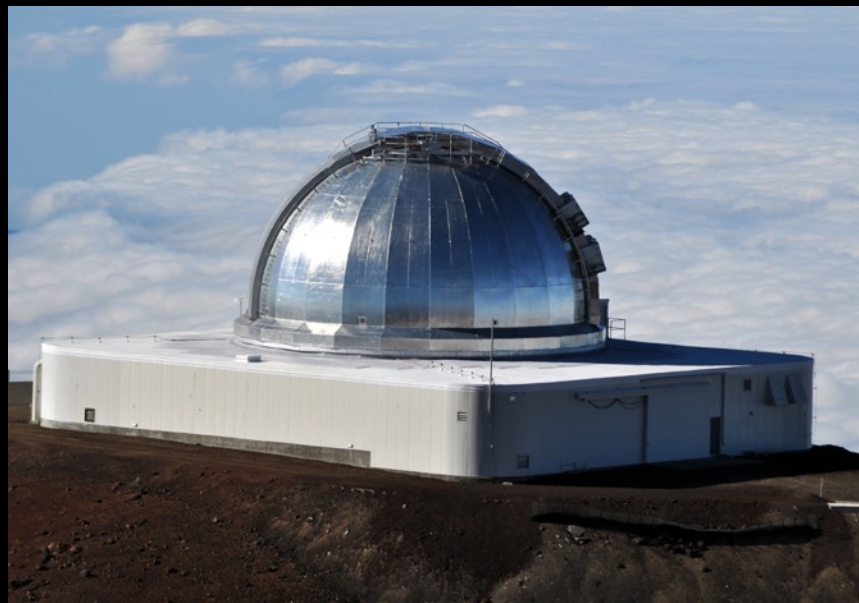
MEarth photometry

Stellar rotation
5 years, PI: D. Charbonneau



Optical spectroscopy *with FAST at FLWO*

Magnetic activity
15 nights, PI: E. Newton



NIR spectroscopy *with IRTF/SpeX*

Stellar characterization
25 nights, PI: E. Newton



MEarth photometry

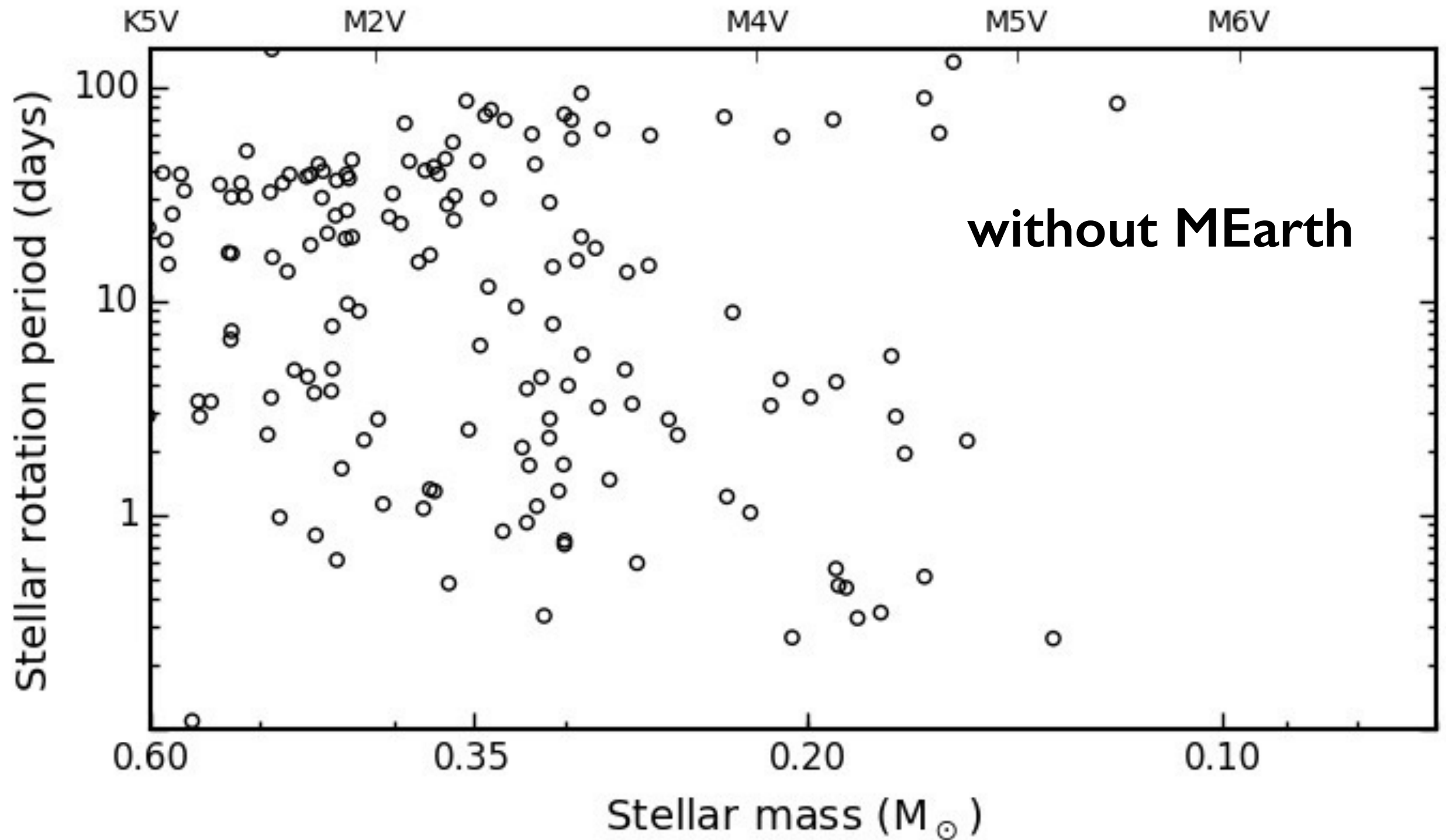
Stellar rotation
5 years, PI: D. Charbonneau



Optical spectroscopy *with FAST at FLWO*

Magnetic activity
15 nights, PI: E. Newton

Periods for nearby northern M dwarfs





The MEarth Project (PI: D. Charbonneau)

Targeted survey looking for transiting planets
Sample from LSPM-North w/ $R < 0.33 R_{\odot}$, $d < 33 \text{ pc}$



Binaries: J. Winters (#319)

MEarth stellar astrophysics at Cool Stars

Overview: J. Irwin (#201)

Photometry: J.A. Dittmann (#141)

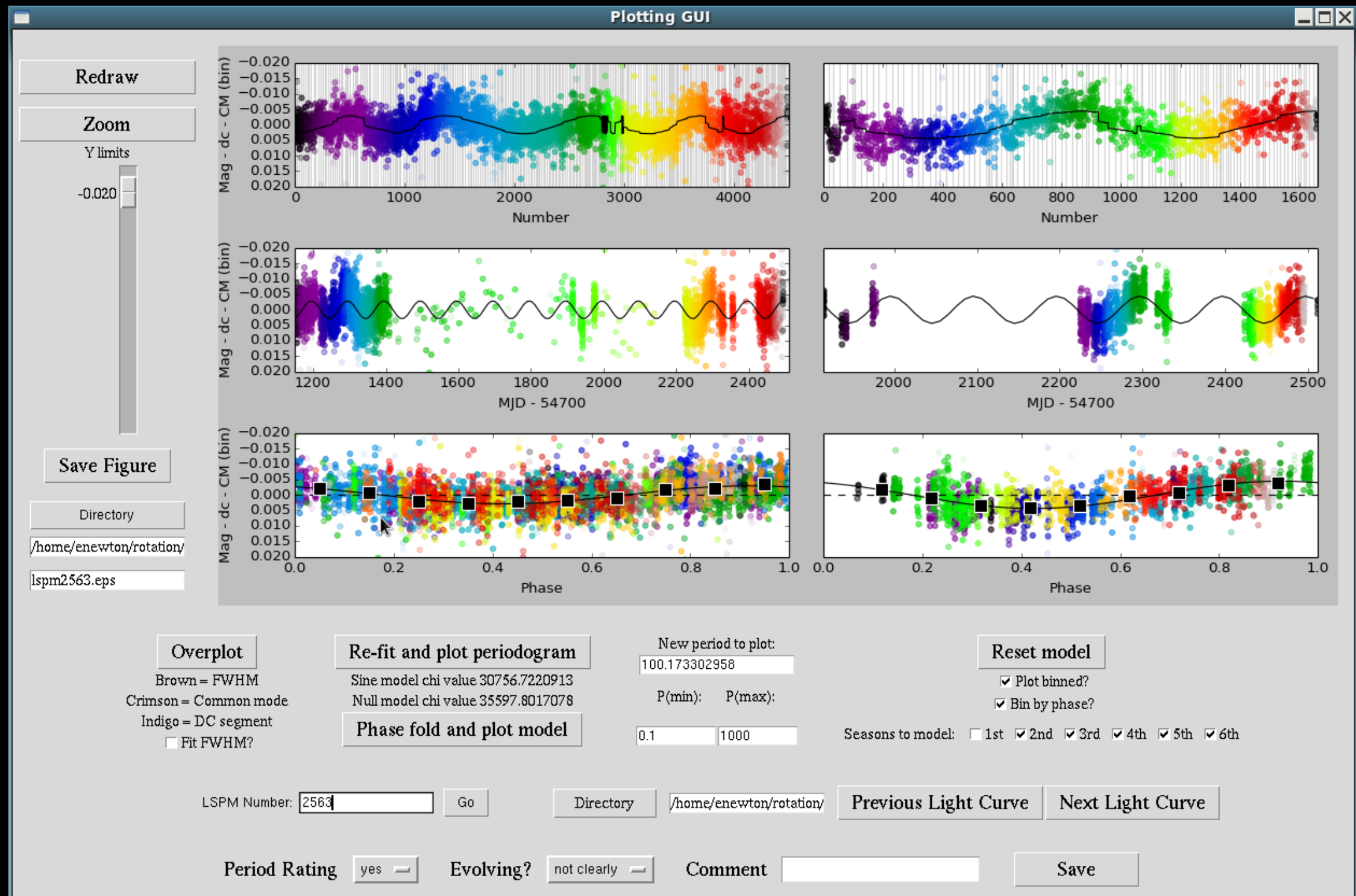
Flares: N. Mondrik (#168)



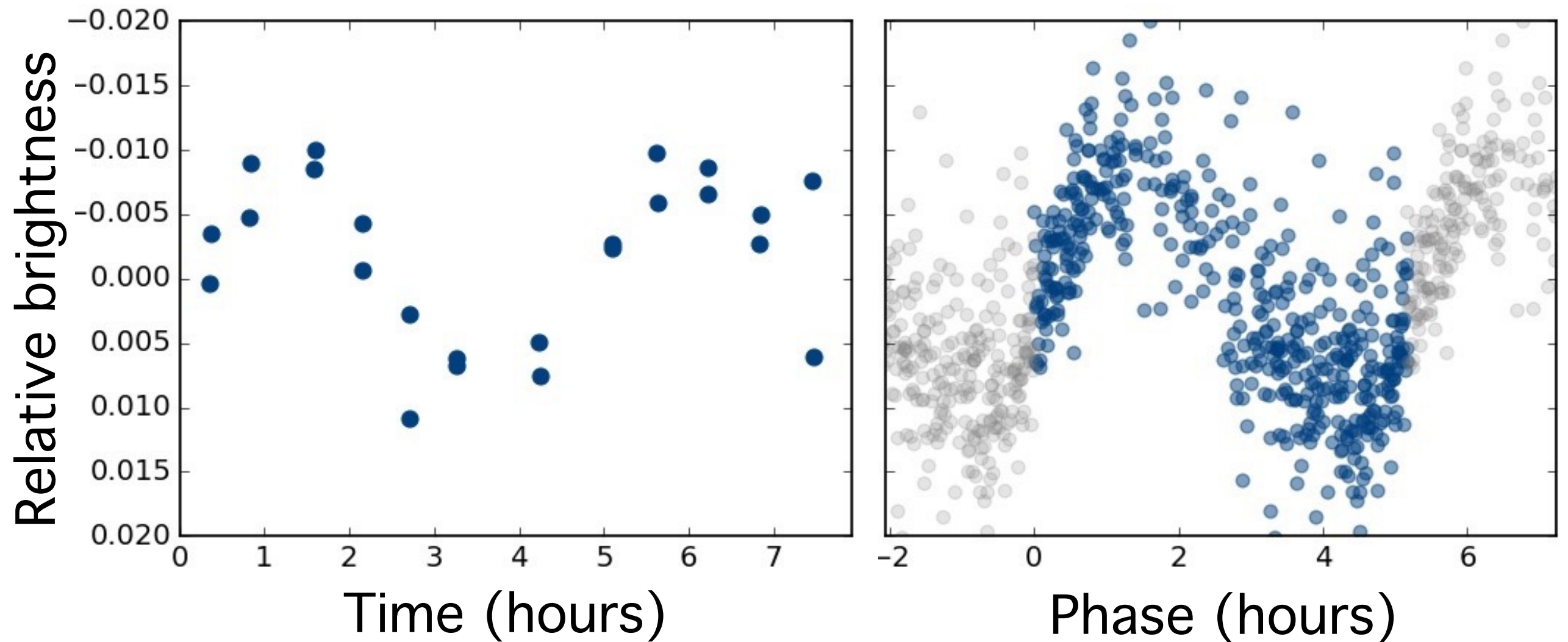
Photometric rotation periods:
searched all 1886 M dwarfs with any
observations from MEarth-North

Simultaneously fit systematics+sinusoid

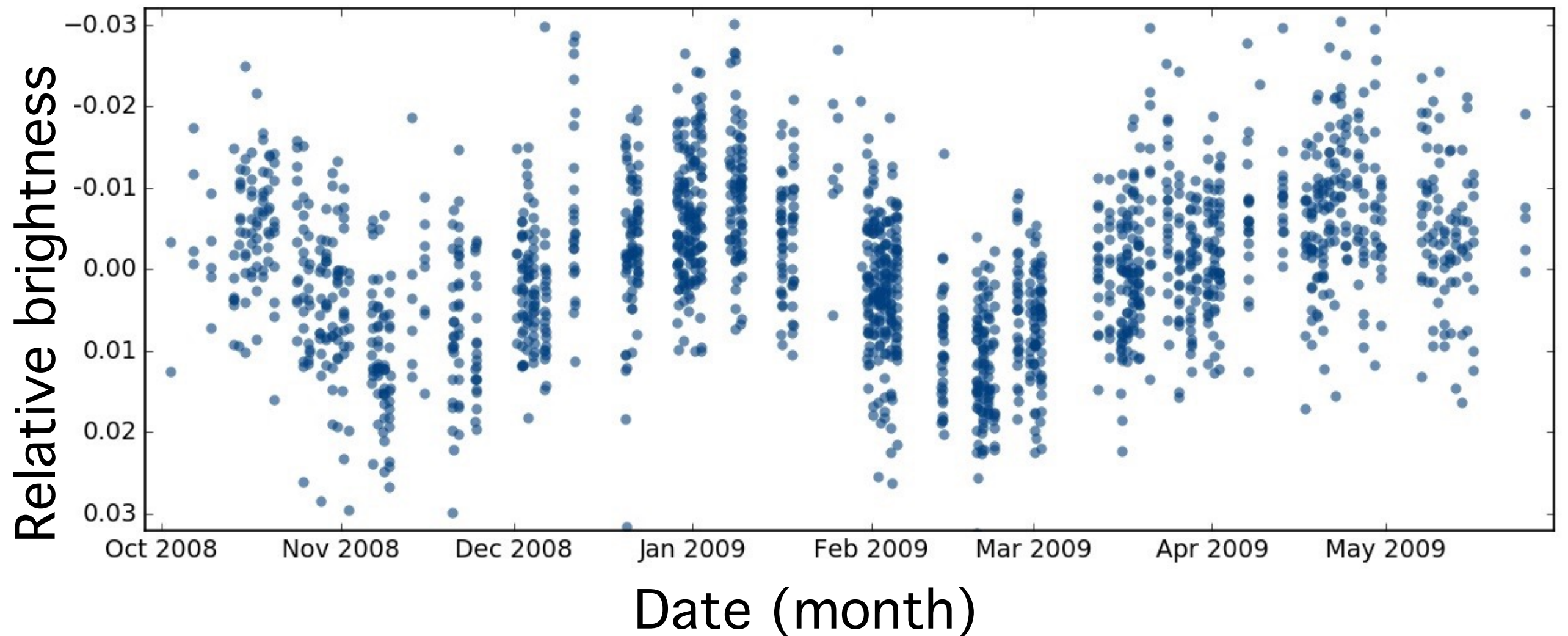
Examined each light curve by eye



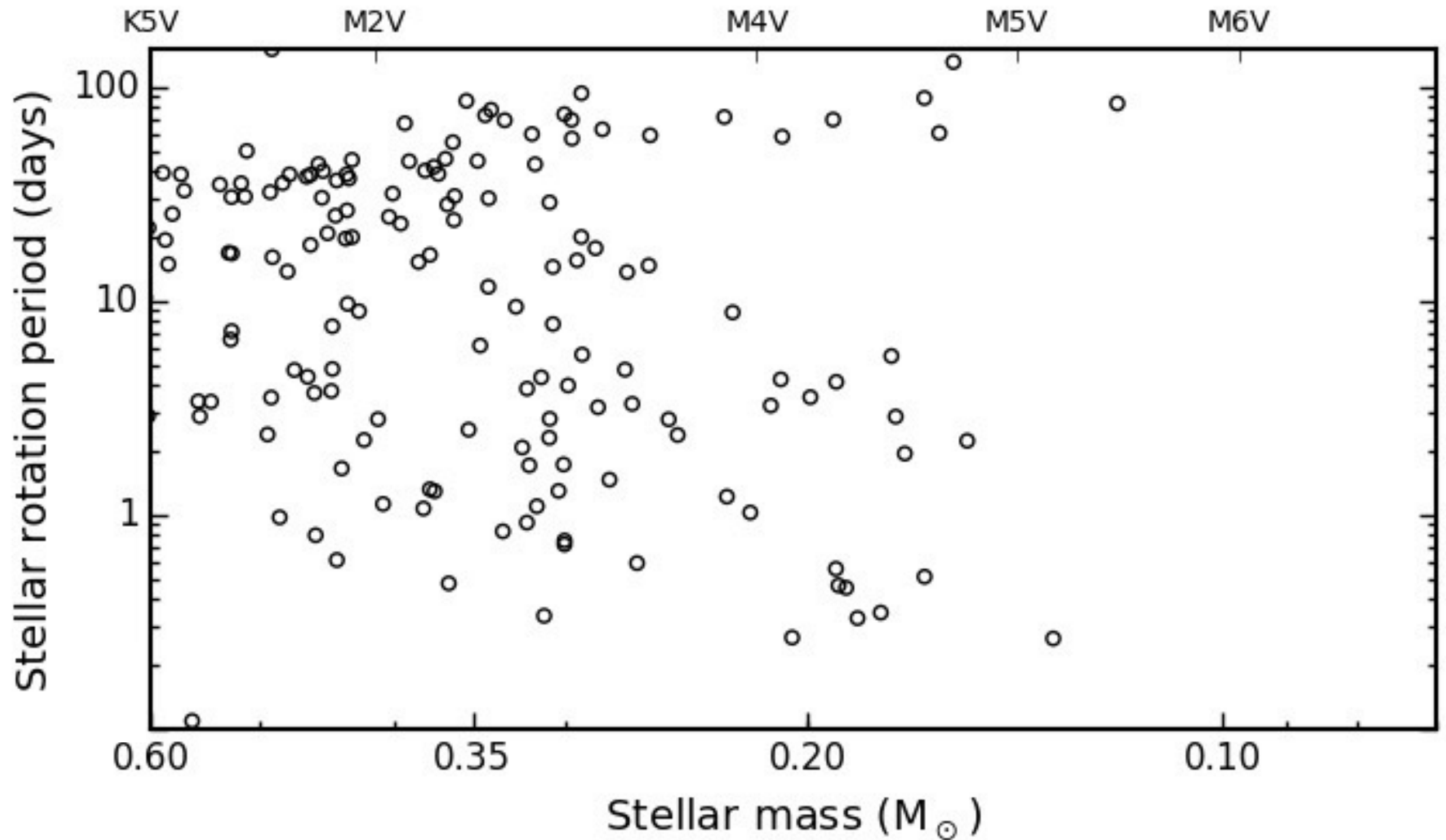
High cadence: sensitivity to short periods



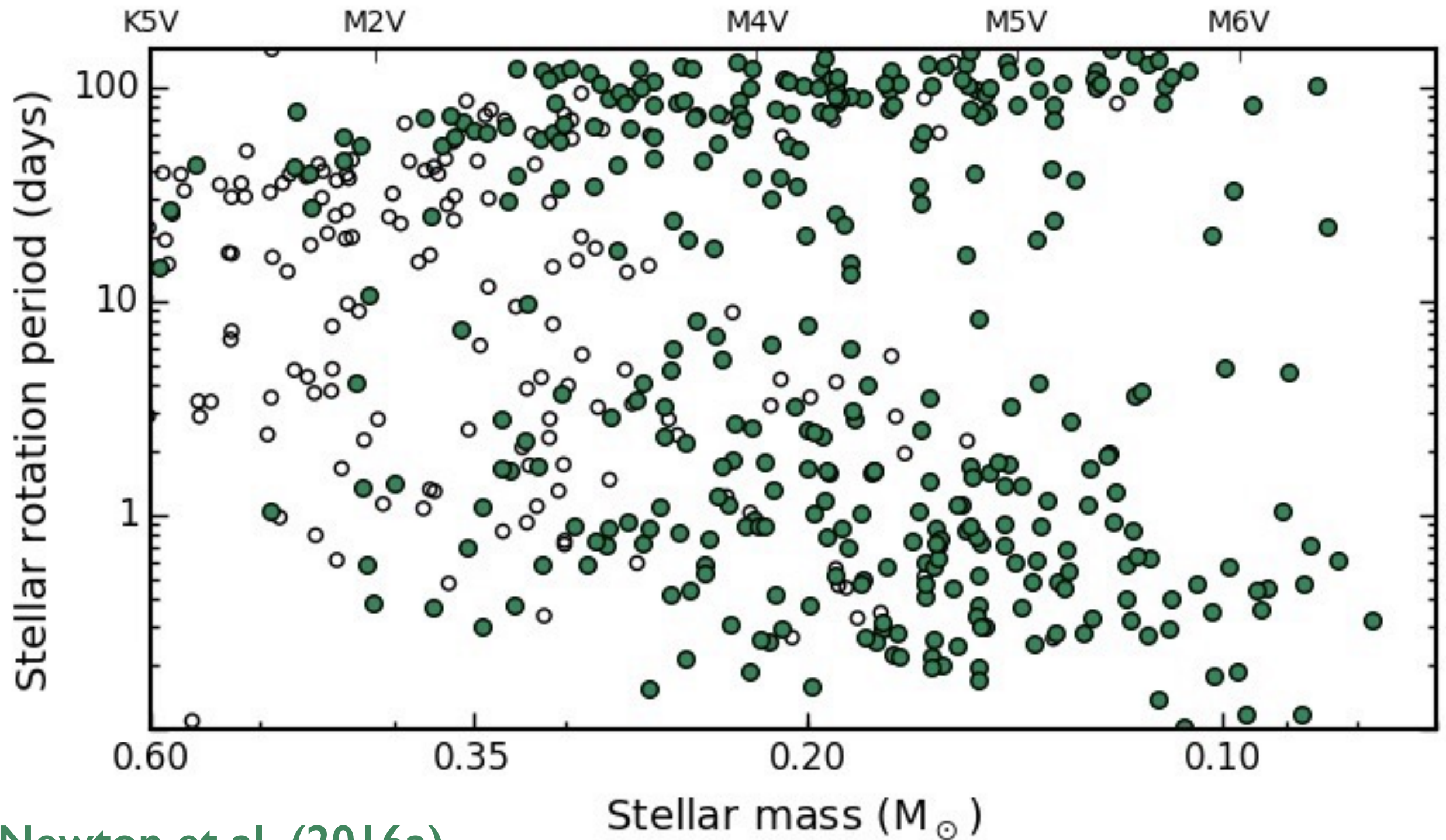
Long time base-line: sensitivity to long periods



Periods for nearby northern M dwarfs

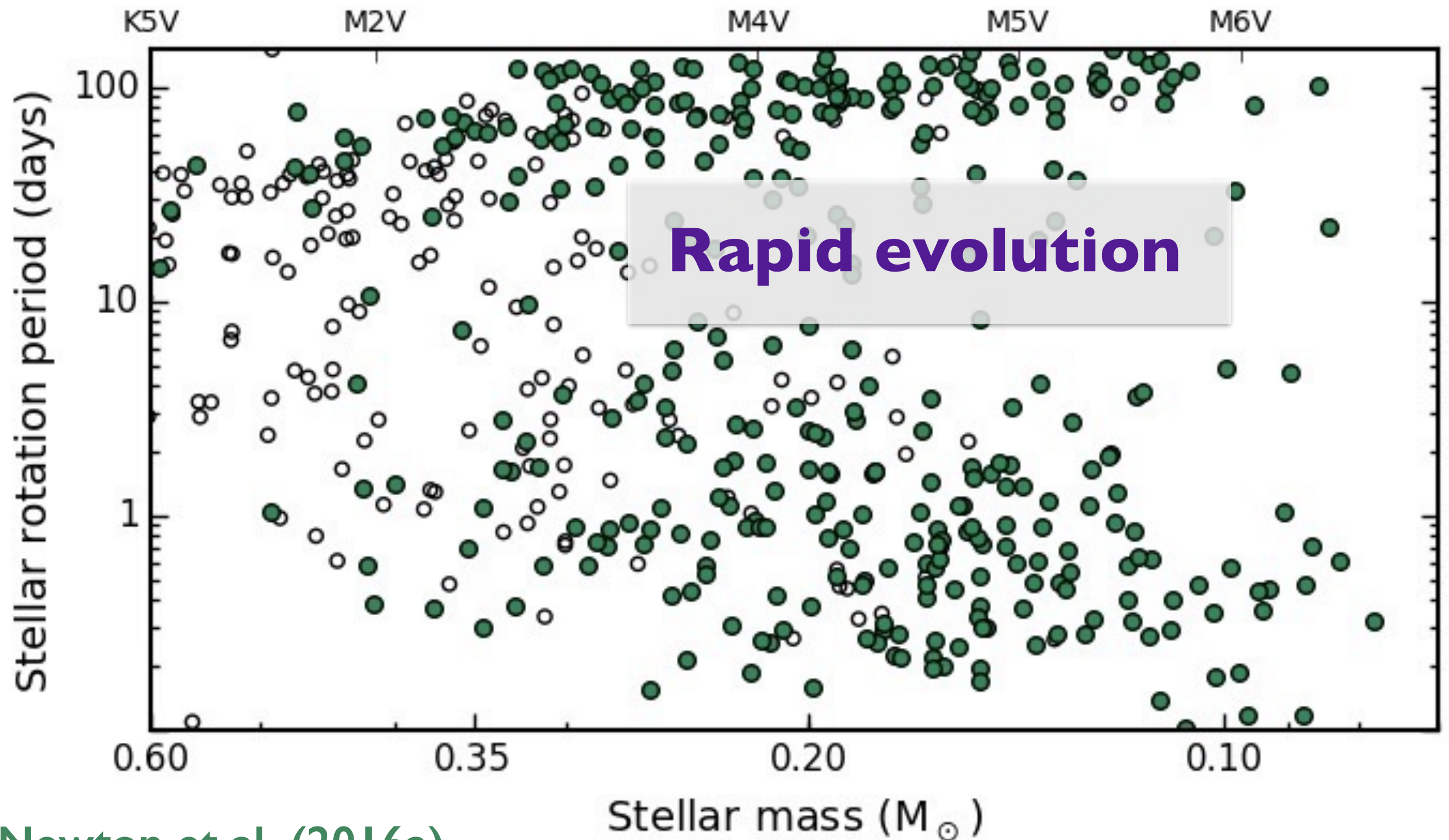


387 new rotation period measurements



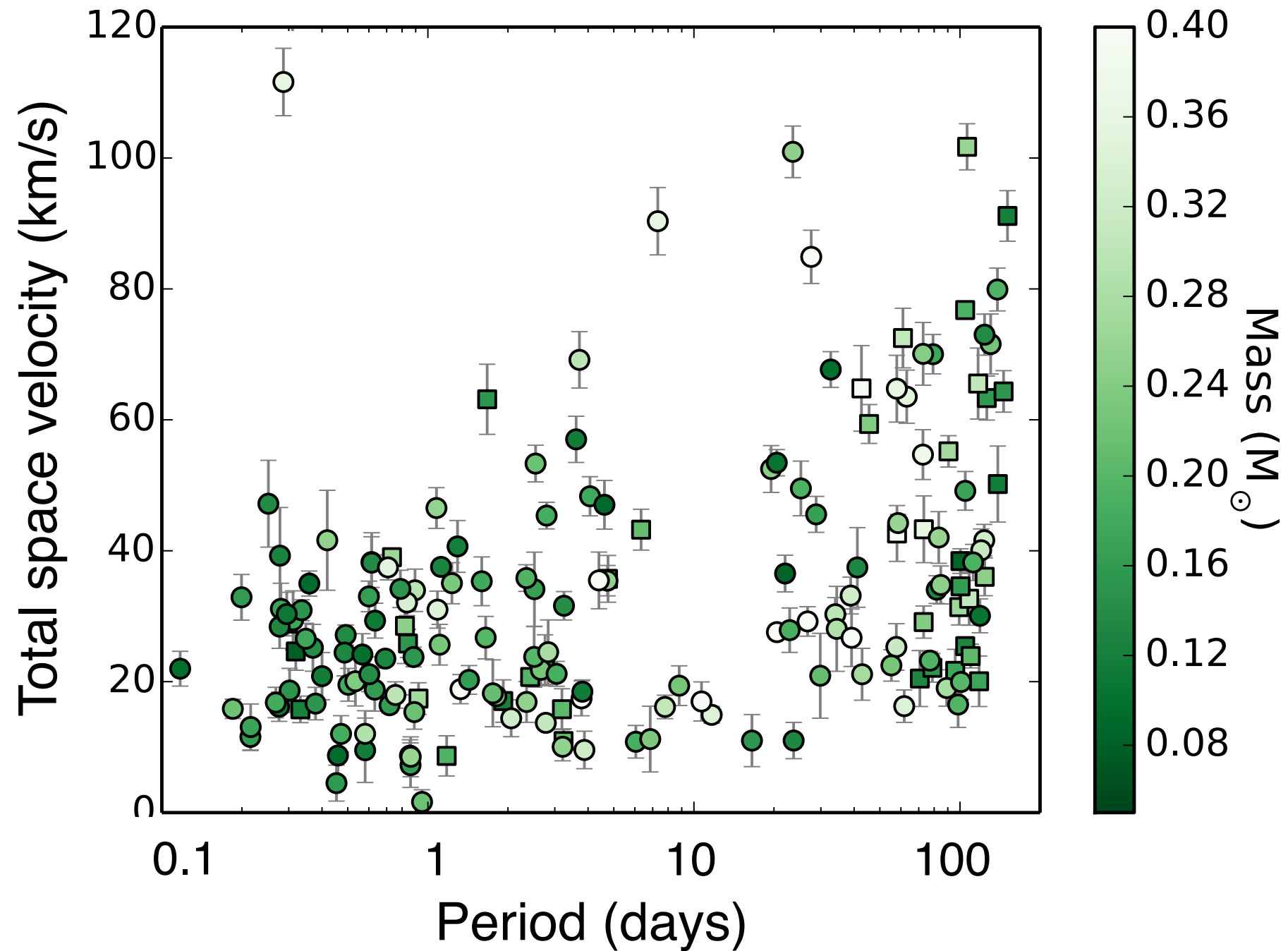
Newton et al. (2016a)

387 new rotation period measurements

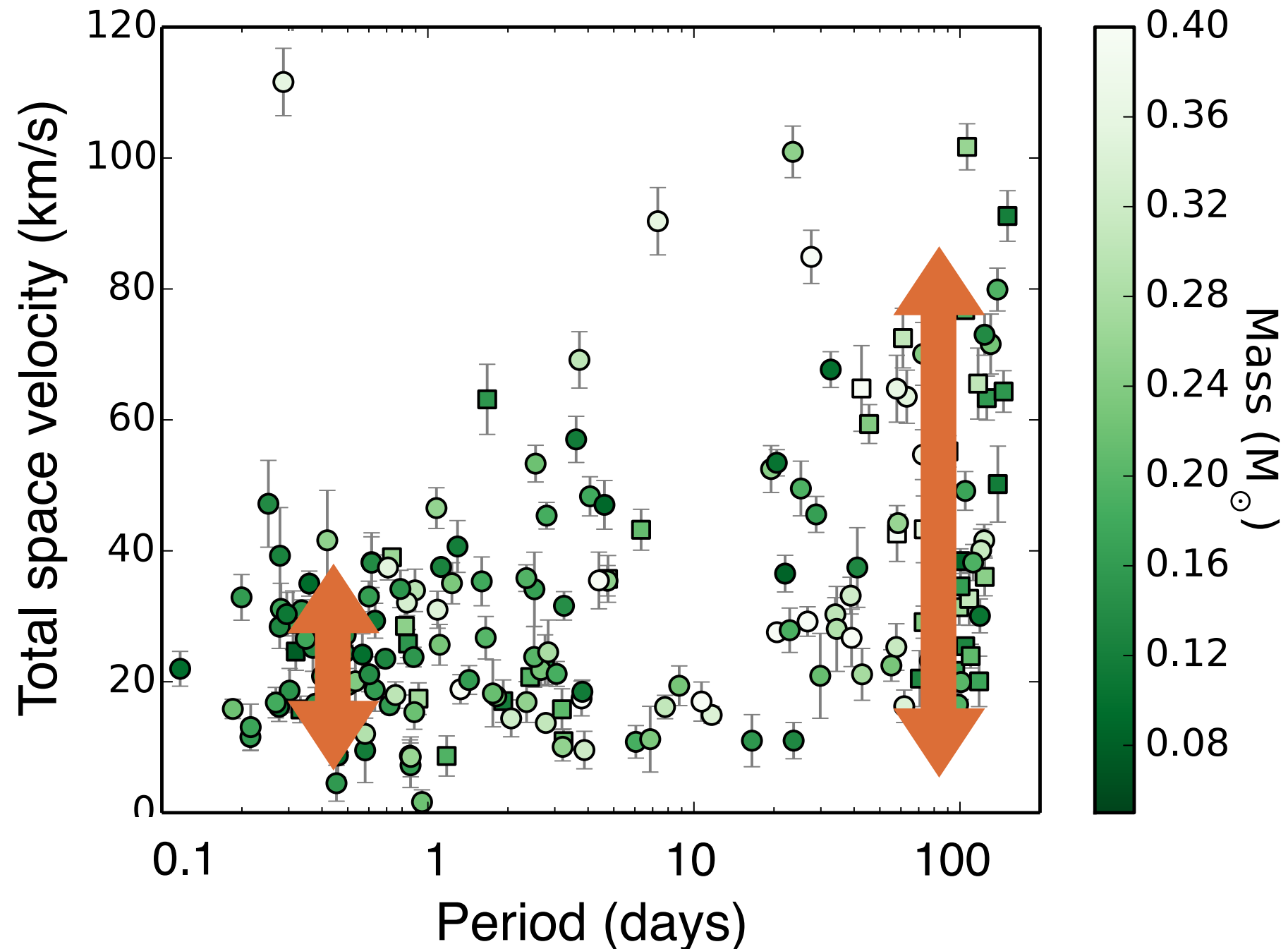


Newton et al. (2016a)

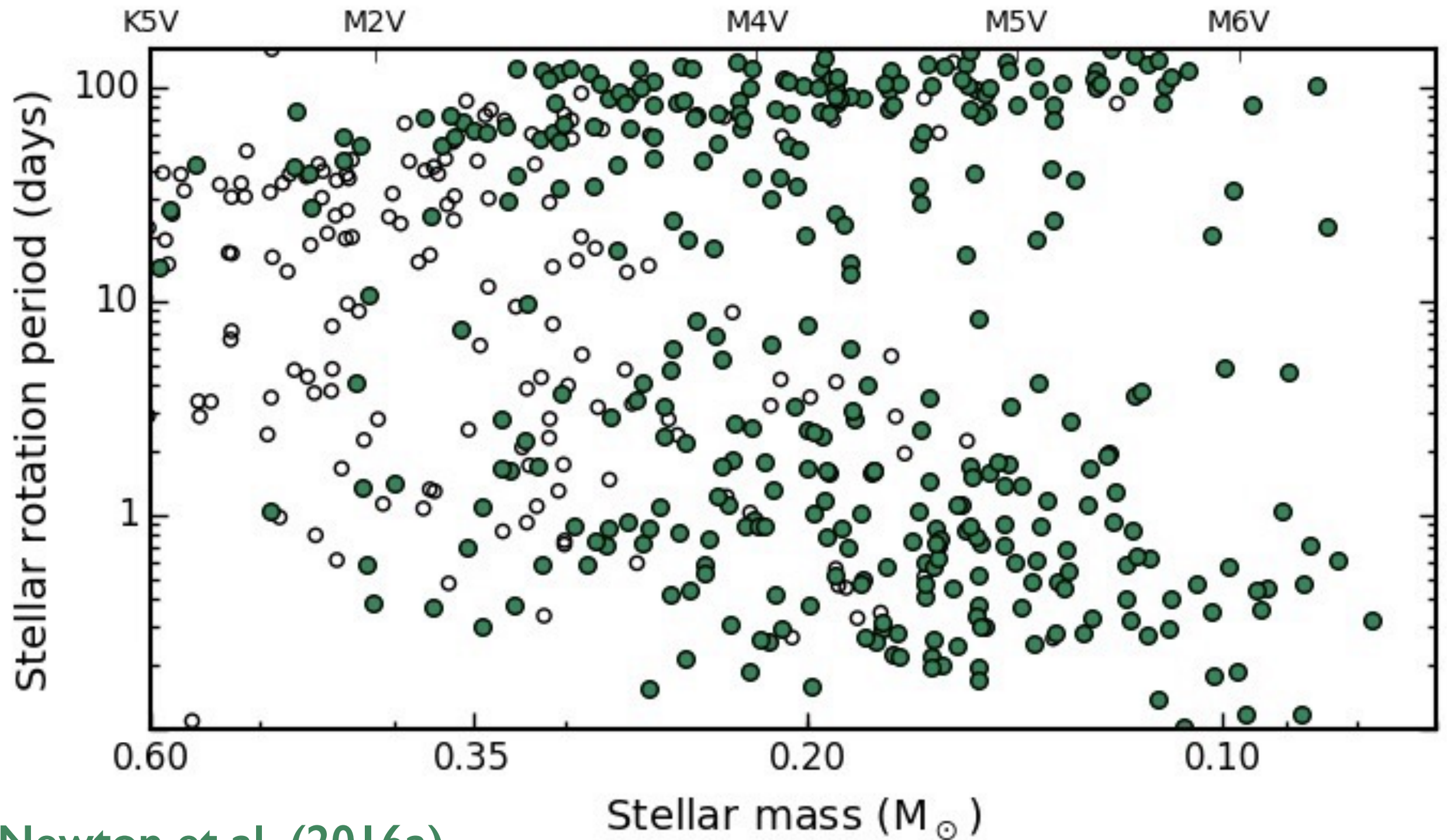
The rotation-velocity dispersion relation



The rotation-velocity dispersion relation

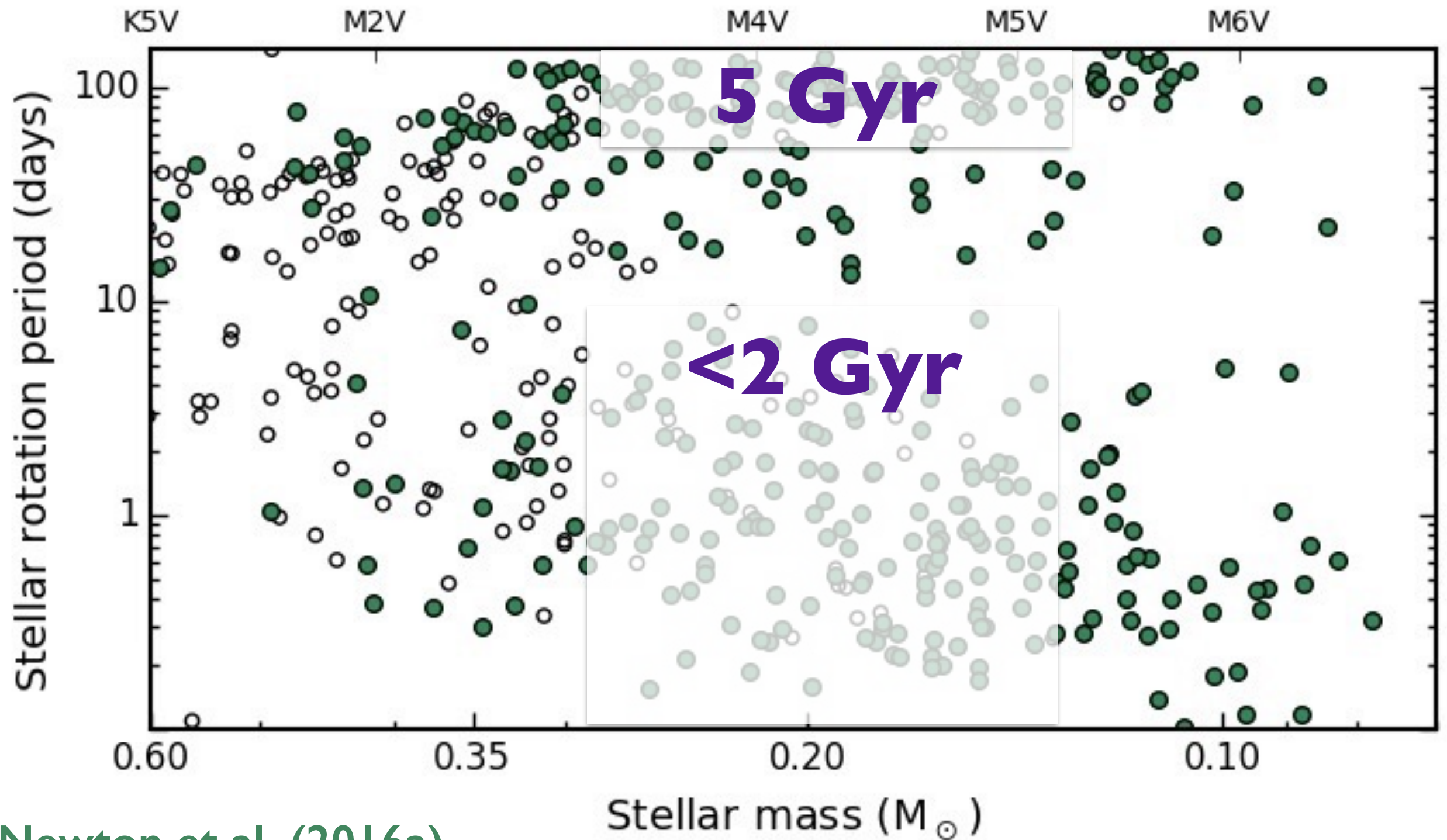


The rotation-age relation

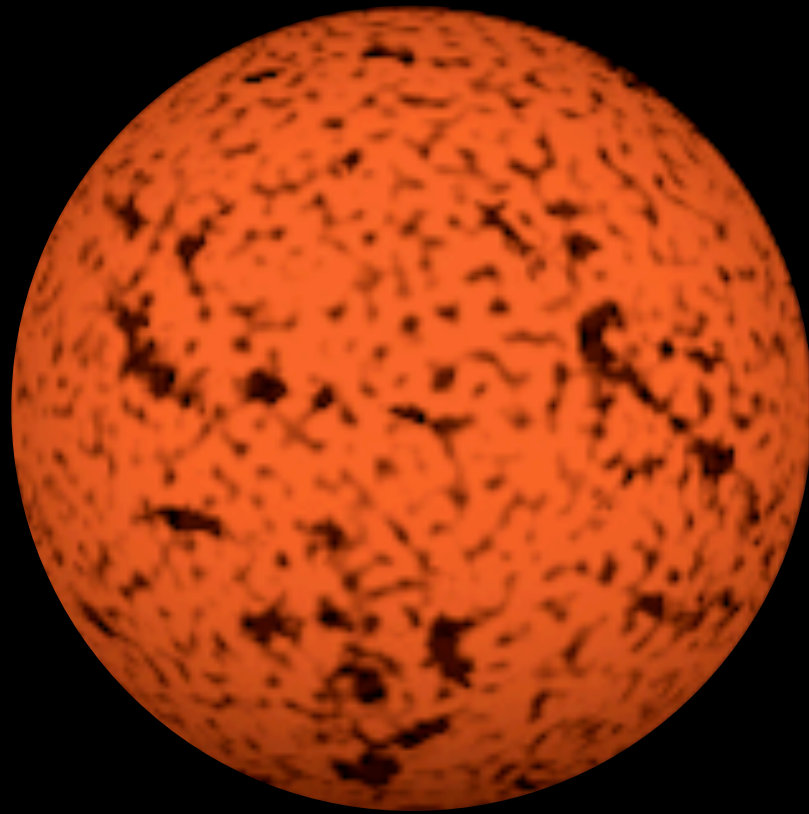


Newton et al. (2016a)

The rotation-age relation

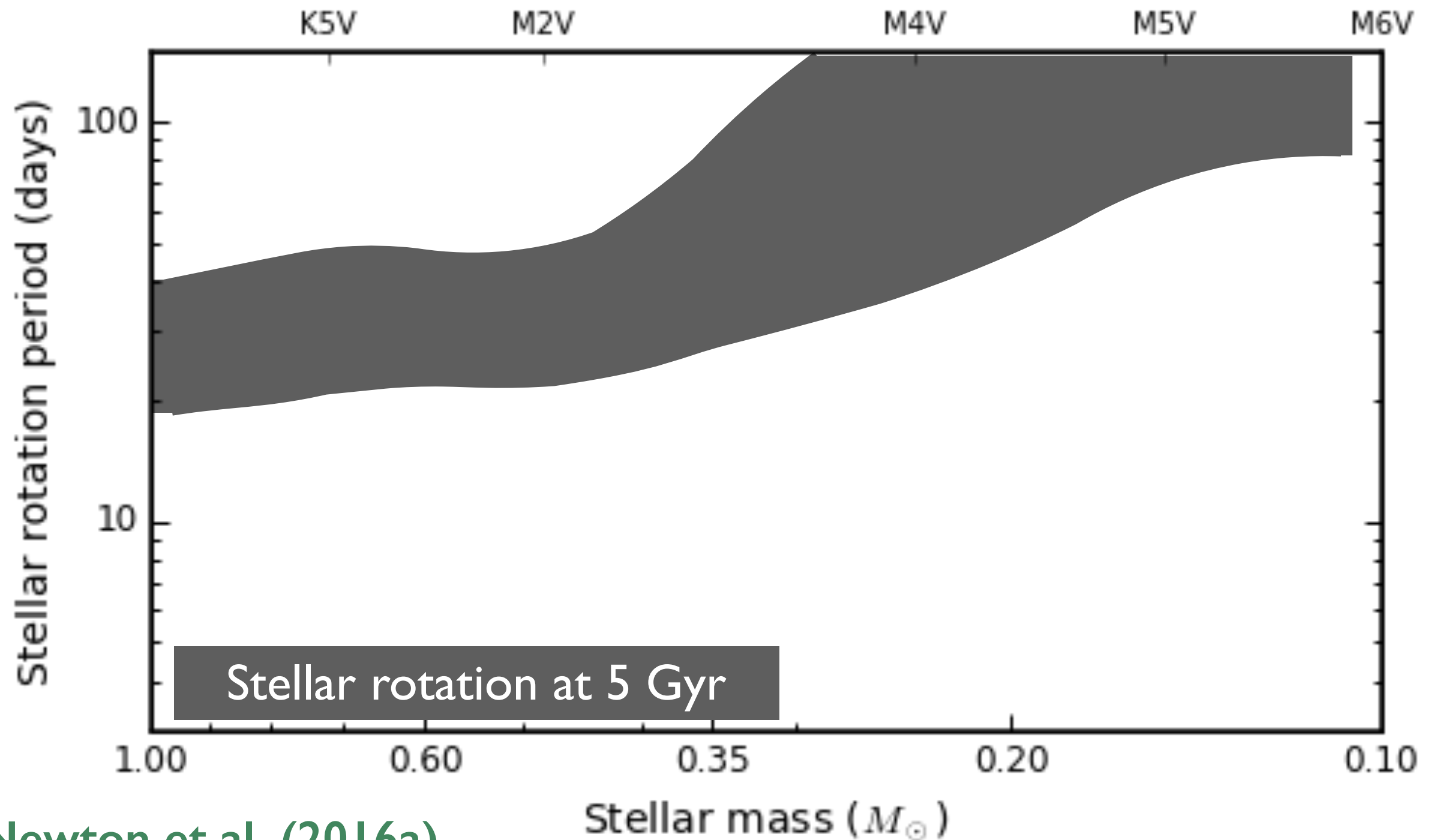


Newton et al. (2016a)



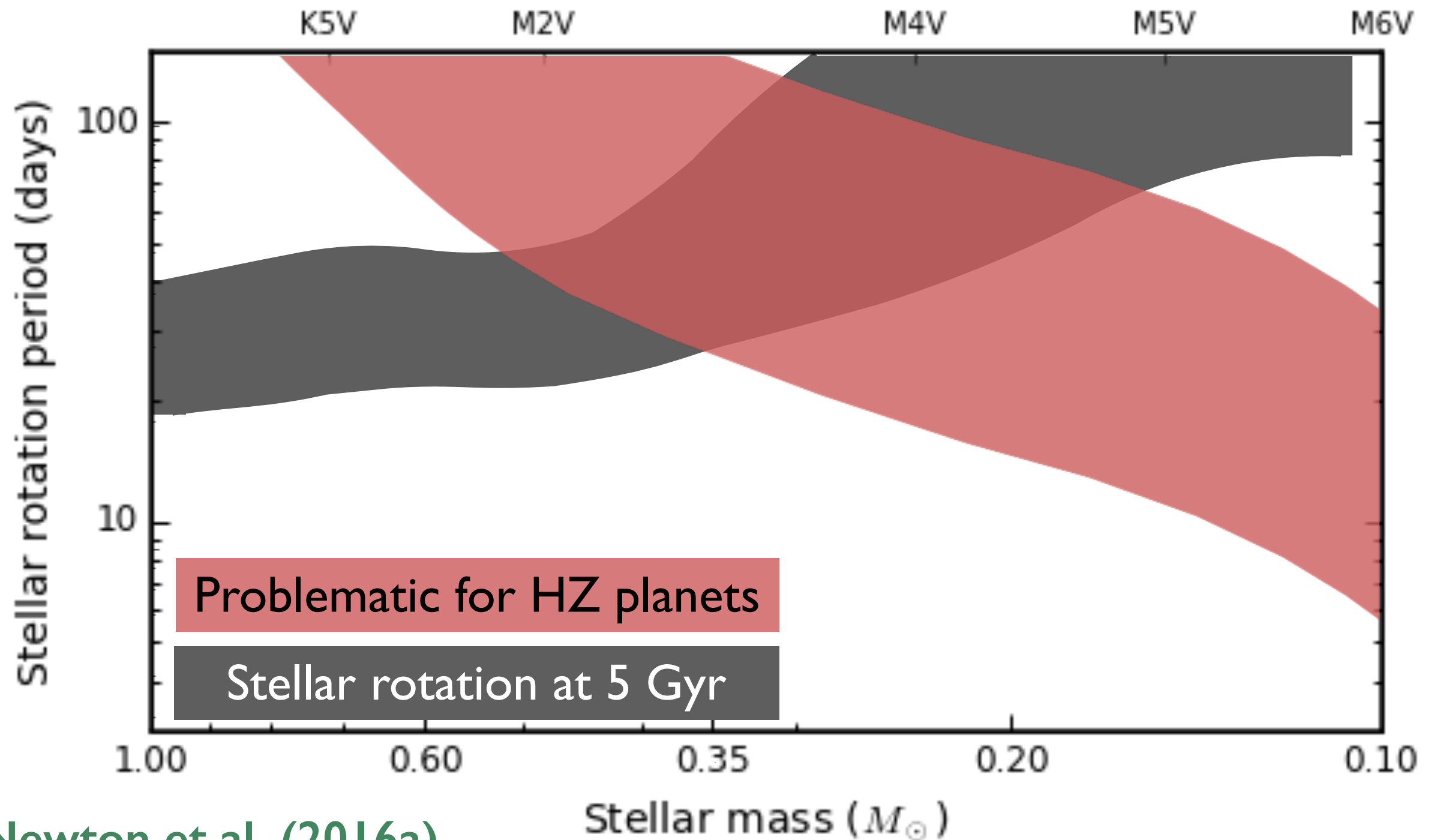
RV surveys for habitable planets

RV surveys for habitable planets



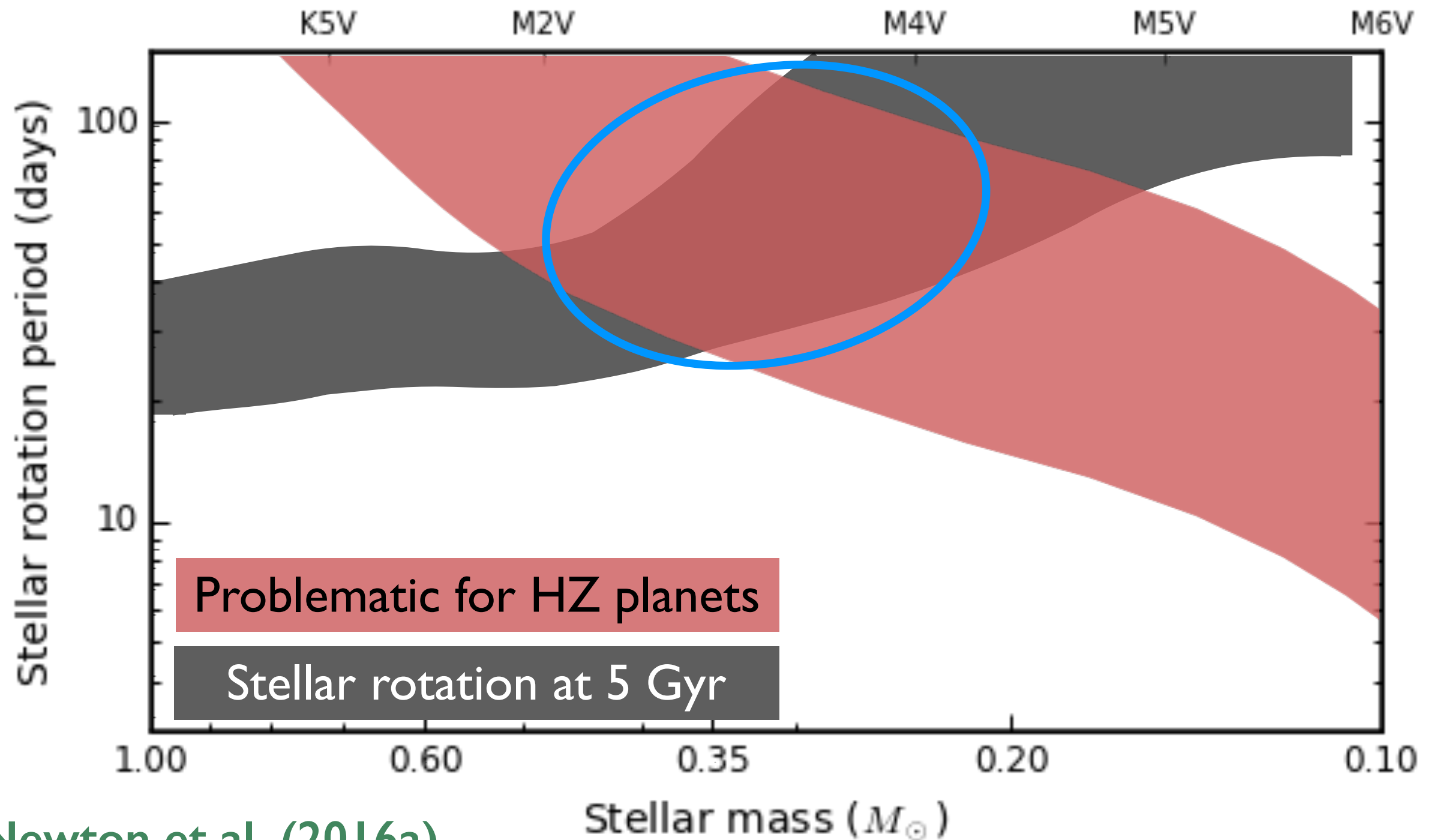
Newton et al. (2016a)

RV surveys for habitable planets



Newton et al. (2016a)

RV surveys for habitable planets



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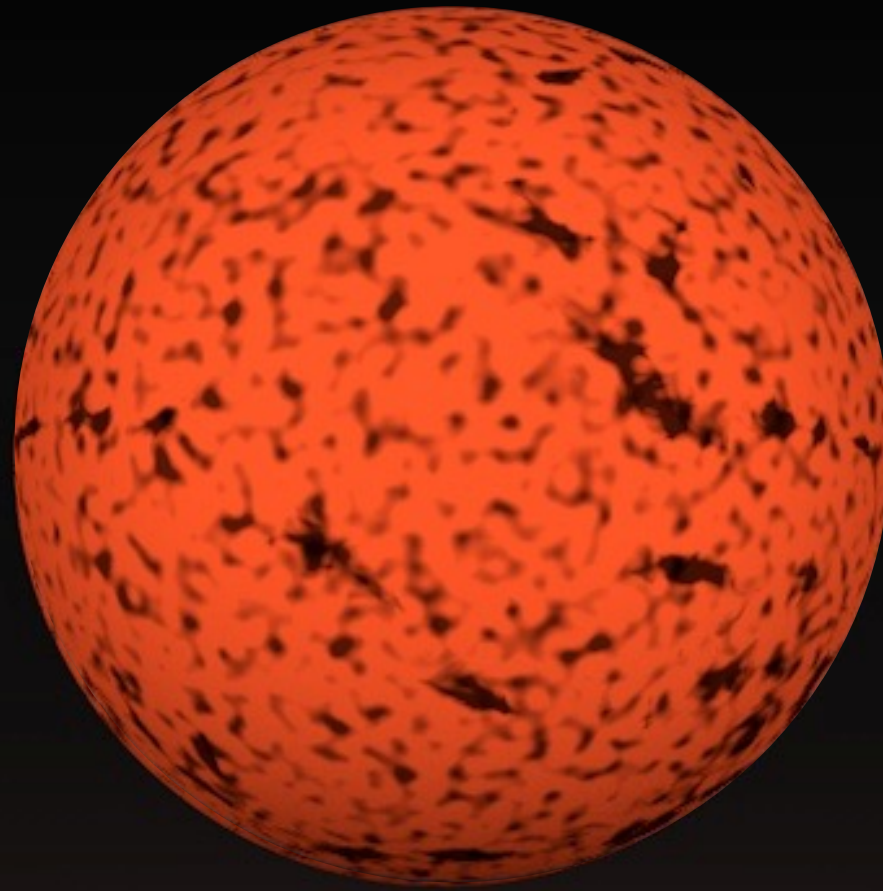
The typical rotation periods for early M dwarfs coincide with the planetary habitable zone. Thus, stellar rotation and activity can be expected to frustrate the detection of habitable planets through RVs.

We suggest targeting **mid-to-late** M dwarfs in the search for habitable planets.

Measure

rotation
periods

magnetic
activity



Investigate

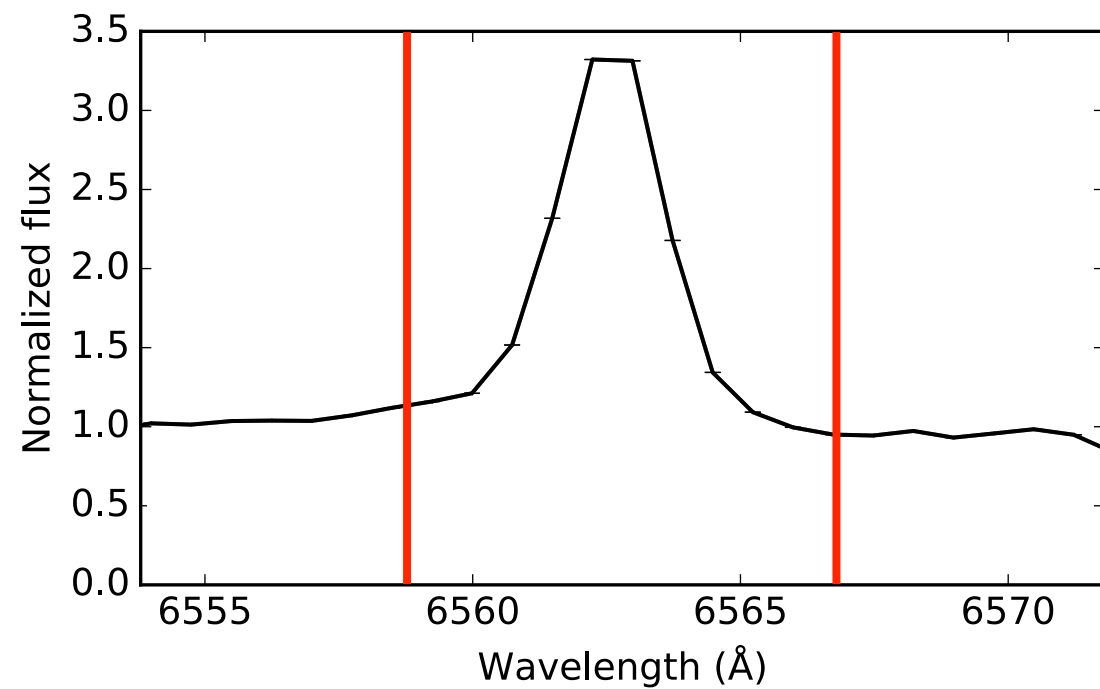
spin-down
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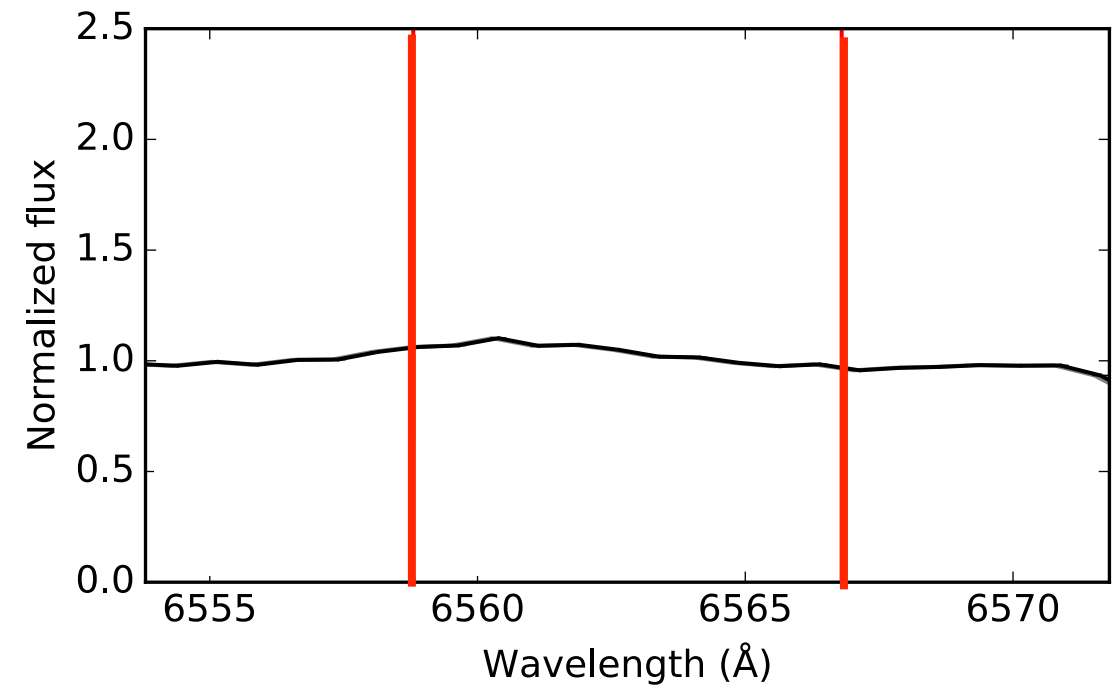


Optical spectroscopy

Magnetic activity

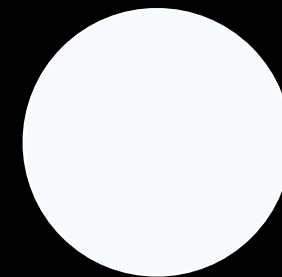
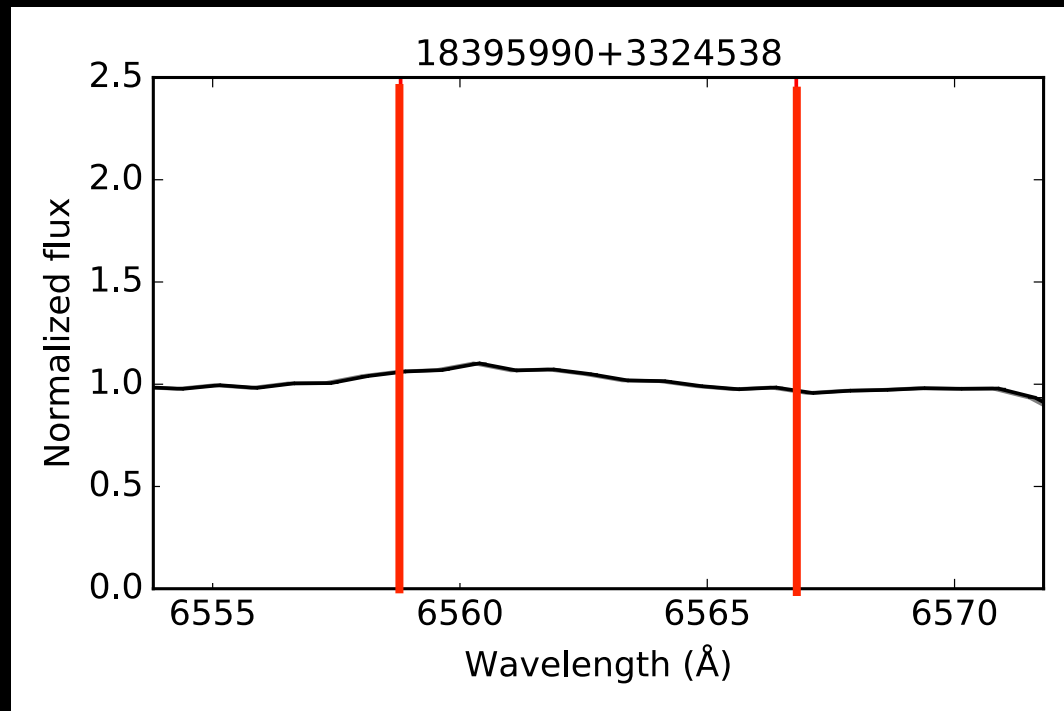


An active star

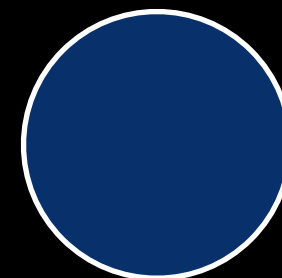
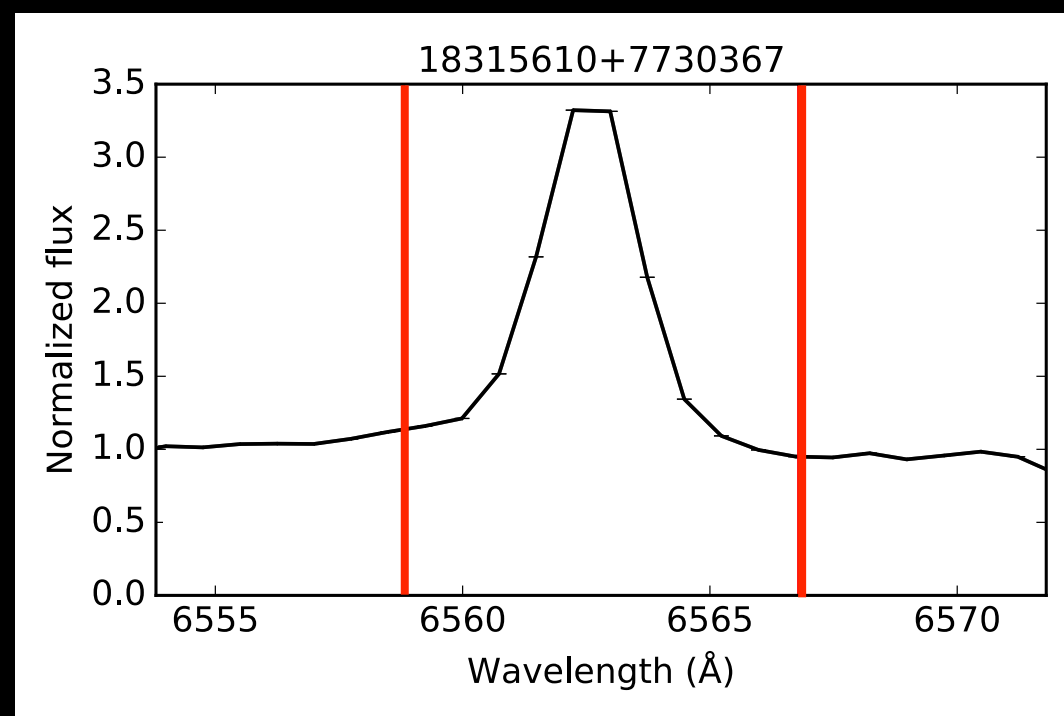


An inactive star

Inactive versus active stars

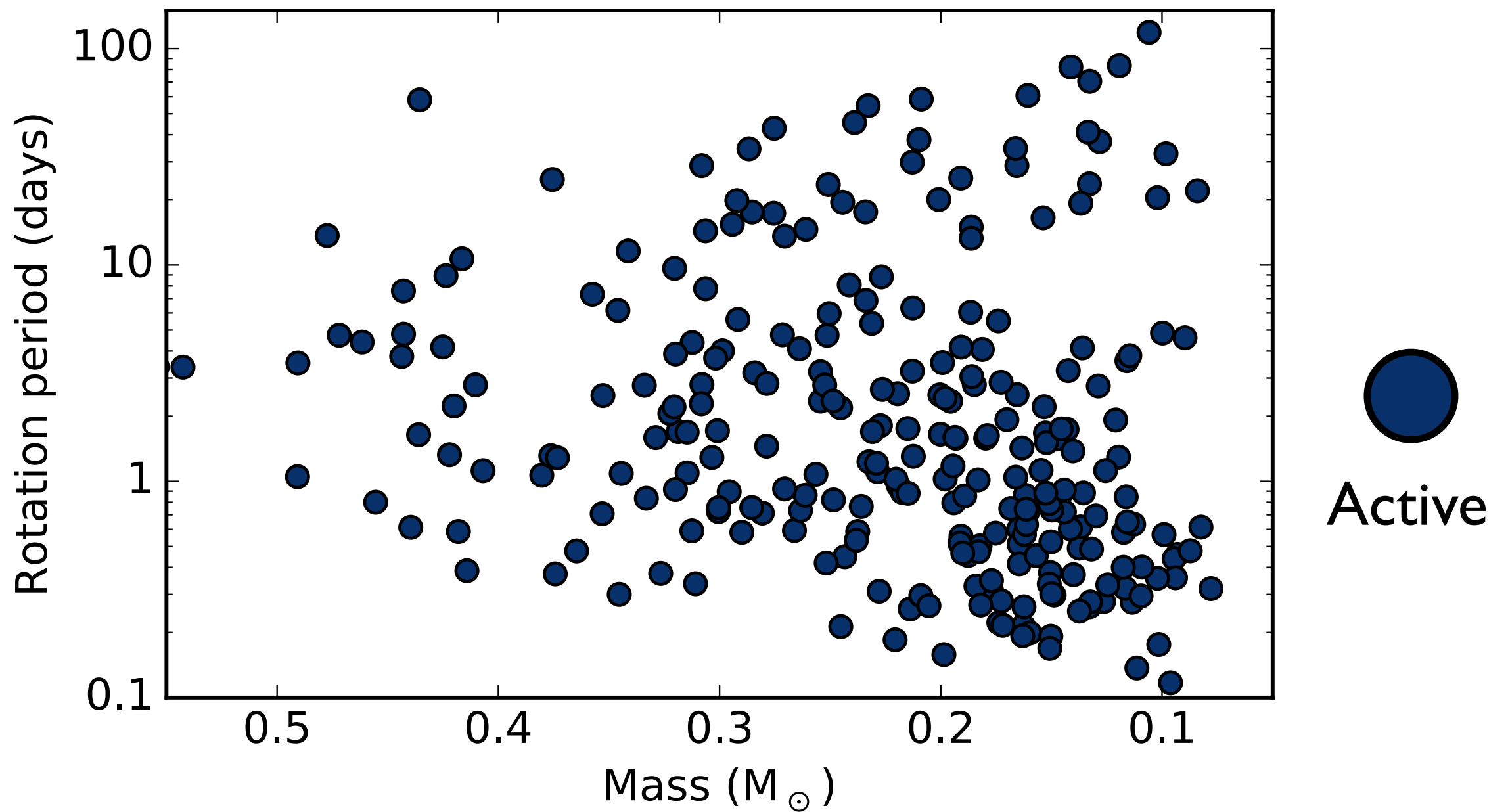


Inactive stars



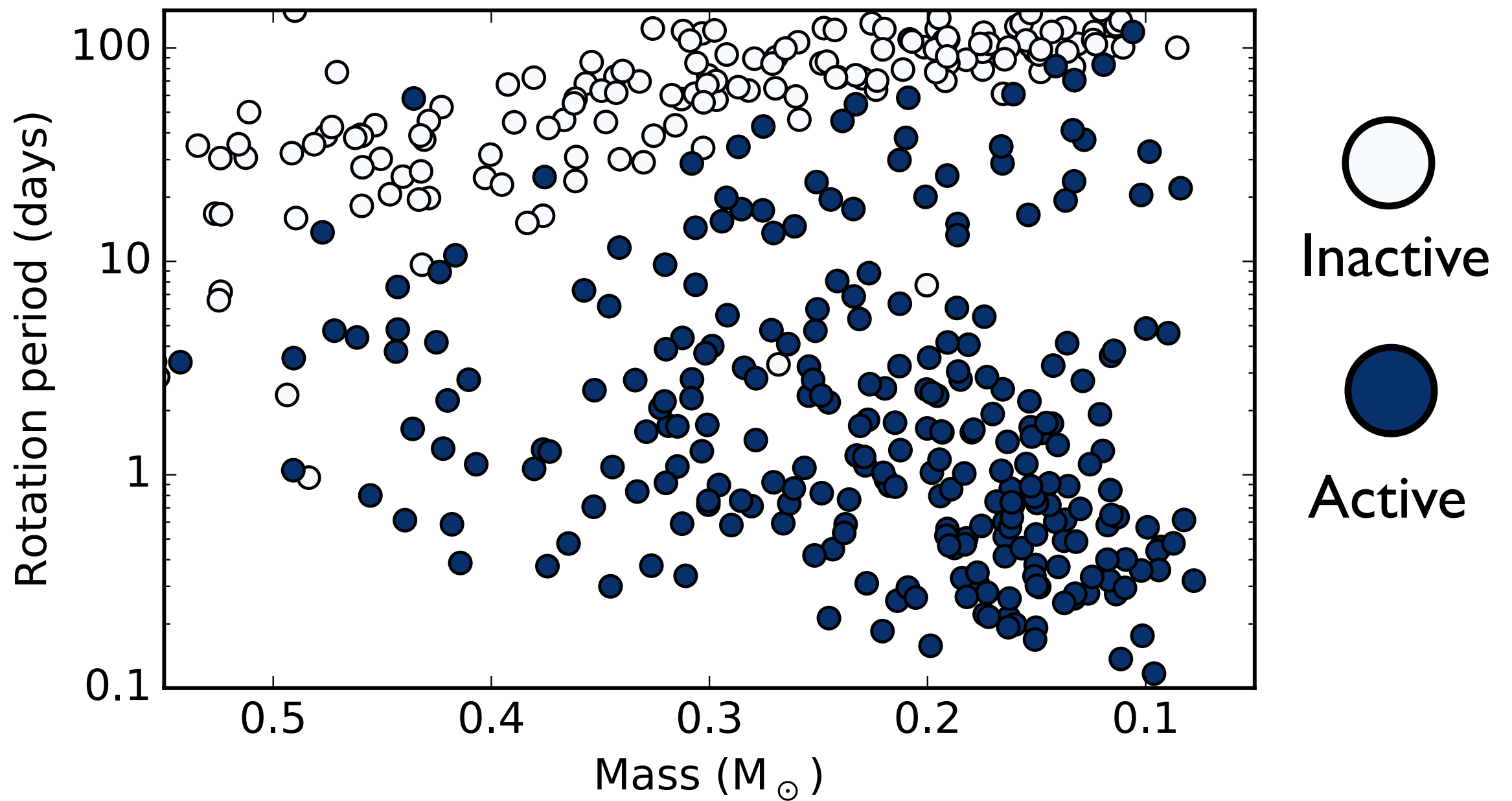
Active star

Inactive versus active stars



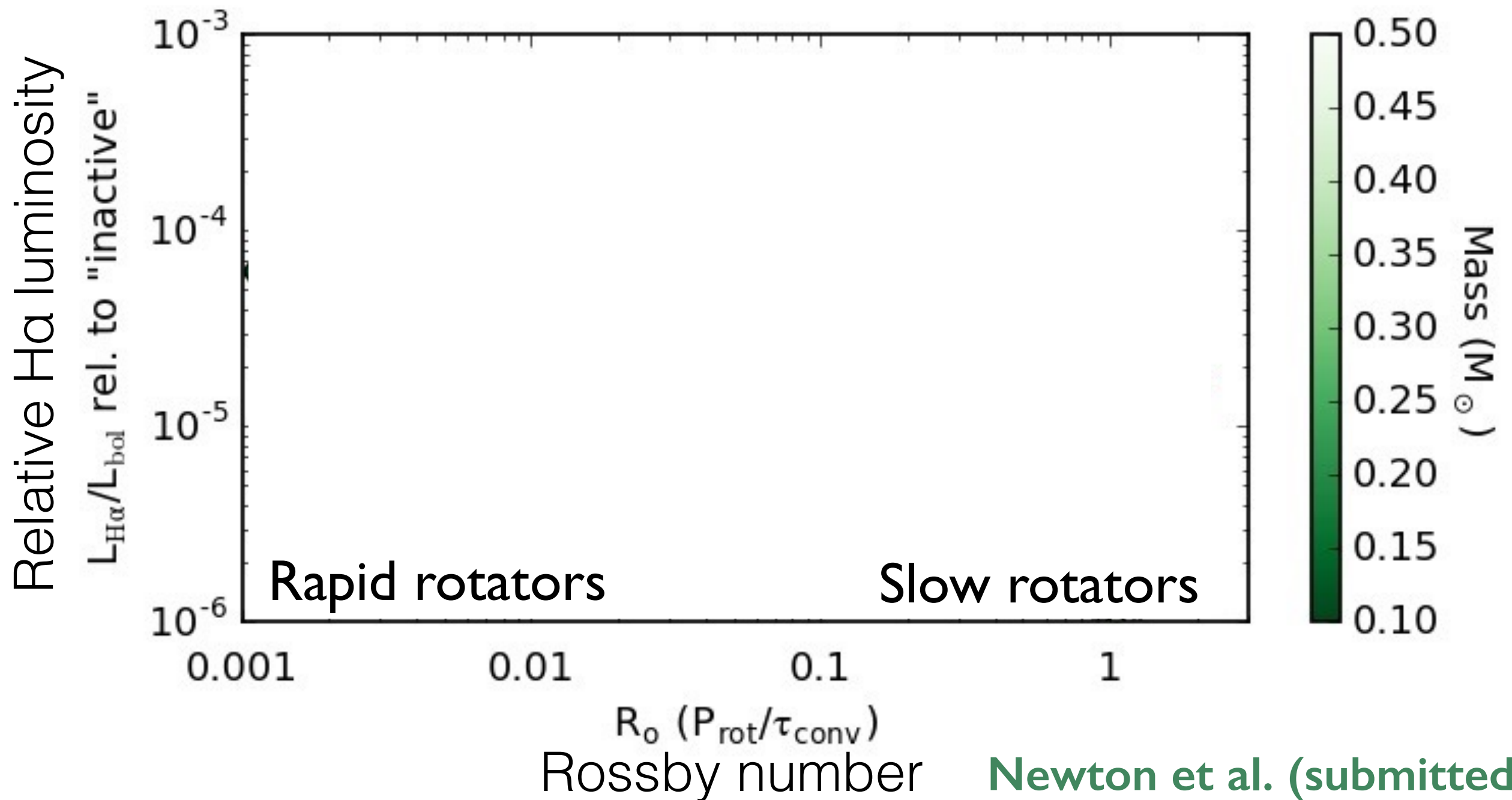
Newton et al. (in prep)

Inactive versus active stars

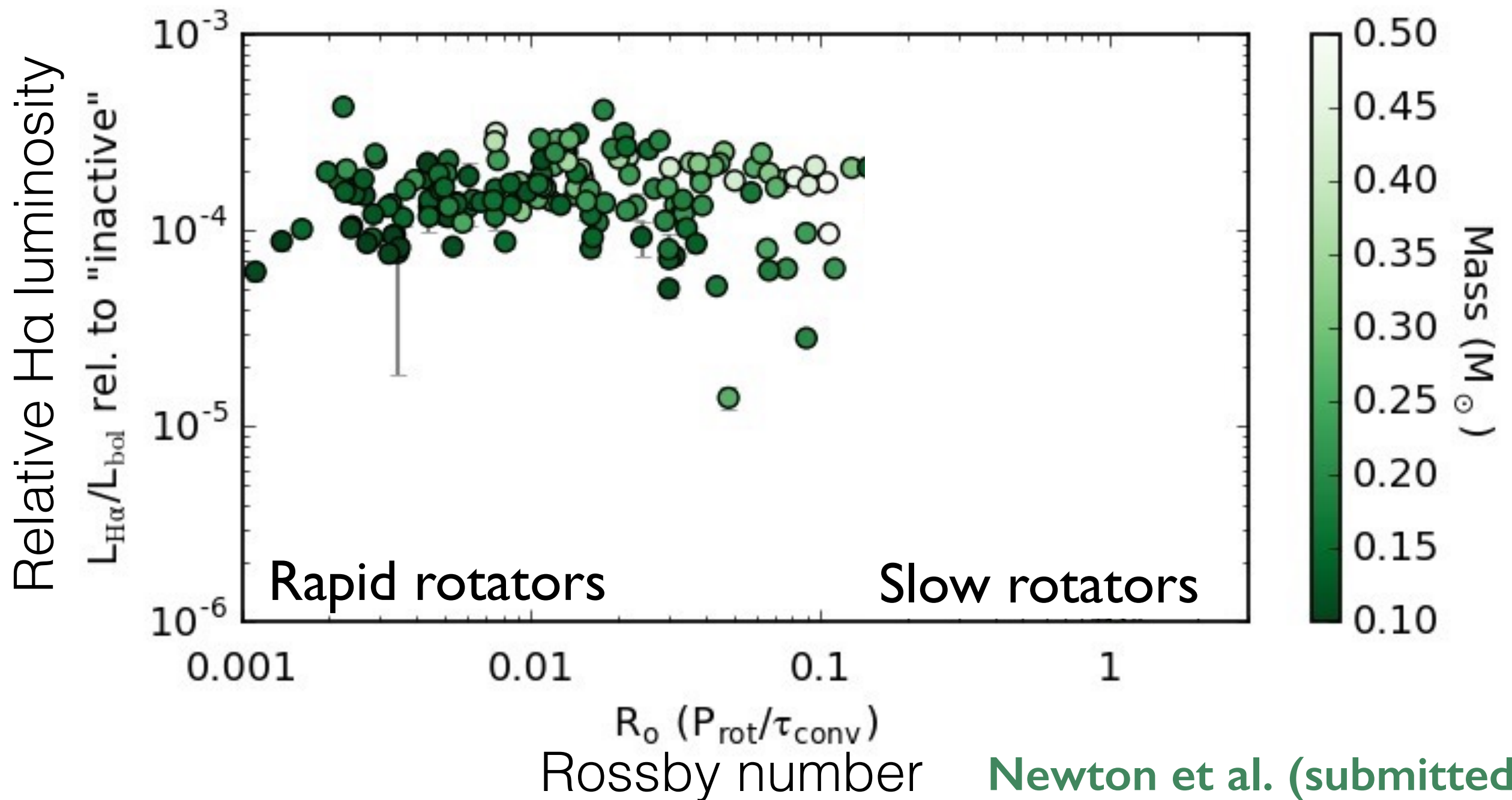


Newton et al. (in prep)

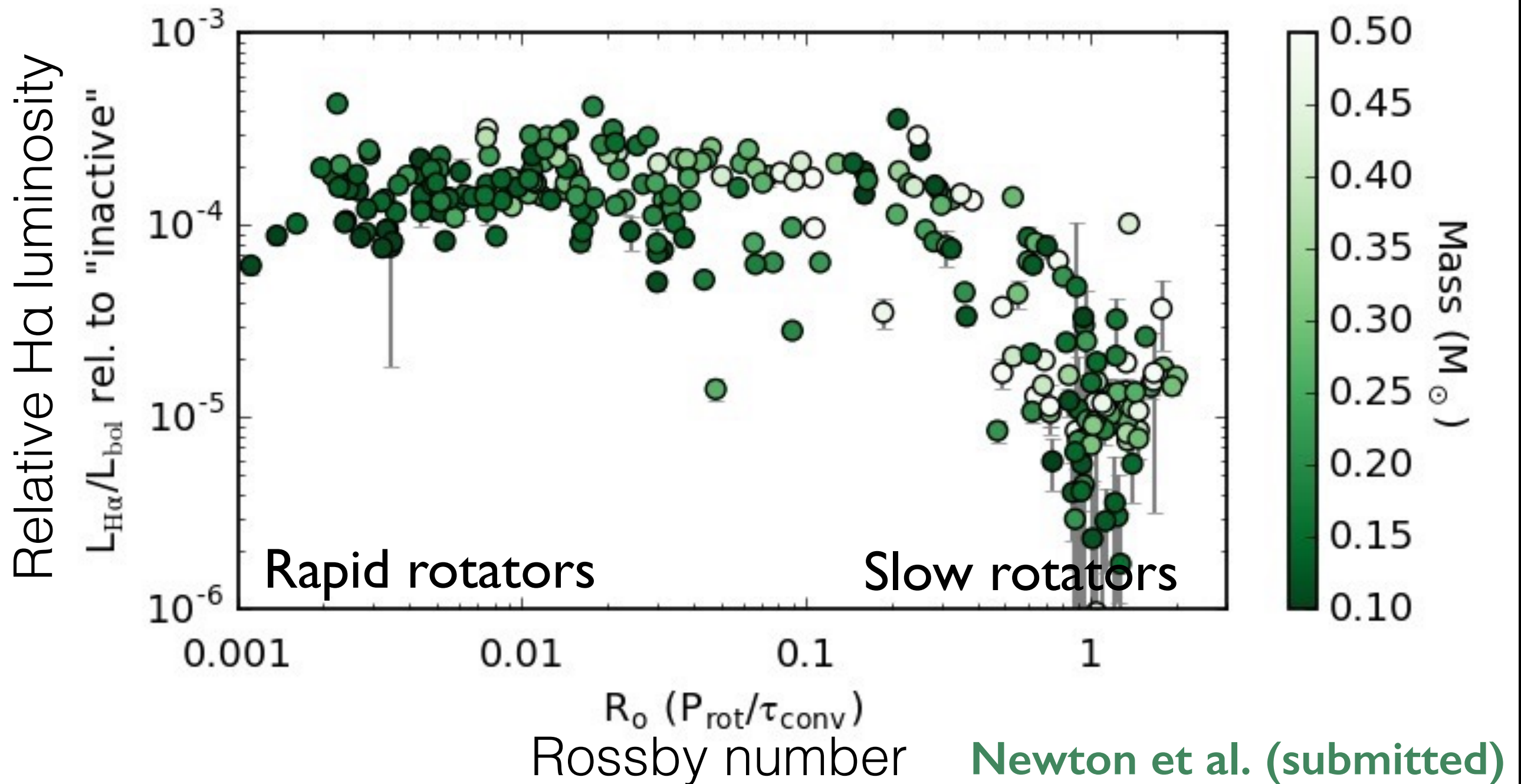
H α and rotation



H α and rotation



H α and rotation



The Properties of M dwarfs

Radial velocities, metallicities, spectral types, distances

Newton, Charbonneau, Irwin et al. (2014) AJ 147 20

Temperatures, radii, luminosities, Kepler's exoplanets

Newton, Charbonneau, Irwin, & Mann (2015) ApJ 800 85

github.com/ernewton/nirew & [/tellrv](https://github.com/ernewton/tellrv)

Rotation and Chromospheric Activity

New rotation periods and the spin-down timescale

Newton, Irwin, Charbonneau et al. (2016a) ApJ 821 93

The impact of stellar rotation on exoplanet discovery

Newton, Irwin, Charbonneau et al. (2016b) ApJL 821 1

The connection between rotation and activity

Newton, Irwin, Charbonneau et al. (submitted)



The evolution of rotation and magnetism in mid M dwarfs

They maintain rapid rotation rates for about 2 billion years.

They undergo rapid angular momentum evolution, at the end of which they cease to display H α in emission.

At 5 Gyr, they have rotation periods of about 100 days. They are inactive but some still display photometric variability.