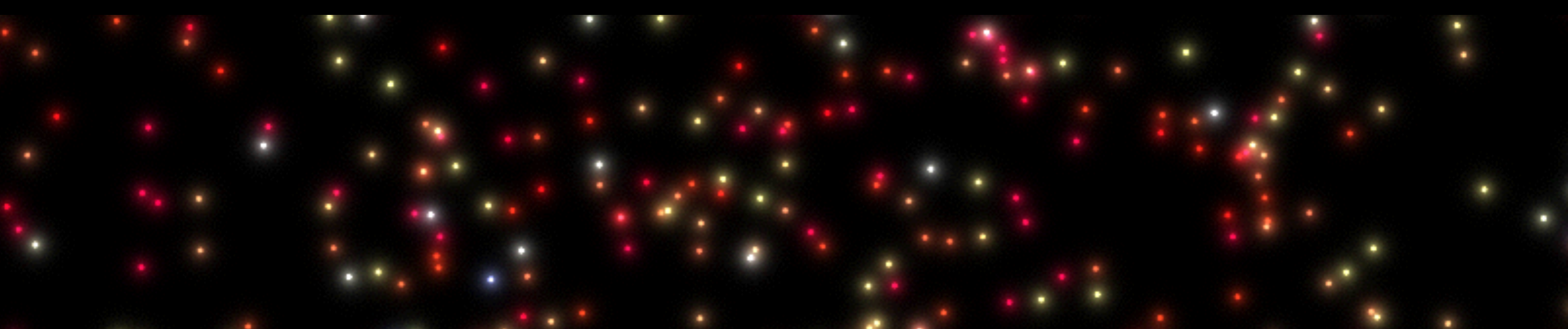


Rotation and activity in M dwarfs



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Technology

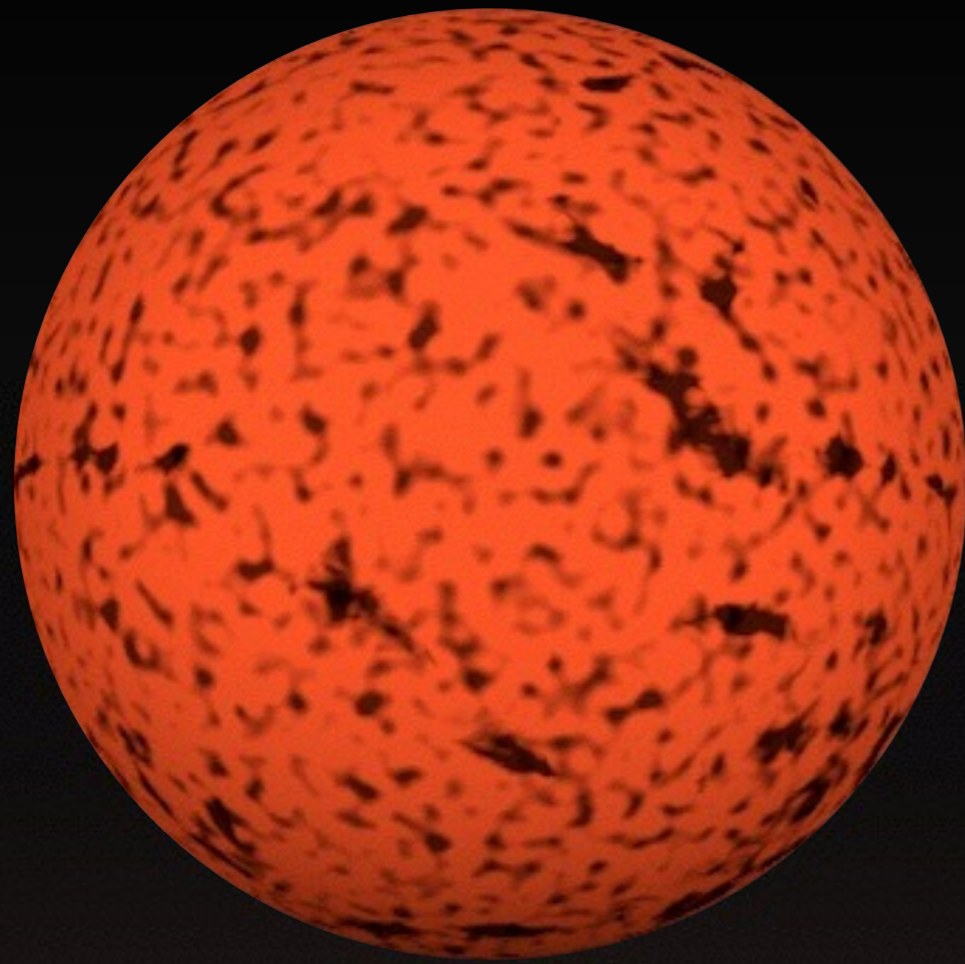


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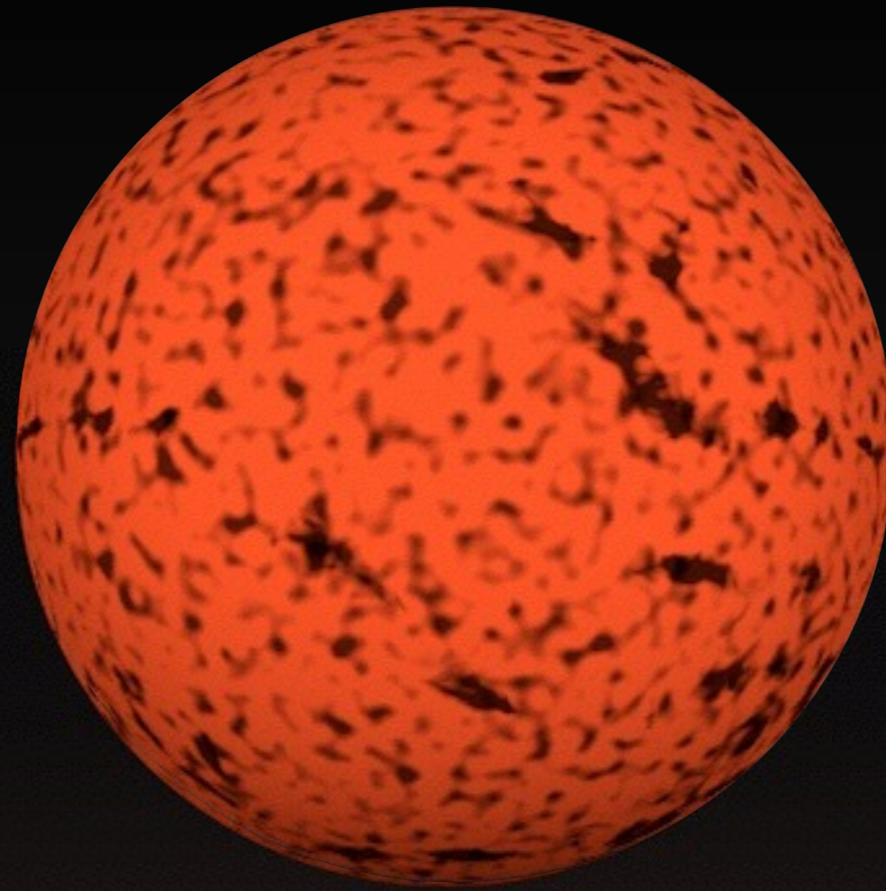
**M dwarfs have spots, rotation, & activity.
They also have planets.**



What do M dwarfs look like?

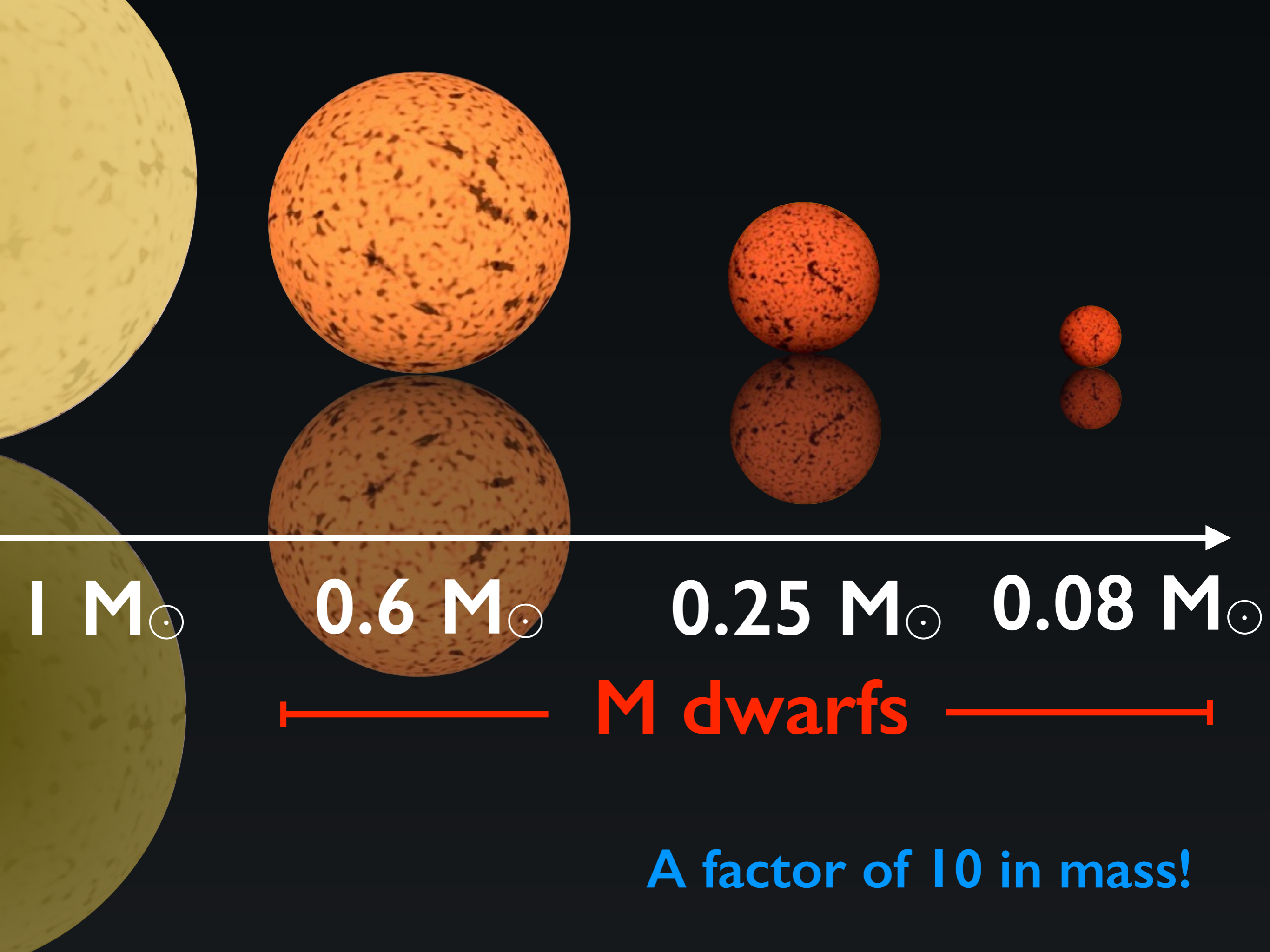
What are their spins and activity levels?

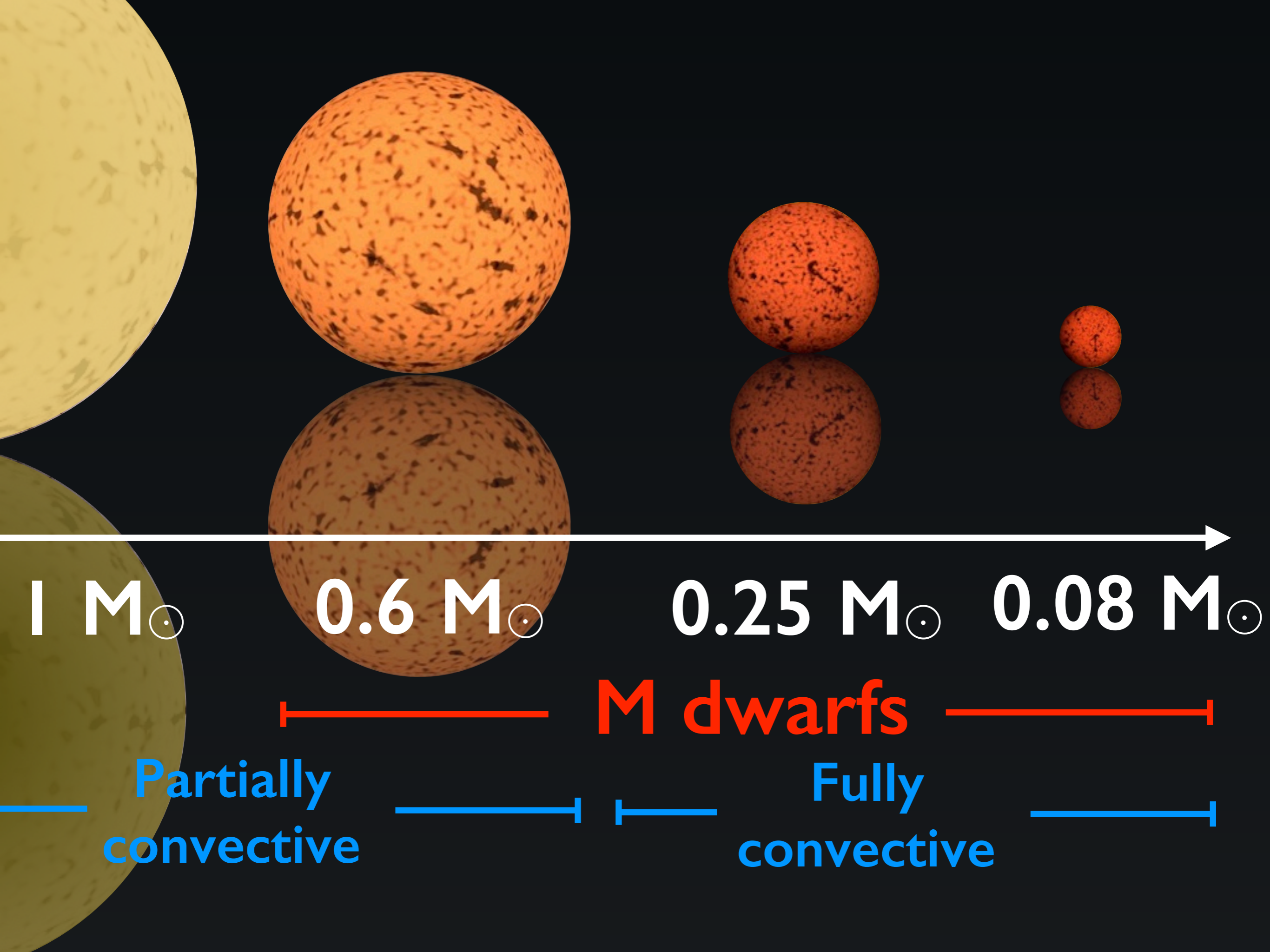
What is the impact on planet detection?

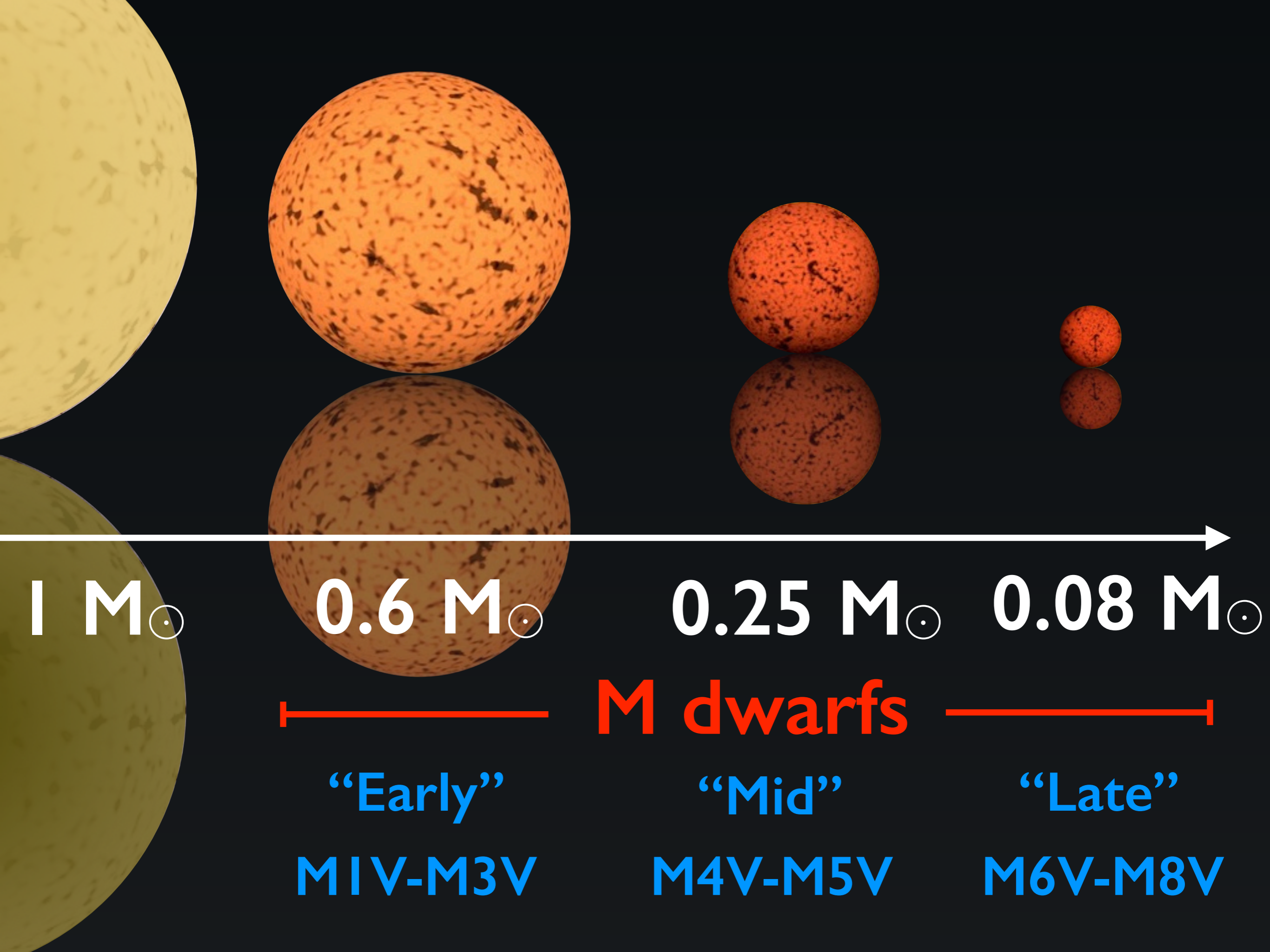


What is an M dwarf?









1 M_{\odot}

0.6 M_{\odot}

0.25 M_{\odot}

0.08 M_{\odot}

M dwarfs

"Early"

"Mid"

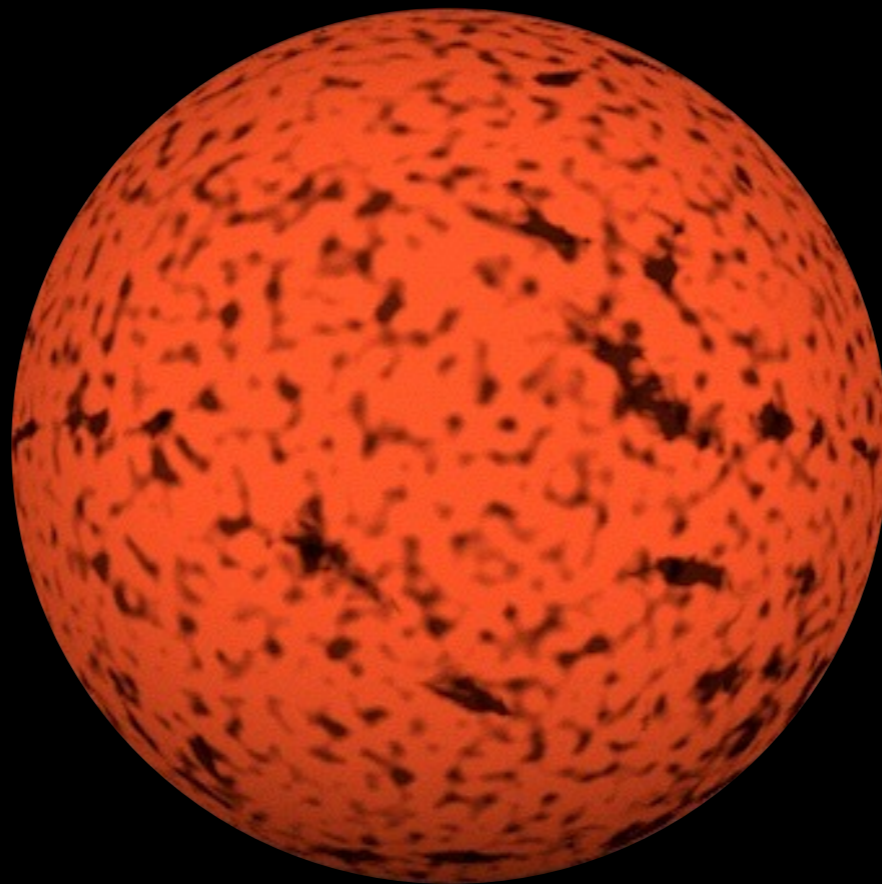
"Late"

M1V-M3V

M4V-M5V

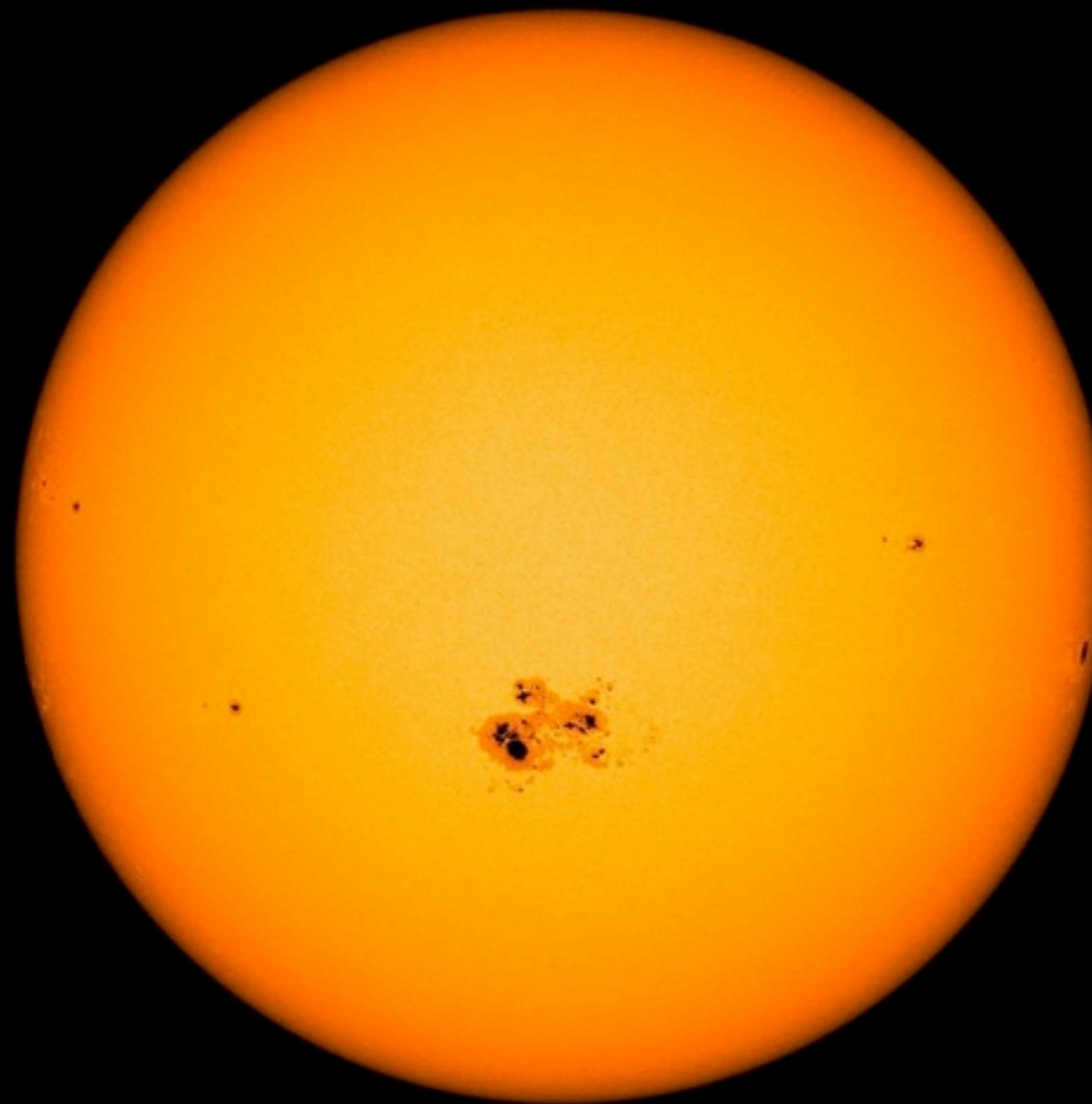
M6V-M8V

**What does the surface
of an M dwarf look like?**



*artist's illustration

Probably not like the Sun



Large spot/groups? Polar spots? Lots of faculae?

change with time
depends on mass
& rotation period

e.g

Barnes et al. (2001)

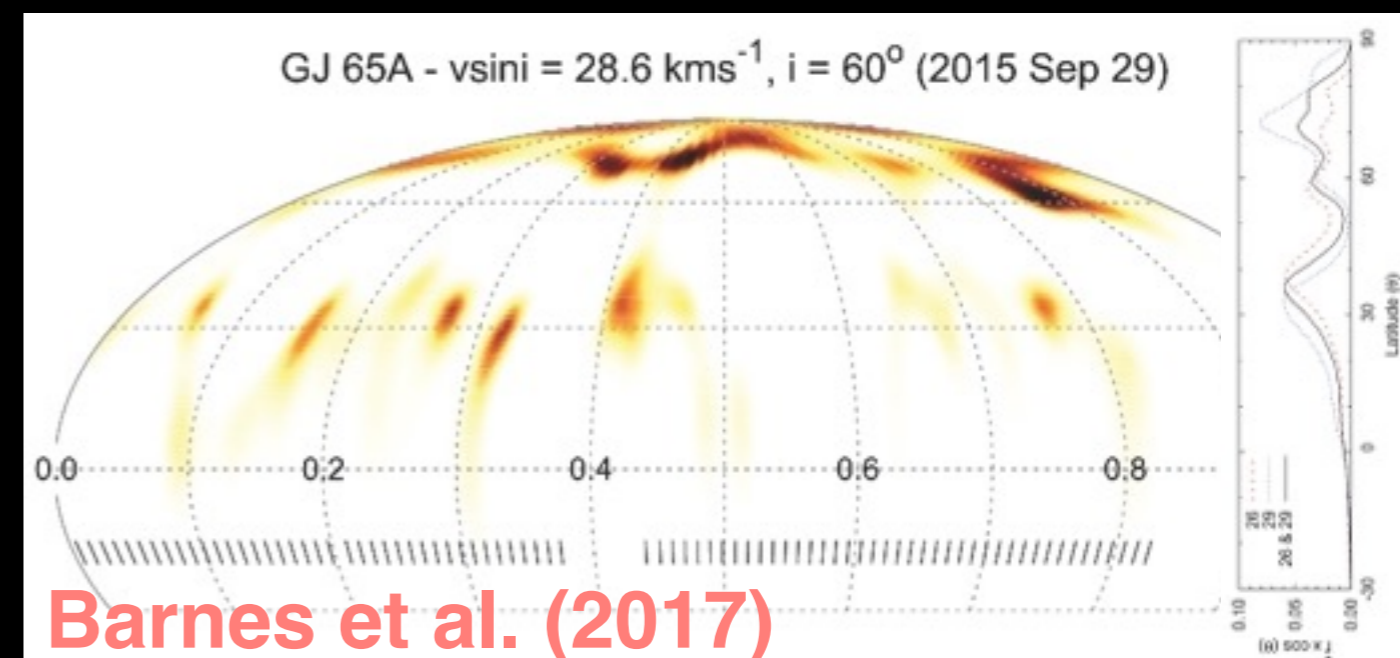
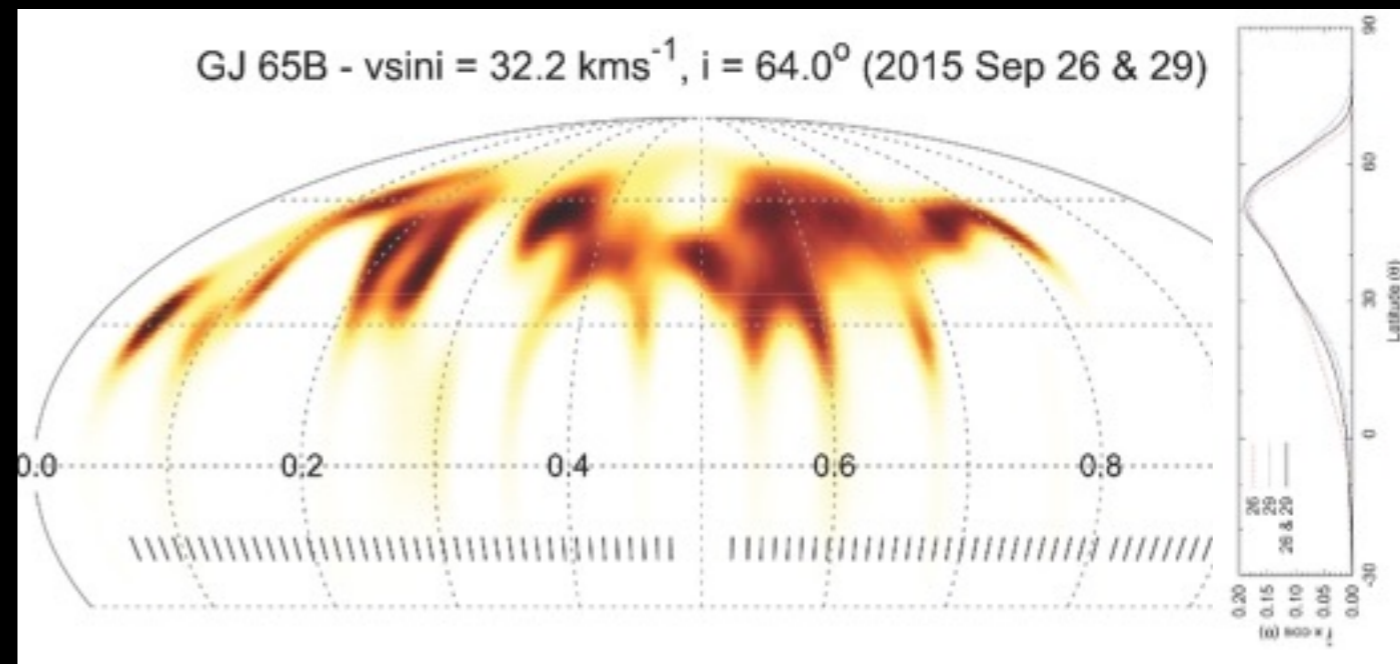
Donati et al. (2008)

Morin et al. (2008, 2010)

Yadav et al. (2015)

Kochukhov & Lavail (2017)

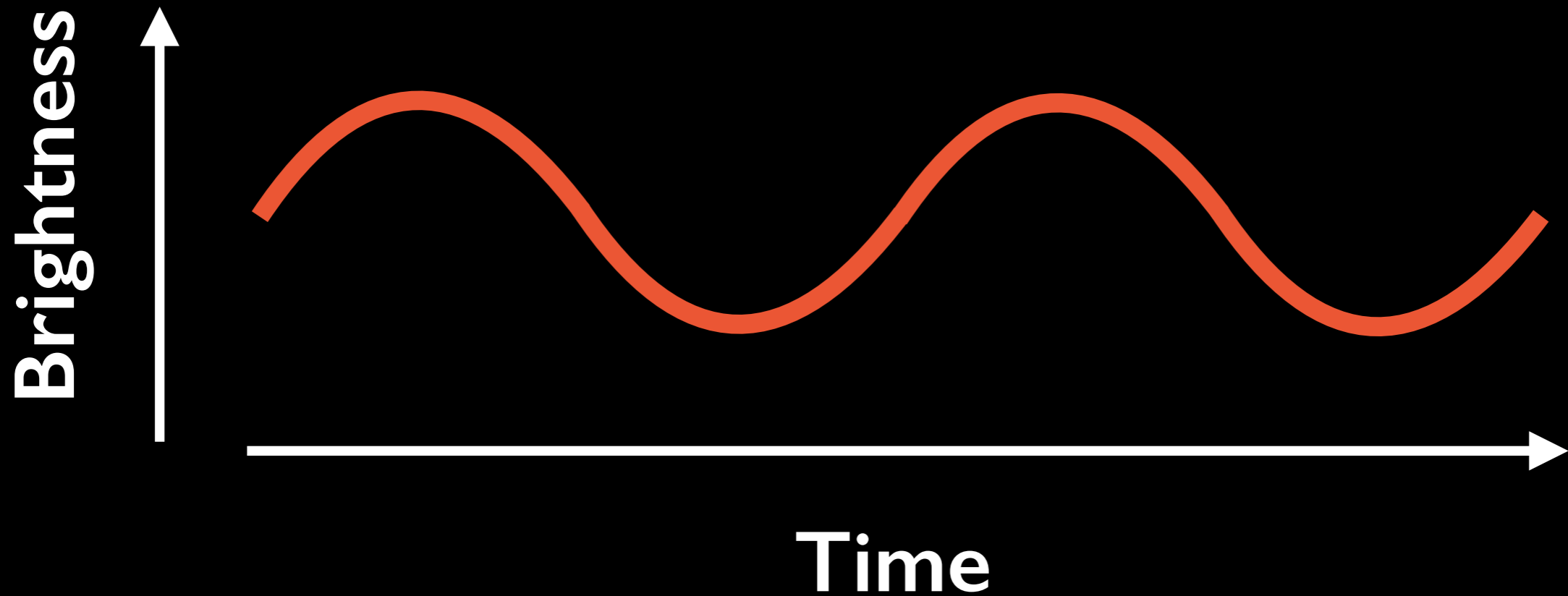
Morris et al. (2018)



Take Away #1

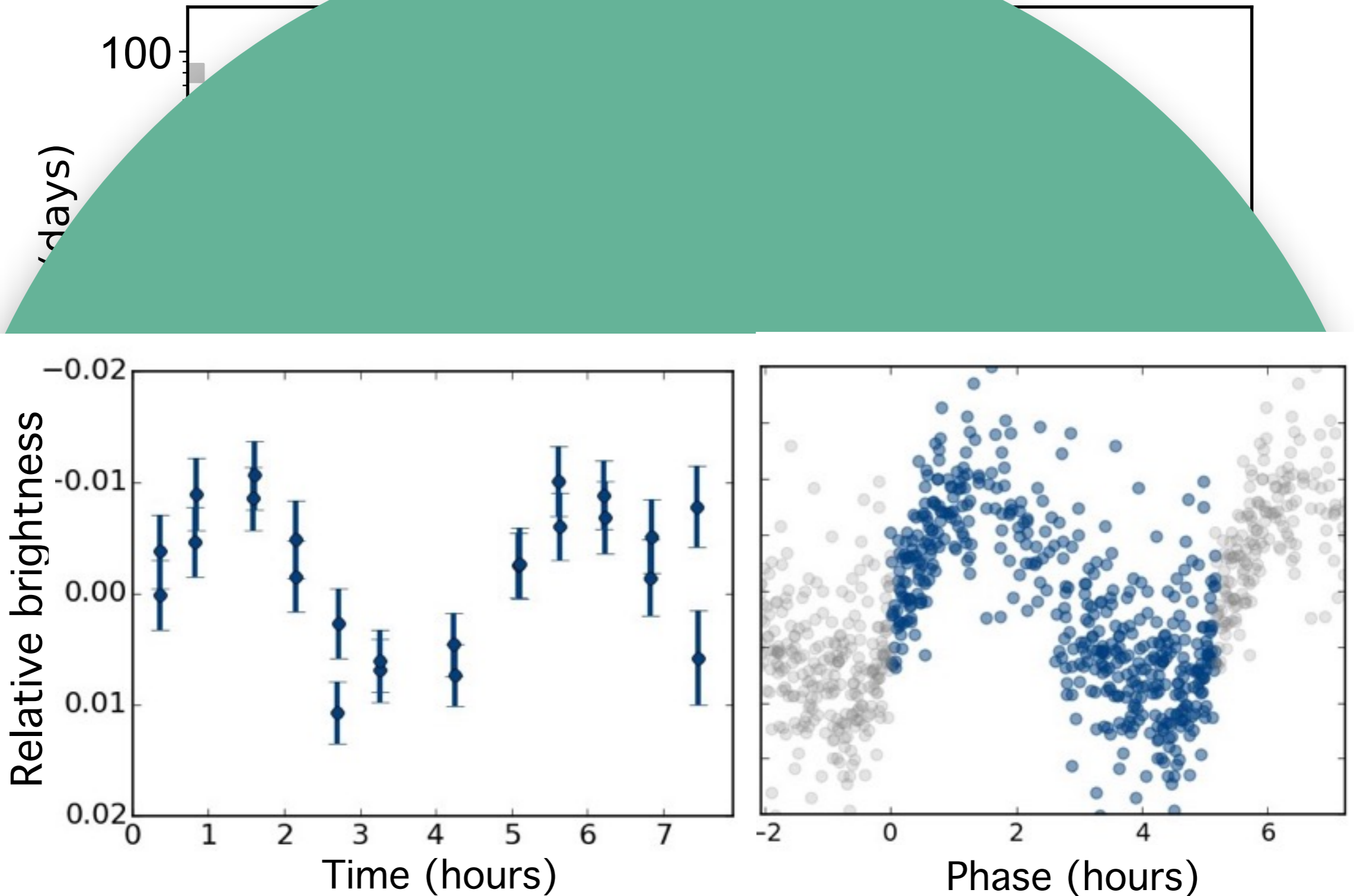
**There's a lot we don't know
about M dwarfs.**

What are M dwarf rotation rates and magnetic activity levels?

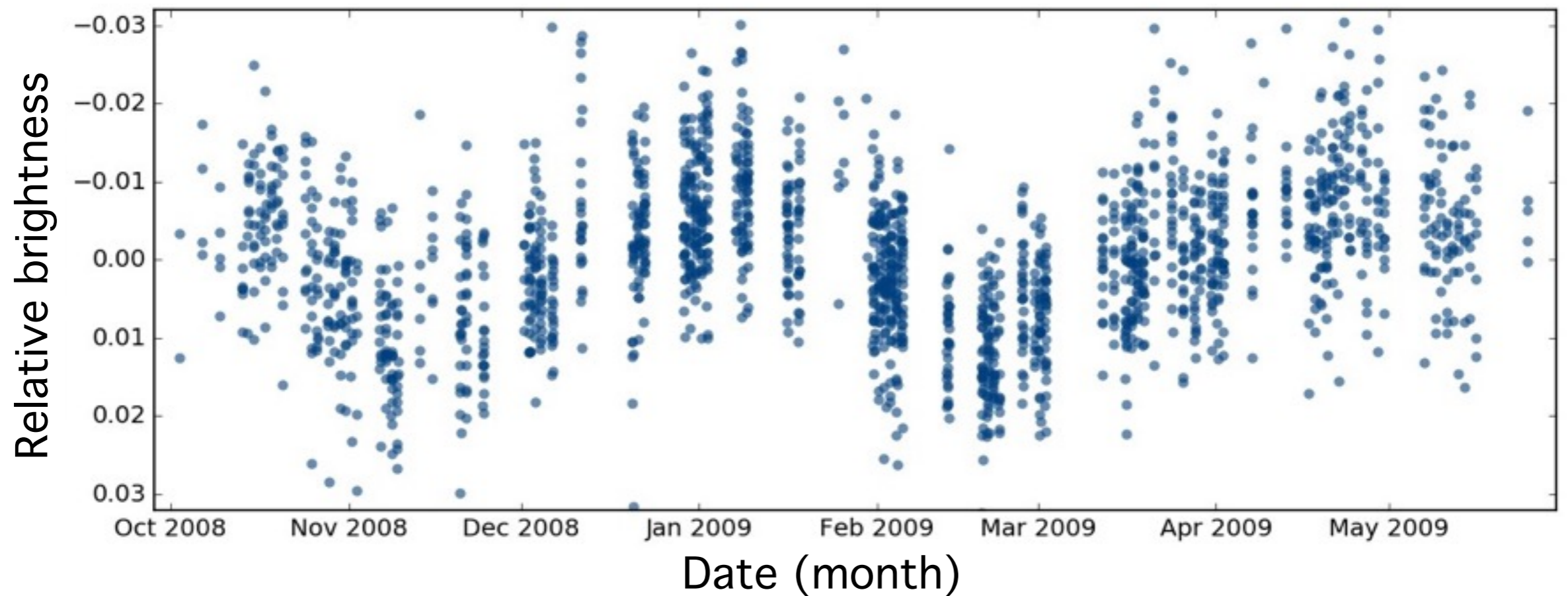


We use photometry to measure stellar rotation periods

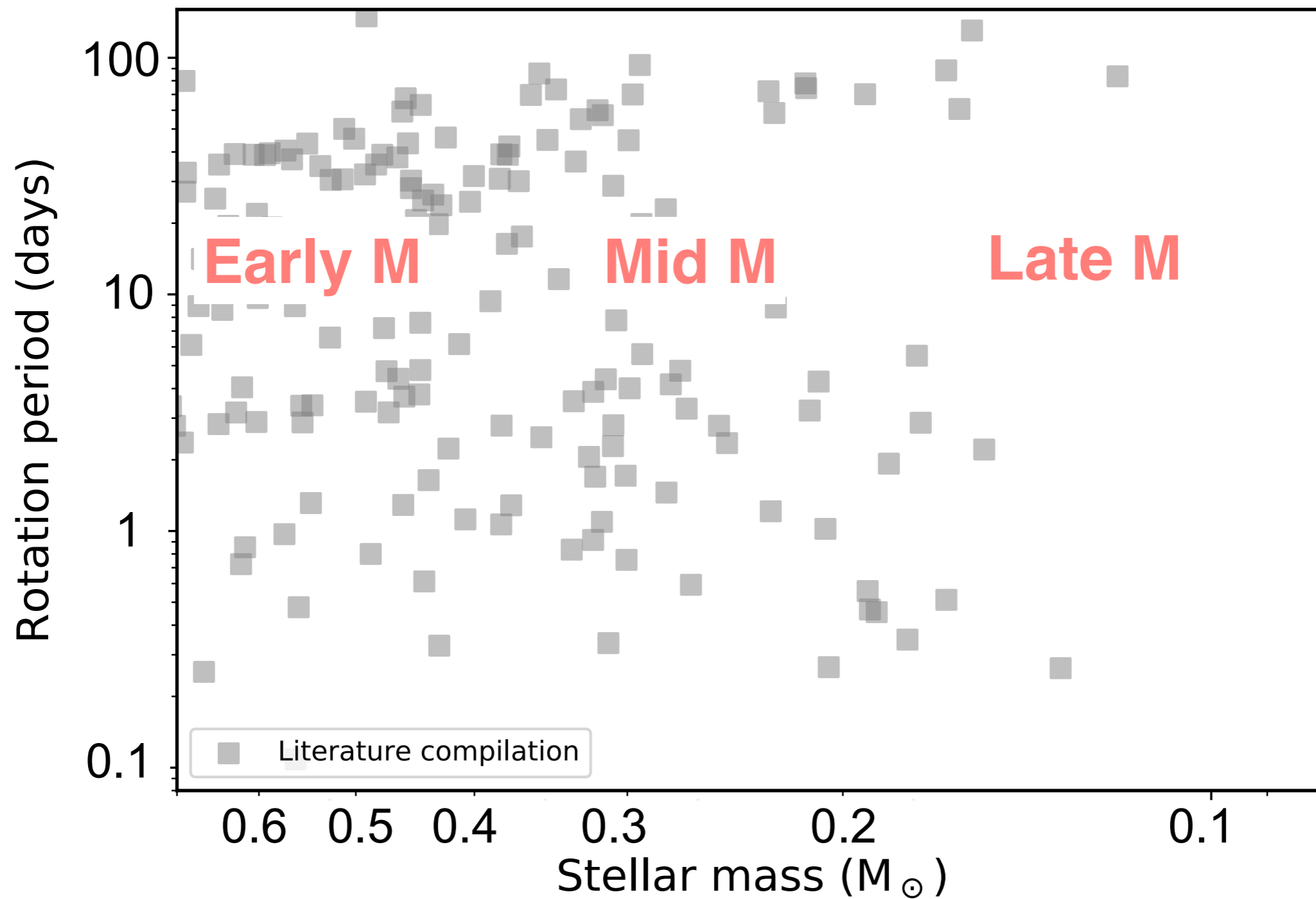
Measuring stellar rotation



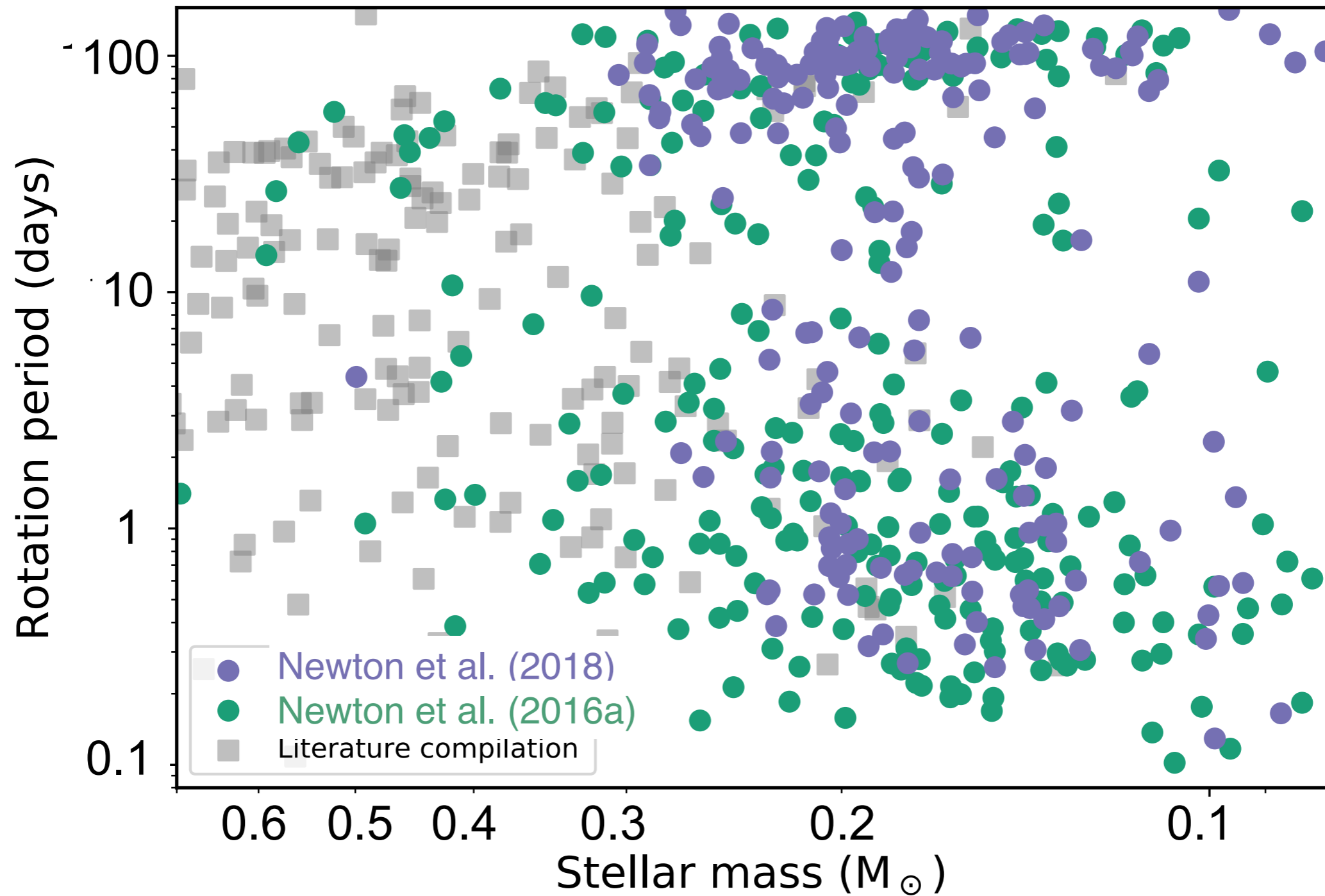
Measuring stellar rotation



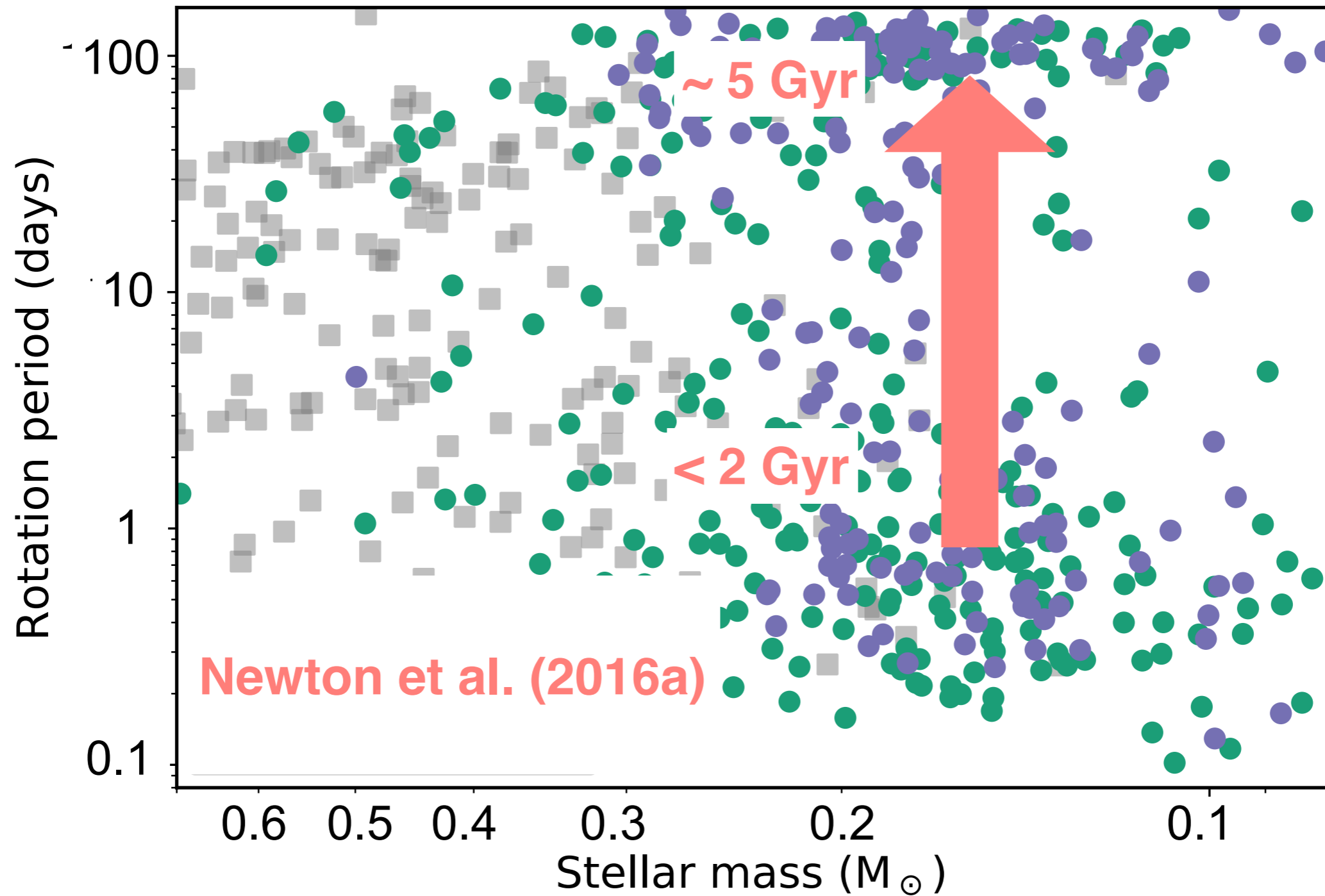
Measuring stellar rotation



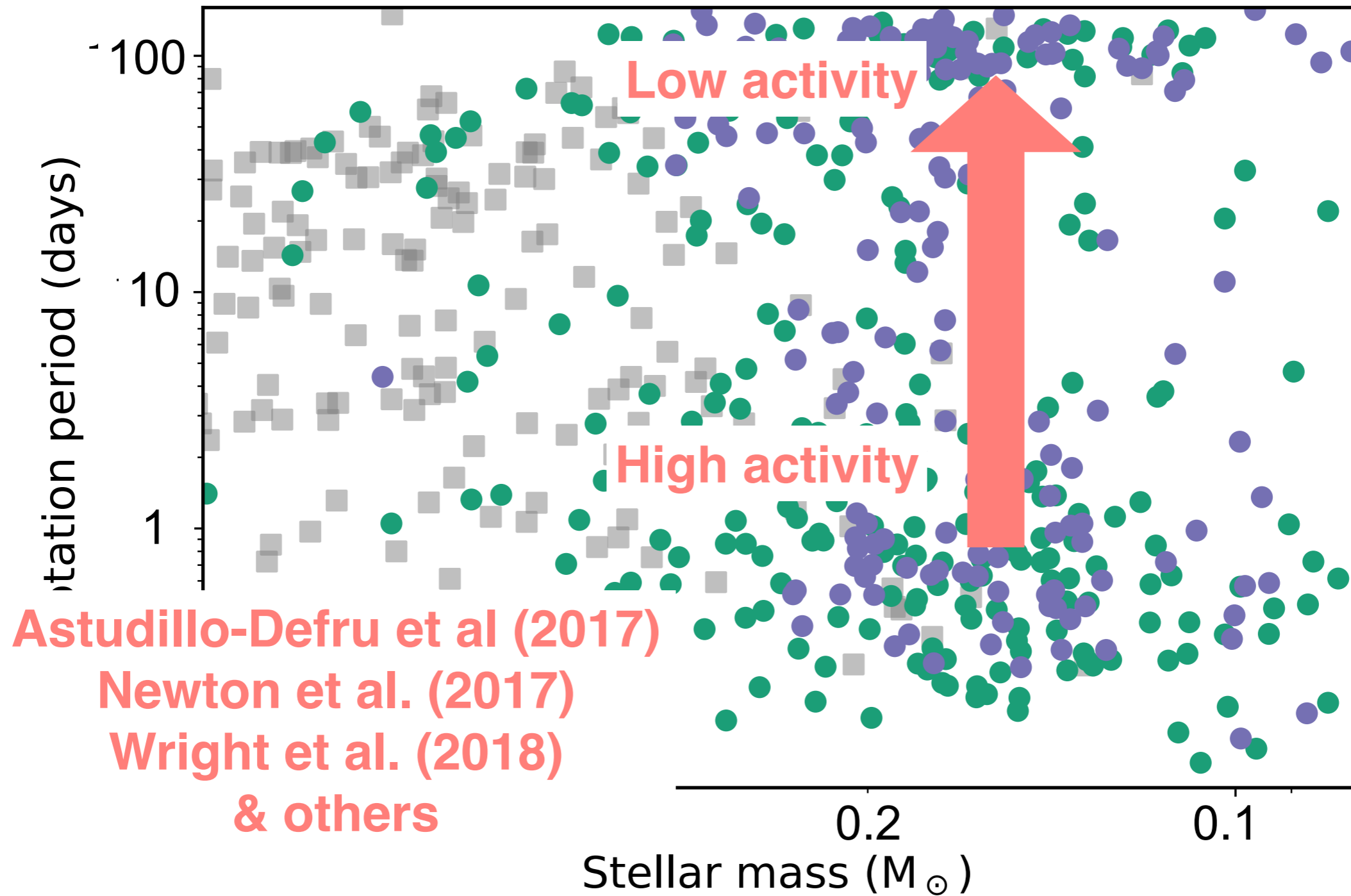
The rotation period distribution



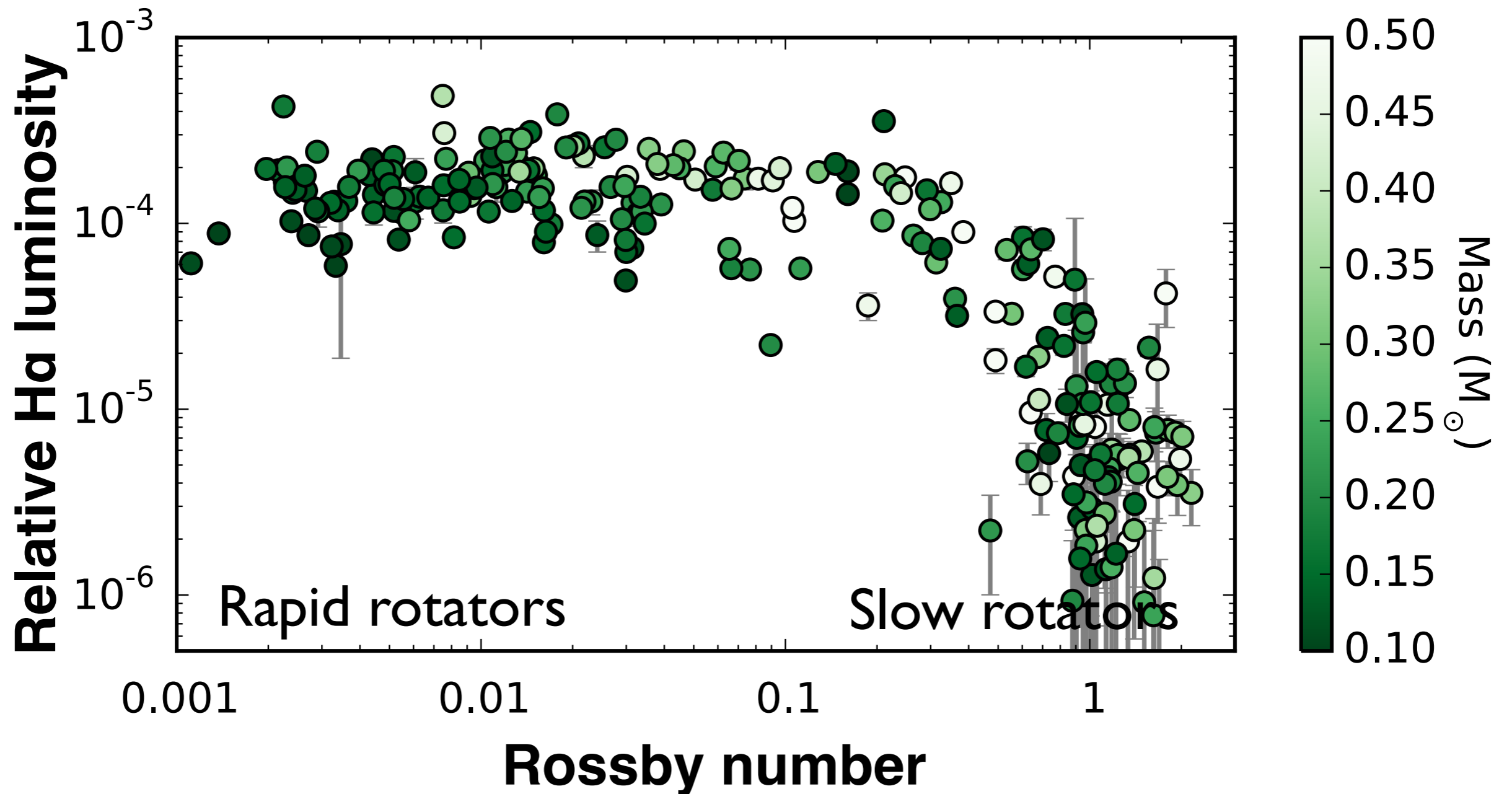
M dwarfs spin down



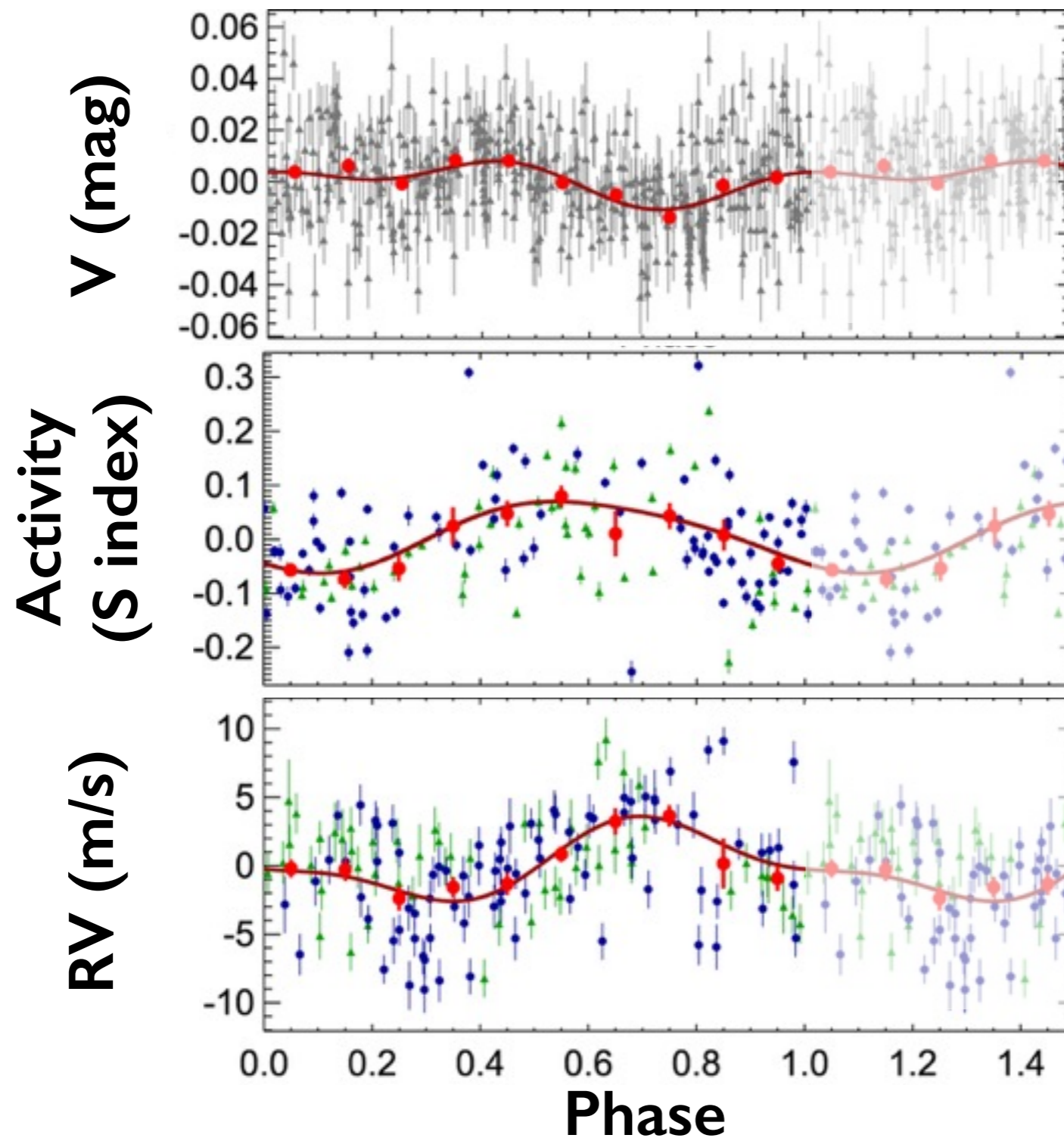
Magnetic activity declines



How are rotation & activity related?



Rotation in spectral features



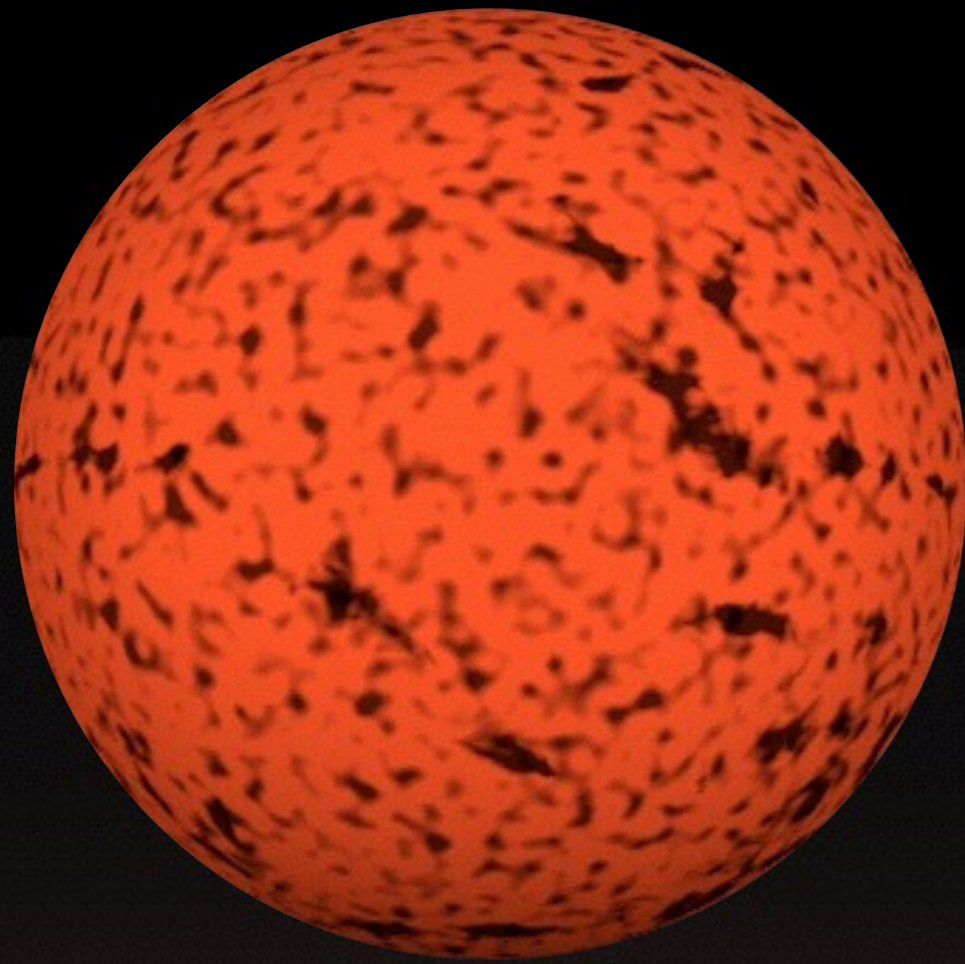
Suárez Mascareño
et al. (2018)

*even in slowly
rotation M dwarfs

Take Away #2

**M dwarfs can have very long periods
and can be magnetically inactive*
but there are still spectral signatures**

***to a stellar astronomer**



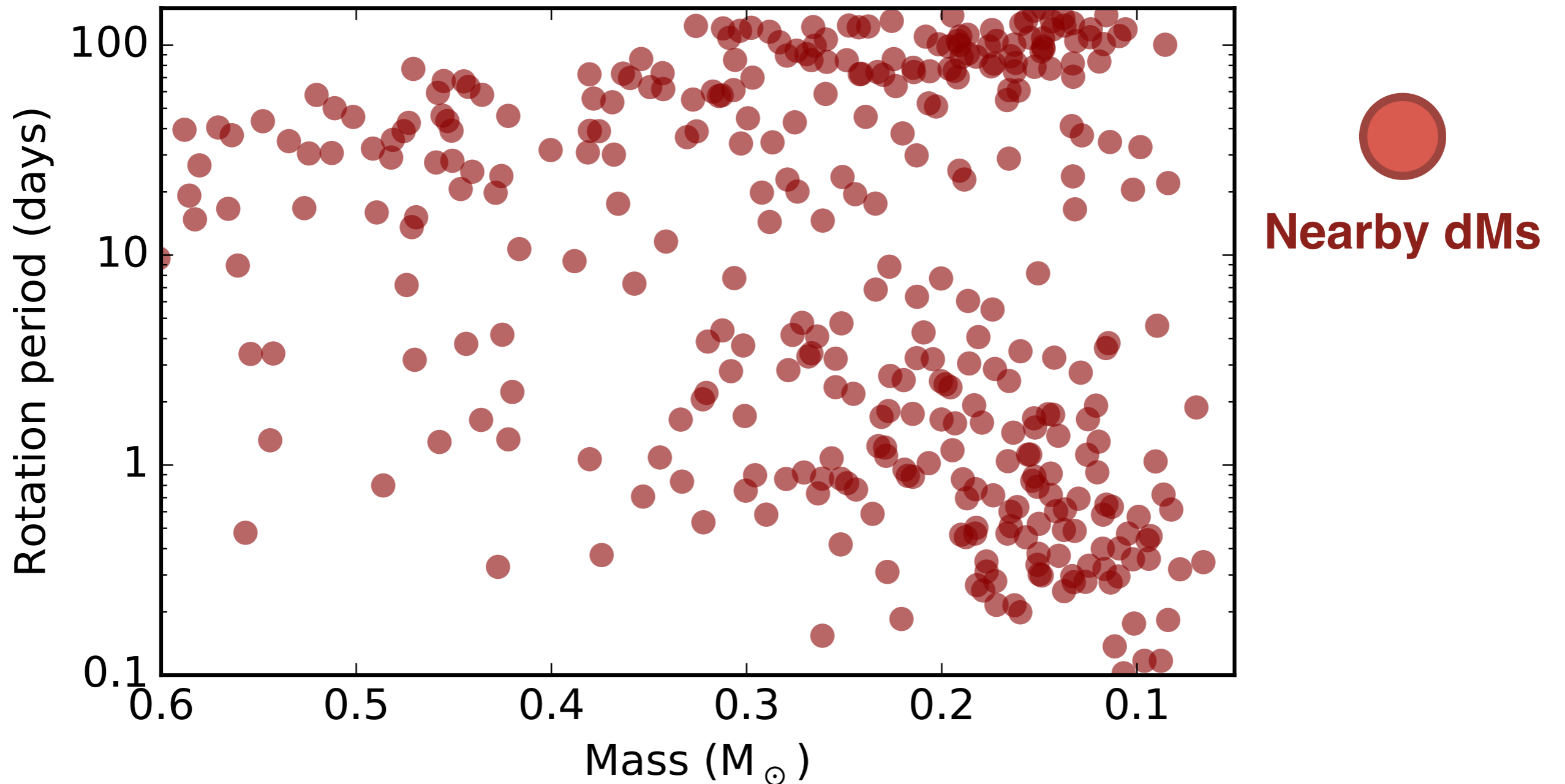
What is the impact on exoplanets?



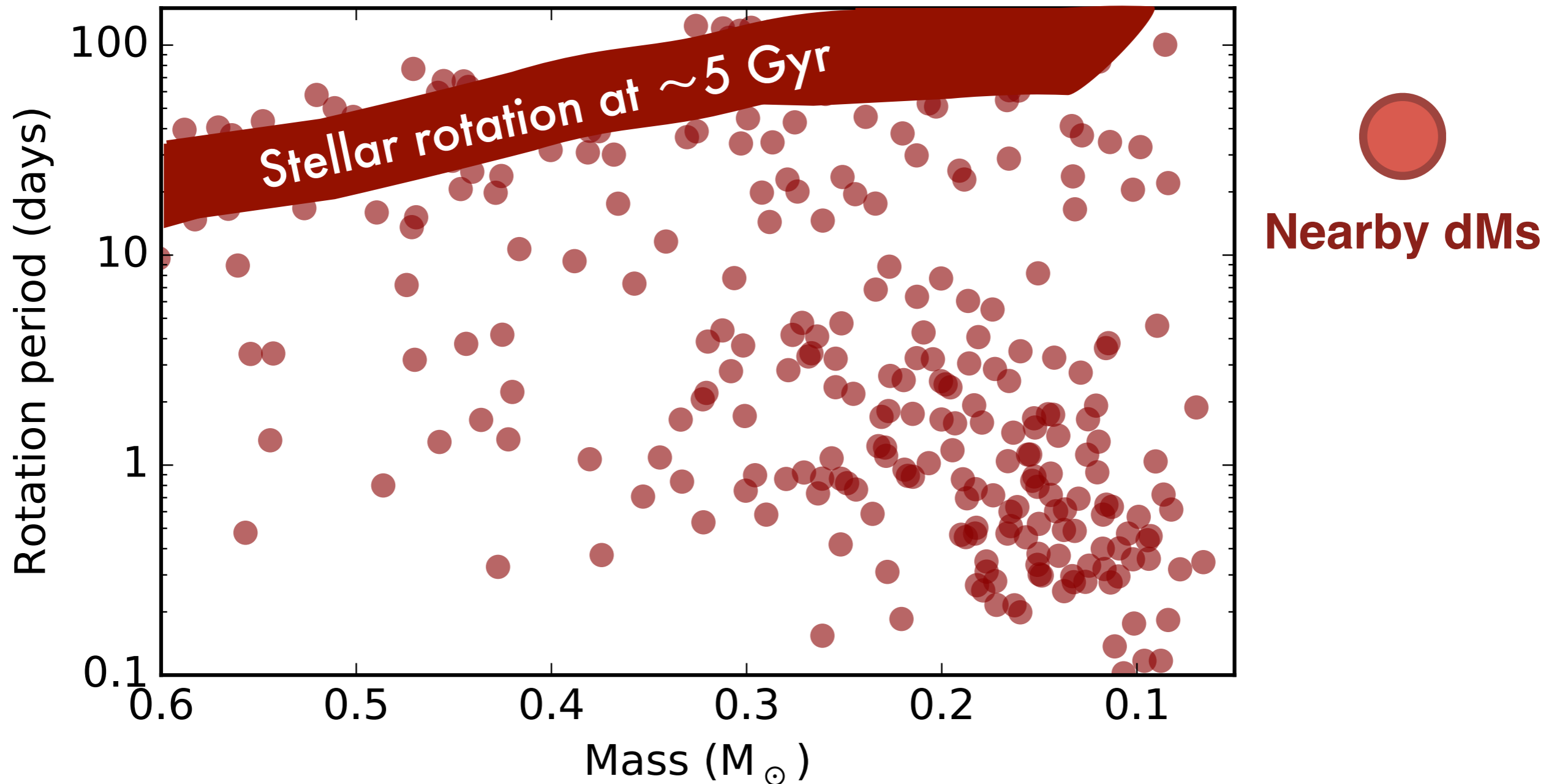
Activity causes radial velocity variations at periods related to the stellar rotation period

**e.g. Boisse et al. (2011)
Aigrain, Pont & Zucker (2012)**

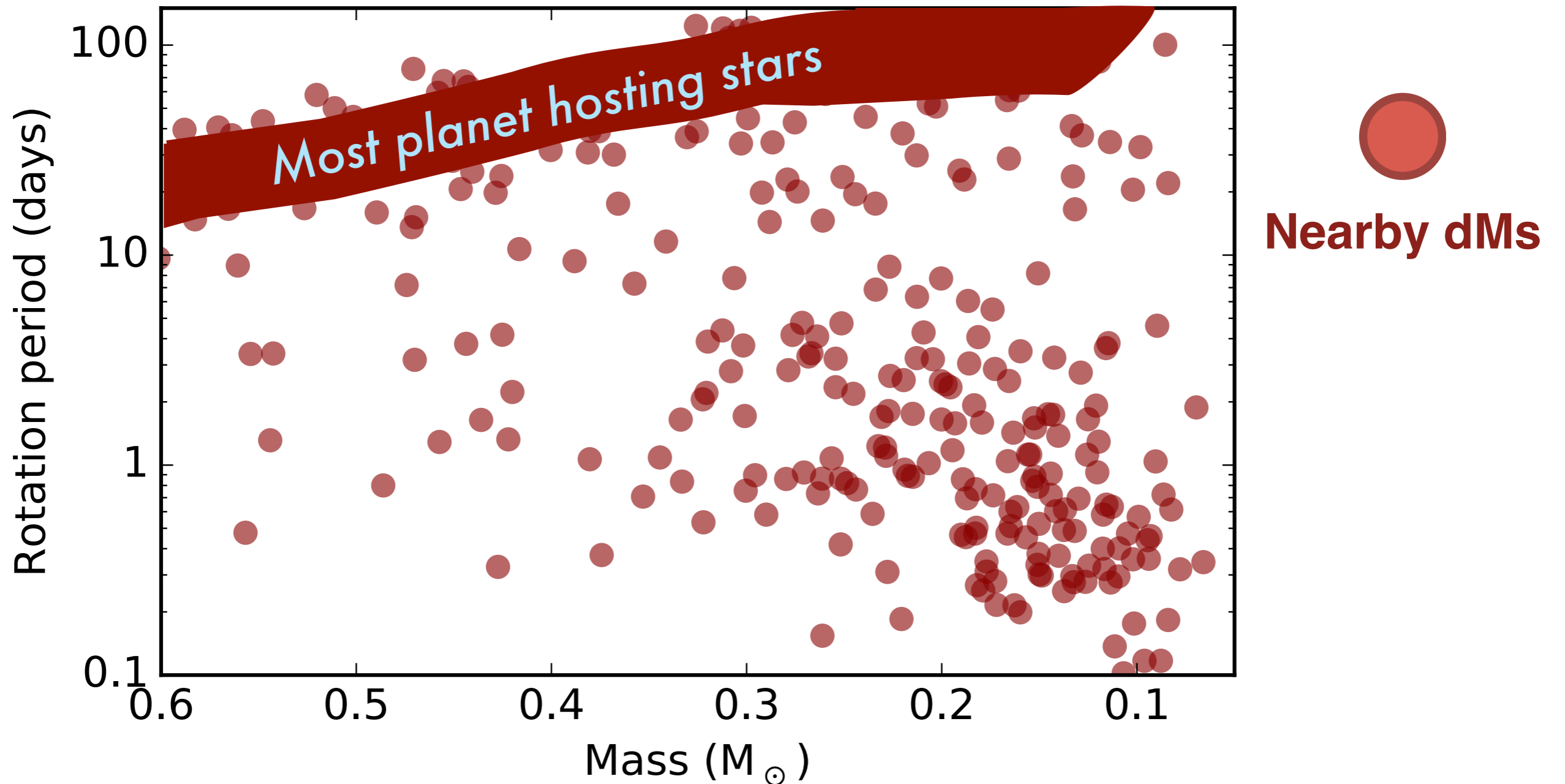
What are the typical periods of planet-hosting stars?



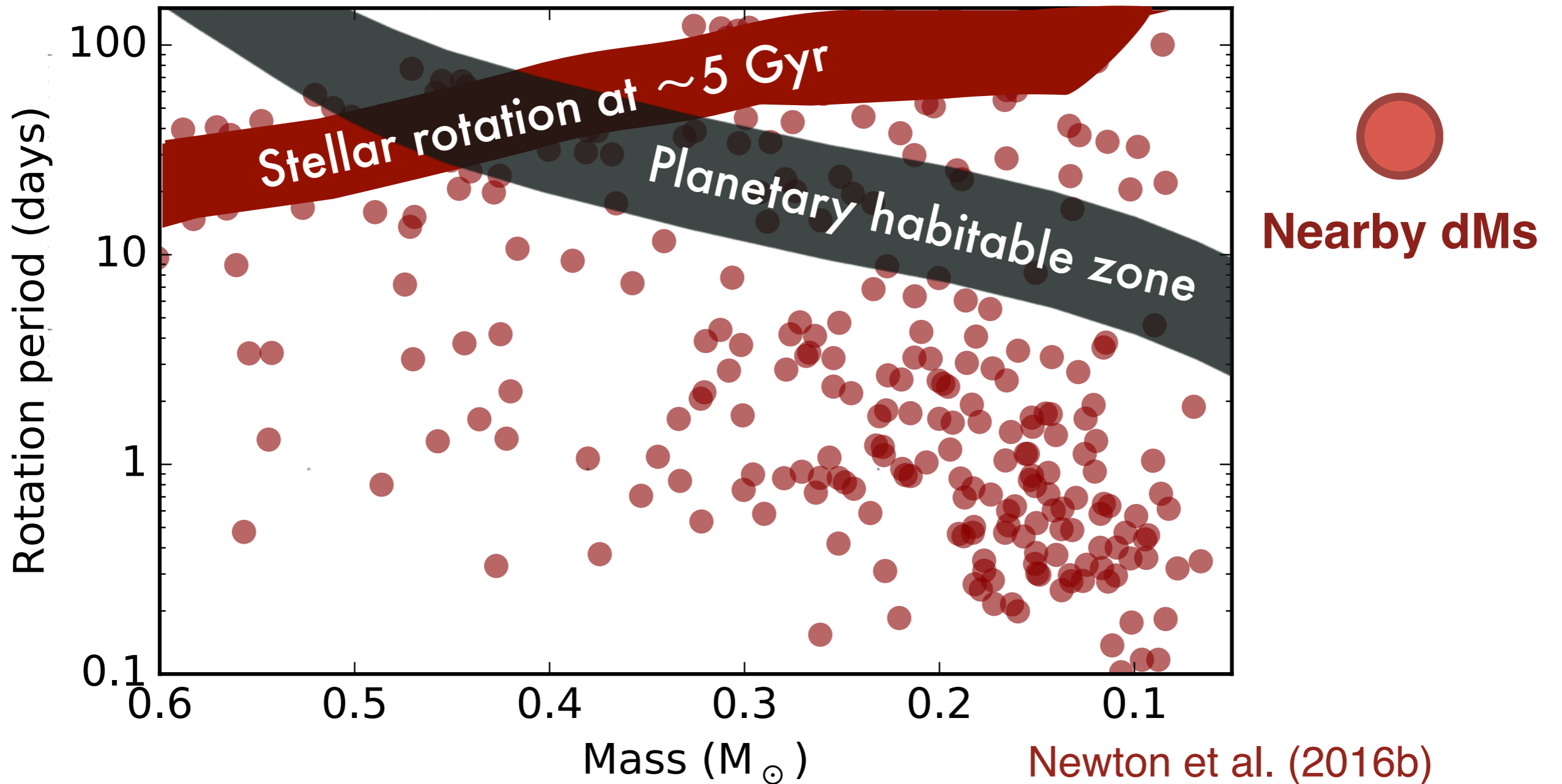
What are the typical periods of planet-hosting stars?



What are the typical periods of planet-hosting stars?



Rotation and the habitable zone



Newton et al. (2016b)
see also Vanderburg et al. (2016)

Take Away #3

**The stellar rotation is a serious concern
for habitable-zone planets around
early-to-mid M dwarfs**

What do M dwarfs look like?

What are their spins and activity levels?

What is the impact on planet detection?

Rotation and activity in M dwarf stars

“M dwarfs” is a diverse group, and there are many open questions

Mid-to-late M dwarfs have two groups of rotators: fast and very slow

Activity induced RV signals are especially important for habitable planets around early Ms