Rotation and activity in M dwarfs

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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?
A factor of 10 in mass!

M dwarfs
M dwarfs

- Partially convective: 1 M☉, 0.6 M☉
- Fully convective: 0.25 M☉, 0.08 M☉
M dwarfs

- "Early": M1V-M3V
- "Mid": M4V-M5V
- "Late": 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)

Barnes et al. (2017)
Take Away #1

There’s a lot we don’t know about M dwarfs.
What are M dwarf rotations rates and magnetic activity levels?
We use photometry to measure stellar rotation periods.
Measuring stellar rotation
Measuring stellar rotation

Date (month)

Relative brightness

Measuring stellar rotation

![Graph showing the relationship between stellar mass and rotation period with labels for Early M, Mid M, and Late M stars.](#)
The rotation period distribution

Newton et al. (2018)
Newton et al. (2016a)
M dwarfs spin down

~ 5 Gyr

< 2 Gyr

Newton et al. (2016a)

Stellar mass ($M_\odot$)
Magnetic activity declines

Newton et al. (2018)
Newton et al. (2016a)
Low activity
Newton et al. (2017)
Wright et al. (2018)
& others
Magnetic activity declines

Astudillo-Defru et al (2017)
Newton et al. (2017)
Wright et al. (2018)
& others

Stellar mass ($M_\odot$)

Low activity
High activity
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?
Nearby dMs

Stellar rotation at $\sim 5$ Gyr

What are the typical periods of planet-hosting stars?
What are the typical periods of planet-hosting stars?
Rotation and the habitable zone

Nearby dMs

Planetary habitable zone

Stellar rotation at $\sim 5$ Gyr

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