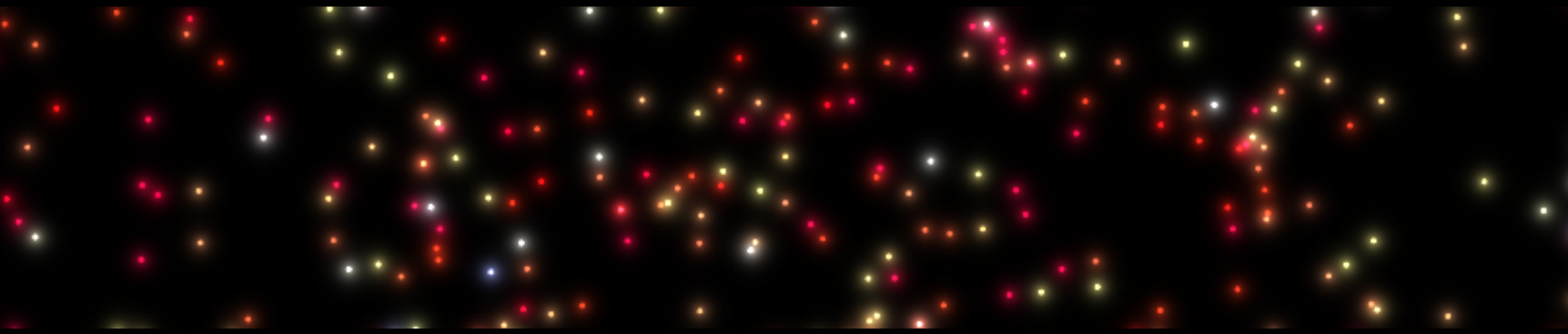
Rotation and activity in M dwarfs



Elisabeth R. Newton

Dartmouth College

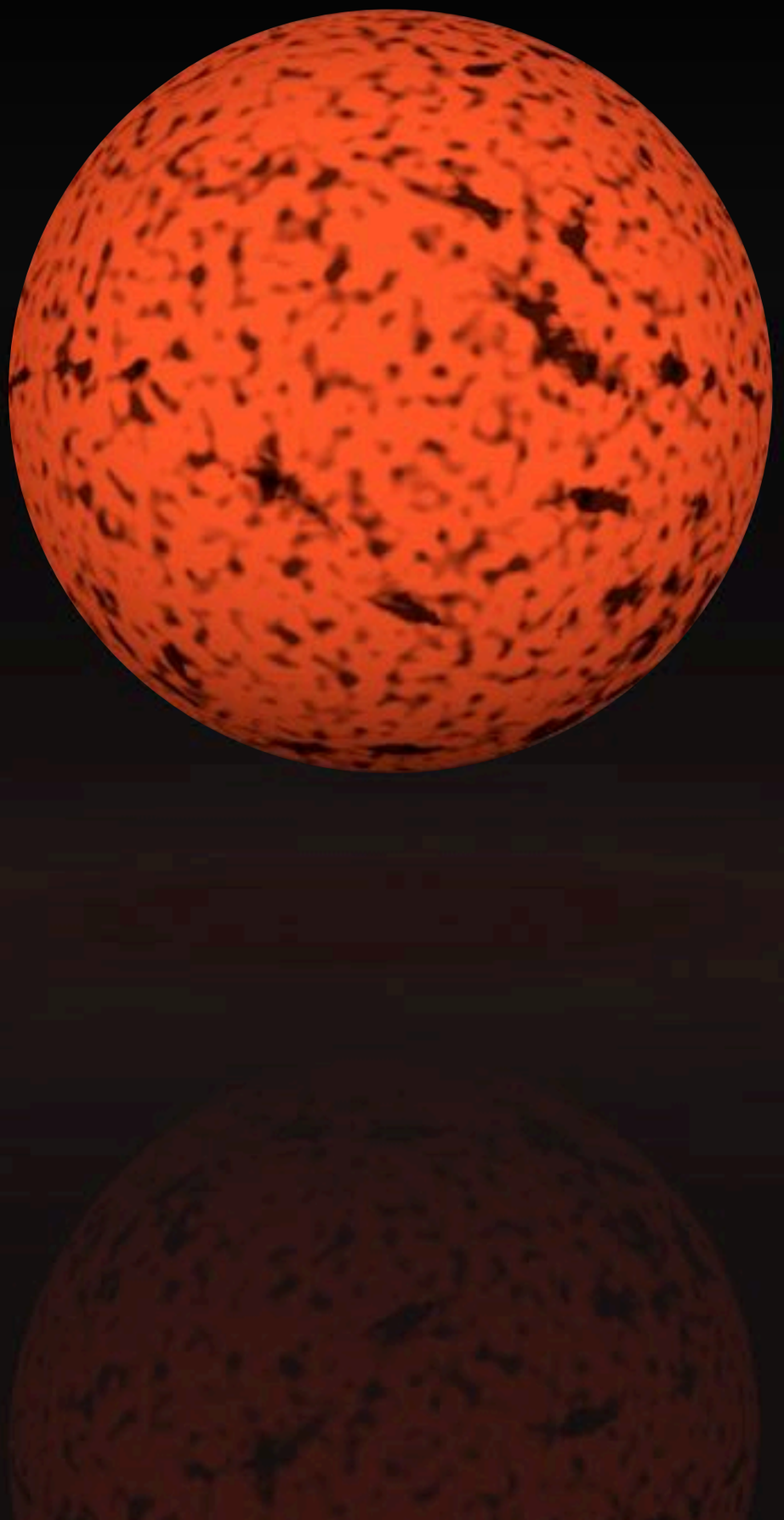
Massachusetts Institute of Technology

HARVARD UNIVERSITY

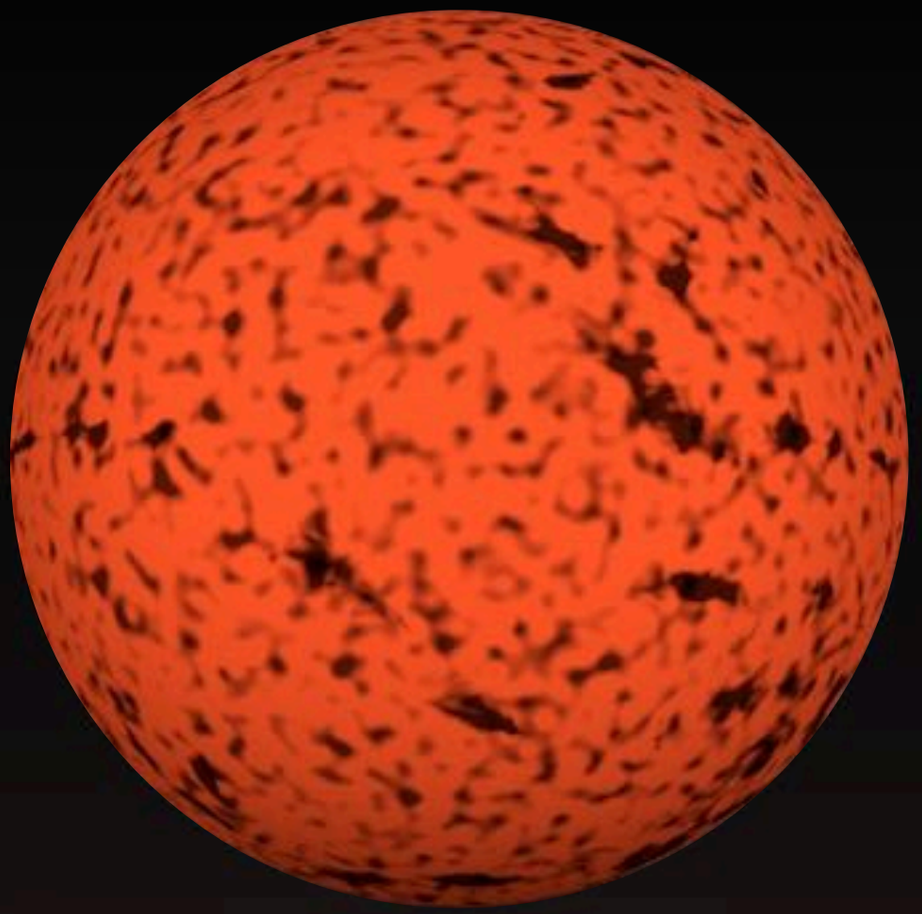
JOHN TEMPLETON FOUNDATION

the David & Lucile Packard FOUNDATION

nsf



M dwarf stellar physics



and exoplanets

In this talk:

Background

Measuring stellar rotation

The rotation-activity relationship

The gap in the rotation period distribution

The spin-down timescale

Impact on planet detection

In this talk:

Background

Measuring stellar rotation

The rotation-activity relationship

The gap in the rotation period distribution

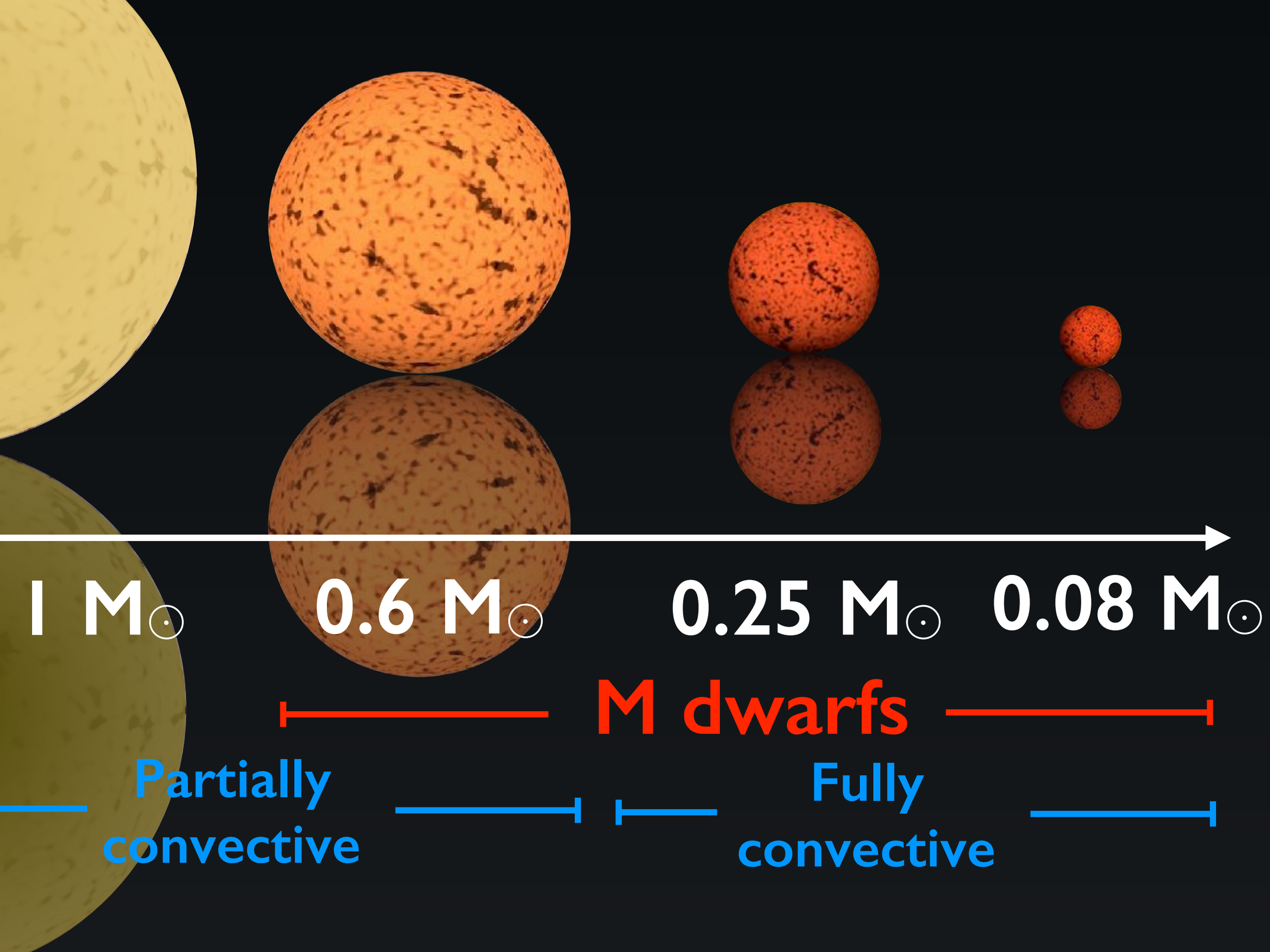
The spin-down timescale

Impact on planet detection

1 $M_\odot$ 0.6 $M_\odot$ 0.25 $M_\odot$ 0.08 $M_\odot$

M dwarfs

A factor of 10 in mass!


1 M⊙
0.6 M⊙
0.25 M⊙
0.08 M⊙
M dwarfs
Partially convective
Fully convective

1 $M_\odot$

0.6 $M_\odot$

0.25 $M_\odot$

0.08 $M_\odot$

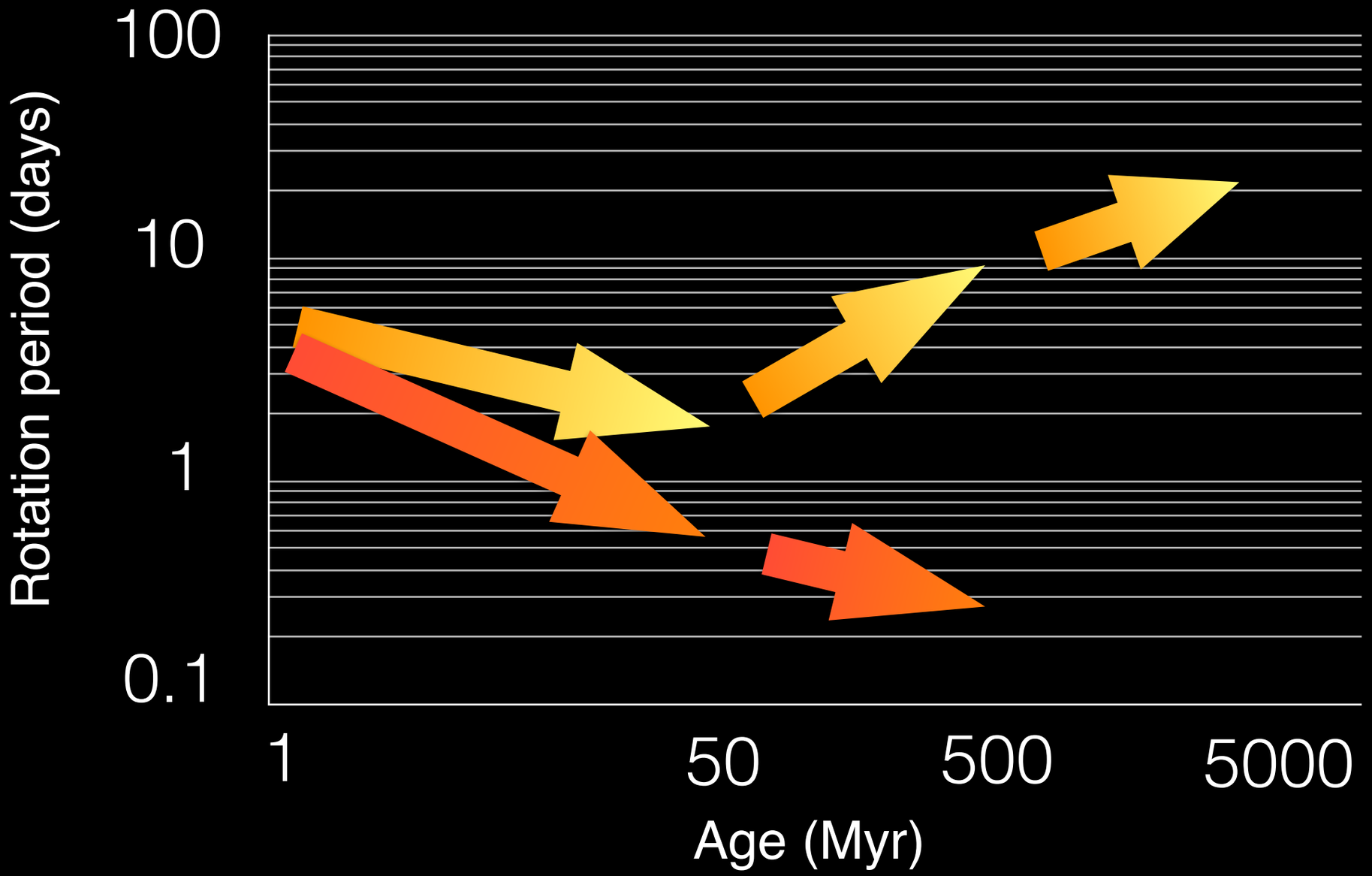
M dwarfs

"Early"
M1V-M3V

"Mid"
M4V-M5V

"Late"
M6V-M8V

Stellar spin-down



c.f. Irwin & Bouvier (2009)

In this talk:

Background

Measuring rotation

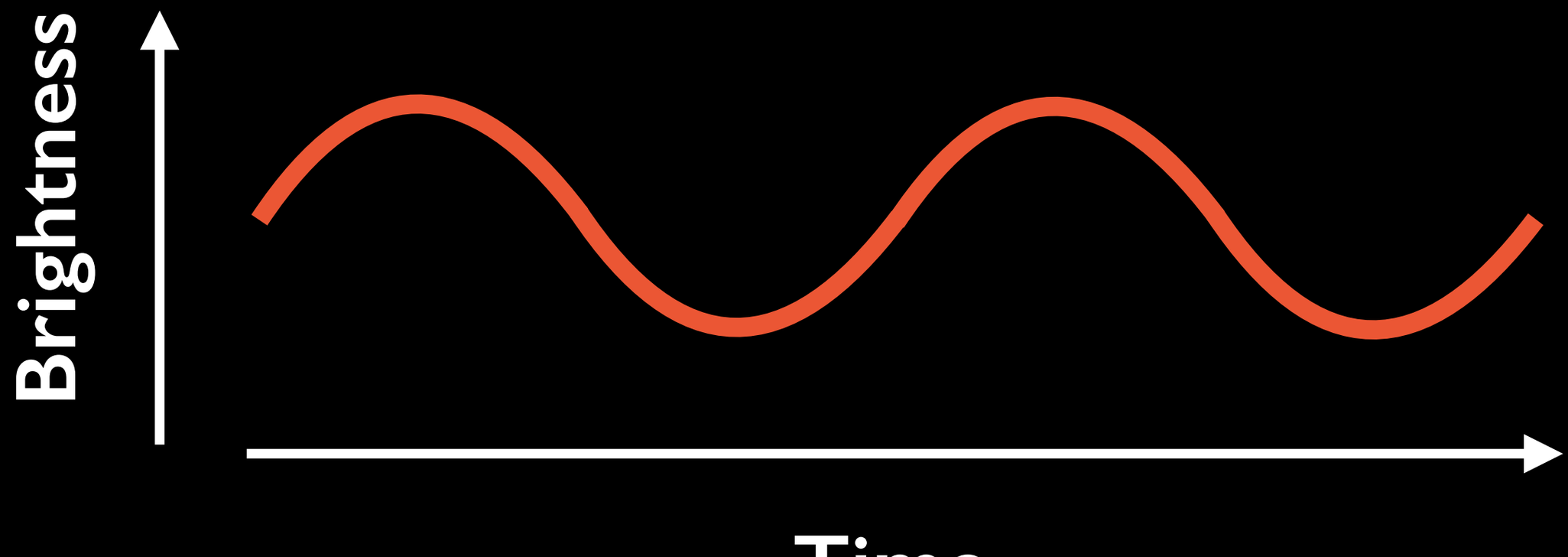
The rotation-activity relationship

The gap in the rotation period distribution

The spin-down timescale

[Ask me about planets]

Rotation periods

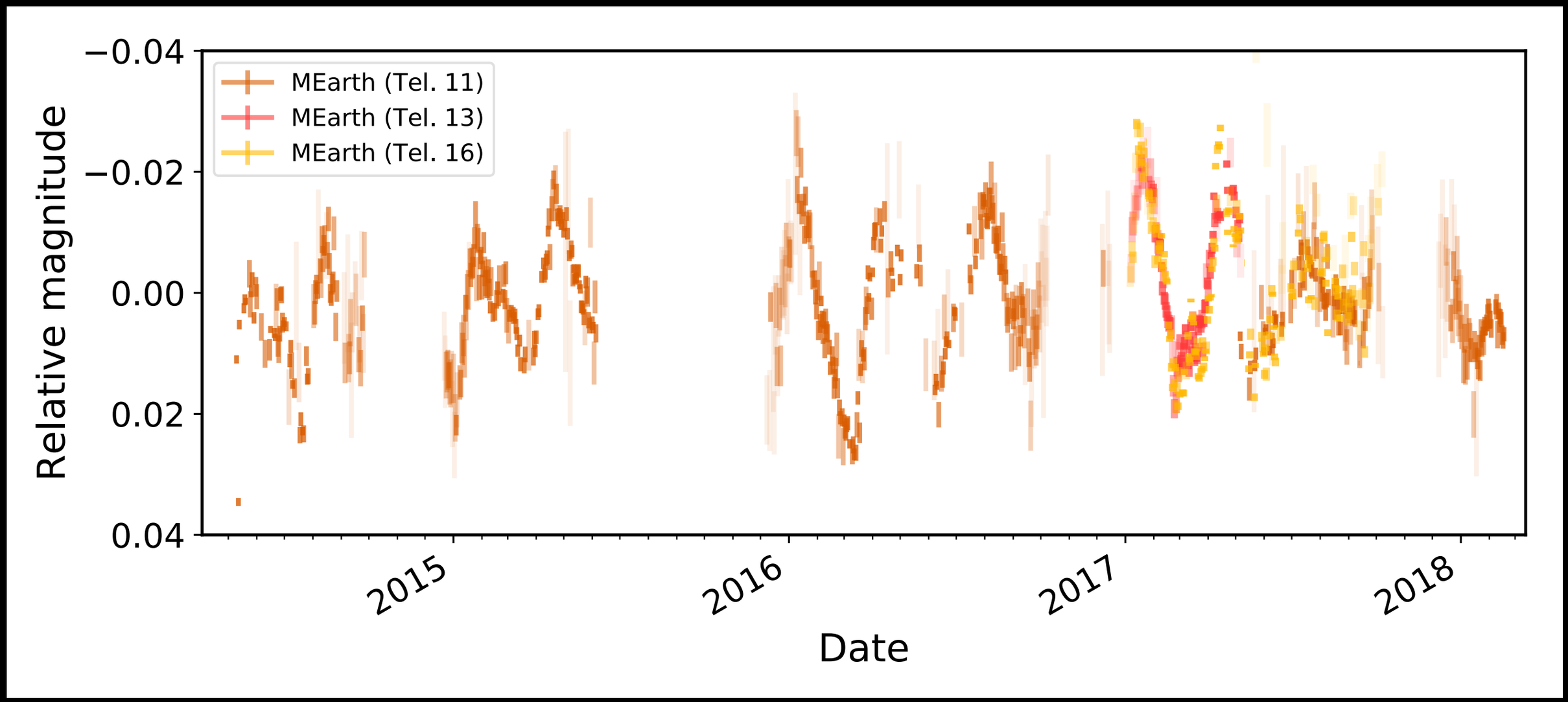


Starspots result from the magnetic field and we use them to measure rotation.

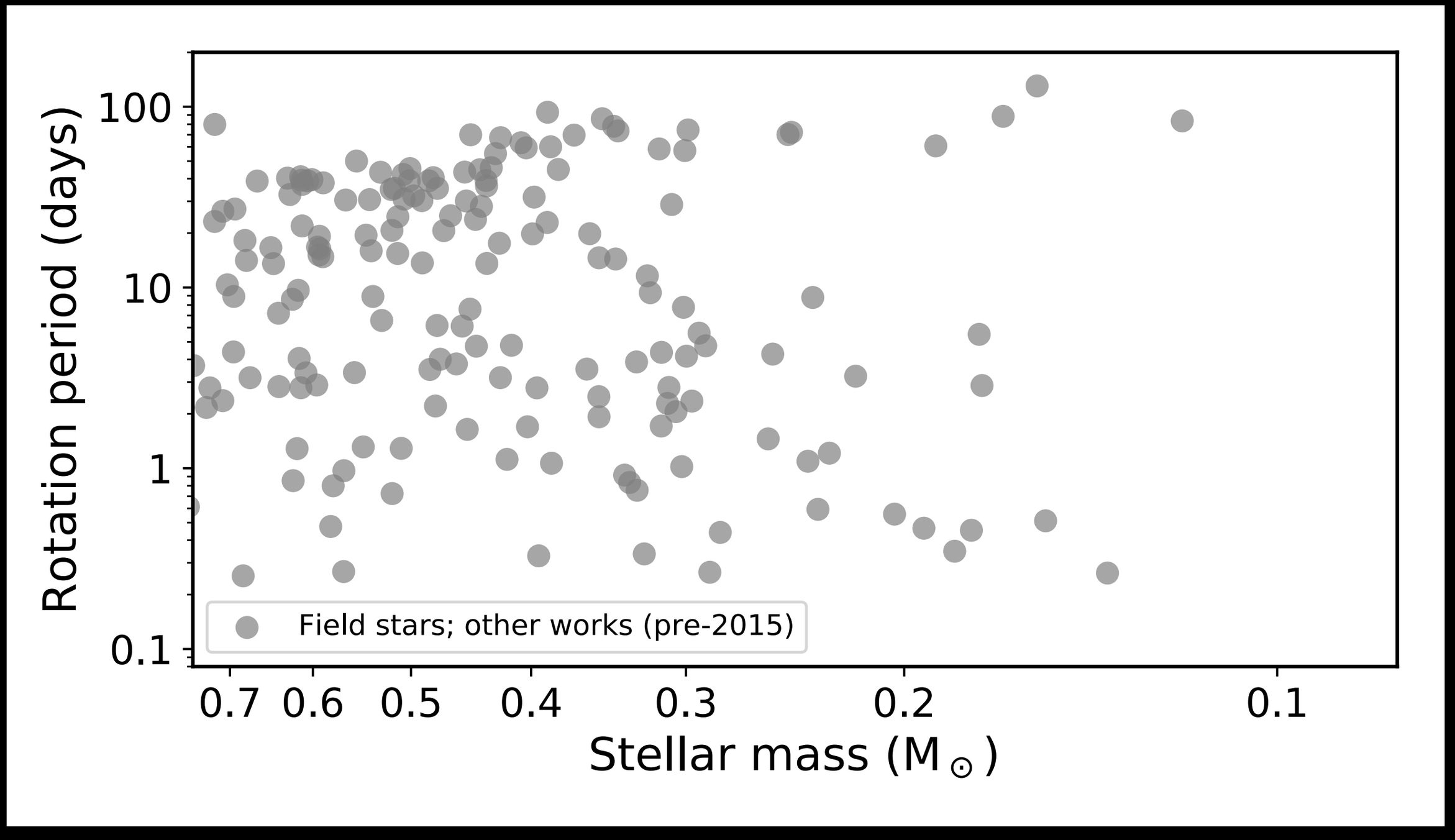
The MEarth Project

Thanks to collaborators: D. Charbonneau, J. Irwin, Z.K. Berta-Thompson, J. Dittmann, J. Winters

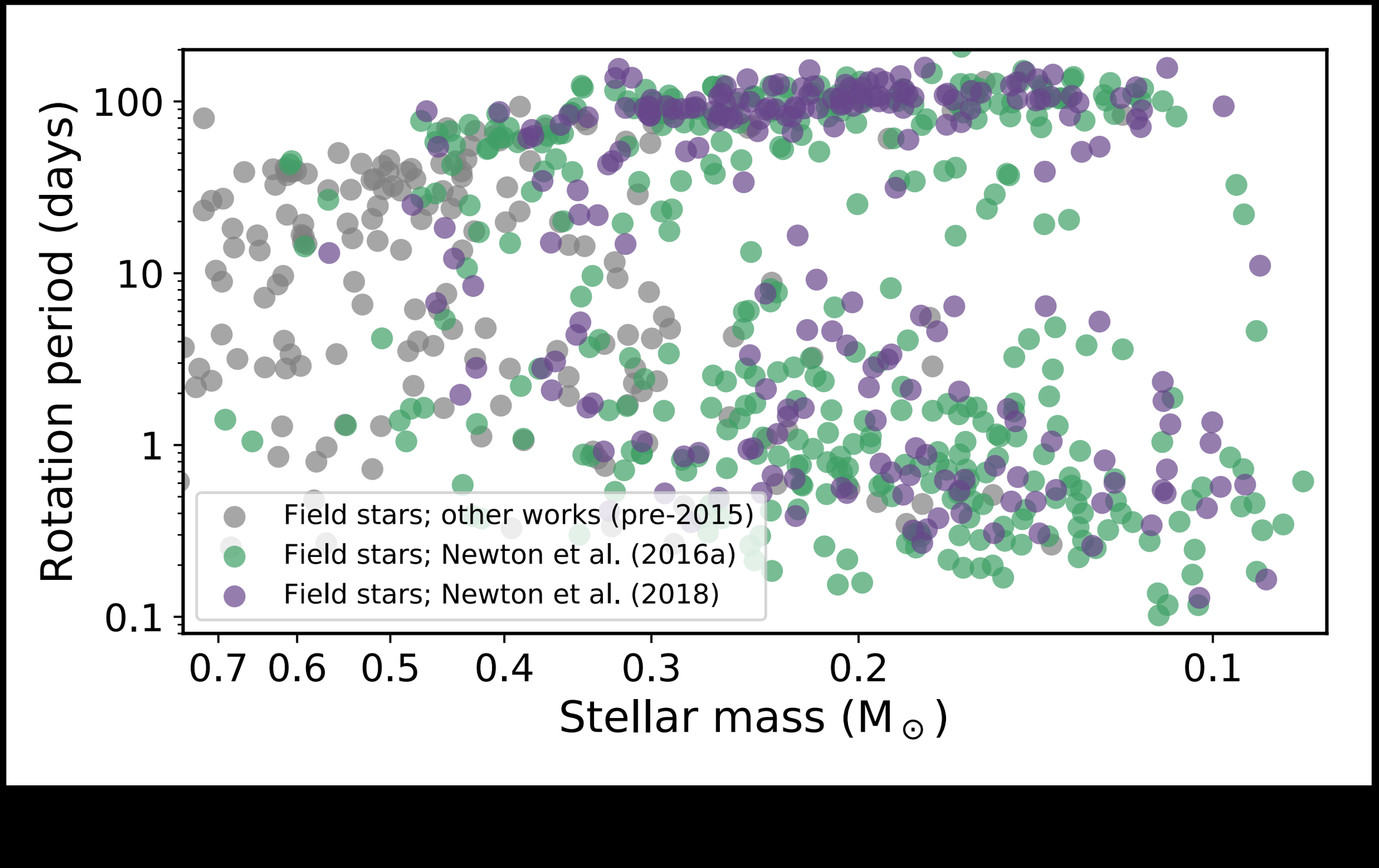
Long time base-line: sensitivity to long periods



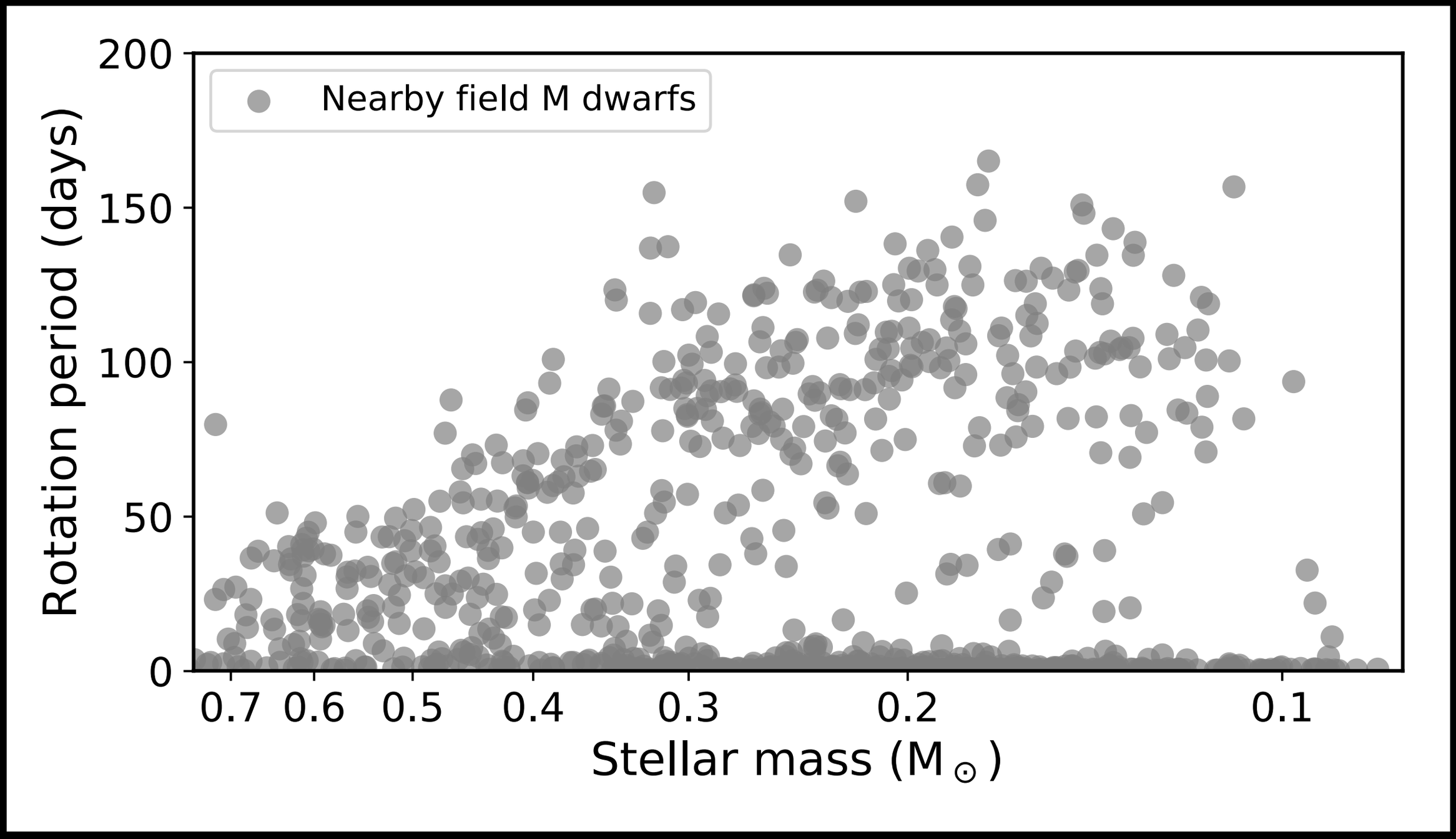
Rotation periods of field stars



Rotation periods of field stars



Rotation periods of field stars



In this talk:

Background

Measuring stellar rotation

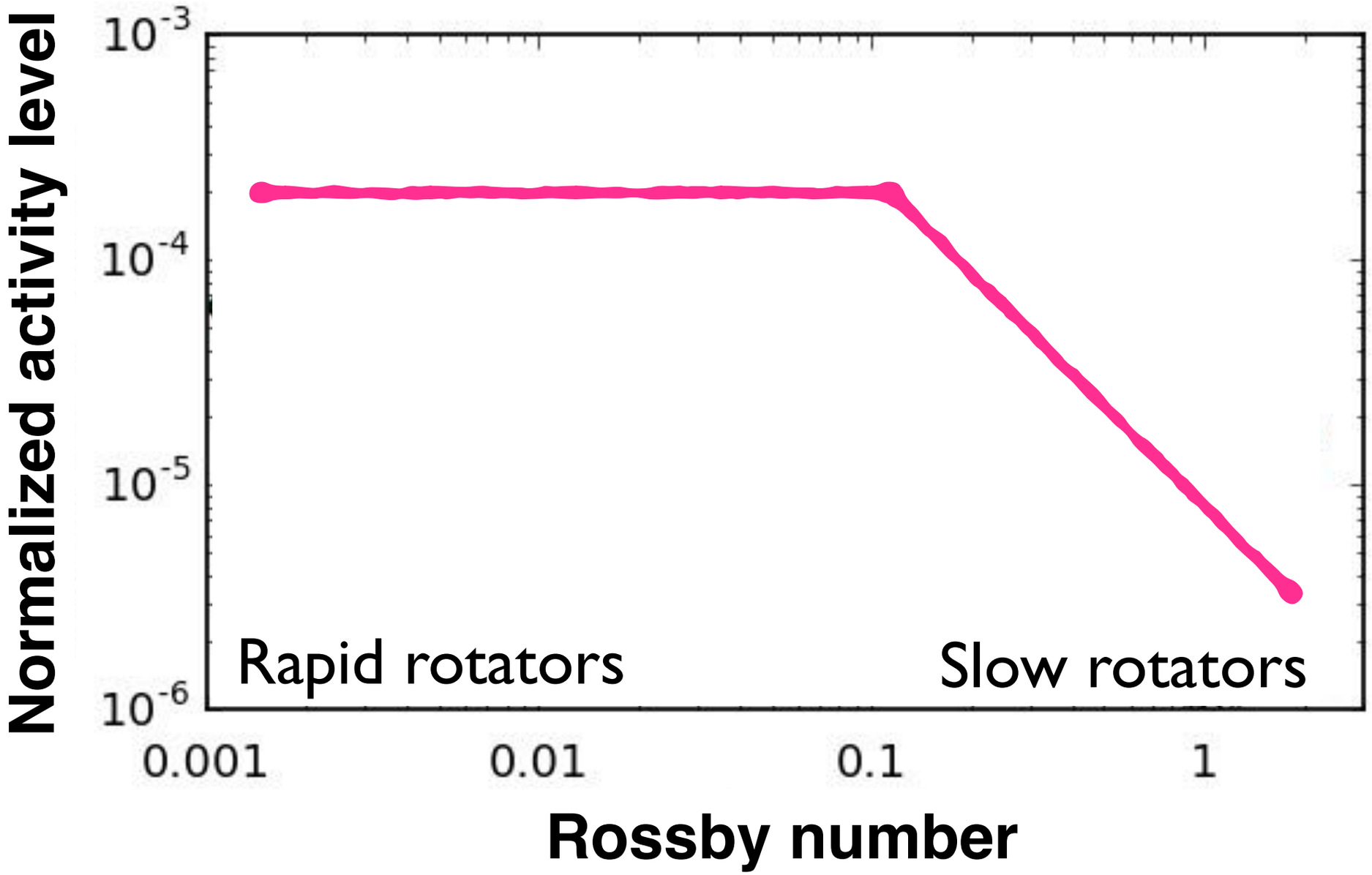
The rotation-activity relationship

The gap in the rotation period distribution

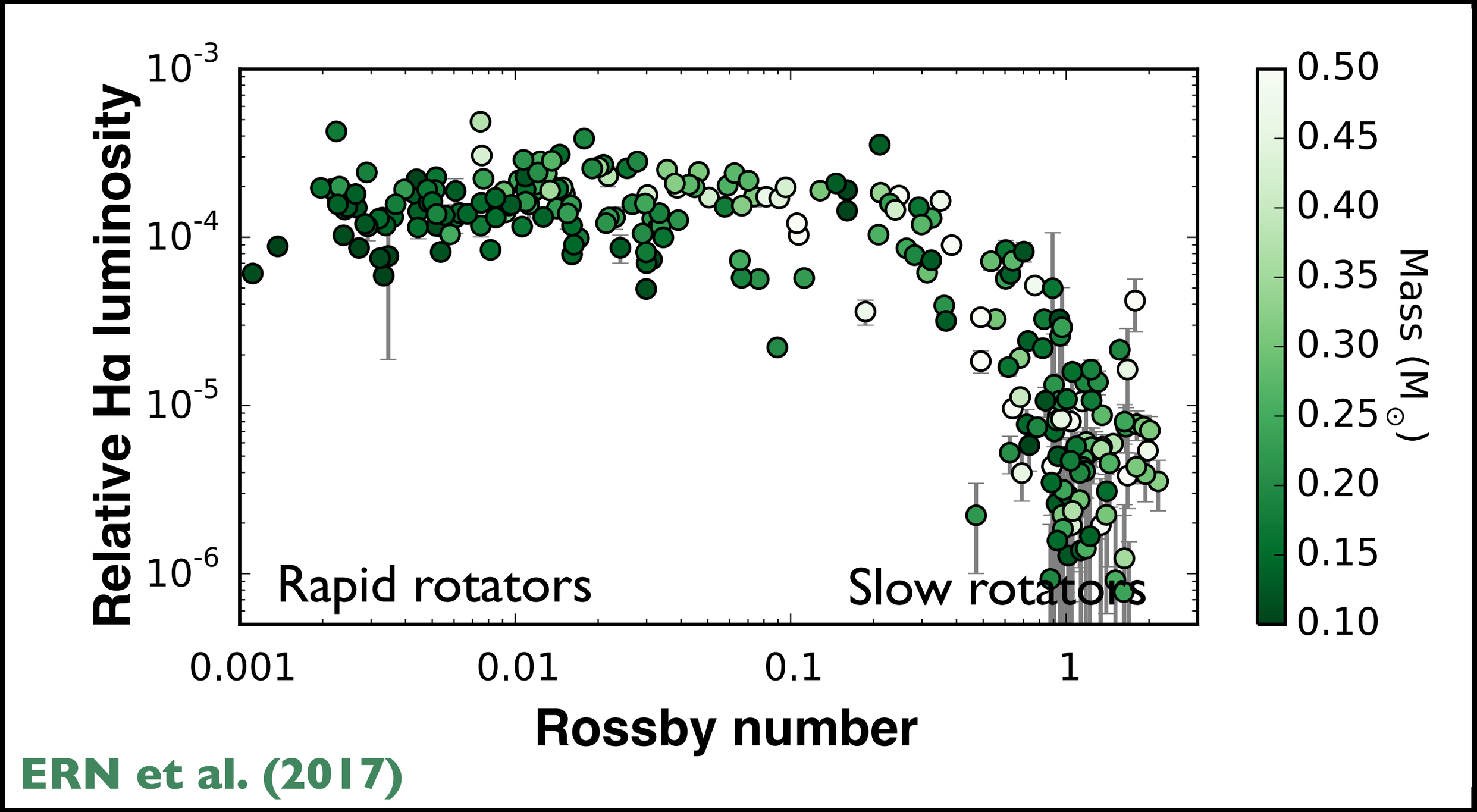
The spin-down timescale

Impact on planet detection

The rotation-activity relation



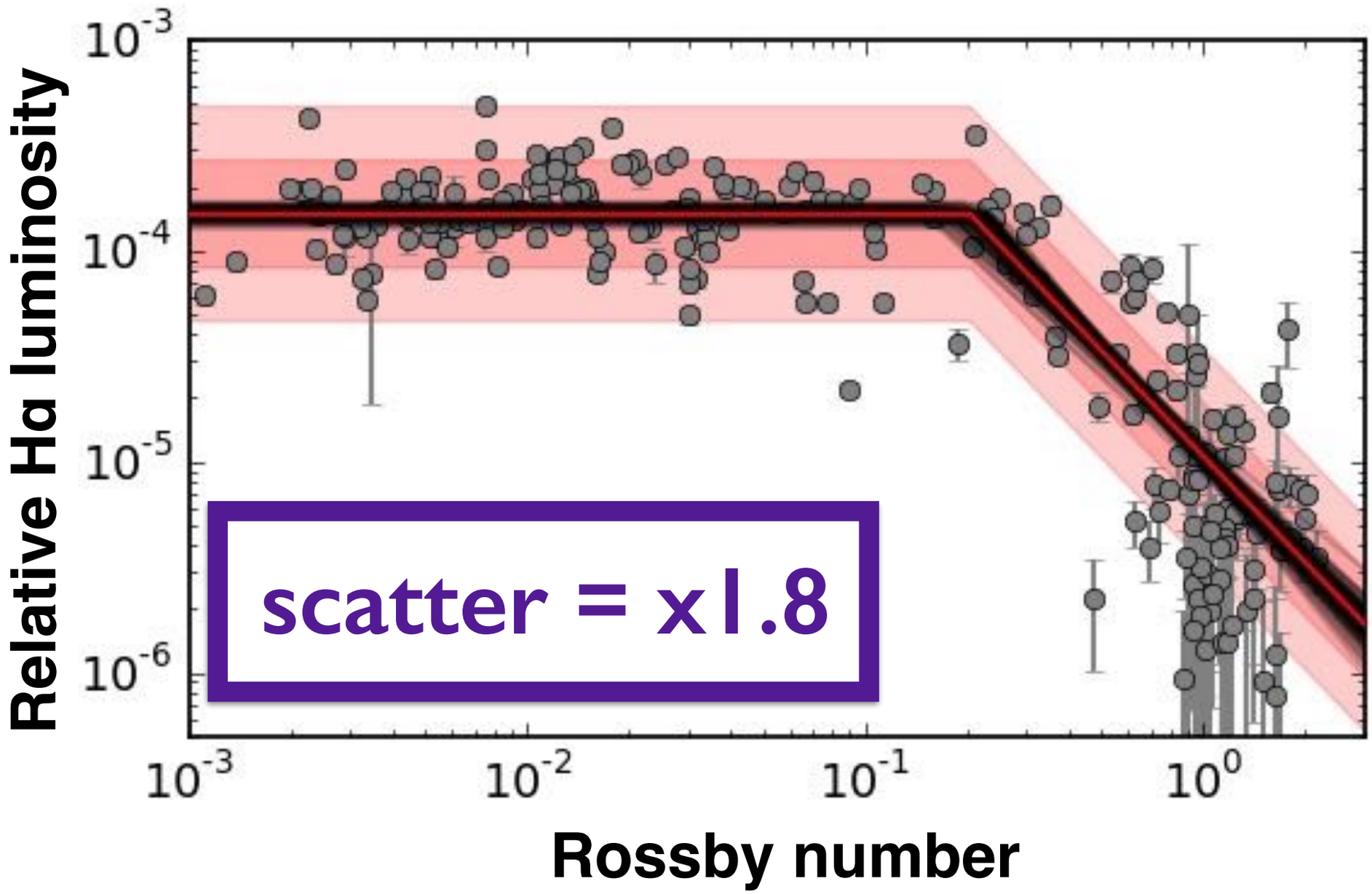
The relation is the same for partially and fully convective M dwarfs



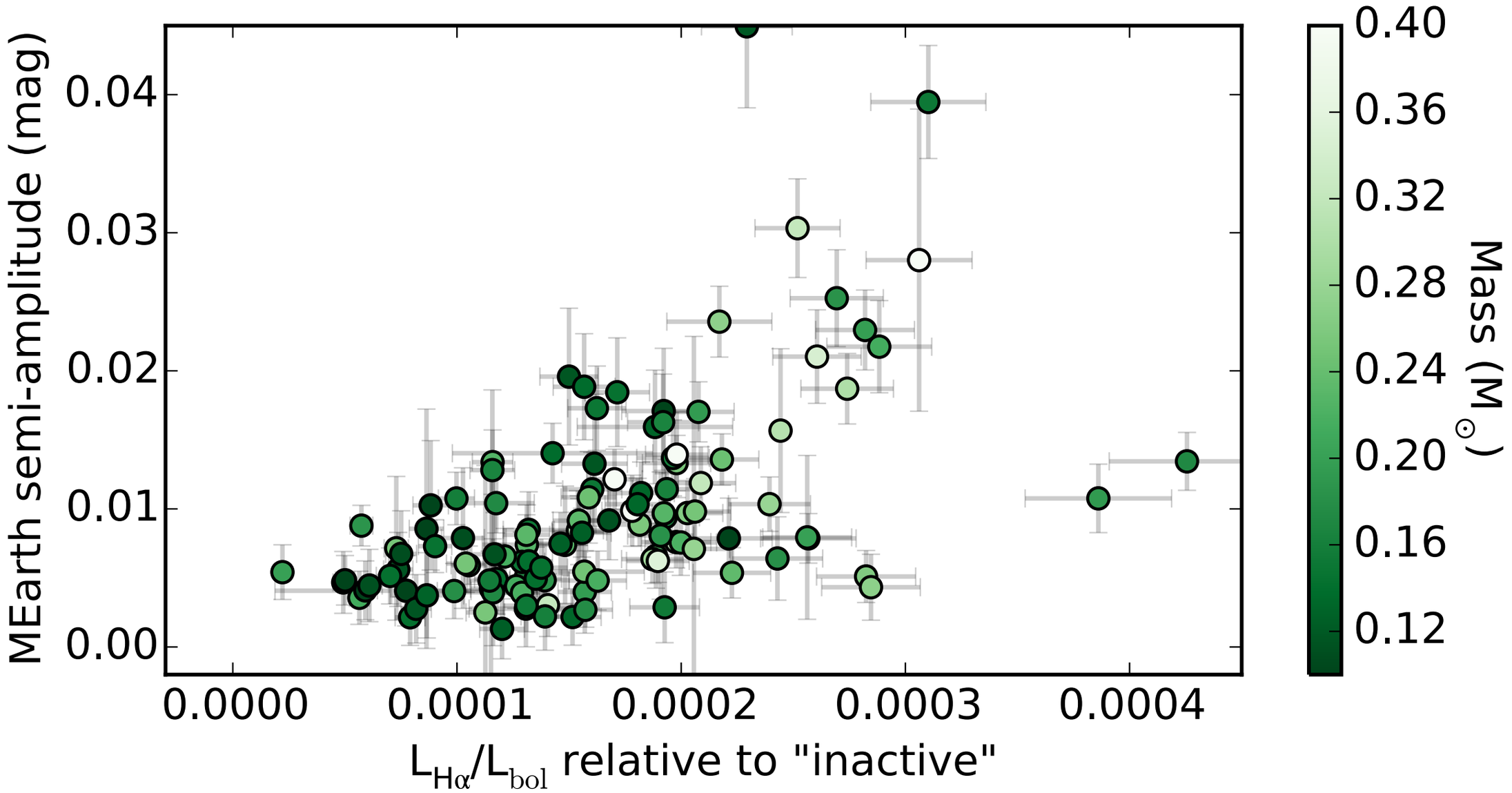
ERN et al. (2017)

More on rotation and activity
in M dwarfs:
See talk by Nick Wright on Friday

Scatter in the Hα-rotation relation



More variable stars are more active



ERN et al. (2017)

More to come on this using TESS + ground-based spectra

In this talk:

Background

Measuring stellar rotation

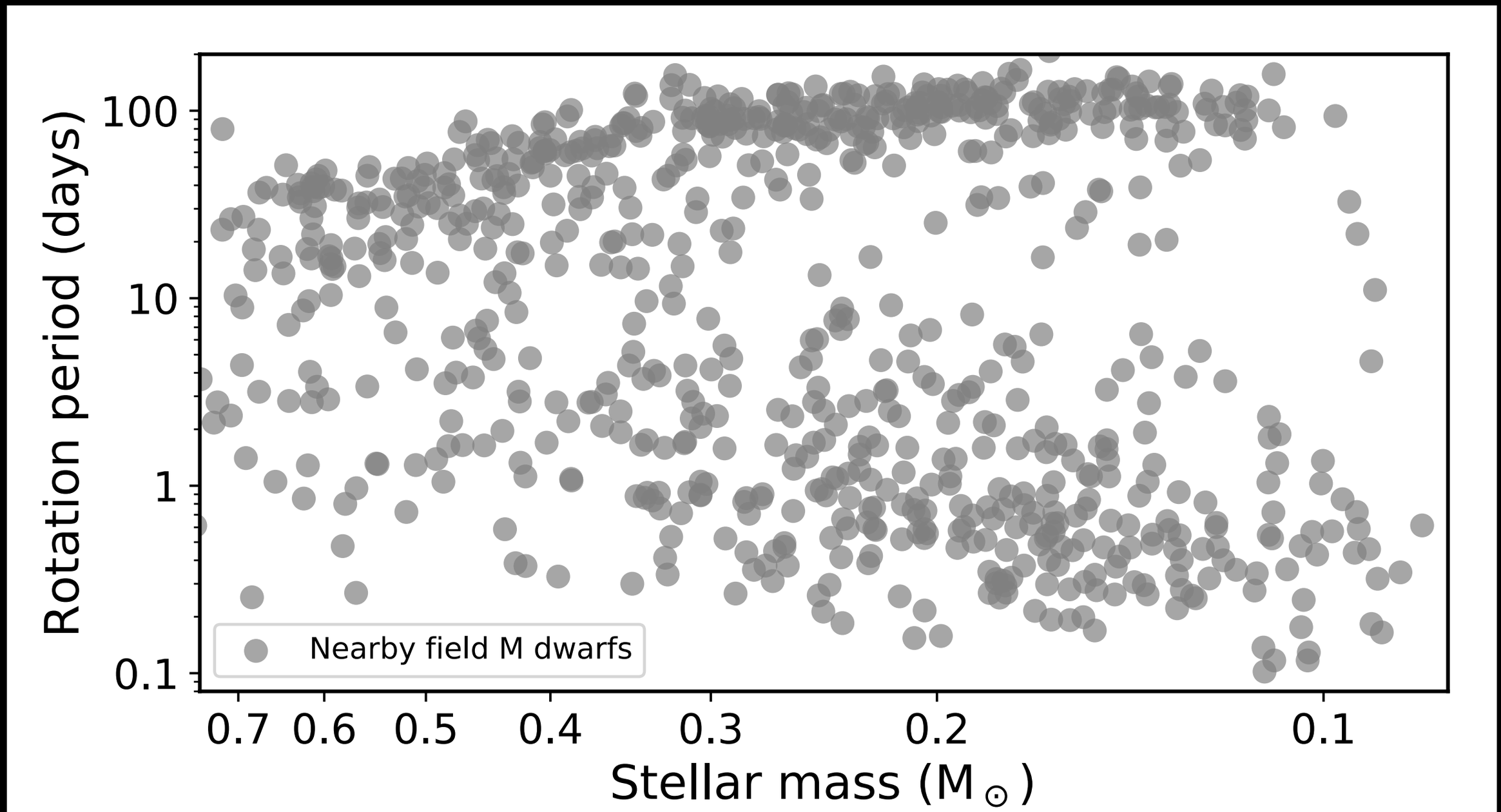
The rotation-activity relationship

The gap in the rotation period distribution

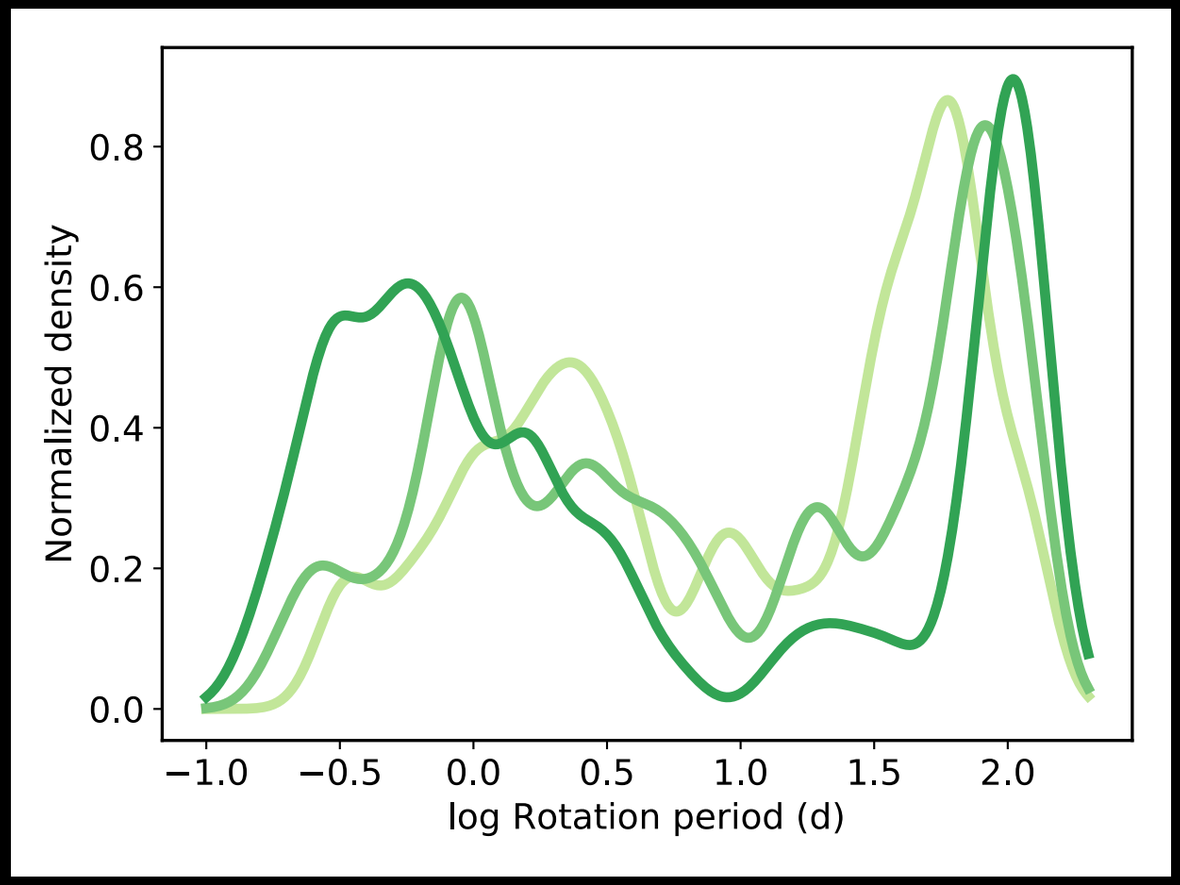
The spin-down timescale

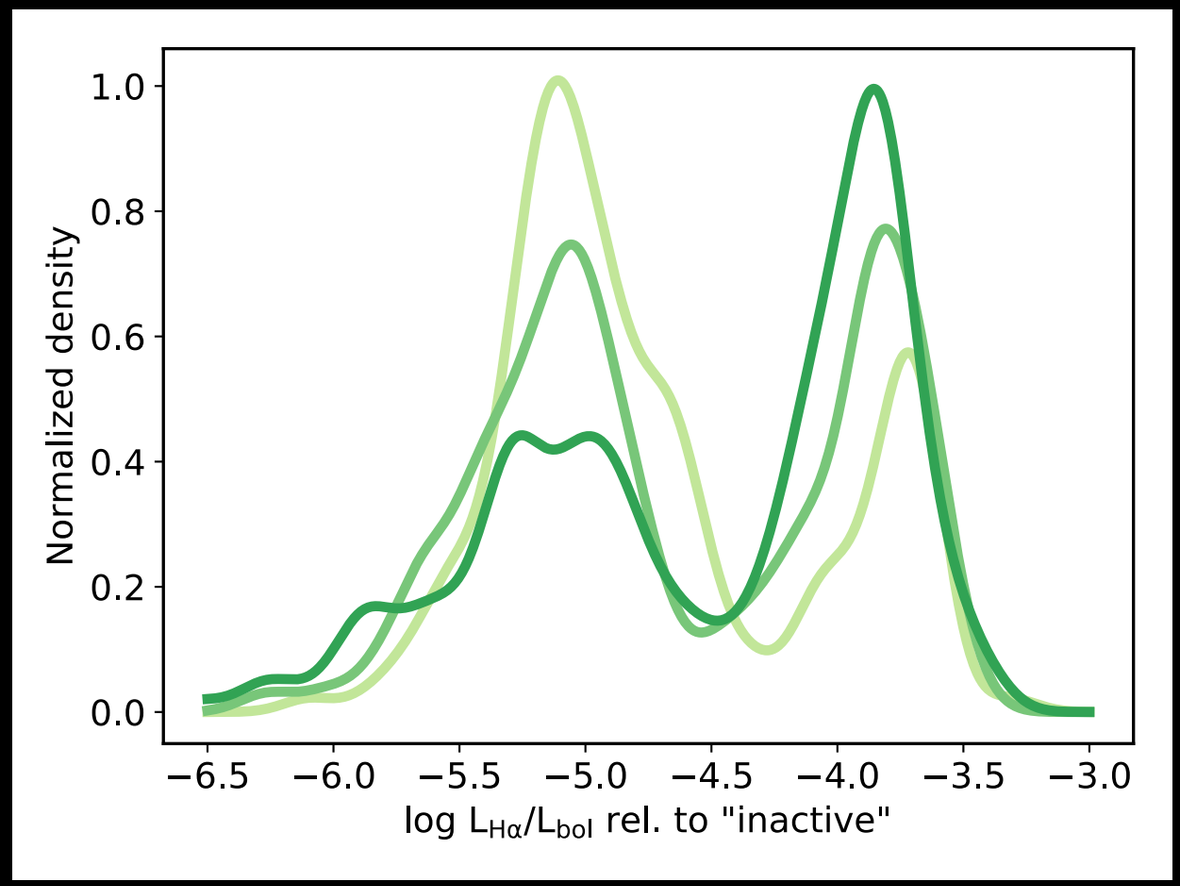
Impact on planet detection

The rotation period gap



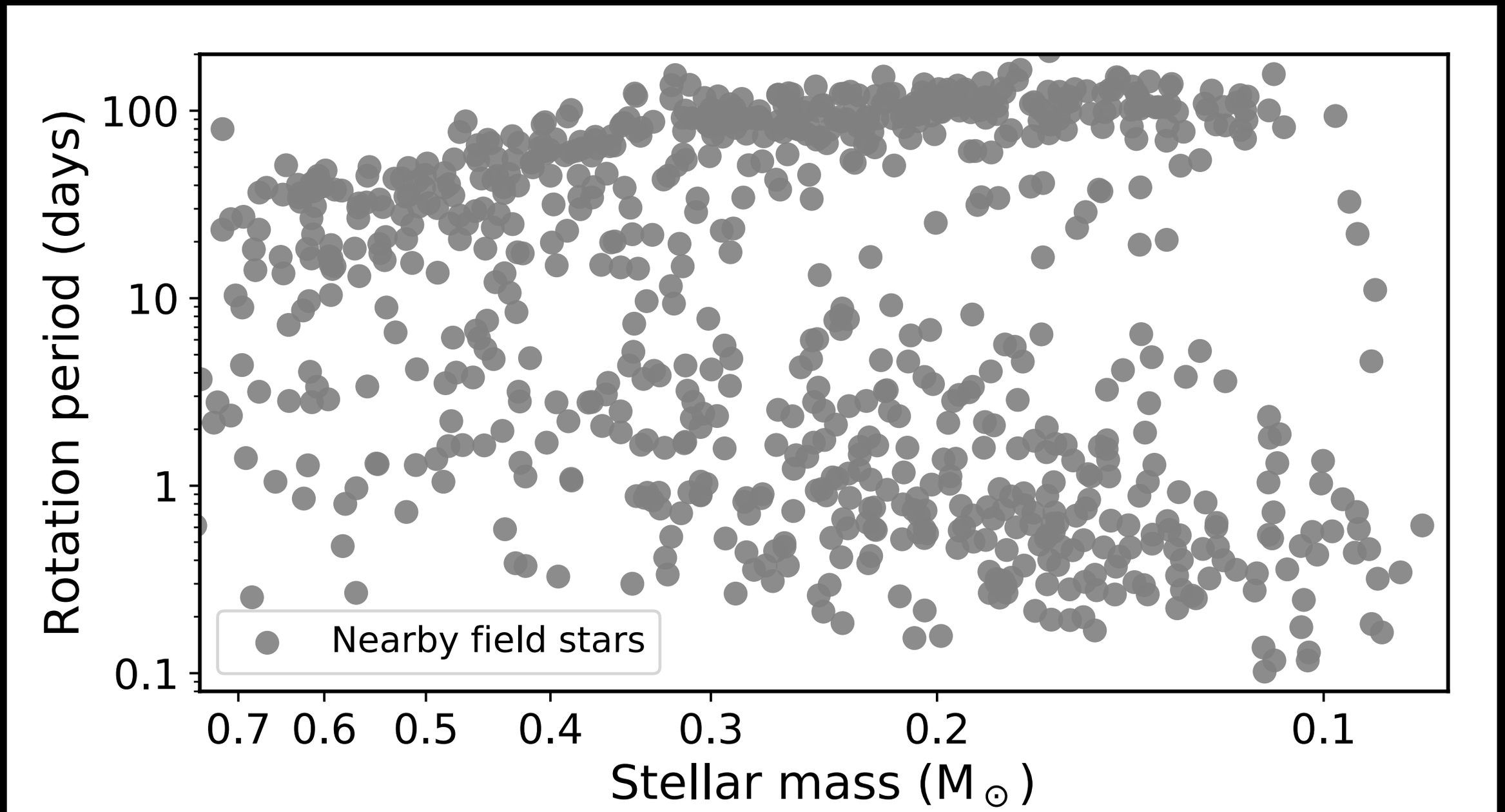
There is a gap in the rotation (and activity) distributions



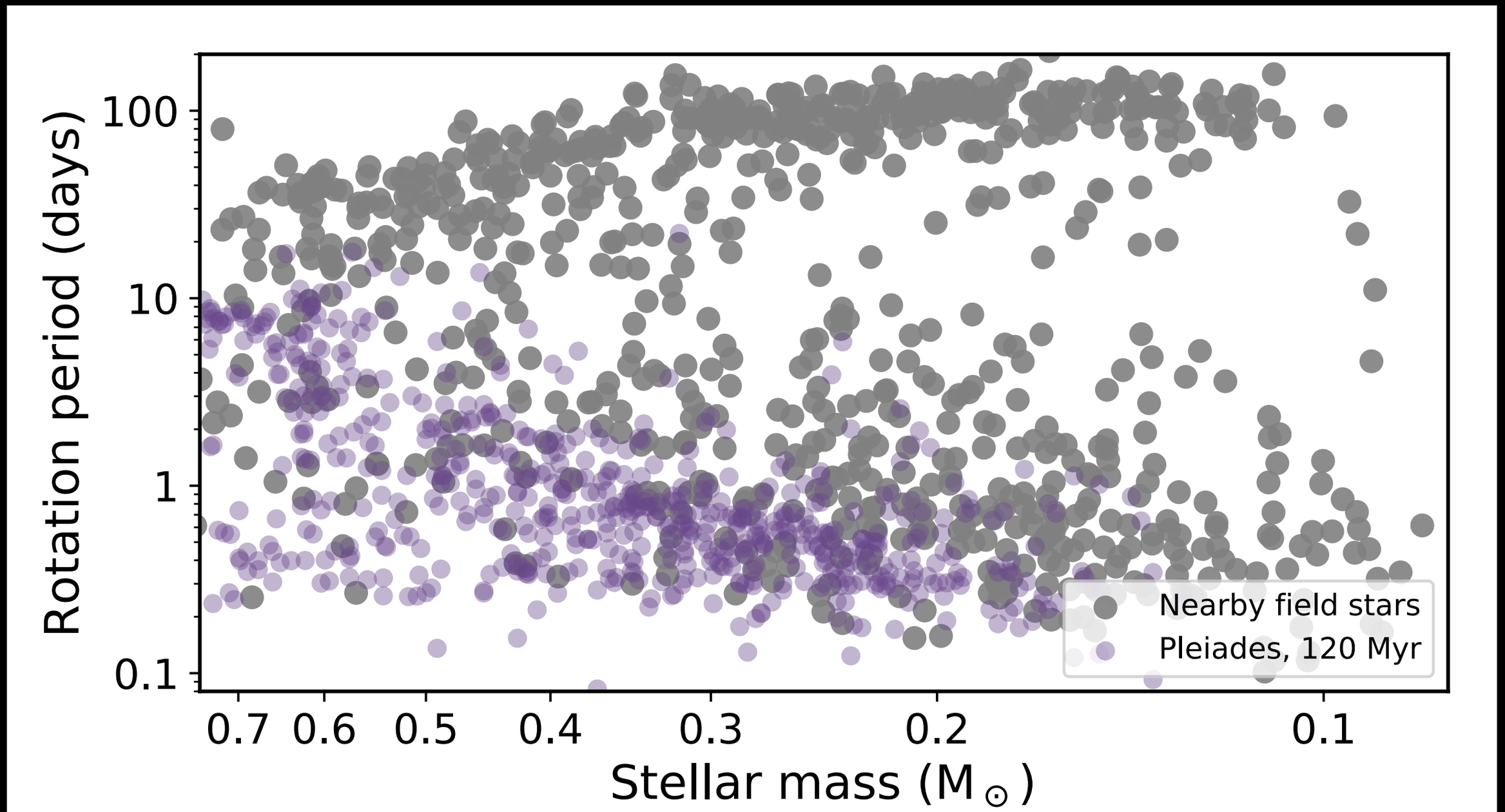


Early — Mid — Late

Placing field stars in context

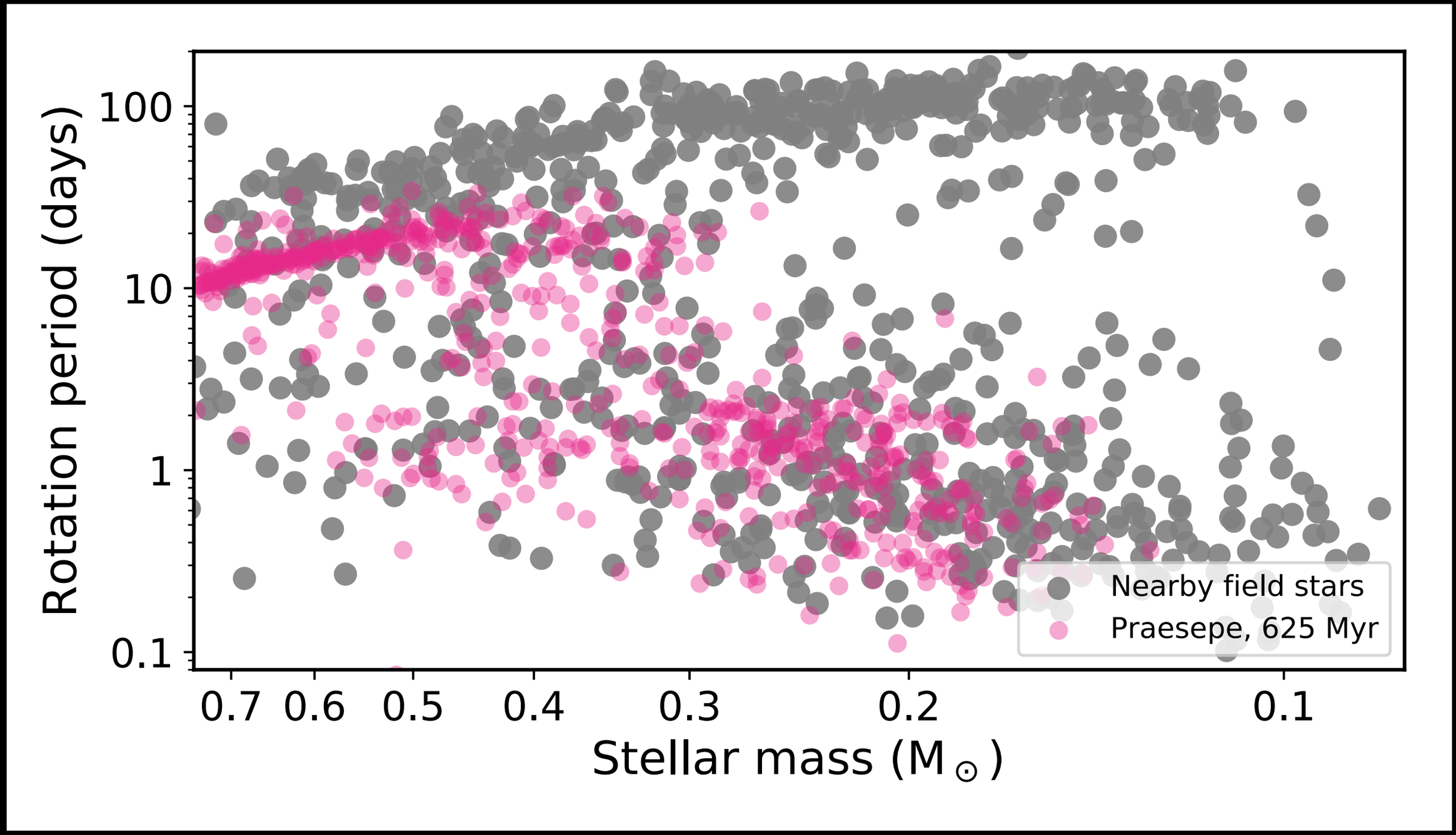


Placing field stars in context



Pleiades, 125 Myr; Rebull et al. (2016)

The M dwarf rotation gap is the same as the cluster gap.



More on M dwarf angular momentum evolution:

See talk by Cecilia Garaffo later today

In this talk:

Background

Measuring stellar rotation

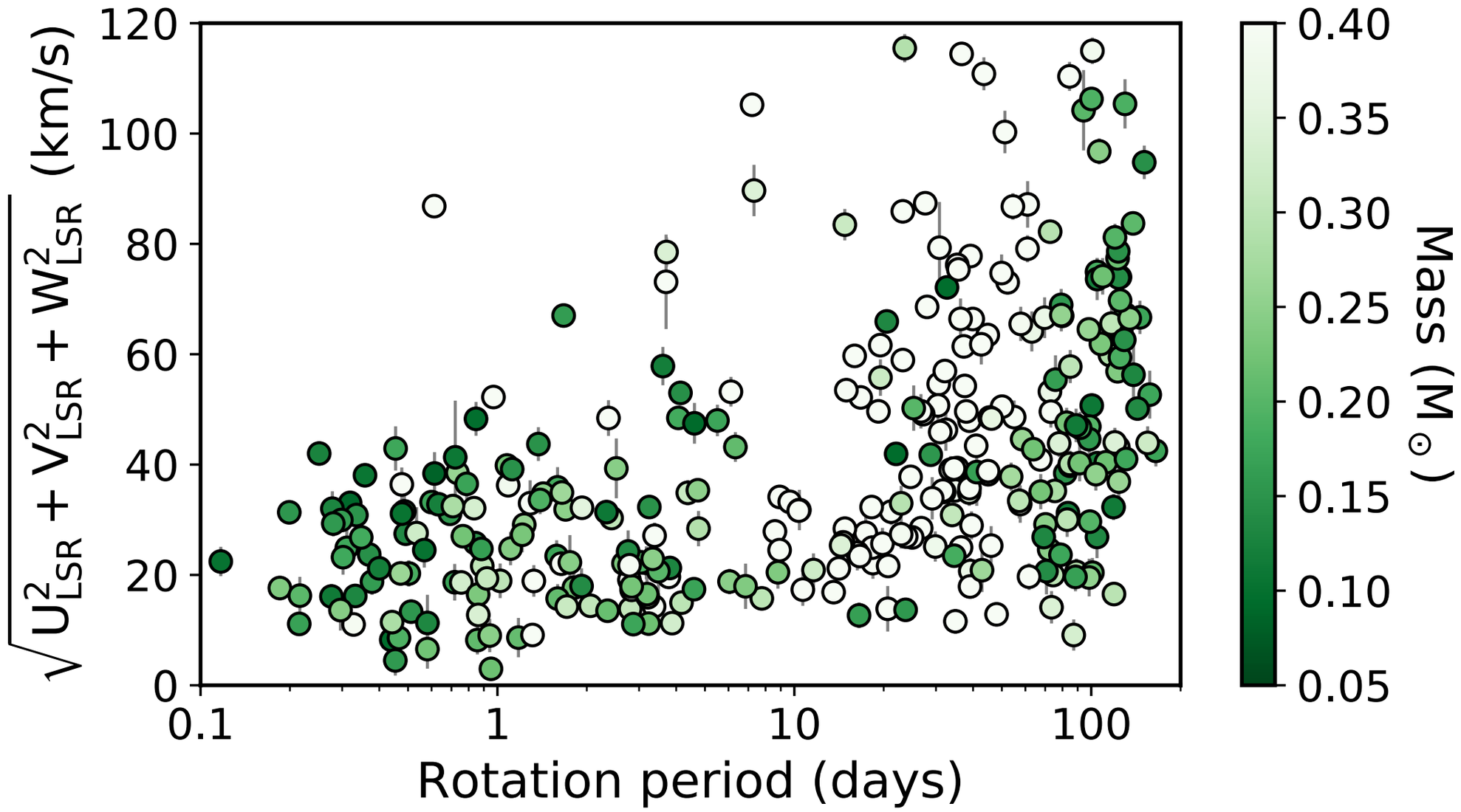
The rotation-activity relationship

The gap in the rotation period distribution

The spin-down timescale

Impact on planet detection

The spin-down timescale

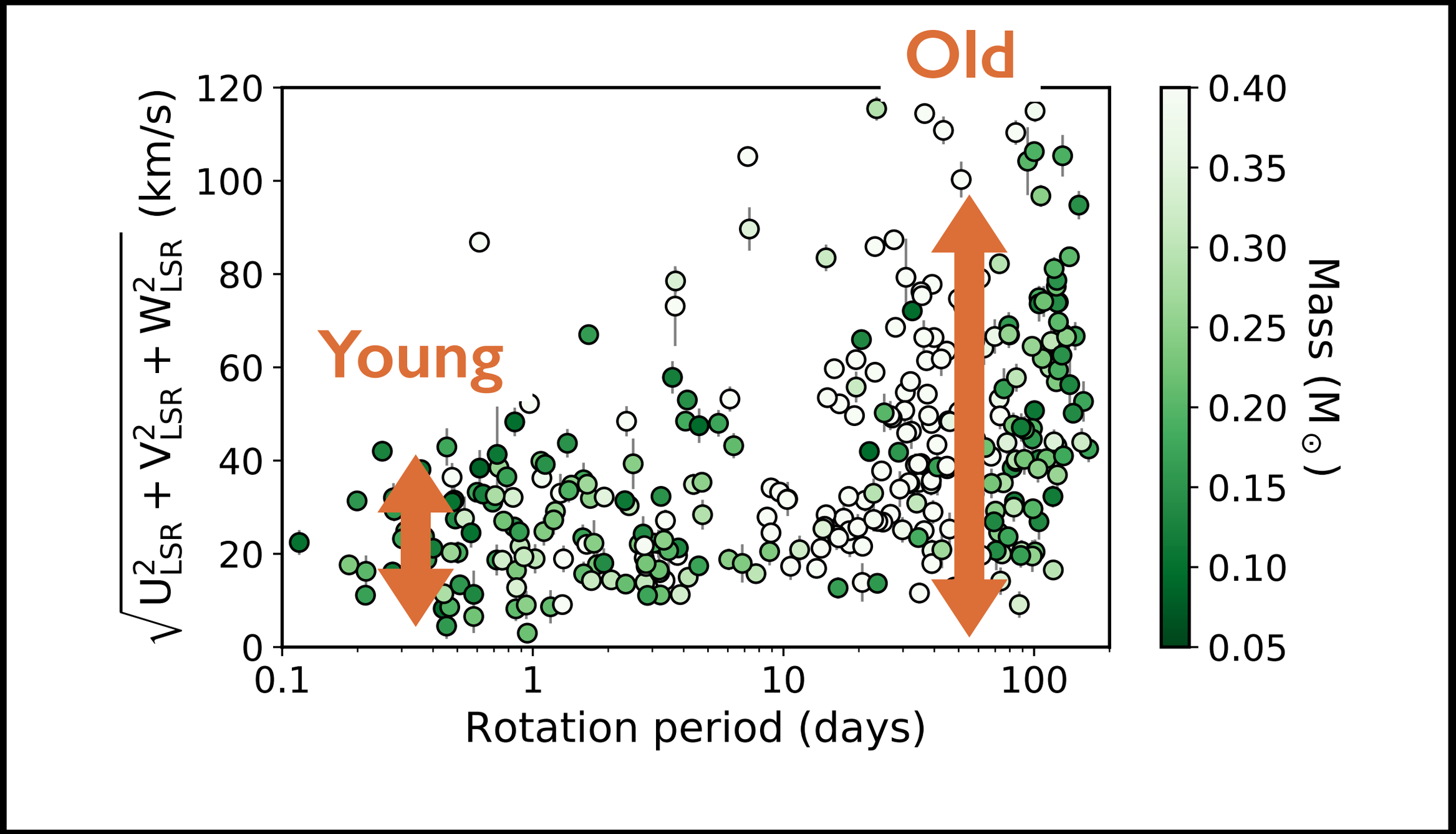


ERN et al. (2016a)

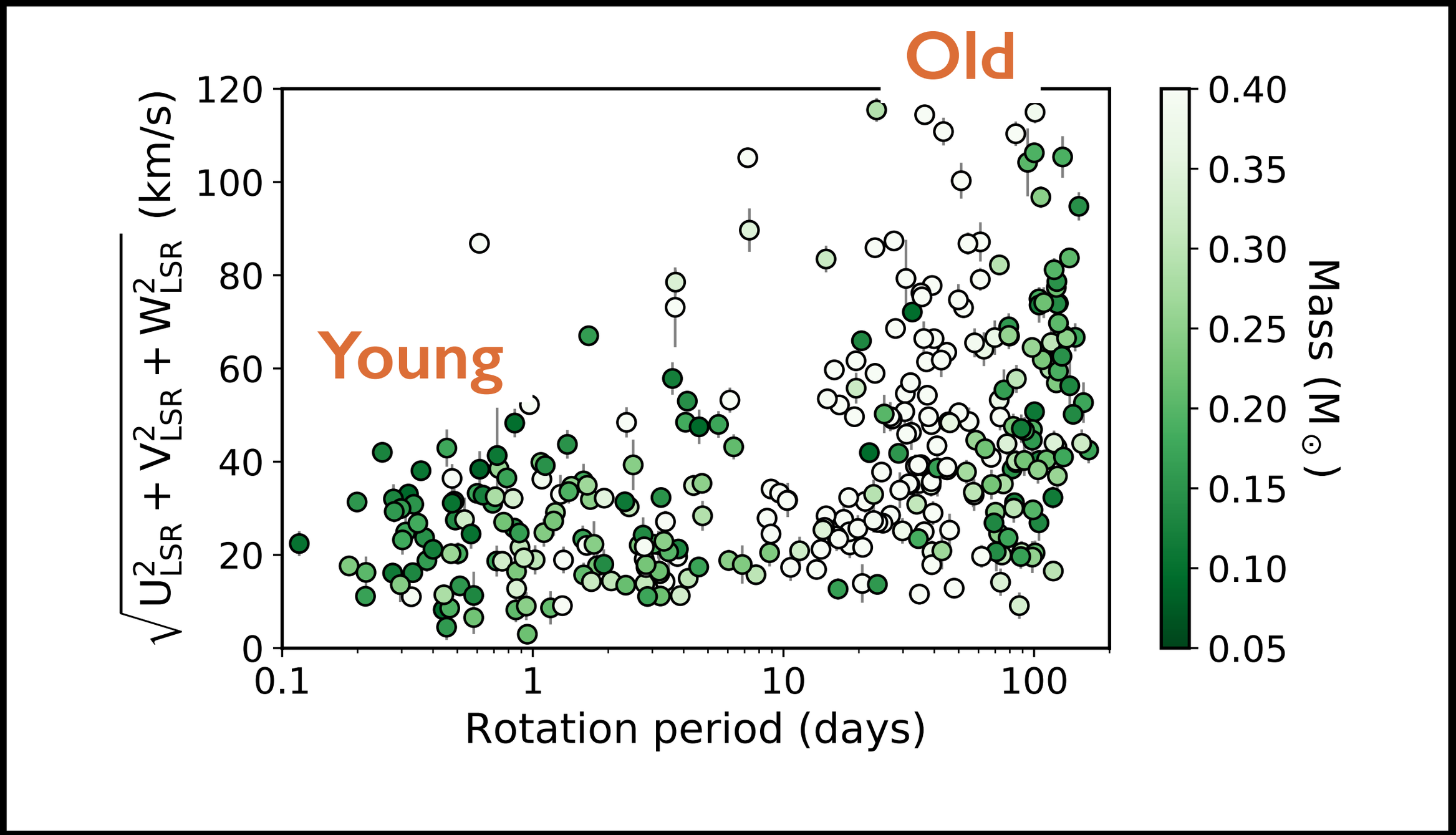
Gaia only helps some because kinematics requires radial velocities:

See poster by Jen Winters

The spin-down timescale



Rapid spin-down occurs around 2 Gyr (with large errors)



Galactic dynamics are great:
See talk by Ruth Angus

In this talk:

Background

Measuring stellar rotation

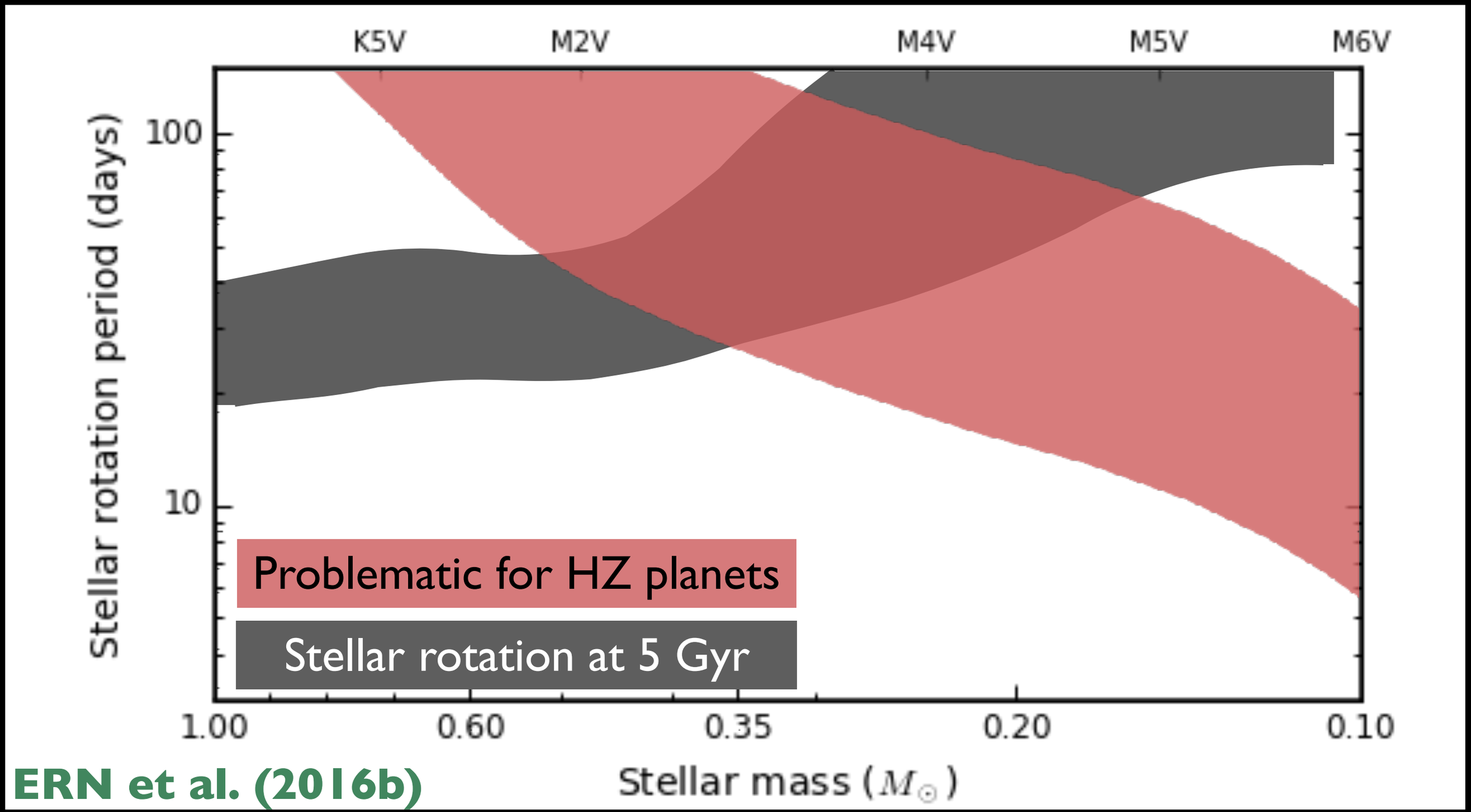
The rotation-activity relationship

The gap in the rotation period distribution

The spin-down timescale

Impact on planet detection

Stellar rotation & habitable planets



ERN et al. (2016b)

In this talk:

Background

Measuring stellar rotation

The rotation-activity relationship

The gap in the rotation period distribution

The spin-down timescale

Impact on planet detection

In this talk:

Stellar mass matters

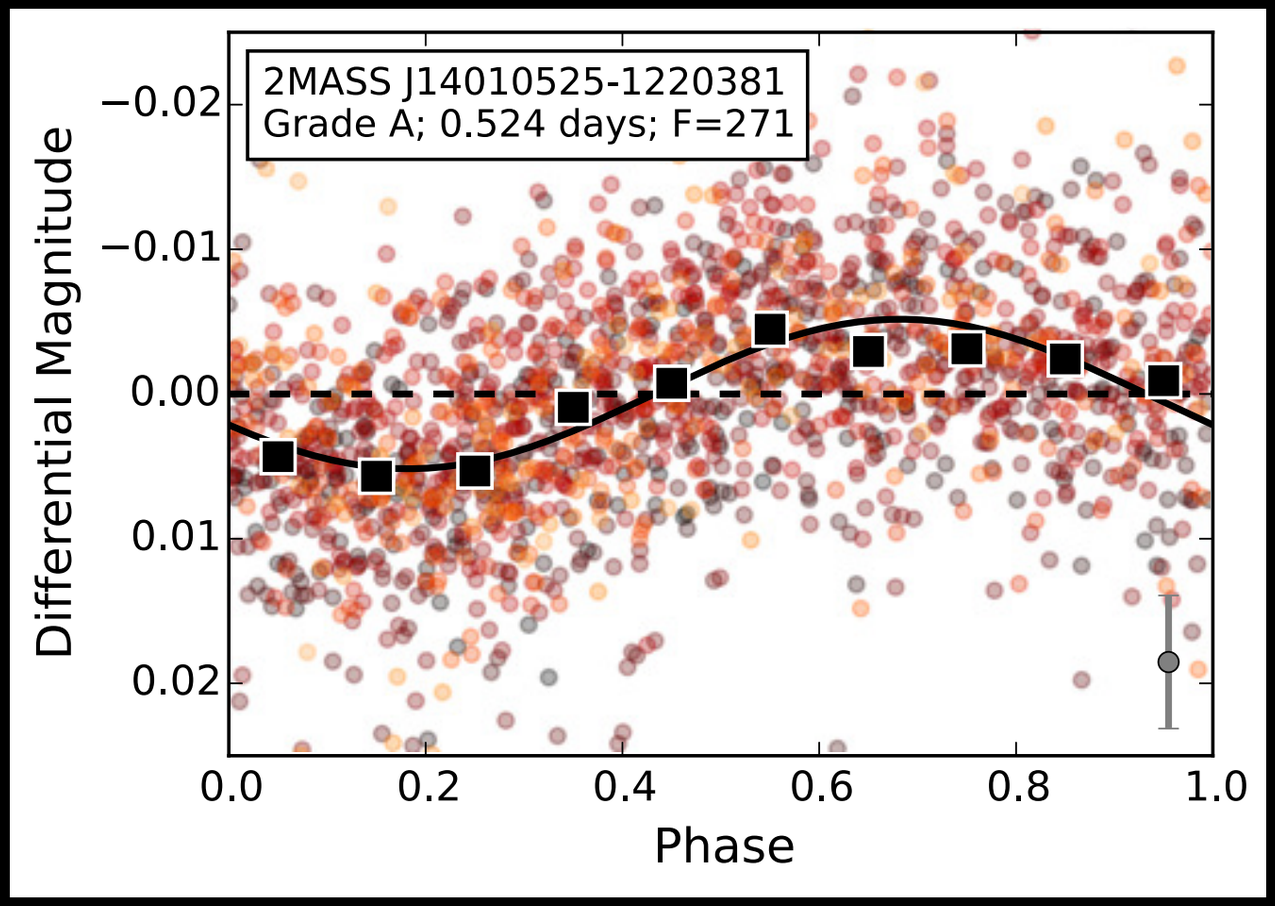
Ground-based data is great

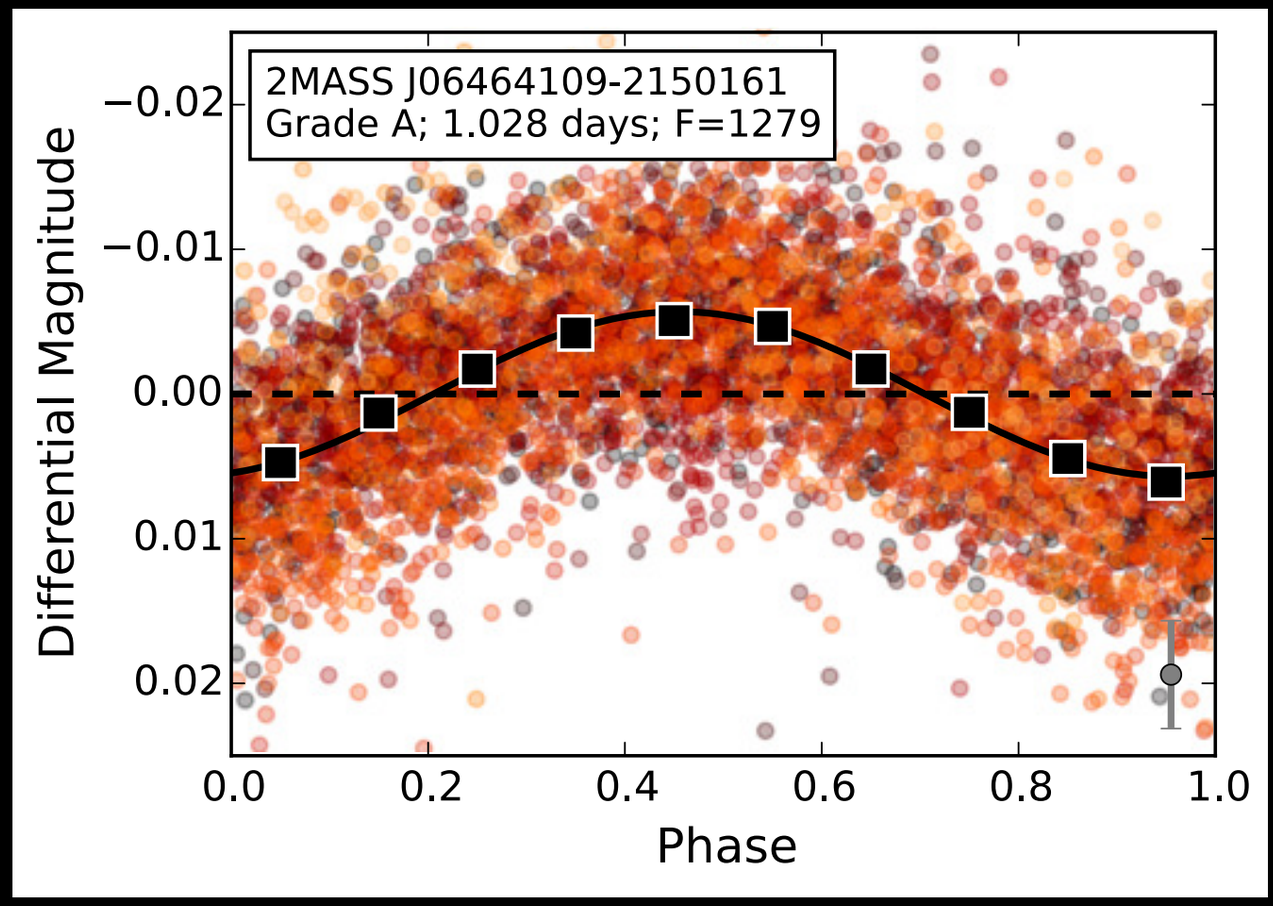
Shape and scatter of rotation-activity relation

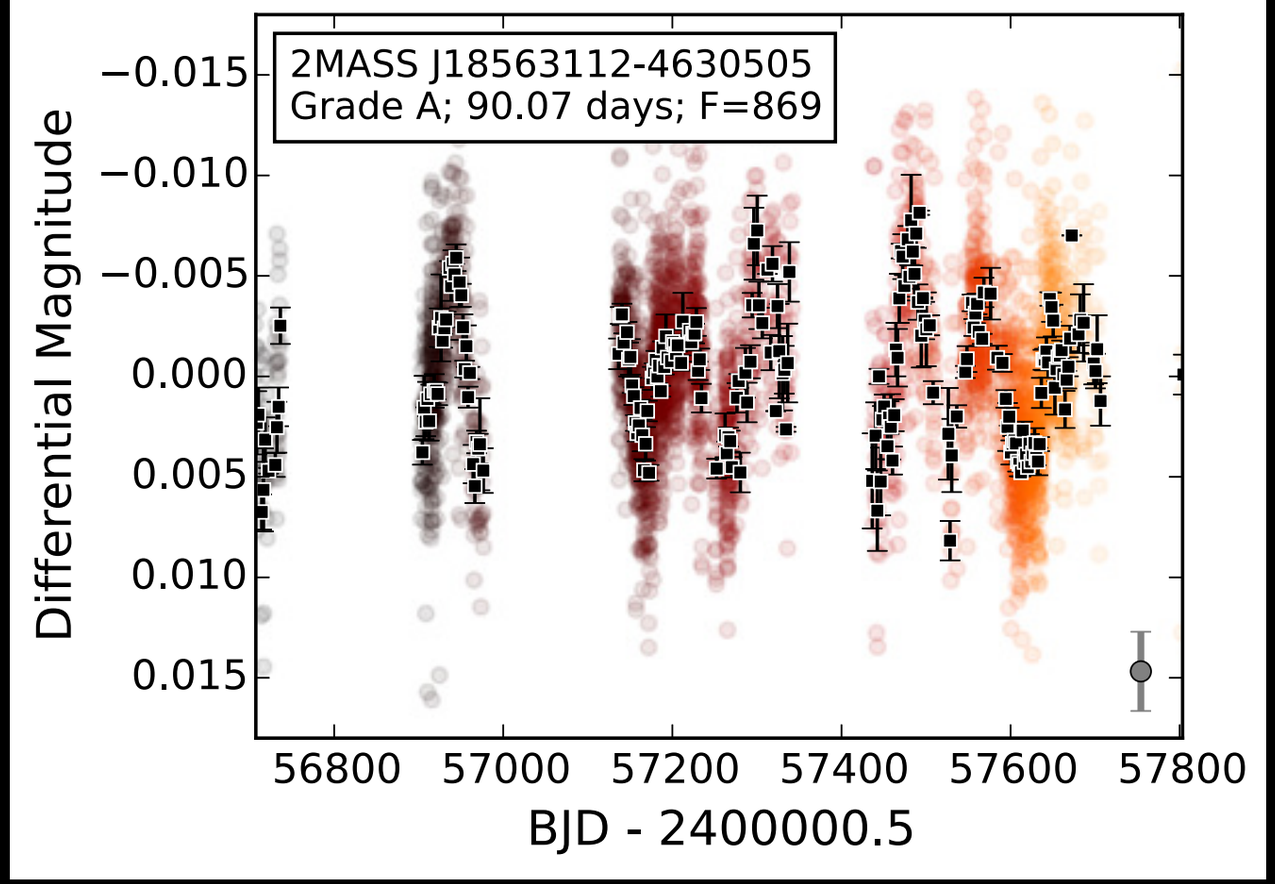
The period gap is akin to what's seen in clusters

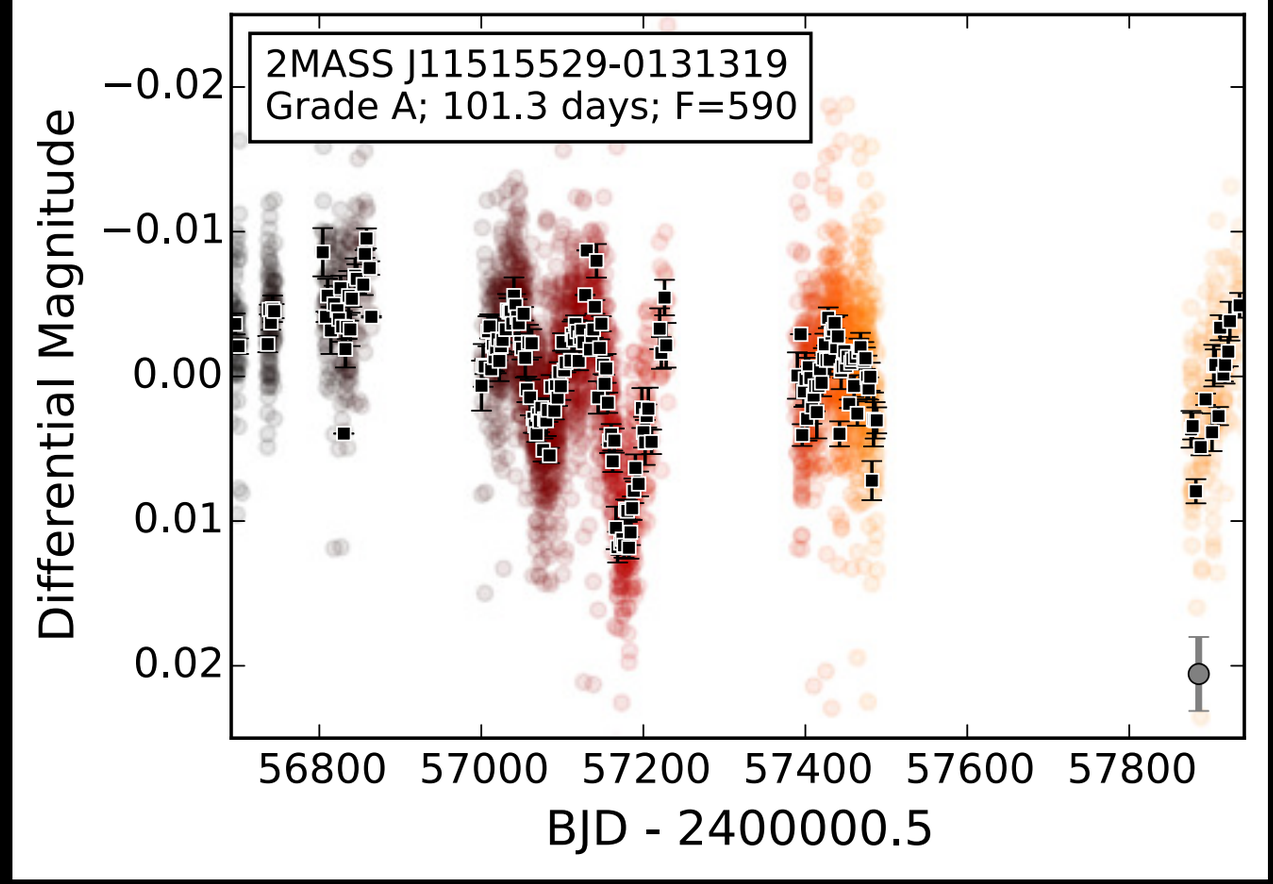
…but it takes M dwafs a few Gyr to spin down

HZ planet are hard for early-to-mid M dwarfs


2MASS J14010525-1220381
Grade A; 0.524 days; F=271
Differential Magnitude
−0.02
−0.01
0.00
0.01
0.02
0.0
0.2
0.4
0.6
0.8
1.0
Phase


2MASS J06464109-2150161
Grade A; 1.028 days; F=1279
Differential Magnitude
−0.02
−0.01
0.00
0.01
0.02
0.0
0.2
0.4
0.6
0.8
1.0
Phase


2MASS J18563112-4630505
Grade A; 90.07 days; F=869
Differential Magnitude
−0.015
−0.010
−0.005
0.000
0.005
0.010
0.015
56800
57000
57200
57400
57600
57800
BJD - 2400000.5


2MASS J11515529-0131319
Grade A; 101.3 days; F=590
Differential Magnitude
−0.02
−0.01
0.00
0.01
0.02
56800
57000
57200
57400
57600
57800
BJD - 2400000.5

The period-amplitude relation