Combining TESS asteroseismology & LBT spectropolarimetry of ρ CrB
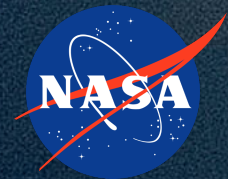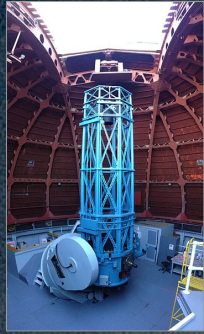
Travis Metcalfe
(SSI → WDRC)

Collaborators: Jennifer van Saders, Sarbani Basu, Derek Buzasi, Jeremy Drake, Ricky Egeland, Daniel Huber, Steven Saar, Keivan Stassun, Warrick Ball, Tiago Campante, Adam Finley, Oleg Kochukhov, Savita Mathur, Timo Reinhold, Victor See, Sallie Baliunas, Willie Soon

Wind Braking Torque $(B_d, B_q, B_o, \dot{M}, P_{rot}, M, R)$
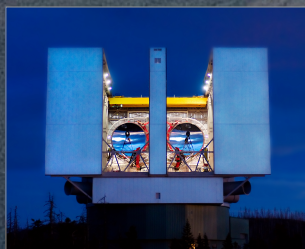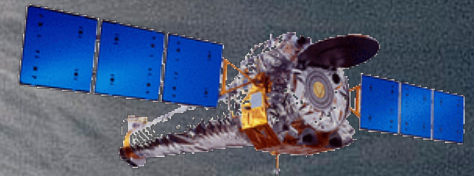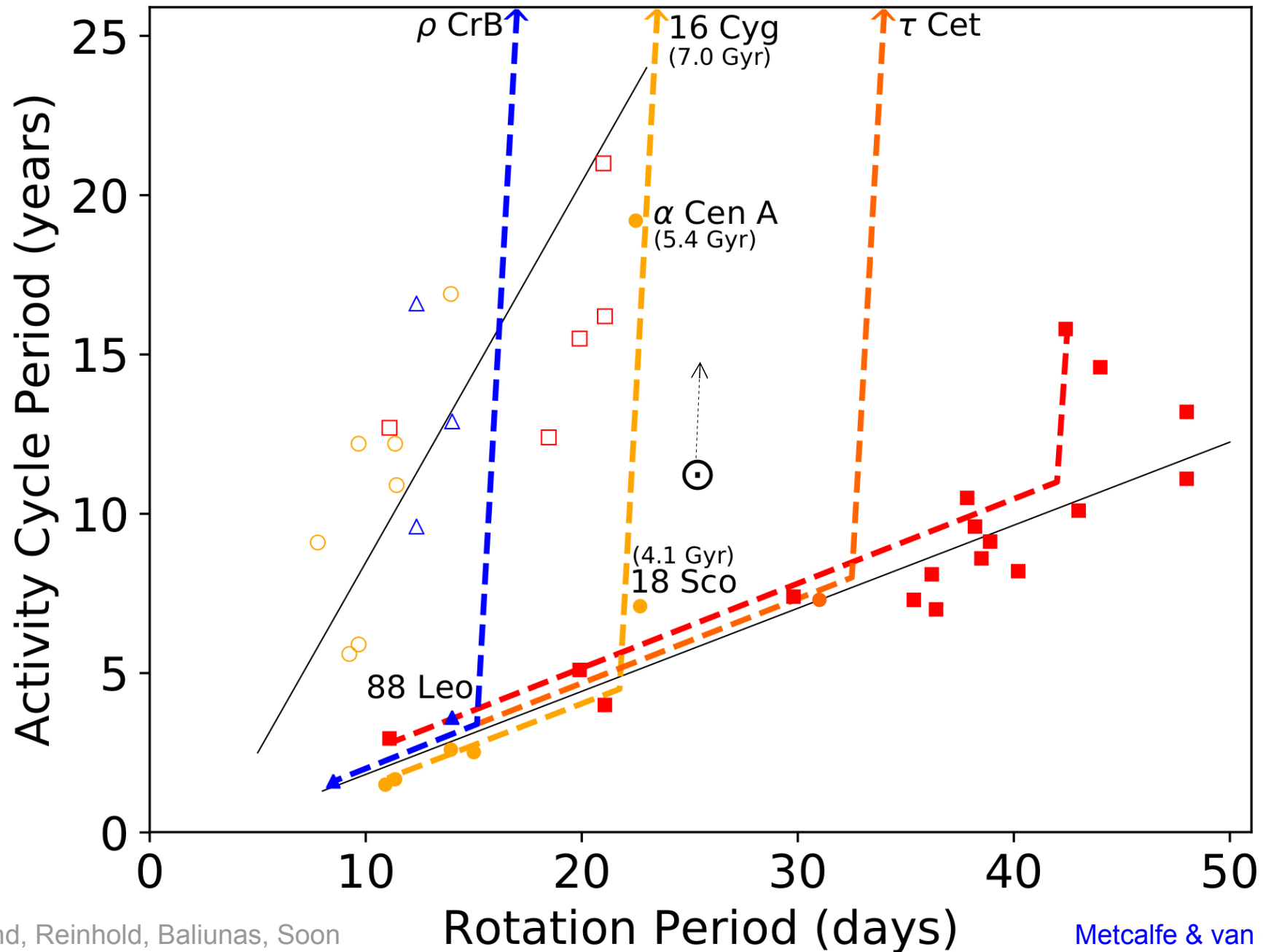
MWO HK data

P_{rot}, R'_{HK}

Chandra x-ray flux

$F_X \rightarrow \dot{M}$

TESS asteroseismology

M, R, age

LBT spectropolarimetry

B_d, B_q, B_o

@travis_metcalfe

MWO: stellar activity and rotation

Metcalfe & van Saders (2017)
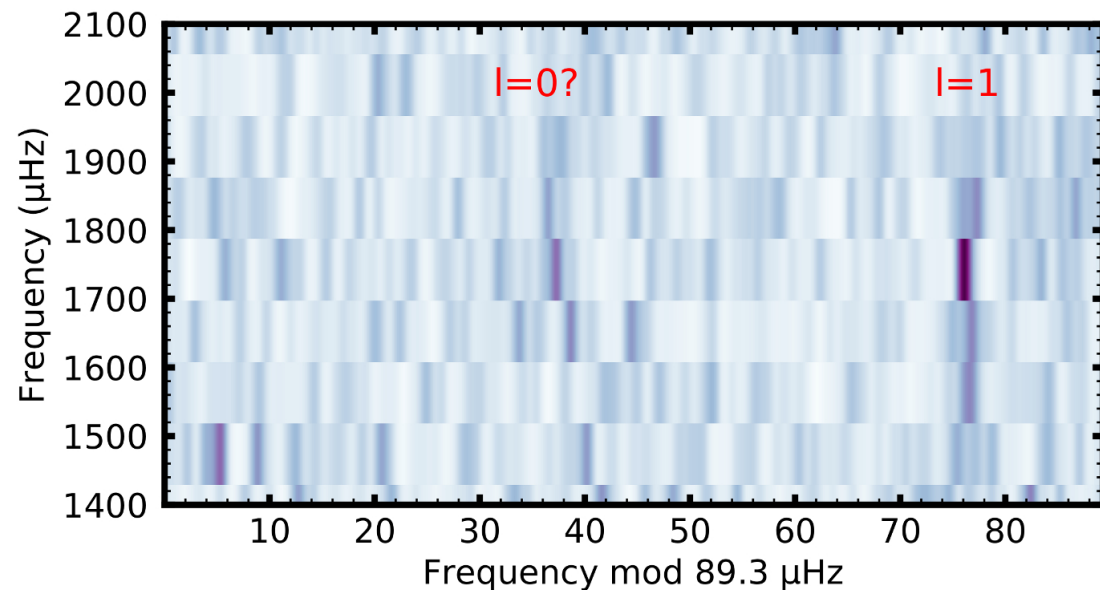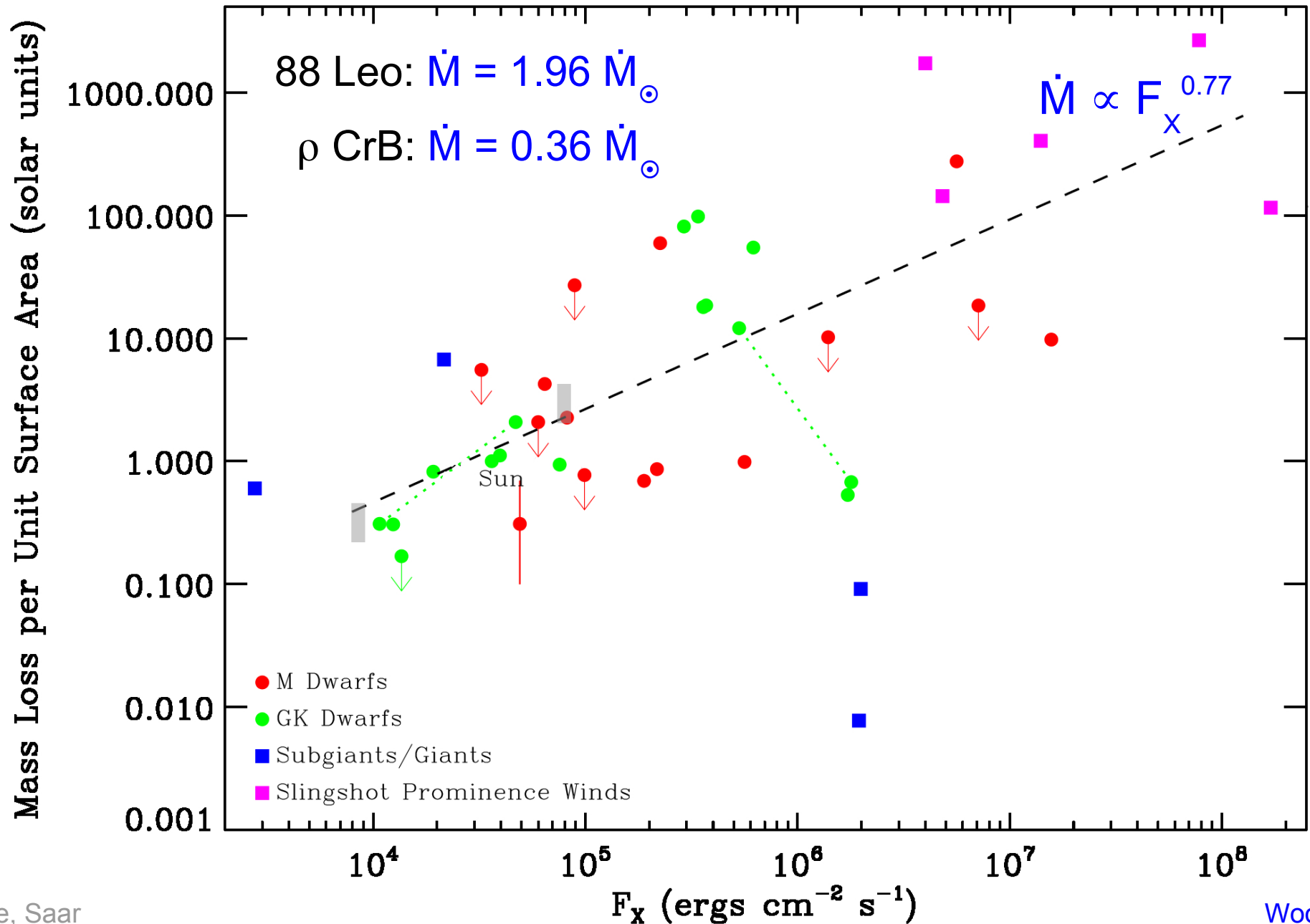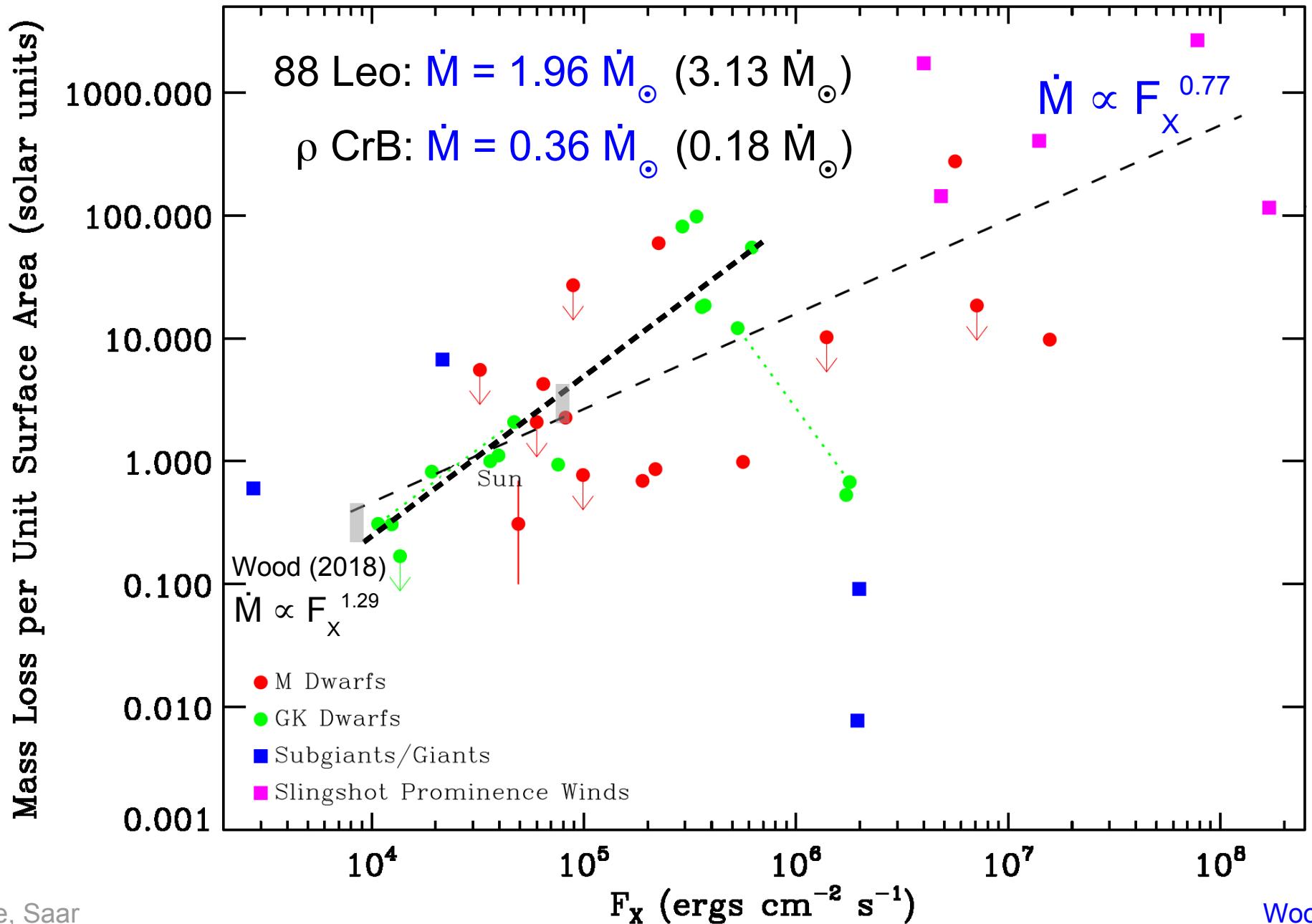
TESS: asteroseismic properties
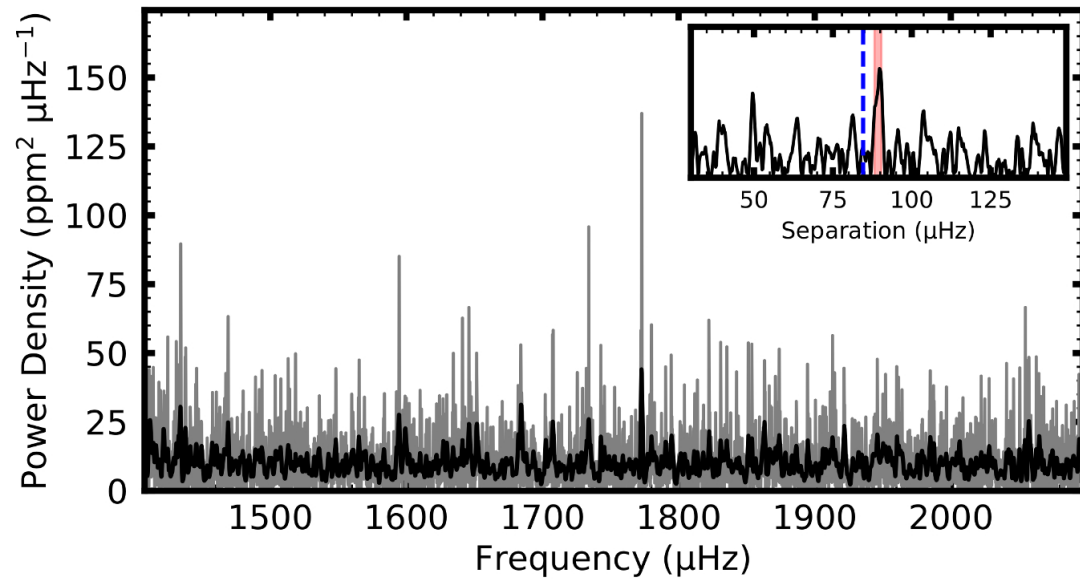
- TESS data from S24-S25: low S/N detection of solar-like oscillations in ρ CrB

- Grid-based modeling gives: R=1.304±0.012 R$_\odot$, M=0.96 ±0.02 M$_\odot$, age=9.8±0.6 Gyr

- Null detection for 88 Leo, so estimate R and M from SED, age from rotation

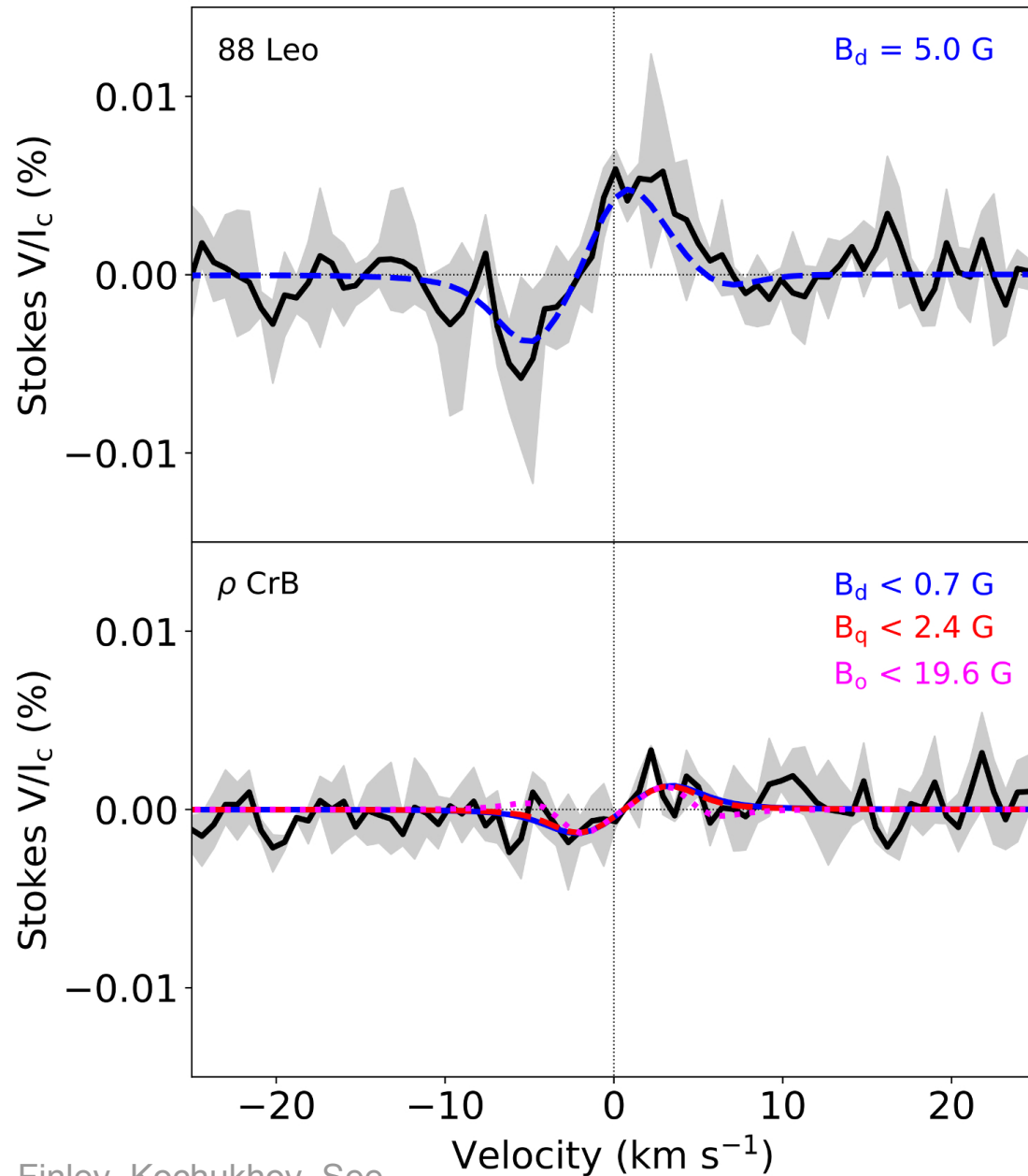Basu, Buzasi, Huber, Stassun, Ball, Campante, Mathur

Chandra: mass-loss rate

Chandra: mass-loss rate

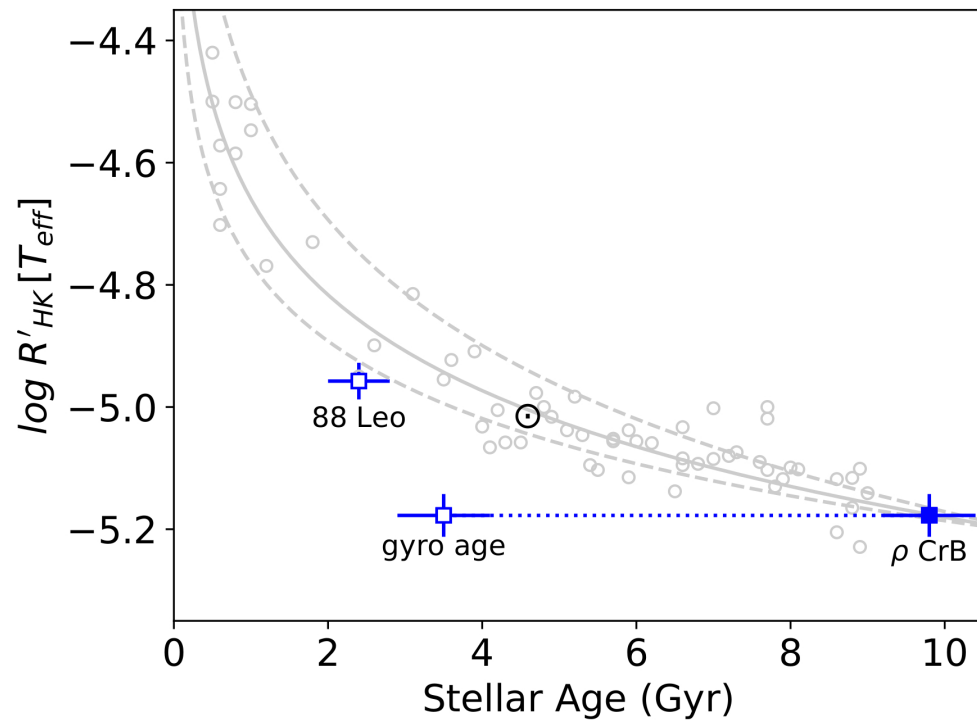# LBT: magnetic morphology

- 88 Leo: detection of large-scale field, dominated by a dipole with strength ~5.0 G

- ρ CrB: relative activity level is 64%, but upper limit on dipole field strength is $B_d < 0.7$ G

- Upper limits on quadrupole and octupole fields are larger from geometric cancellation

Finley, Kochukhov, See

Metcalfe+(2019)

RESULTS: weakened magnetic braking
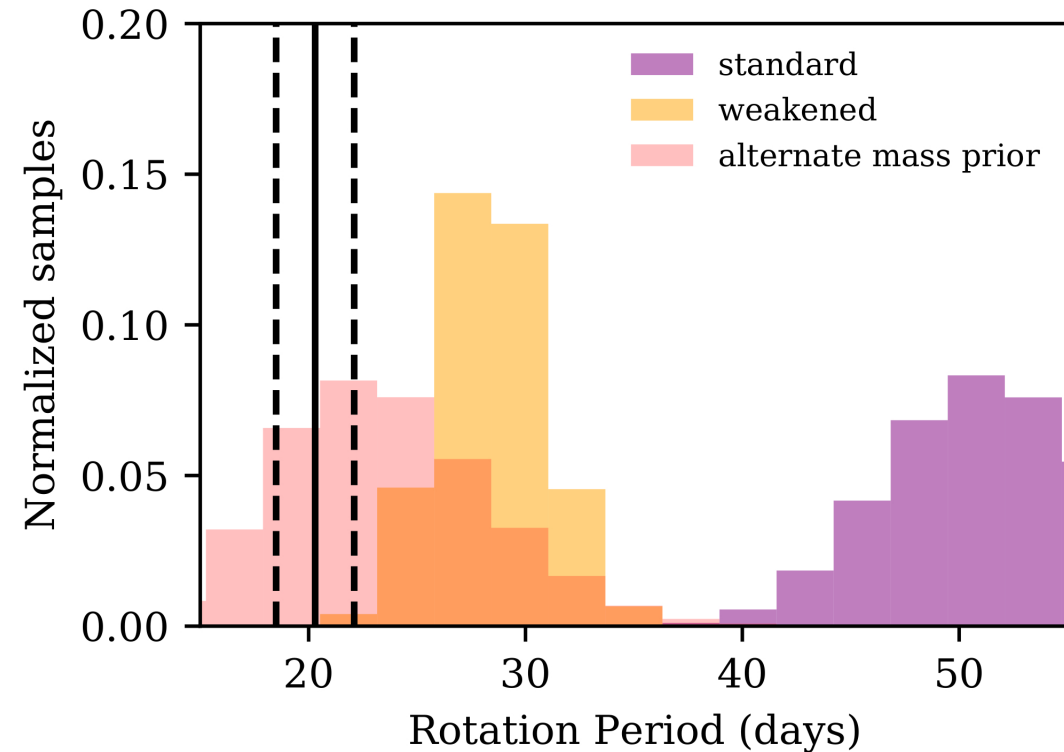
- Asteroseismic age of ρ CrB is consistent with activity-age relation

- Weakened braking models required to match the rotation of ρ CrB

- **Wind braking torque for ρ CrB is < 8% of torque for 88 Leo**

Summary of conclusions

- Asteroseismic age of ρ CrB agrees with the expected evolution of its mean activity level (gyro age does not)

- Wind braking torque for ρ CrB is < 8% of the torque for 88 Leo (without a morphology shift it would be 32%)

- Standard spin-down models can match the rotation of 88 Leo, but weakened braking is required for ρ CrB

- Future tests from new LBT/PEPSI spectropolarimetry, combined with 20-sec TESS observations in Cycle 4

Read the paper at arXiv:2108.01088