MAGNETIC CYCLES AND ROTATION IN LATE TYPE STARS

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MAGNETIC ACTIVITY PRODUCES INHOMOGENEITIES IN THE STELLAR SURFACE, WHICH COMBINED WITH THE STELLAR ROTATION CAUSE SEVERAL DIFFERENT OBSERVABLE PERIODIC PHENOMENA, SUCH AS BRIGHTNESS CHANGES, DOPPLER CHANGES AND CHANGES IN THE MEASURED INTENSITY OF SEVERAL EMISSION LINES.

LONG TERM MAGNETIC ACTIVITY, SIMILAR TO THE SOLAR CYCLE, HAS BEEN OBSERVED IN MANY MAIN SEQUENCE STARS. FROM STARS WITH MASSES LARGER THAN THE SUN, TO TINY M-DWARFS SUCH AS PROXIMA, WHERE THE MECHANISM BEHIND THESE CYCLES REMAINS VIRTUALLY UNEXPLORED.

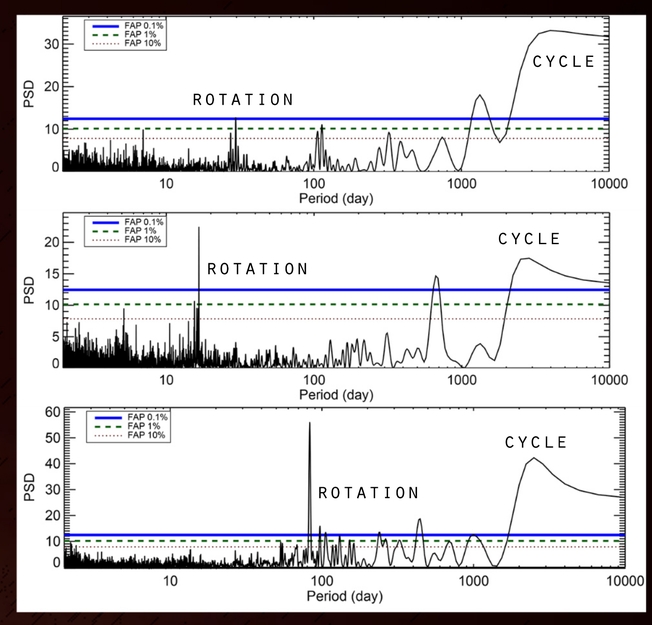
USING A COMBINATION OF HIGH RESOLUTION SCPECTROSCOPIC INDICATORS AND GROUND-BASED PHOTOMETRY, WE ARE INVESTIGATING THE VARIATIONS OF CHROMOSPHERIC ACTIVITY OF MORE THAN 3000 THOUSAND STARS. HERE WE PRESENT SOME PRELIMINARY RESULTS, ON A SAMPLE OF ~300 STARS THAT ALREADY ILLUSTRATES THE BEHAVIOUR OF THE SAMPLE.

GLS PERIODOGRAM OF SELECTED EXAMPLES

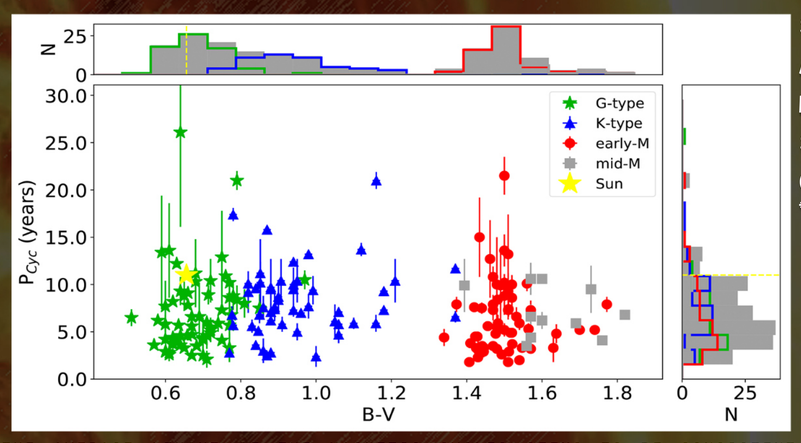
HD 2071 - G-TYPE
ROT - 24 DAYS
CYC - 11 YEARS

HD 224789 - K-TYPE
ROT - 17 DAYS
CYC - 7 YEARS

PROXIMA - M-DWARF
ROT - 82 DAYS
CYC - 7 YEARS



MAGNETIC CYCLES AND ROTATION

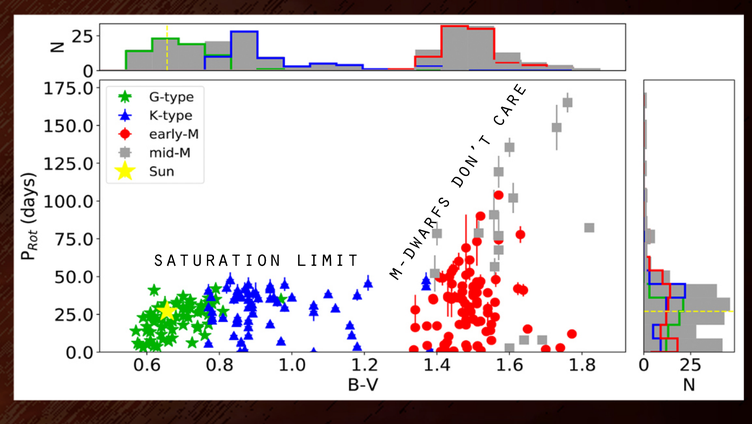


THE AVERAGE LENGHT OF THE MAGNETIC CYCLES SEEMS TO BE CONSISTENT ACROSS ALL SPECTRAL TYPES, FOR THE STARS IN OUR SAMPLE. WE MEASURE A MEAN CYCLE LENGHT OF 7 ± 4 YEARS (CONTINUATION OF SUAREZ MASCAREÑO ET AL. 2016). G- AND K-TYPE STARS SHOW A WEAK CORRELATION BETWEEN THE LENGHT OF THE CYCLE AND THE TEMPERATURE. REDDER STARS, ON AVERAGE, SHOW SLIGHTLY LONGER CYCLES.

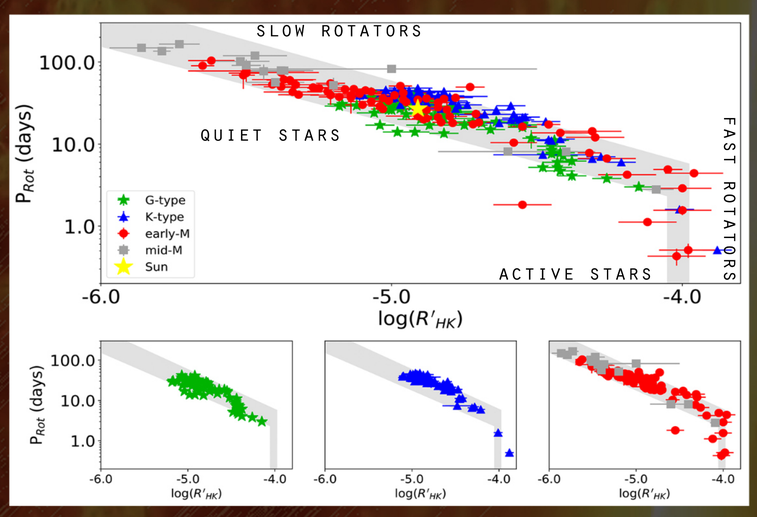
SOLAR-LIKE MAGNETIC CYCLES ARE COMMON FOR ALL SPECTRAL TYPES. MOST OF OUR MEASUREMENTS SHOW CYCLES SHORTER THAN THE SUN, PROBABLY DUE TO LIMITATIONS IN THE OBSERVATIONAL BASELINE.
*INCOMPLETE CYCLES ARE NOT YET INCLUDED.

WE ARE ABLE TO MEASURE THE ROTATION IN MOST OF THE STARS ON OUR SAMPLE, INDEPENDENTLY OF THE LEVEL OF MAGNETIC ACTIVITY. OUR PRELIMINARY RESULTS ARE CONSISTEN WITH PREVIOUS STUDIES USING BOTH GROUND-BASED AND SPACE-BASED DATA.

THE UPPER ENVELOPE OF THE ROTATION PERIOD INCREASES WITH DECREASING TEMPERATURE, SO DOES THE MEAN ROTATION PERIOD AND THE DISPERSION OF ROTATION PERIODS. K-TYPE STARS (28 ± 14 DAYS) ARE SLOWER ROTATORS THAN G-TYPE STARS (22 ± 10 DAYS), AND EARLY M-DWARFS (31 ± 22 DAYS) ARE SLOWER THAN K-DWARFS. FULLY CONVECTIVE M-DWARFS ARE THE SLOWEST (80 ± 45 DAYS).



ROTATION-ACTIVITY RELATIONSHIP



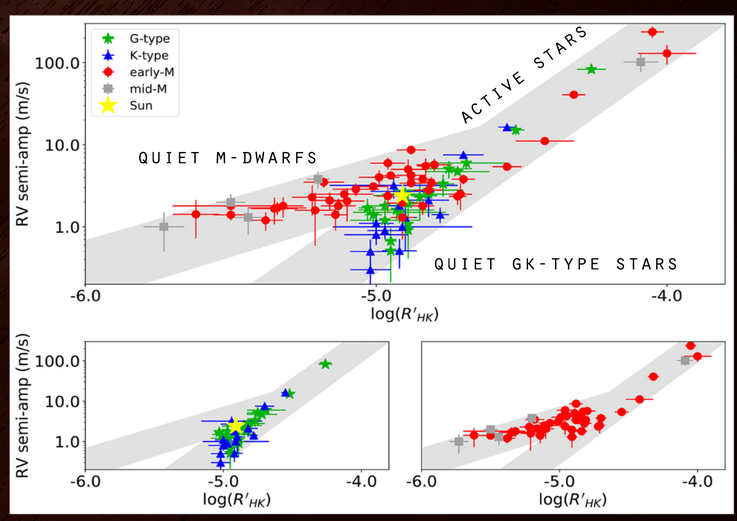
THERE IS A CLEAR CORRELATION BETWEEN THE ROTTION PERIOD AND THE MEAN LEVEL OF CHROMOSPHERIC ACTIVITY, MEASURED AS THE LOG R' HK, FOR ALL SPECTRAL TYPES (R = 0.85). CONTINUATION OF SUAREZ MASCAREÑO ET AL 2015, 2016, 2018B. MEASURING THE LOG R'HK IT IS POSSIBLE TO ESTIMATE THE ROTATION PERIOD ITH A ~20% UNCERTAINTY

ROTATION AND SOME OF THE EFFECTS RELATED TO STELLAR ROTATION ARE WELL CORRELATED WITH THE MEAN LEVEL OF CHROMOSPHERIC ACTIVITY. THE MEASUREMENT OF SAID EFFECTS CAN IMPROVE OUR UNDERSTANDING OF STELLAR SURFACES, AND IS A KEY STEP TO DISENTANGLE STELLAR SIGNALS FROM PLANETARY SIGNALS.

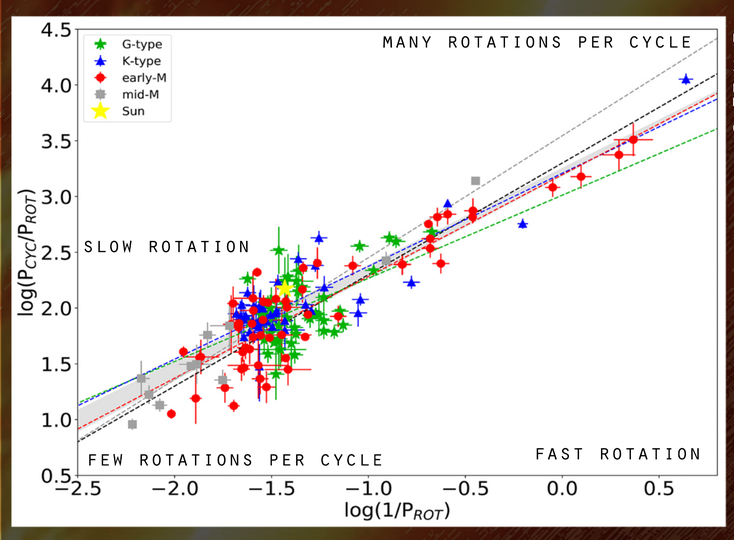
$\log_{10} P = -3.30 - 0.96 \times \log R'_{HK}$

$\log_{10} K = 12.35 + 2.48 \times \log R'_{HK}$ (GK)
$\log_{10} K = 5.70 + 1.06 \times \log R'_{HK}$ (M)

THE RV SEMI-AMPLITUDE INDUCED BY ROTATION IS ALSO WELL CORRELATED WITH THE LOG R'HK (R = 0.6 FOR ALL STARS, 0.85 FOR G- AND K-TYPE). ACTIVE STARS (LOG R'HK > -4.8) BEHAVE QUITE HOMOGENEOUSLY, BUT FOR QUIET STARS WE SEE TWO BRANCHES, ONE FOR G- AND K-TYPE STARS, AND ANOTHER ONE FOR M-DWARFS (CONTINUATION OF SUAREZ MASCAREÑO ET AL. 2017B, 2018B).



A PROXY TO THE DYNAMO MECHANISM



FULLY CONVECTIVE M-DWARFS

1-1 RELATIONSHIP: NO CORRELATION

EARLY-M DWARFS
K-TYPE

G-TYPE

CYCLE VS ROTATION CORRELATION

FULL SAMPLE:	SLOPE 0.89, R = 0.10
G-TYPE STARS:	SLOPE 0.76, R = 0.26
K-TYPE STARS:	SLOPE 0.83, R = 0.26
EARLY-M DWARFS:	SLOPE 0.93, R = 0.11
MID-M DWARFS:	SLOPE 1.20, R = -0.32

THE EXISTENCE OF A RELATIONSHIPO BETWEEN THE LENGTH OF THE MAGNETIC CYCLE AND THE ROTATION PERIOD HAS BEEN DISCUSSED FOR A LONG TIME. BALIUNAS ET AL. (1996) SUGGESTED P_{CYC}/P_{ROT} AS AN OBSERVABLE TO OBSERVE HOW BOTH QUANTITIES RELATE TO EACH OTHER. IT WAS SUGGESTED THAT THE LENGHT OF THE CYCLE SCALES AS $\sim D^{L}$, WHERE L IS THE SLOPE OF THE RELATION AND D IS THE DYNAMO NUMBER. SLOPES DIFFERENT FROM ~1 WOULD IMPLY A CORRELATION BETWEEN THE LENGHT OF THE CYCLE AND THE ROTATION PERIOD.

PREVIOUS WORKS HAVE FOUND A VARIETY OF RESULTS, SHOWING BOTH CORRELATION AND NO CORRELATION BETWEEN BOTH QUANTITIES. OUR DATA SHOWS A VERY WEAK CORRELATION FOR THE WHOLE SAMPLE (SLOPE 0.89, R = 0.1), BUT STRONGER FOR THE INDIVIDUAL SUB-SAMPLES. G-TYPE STARS SHOW THE STRONGEST POSITIVE CORRELATION (SLOPE 0.76, R = 0.26). K-TYPE STARS SHOW A SIMILAR SCENARIO (SLOPE 0.83, R = 0.25). EARLY-M DWARFS SHOW A WEAKER CORRELATION (SLOPE 0.93, R = 0.11), AND FULLY CONVECTIVE M-DWARFS SHOW A VERY DIFFERENT SITUATION, WITH A STRONGER, BUT OPPOSITTE, CORRELATION (SLOPE 1.20, R = -0.33). THIS RESULTS SUPPORT THE IDEA THAT THERE IS A COMMON DYNAMO BEHAVIOUR FOR G- AND K-TYPE STARS, WHICH DOES NOT APPLY TO M-DWARFS. FULLY CONVECTIVE M-DWARFS SHOW A COMPLETELY DIFFERENT BEHAVIOUR, IMPLYING A DIFFERENT DYNAMO MECHANISM (CONTINUATION OF SUAREZ MASCAREÑO ET AL. 2016).

WANT TO ASK/DISCUSS SOMETHING?

YOU CAN FIND ME HERE! (PROBABLY NEXT TO COFFEE)

YOU CAN EMAIL ME AT ALEJANDRO.SUAREZMASCARENO@UNIGE.CH OR ASUAREZMASCARENO@GMAIL.COM
YOU CAN FIND ME ON TWITTER @ALEXSM10000FT