Stars and their variability observed from space
C. Neiner, W. W. Weiss, D. Baade, R. E. Griffin, C. C. Lovekin, A. F. J. Moffat (eds)

MOBSTER*: SEARCH FOR PERIOD EVOLUTION IN ORION'S MAGNETIC B-TYPE STARS

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Abstract. Magnetic hot stars are expected to spin down through angular momentum loss via their magnetospheres, but the small number of magnetic early-type stars for which period change has been measured directly yields ambiguous results. We aim to utilize *TESS* data in conjunction with archived photometric and magnetic measurements to constrain period changes in a larger sample of stars.

Keywords: Stars: individual: HD 35298, HD 36526, HD 37017, rotation, magnetic field, early-type

1 Introduction

Magnetic wind confinement greatly increases the moment arm of a star, and is therefore expected to lead to angular momentum loss (Weber & Davis 1967; ud-Doula et al. 2009). Magnetic hot stars are consequently expected to be slower rotators than hot stars without magnetic fields, and this is indeed observed to be the case (e.g. Alecian et al. 2013; Shultz et al. 2018). Furthermore, the rotation periods of magnetic B-type stars increase rapidly with fractional main-sequence age (Shultz et al. 2019b). Despite this strong supporting evidence for magnetic spindown at the population level, direct measurements of period changes have so far yielded contradictory results; σ Ori E is spinning down at the expected rate (Townsend et al. 2010), HD 142990 is spinning *up* (Shultz et al. 2019a), and CU Vir and Landstreet's Star (HD 37776) are both exhibiting complex patterns of alternating spin-down and spin-up (Mikulášek et al. 2011; Mikulášek 2016; Mikulášek et al. 2017).

2 Expanding the sample

We obtained *TESS* light-curves for the Orion magnetic B-type stars HD 35298 (B5p V), HD 36526 (B5p V), and HD 37017 (B2p V). Multi-year light-curves from the Kilodegree Extremely Little Telescope (KELT; Pepper et al. 2007, 2012) are available for all the stars, as are high-quality magnetic measurements obtained by the MiMeS programs with the ESPaDOnS spectropolarimeter. We then obtained all available photometric (North 1984; van Leeuwen 2007; Mikulášek et al. 2007) and magnetic (Borra & Landstreet 1979; Bohlender et al. 1987; Yakunin 2013; Romanyuk et al. 2016; Shultz et al. 2018) data. For each star, the total dataset spans between about 30 and 45 years.

Periods were determined independently from each dataset (top panels of Fig. 1), and do not show any evidence of a systematic change with time for any of the stars. The photometric data, which are available in much greater abundance, were then used to calculate observed minus calculated ($O-C$) diagrams by shifting the model light-curve obtained from a harmonic fit to the *TESS* data in phase in order to obtain the best match of the harmonic fit to each time-binned subset of the total photometric time-series. Those are shown in the second row of Fig. 1. $O-C$ uncertainties were determined via bootstrapping, and period change rates were determined from parabolic fits to each bootstrapping iteration (third row of Fig. 1). HD 35298 and HD 36526 respectively show very slight evidence of period decrease and period increase, albeit much slower than in previously reported cases of period change. The light-curve of HD 37017's is consistent with no change in period.

The bottom rows of Fig. 1 show the phase-binned photometric and longitudinal magnetic field $\langle B_z \rangle$ measurements, folded with constant periods determined via minimizing the slopes of the $O-C$ diagrams. In all three cases the photometric and magnetic variations can plausibly be phased with a constant period.

*Magnetic OB[A] Stars with TESS: probing their Evolutionary and Rotational properties; David-Uraz et al. (2019); see also David-Uraz et al., these proceedings.

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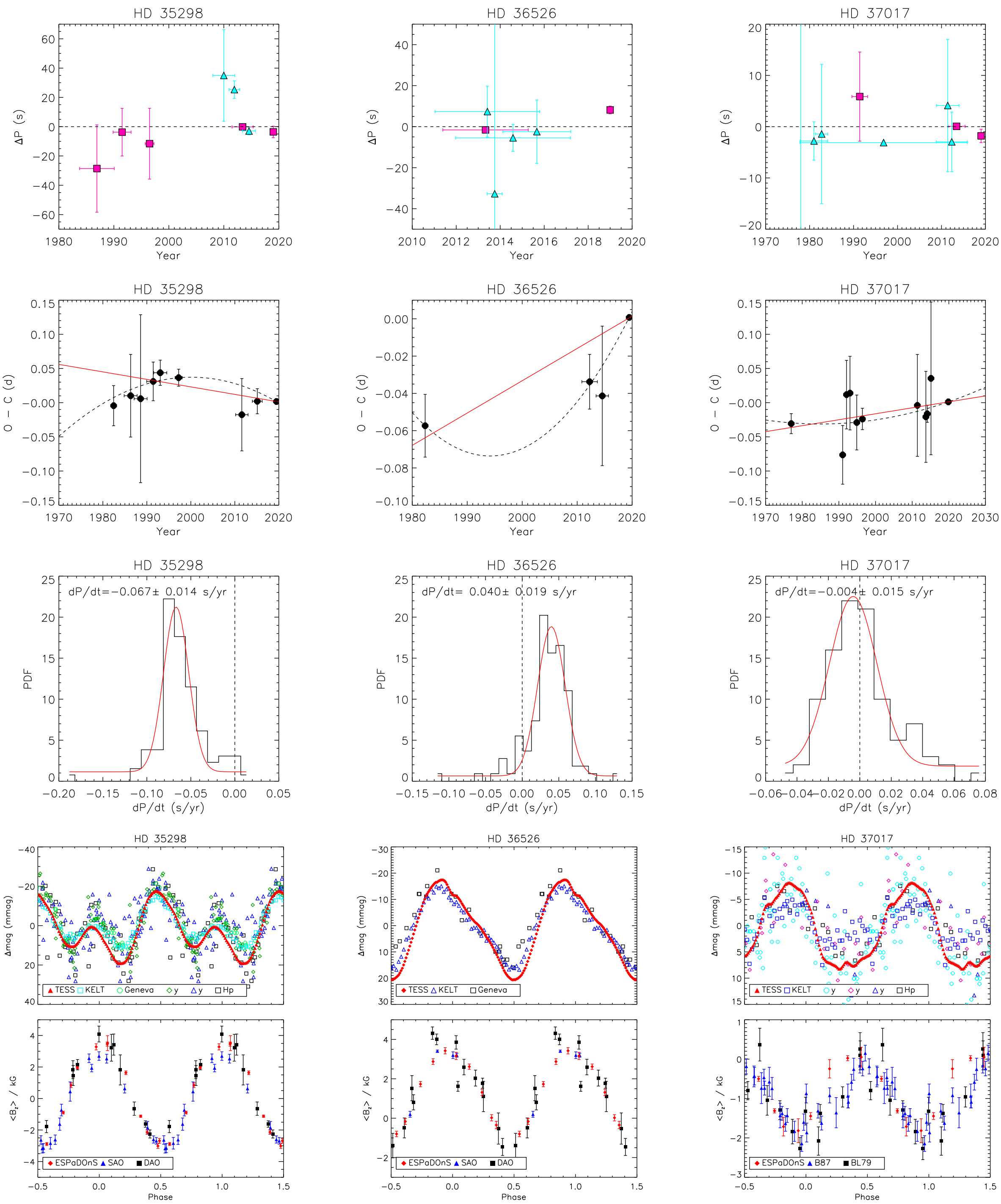

Fig. 1. *Top*: Periods as a function of time. Periods from magnetic data as blue triangles; photometric data as magenta squares. *Second row*: Photometric $O-C$ diagrams with parabolic and linear fits. *Third row*: $\dot{P}$ determined from parabolic fits to bootstrapped $O-C$ iterations. Dashed lines indicate $\dot{P}=0$. *Bottom rows*: phase-binned photometric and magnetic data folded with the best (constant) periods determined via $O-C$ minimization.

3 Conclusions

While there is some evidence of period change in the $O-C$ diagrams of HD 35298 and HD 36526, the photometric and magnetic time-series of all three stars can be phased with constant periods. There is therefore no strong evidence of period change over the past 4 decades in any of these three stars.

MES acknowledges financial support from the Annie Jump Cannon Fellowship, supported by the University of Delaware and endowed by the Mount Cuba Astronomical Observatory. ADU acknowledges financial support from the Natural Sciences and Engineering Research Council of Canada (NSERC). ZM was supported by GAR grant 18-05665S.

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