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Magnetic Activity of Two Similar Subgiants in Binaries with Very Different Mass Ratios: EI Eri and V711 Tau

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Abstract. We use more than three decades-long photometry to study the activity patterns on the two fast-rotating subgiant components in EI Eri (G5IV) and V711 Tau (K1IV). From yearly mean rotational periods from the light curves, we find that EI Eri, with well-measured solar-type differential rotation, always has spots from the equator to high latitudes. The measured differential rotation of V711 Tau is controversial, and in any case is very small. The spots on the K1IV star in V711 Tau seem to be tidally locked. The physical parameters of the two systems are similar, with one remarkable difference: EI Eri has a low mass M4-5 dwarf companion, whereas V711 Tau has a G5V star in the system, thus their mass centers are in very different positions. This may modify the whole internal structure of the active stars, causing marked differences in their surface features.

Keywords. stars: activity, stars: imaging, stars: individual (EI Eri, V711 Tau), stars: spots, stars: late-type

1. Introduction

Magnetic activity on stars under the influence of a close binary companion is an important but not well-studied topic. For decades, it has been known that the measure of activity is closely related to the parameters of the companion star and the orbit of the binary. Yet, apart from some statistical analysis of the strength of activity in different binaries (e.g., Schrijver & Zwaan 1991) and a first attempt of modelling the behaviour of magnetic flux tubes in the gravitational field of a companion star in a binary for a simplified case (Holzwarth & Schüssler 2003a, Holzwarth & Schüssler 2003b), not much have been done in this interesting field. It is thought as well, that the strength and even the orientation of the differential rotation is modified by the binary companions. Surface patterns of active stars could best be depicted through Doppler Imaging. Unfortunately, the available Doppler maps are too few, both for a time-sequence of a star and for the number of stars, due to the known restrictions such as brightness, inclination and rotational velocity of the objects. On the other hand, much less restricted long-term photometric monitoring of active stars is carried out for decades (cf. Strassmeier *et al.* 1997), and those datasets, apart from the long-term, cyclic changes, contain information on the rotational behaviour of the spotted stars. In this work, we analyse two similar, post-main sequence subgiants, which have companions of very different masses, consequently, the mass centers are in different positions. The results are verified through existing Doppler images.

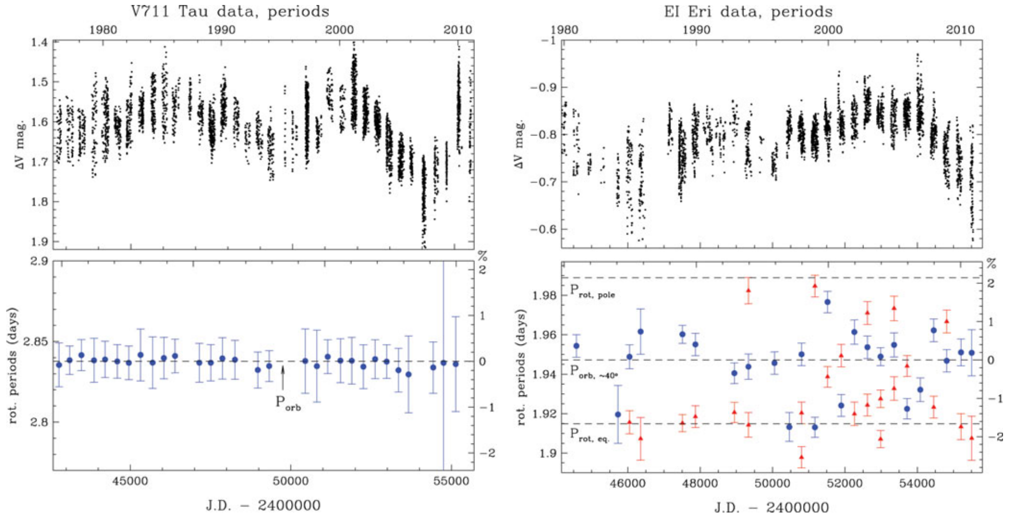

Figure 1. Observed data and yearly period values for EI Eri (left, blue dots: periods with the highest amplitude, red triangles: additional periods) and V711 Tau (right). The y-scale on the right sides show the difference between the rotational and orbital periods, in percents. See text.

2. Basic stellar and orbital parameters, and results

EI Eri: sp. types G5IV+dM4-5, $T_{\rm eff}$ ≈5500K, masses: 1.09/0.25 $M_\odot$, radii: 2.37/0.3 $R_\odot$, $v$sin$i$=51 km/s, $i \approx 56^o$, $P_{\rm orb}$=1.947232 days, $a = 5.0 \times 10^6$km, (Washüttl *et al.* 2009), and V711 Tau: sp. types K1IV+G5V, $T_{\rm eff}$ ≈4750/5500K, masses: 1.45/1.14 $M_\odot$, radii: 4.12/1.32 $R_\odot$, $v$sin$i$=41 km/s, $i \approx 33^o$, $P_{\rm orb}$=2.83774 days, $a = 8.06 \times 10^6$km (Garcia-Alvarez *et al.* 2003). Both systems are circularized and synchronized.

Observations of about three decades, plotted in Fig. 1, upper panels, show that the two active subgiants have very similar cyclic behaviour and light curve amplitudes. Yet, a marked difference appear when we plot the yearly mean rotational period(s) in Fig. 1, lower panels. The multiple yearly periods of EI Eri, reaching ±2% deviation from the orbital period. is a clear signature of a differential rotation, verified by Doppler Imaging (Kővári *et al.* 2009). V711 Tau has just one rotational period close to the orbital one each year, and its first harmonic, indicating two spotted regions opposite to each other (cf. Lanza *et al.* 2006). This difference originates very possibly from the difference between the secondaries.

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