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Lithium for CoRoT Eclipsing Binaries

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Abstract. In synchronized binary systems the lithium should be less depleted than that of its single counterparts and that of non-synchronized binary systems. By using the spectra we can recharacterize the systems through the determination of the temperature and identify the Lithium lines. The three targets present different characteristics of rotation and eccentricity. We are interested to found how the tidal force affects the rotation and the lithium depletion in close-detached eclipsing binaries. The synchronized system presented the greatest lithium value and some inconsistencies were founded in the spectral types.

Resumo. Em sistemas binários sincronizados, o lítio pode se esgotar de forma mais lenta quando comparado à estrelas simples ou sistemas binários não sincronizados com as mesmas características. Com o uso do espectro podemos recaracterizar os sistemas através da determinação da temperatura e identificar as linhas do lítio. Os três sistemas apresentam diferentes características de rotação e excentricidade. Nós estamos interessados em descobrir como a força de maré afeta a rotação e a exaustão do lítio em sistemas binários eclipsantes próximos. O sistema que se encontra sincronizado apresenta o maior valor de lítio e algumas inconsistências foram achadas no tipo espectral.

Keywords. Star: abundances – Star: Rotation – Binaries: eclipsing

1. Introduction

Binaries systems close detached can undergo tidal effects, the consequences are syncronization of the system - orbiral period synchronized with rotational period, circularization of the orbit - eccentricity equal to zero, and coplanarity - the equatorial planes of the two stars coincide with the orbital planes (e.g. Lecar et al. 1976; Zahn 1989). This situation can influence in others characteristics of the systens, as the chemical abundance. The lithium (Li) depletion is related to the loss of angular momentum and their surface abundance in synchronized binary systems should be less depleted than that of its single counterparts and that of non-synchronized binary systems.

In fact, Zahn (1994) has shown that late-type binary systems of short enough orbital period retain more of their original Li than their single counterparts. This author has found that such a period is typically below 8 days for solar-type stars of population I and below 6 days for halo stars. The same trend was found by Spite et al. (1994) for old disk and halo stars. This inhibition of lithium depletion was also observed in subgiant stars of population I (Randich et al. 1999).

To detect synchronized systems we need to identify the orbital and rotational period. While the orbital period is well exploited in the literature (as the eccentricity), the rotational period values are seldom. We use the DRUM TONES algorithm (de Almeida et al. 2018) which identify where in the complete time series (light curve) happens the greatest variations. By doing the differential of the light curve, a new time series that represents the variation of the curve is obtained. By subtracting the Model from the original light curve, we obtain a new curve that contains all original signals but the spot modulation, and by analyzing the signal without the transit signals, we can obtain the rotation.

Thanks to the Gemini Telescope we observed the spectra of the three targets with the Gemini Remote Access to CFHT ESPaDOnS Spectrograph — GRACES (Chene et al. 2014). GRACES offers an opportunity to acquire high-resolution data with star configuration only and with its great coverage (370nm to 1000 nm) we can access the spectral lines of several elements, essential for a careful accurate chemical analysis.

In this study we are presenting the spectroscopic analyses of three eclipsing binaries close-detached. We propose to analyse the effects of synchronization on the Li abundances of F, G and K types, on the basis of high precision spectroscopic observations.

2. Sample

In the figure 1 we present the three systems. The first frame shows the syncronization, the second shows the light curves where we can see, the primary and secondary eclipses, and the rotation modulation. In the third, we separeted only the rotation modulation.

CoRoT 102715978 is a system formed with a F star, subgiant, synchronized and not circularized; CoRoT 102774523 is a system with a primary star of the spectral type K, dwarf, synchronized and circularized; CoRoT 102825481 is a system with a primary star of the spectral type G type, dwarf, not sinchronized but circularized.

3. Results and conclusions

From photometry, these targets light curve give us orbital period and eccentricity well agreed with literature values. The rotational period is obtained by the DRUM TONES algorithm.

We have chosen three systems in all our samples to observe the spectra. This is only a short part of our sample but they have rotational periods well determined and it is just a start to study the lithium abundance in binary stars. Beck et al. 2017 showed the relationship between lithium and rotation for solar analogs and could quantify a linear relationship between the rotational period and the lithium abundance for rotation periods shorter than solar. do Nascimento et al. (2003) observed in subgiant stars that the fastest rotators also have the highest lithium content.

The CoRoT satellite identified 2269 EBs (Deleuil et al. 2018), by using a differential flux method, we composed our fi-

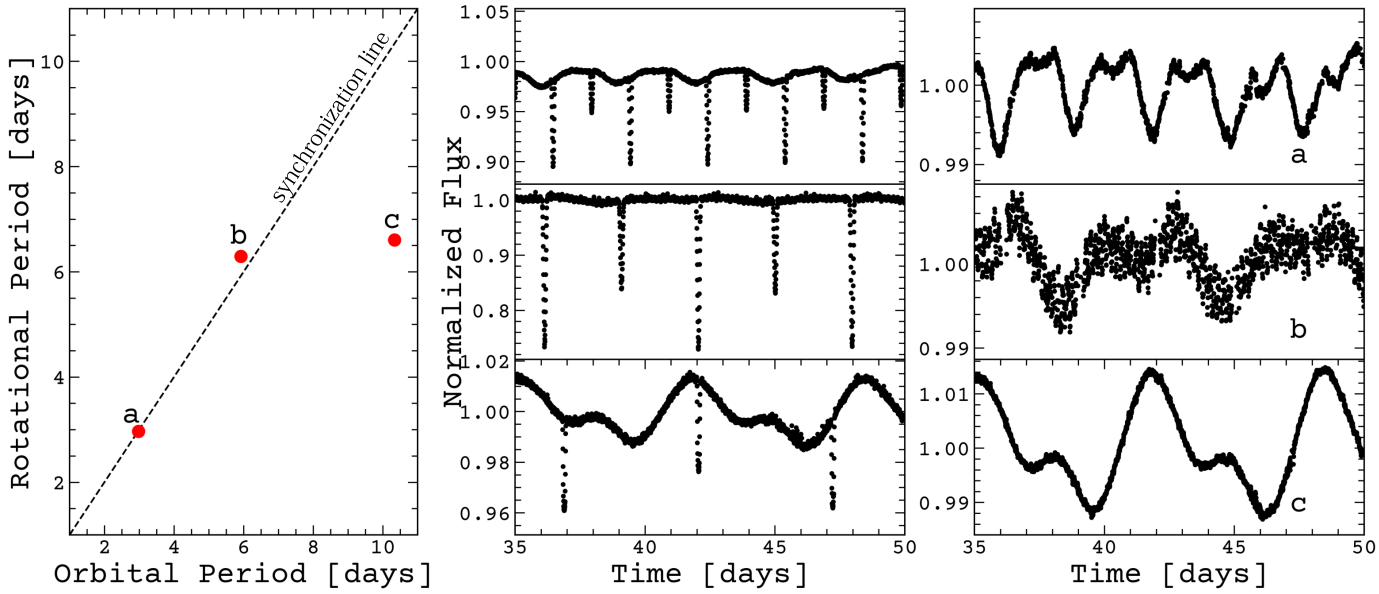

Figure 1. Left: rotation period as a function of the orbital period. Center: Raw light curves for each star in the sample. Right: stellar light curves without binary eclipses and ready to the rotational period analysis. (a) COROT 102715978, (b) COROT 102774523 and (c) COROT 102825481.

Table 1. Some results from spectral reduction and rotational period.

CoRoT	Teff (K)	logg (cm/s^2)	vsini (km/s)	A(Li) (dex)	P_{rot} (d)
102715978	6310.43	4.84	1.56	2.45	2.966
102774523	5271.19	3.96	16.73	2.21	6.295
102825481	6274.03	4.93	1.60	1.40	6.605

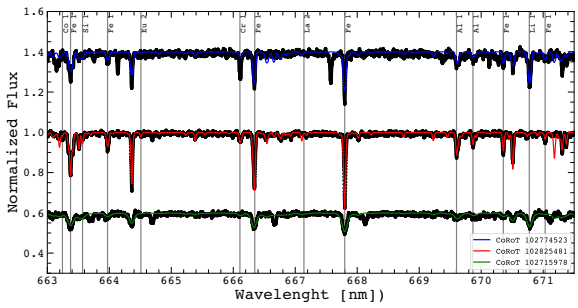

Figure 2. Spectra of the three targets.

nal sample of three systems, detached and with a clear rotational period modulation. The rotation period and the synchronization is an indicative of the lithium abundance and these targets confirm this characteristic. This is expected since we choose close binaries. Nevertheless, there is no clear linear relationship between these two parameters. Therefore is so important to extend this study

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