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A TESS survey of flare activity and stellar rotation of Young Stellar Objects (YSO) in the Taurus region

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In this work, we present the most numerous survey of flare detection on 346 YSOs in the Taurus region, which represents ∼67% of the low mass members cataloged by Esplin & Luhman (2019) and the majority classified as T Tauri Stars (TTSs). We studied in the sample the presence of flares and their characteristics, such as duration, peak amplitude, bolometric luminosity and energy released.

Using the TESSExtractor tool (Serna et al., in prep.), we obtained and corrected by systematic effects 643 TESS light curves with a 2 minutes cadence in sectors 43 and 44, alongside the stars' rotation period. We developed a tool called FLAN (FLare ANalizer), which applies a 4th-order Savitzky-Golay filter several times on a light curve to find and de-trend signals not related to the flare. When the light curve is completely normalized, FLAN looks for the presence of flares, detecting at least 1 point $\geq 3\sigma$ over the continuum and two consecutive points $\geq 2.5\sigma$ as the criterion. This allows us to report flares with a minimum duration of 10 minutes.

As a result, we detected 1700 flares. In every positive case, FLAN calculated its duration, amplitude, and area. Stellar parameters such as luminosity and mass, relevant for calculating the flare luminosity, were obtained from the program MassAge (Hernández et al., in prep.). Likewise, the bolometric energy (E_{Bol}) is quantified after integrating the flare luminosity along its duration. Additionally, YSOs tend to have energies between 10^{35-37} erg. When it is compared with M-type stars from Günther et al. (2020) and Solar-type stars from Tu et al. (2021), both classified as main-sequence (MS), we found that YSOs produce systematically more energetic and more frequent flares than MS stars. Therefore, flares become less intense as stars get older (Figure 1).

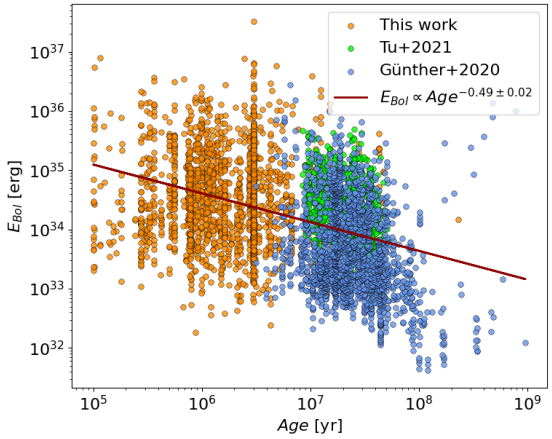

Figure 1. Relation between E_{Bol} and age compared with Günther et al. (2020) and Tu et al. (2021)

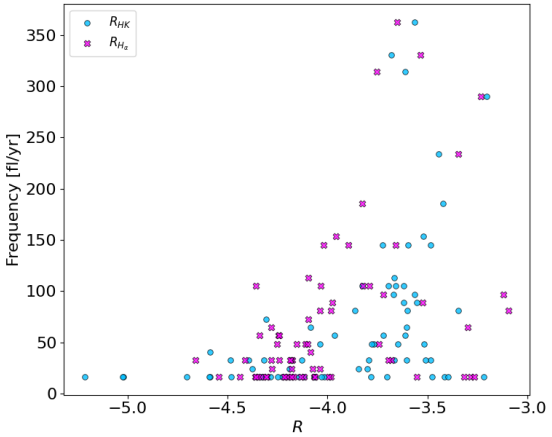

Figure 2. Frequency of flares in 168 stars with LAMOST and FAST spectra in which $R_{H\alpha}$ and R_{HK} is calculated.

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Finally, from LAMOST and FAST spectra of 168 WTTS in our sample, we measured the equivalent widths and the activity index R for H_α and Ca II HK lines. We found that these stars are very active ($R > -5.0$), showing more probability of producing a higher rate of flares (Figure 2). This work was supported by the projects CONACyT No. 86372 and PAPIIT CG-101723.

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