

# Natural scatter in Stellar magnetic activity of co-eval same spectral type low mass stars 

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Populations of stars with similar ages can display scatter in their rotation and activity levels. In our project, we study wide binaries of the same spectral type with the goal to find the scatter in activity in the pairs. We look for co-eval F, G, K and M spectral type binaries located in the solar neighborhood.

We use archival X-ray data from Chandra and XMM-Newton to estimate the X-ray luminosity of stars. The Luminosity can be used as an indicator of stellar activity. We have analyzed ca. 30 wide binary systems in X-rays, the majority of them being of spectral type K or M.

## Introduction



Figure 1: Ratio of Xray to Bolometric luminosity $\left(R_{x}\right)$ plotted against the Rossby number (Ro $\propto$ Period of rotation) [1]

- As stars age, their rotational rate slows down due to magnetic braking which reduces magnetic activity[1].
- Can same mass co-eval stars be expected to show similar stellar activity?
II. Data processing


Figure 2: Selecting extraction region with background for HD48766 and HD48767 ( $F$ type binaries). The stellar extraction regions for most stars in the sample are $\sim 1-2$ " and backgrounds are 5 times that of the stellar extraction region.

- Cool Main sequence binaries are filtered using proper motion Gaia binary catalog [2].
- $F, G, K$ and $M$ type stars were filtered based on the Gaia photometry with canonical main sequence values [3].
- We found 17 and 13 binaries in XMM-Newton and Chandra respectively (XMM: 10-M, 6-K and 1-F type binaries and Chandra: 5-M, 4-K, 2-G and 1-F type binaries)


Fig. 3: The difference in activity of the binary stars observed using XMM-Newton in the energy band $0.2-12 \mathrm{keV}$. The dashed line shows the mean of difference in $\log _{x}$ for solar neighbourhood stars. The mean difference for M type solar neighbourhood stars are 0.73 dex and for $K$ type it is 0.58 dex . While the difference for coeval M type binaries are 0.56 dex and for K type binaries is 0.31 dex. This is significantly smaller than the observed scatter of same-mass stars in the solar neighborhood.
Note: The outlier at 1.57 dex is a suspected triple system with one suspected unresolved star.

## IV. Next steps

- XMM analysis is in progress and Chandra analysis will follow.
- Currently we look at similar mass binaries, but we plan to study the scatter in different type binaries
- We will also analyse $M$ dwarfs further as activity decrease in this regime is of particular interest for exoplanet habitability.


## References

[1] Wright et al. (2011). APJ 743, 1, 48, 16 pp.
[2] El-Badry et al. (2018). MNRAS 408, 4884-4902
[3] Pecaut et al. (2013). APJ 208:9, 22pp.

