A GLANCE AT YOUNG STELLAR ROTATORS THROUGH THE EYES OF K2 AND GAIA

S. N. Breton[1], E. Distefano[1], A. C. Lanzafame[1,2] and D. B. Palakkatharappil[3]

Abstract. The *Gaia* mission, after more than a decade of surveying the Milky Way, will constitute a stepping stone for astronomical studies in the decades to come. In particular, a photometric survey such as PLATO will greatly benefit from the previous efforts of stellar characterisation provided by Gaia. We therefore want to investigate how Gaia observation might be of use for future rotation and activity measurements from PLATO. To this purpose, we analyse 1063 light curves from the K2 mission where a rotation measurement is available from Gaia DR2 or DR3.

Keywords: stars, rotation, solar-type, activity, space photometry

1 Introduction

Over the past years rotation catalogues were released by the Gaia consortium (Lanzafame et al. 2018; Distefano et al. 2023). Unexpected magnetic transitions at young ages were observed in the data (Lanzafame et al. 2019). Unfortunately, no intersection between *Gaia* rotation catalogue and the *Kepler* (Borucki et al. 2010) field exists, preventing to take advantage of the 4-year *Kepler* continuous observation. Nevertheless, some of the stars have K2 (Howell et al. 2014) light curves.

2 Data analysis

When they exist, we analyse the EVEREST (Luger et al. 2016) K2 light curves of the stars in the *Gaia* rotation catalogue to search for the corresponding rotation modulation. We analyse the light curve of 1063 stars in total. We use combination of methods: wavelet decomposition, auto-correlation function, and composite spectrum (see Breton et al. 2025, for more details). The stellar rotation period is then validated with the ROOSTER random forest methodology (Breton et al. 2021), as it will be done for the PLATO mission (Rauer et al. 2025; Breton et al. 2024).

3 Results

We obtain a reliable rotation periods in the K2 light curves for 744 stars. Among them, we have a measurements compatible with the period provided in the *Gaia* catalogue for 598 stars. In Fig. 1, we compare the location of the K2 stars in the $P_{\rm rot}$ vs $G_{\rm BP} - G_{\rm RP}$ diagram with the *Kepler* and *Gaia* distribution, respectively. The parameter space covered between the two missions are clearly very different. In addition, an important feature of the Gaia observations is the discovery of a group of ultra-fast rotators with low levels of activity (Lanzafame et al. 2019). Our analysis shows that stars from this groups are not represented in the K2 dataset, as they have an apparent magnitude that make them too faint for the *Kepler*/K2 telescope capabilities.

[1] INAF - Osservatorio Astrofisico di Catania, Via S. Sofia, 78, 95123 Catania, Italy
[2] University of Catania, Astrophysics Section, Dept. of Physics and Astronomy, Via S. Sofia, 78, 95123, Catania, Italy
[3] Université Paris-Saclay, Université Paris Cité, CEA, CNRS, AIM, 91191, Gif-sur-Yvette, France

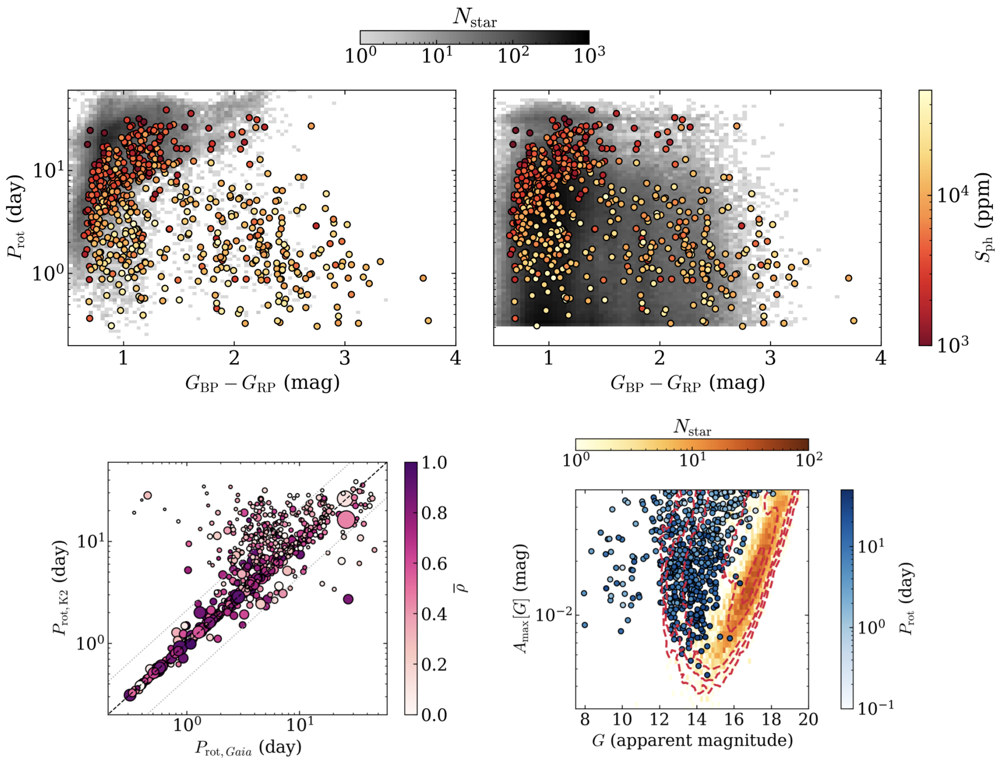

Fig. 1. *Top:* $P_{\rm rot}$ vs $G_{\rm BP} - G_{\rm RP}$ diagram. The $S_{\rm ph}$ value is colour-coded for the K2 stars. On the left panel, the sample is compared with the density distribution of the *Kepler* stars from Santos et al. (2019, 2021, in grey) while on the right panel it is compared with the density distribution of the stars from Gaia DR3 (in grey). *Bottom left:* Comparison between the K2 and *Gaia* rotation periods. *Bottom right:* Comparison of the location of the K2 stars and *Gaia* UFR in the $A_{\rm max}[G]$ vs G diagram. Figure taken from Breton et al. (2025).

4 Conclusions

TESS (Ricker et al. 2015) and PLATO should be able to provide additional external validation for the *Gaia* rotation measurements. Nevertheless, some of the most puzzling populations (e.g. low-activity ultra-fast rotators) are faint targets which might require additional instrumental resources in the future. In addition, *Gaia* multi-band photometry should be useful to characterise better the magnetic variability of the PLATO targets. Combined with PLATO light curves, it will offer the possibility to measure photometric variability of these stars on a timespan of almost two decades.

S.N.B acknowledges support from PLATO ASI-INAF agreement no. 2022-28-HH.0 "PLATO Fase D". D.B.P acknowledges support from PLATO CNES grant.

References

Borucki, W. J., Koch, D., Basri, G., et al. 2010, Science, 327, 977
Breton, S. N., Distefano, E., Lanzafame, A. C., & Palakkatharappil, D. B. 2025, arXiv e-prints, arXiv:2507.20909
Breton, S. N., Lanza, A. F., Messina, S., et al. 2024, A&A, 689, A229
Breton, S. N., Santos, A. R. G., Bugnet, L., et al. 2021, A&A, 647, A125
Distefano, E., Lanzafame, A. C., Brugaletta, E., et al. 2023, A&A, 674, A20
Howell, S. B., Sobeck, C., Haas, M., et al. 2014, PASP, 126, 398
Lanzafame, A. C., Distefano, E., Barnes, S. A., & Spada, F. 2019, ApJ, 877, 157
Lanzafame, A. C., Distefano, E., Messina, S., et al. 2018, A&A, 616, A16
Luger, R., Agol, E., Kruse, E., et al. 2016, AJ, 152, 100

Rauer, H., Aerts, C., Cabrera, J., et al. 2025, Experimental Astronomy, 59, 26

Ricker, G. R., Winn, J. N., Vanderspek, R., et al. 2015, Journal of Astronomical Telescopes, Instruments, and Systems, 1, 014003

Santos, A. R. G., Breton, S. N., Mathur, S., & García, R. A. 2021, ApJS, 255, 17

Santos, A. R. G., García, R. A., Mathur, S., et al. 2019, ApJS, 244, 21