Boletim da Sociedade Astronômica Brasileira, **37**, no. 1, 369-370

Tidal Spin-Up of Host Stars by Hot Jupiters

A Spectral Type Analysis

Y. Lopes & J. D. do Nascimento

[1] Universidade Federal do Rio Grande do Norte. e-mail: ylanaakarolina@gmail.com, jdonascimento@fisica.ufrn.br

Abstract. The high occurrence of Hot Jupiters in close-in orbits raises key questions about how massive planets affect stellar rotation. Previous studies have focused on tidal interactions and magnetic braking in G-type stars, but how these processes vary with stellar type remains unclear. We extend the study of tidal spin-up to F-, G-, K-, and M-type stars using *TESS* data and the NASA Exoplanet Archive (April 2025). Systems with published projected rotational velocities ($v \sin i$) were grouped into Hot Jupiters ($P_{orb} < 10$ days), Cold Jupiters ($P_{orb} > 100$ days), and small planets. Spectral classifications were obtained from SIMBAD. Rotational periods and $v \sin i$ distributions were analyzed via Kernel Density Estimation, and the Kolmogorov–Smirnov test assessed statistical differences among planet categories. Stars hosting Hot Jupiters rotate faster, especially among G-, K-, and M-types, suggesting tidal torques enhance stellar rotation in stars with deeper convective zones. F-type stars show little or no spin-up, consistent with weaker tidal dissipation. Despite smaller K and M samples, the trends remain physically consistent. These results highlight the dependence of tidal effects on stellar structure. Future missions like ESA's *PLATO*—through precise age and rotation measurements—will be essential to test and refine these conclusions.

Resumo. A alta ocorrência de Júpiteres Quentes em órbitas próximas levanta questões fundamentais sobre como planetas massivos afetam a rotação de suas estrelas hospedeiras. Estudos anteriores concentraram-se nas interações de maré e na frenagem magnética em estrelas do tipo G, mas ainda não está claro como esses processos variam com o tipo estelar. Neste trabalho, ampliamos o estudo do spin-up por maré para estrelas dos tipos F, G, K e M, utilizando dados do *TESS* e do NASA Exoplanet Archive (abril de 2025). Sistemas com velocidades rotacionais projetadas publicadas ($v \sin i$) foram classificados em Júpiteres Quentes ($P_{orb} < 10$ dias), Júpiteres Frios ($P_{orb} > 100$ dias) e pequenos planetas. As classificações espectrais foram obtidas a partir do SIMBAD. Os períodos de rotação e as distribuições de $v \sin i$ foram analisados por meio de Estimação de Densidade por Núcleo (KDE), e o teste de Kolmogorov–Smirnov foi aplicado para avaliar diferenças estatísticas entre as categorias planetárias. Estrelas que hospedam Júpiteres Quentes tendem a rotacionar mais rapidamente, especialmente entre os tipos G, K e M, indicando que torques de maré aumentam a rotação estelar em estrelas com zonas convectivas mais profundas. Estrelas do tipo F mostram pouca ou nenhuma aceleração rotacional, em concordância com sua menor dissipação de maré. Apesar do tamanho reduzido das amostras de tipos K e M, as tendências observadas são fisicamente consistentes. Esses resultados destacam a forte dependência dos efeitos de maré na estrutura interna estelar. Missões futuras, como a *PLATO* da ESA — por meio de medições precisas de idade e rotação estelar — serão essenciais para testar e refinar essas conclusões.

Keywords. (Stars): planetary systems – Stars: rotation – Planet-star interactions

1. Introduction

The discovery of a large population of Hot Jupiters – massive gaseous planets orbiting within a few days around their host stars – has profoundly impacted our understanding of planetary system dynamics Biazzo et al. (2022). Their close proximity to the star gives rise to strong tidal interactions that can modify the orbital and rotational evolution of both bodies Zahn (1977); Tassoul (2000). Through tidal torques, angular momentum can be transferred from the planetary orbit to the stellar envelope, potentially increasing the stellar rotation rate Mathis (2018). This mechanism has been proposed as an explanation for anomalously rapid rotation observed in some planet-hosting stars Tejada Arevalo et al. (2021), suggesting that close-in planets may play a direct role in reshaping stellar angular momentum evolution. Such effects are particularly relevant to studies of gyrochronology and stellar magnetic braking, which rely on the assumption of isolated rotational evolution Santos et al. (2021).

Previous studies have mainly investigated tidal interactions in G-type main-sequence stars Tejada Arevalo et al. (2021), focusing on the balance between tidal synchronization and magnetic braking. However, the efficiency of tidal dissipation and the resulting spin-up are expected to vary significantly with stellar type, due to structural differences in convective and radiative zones Zahn (1977); Mathis (2018); Tassoul (2000); Biazzo et al. (2022); Ahuir et al. (2021). Theoretical models predict that F-type stars, with shallow convective envelopes, experience weak tidal coupling and minimal spin-up, whereas K- and M-type stars, with deeper convective zones, are more susceptible to tidal angular momentum transfer. Despite these predictions, a systematic observational analysis across multiple spectral types remains limited.

To investigate whether close-in giant planets influence stellar rotation across different spectral types, we selected 84 Hot Jupiter hosts (R > 0.3 $R_{\rm Jup}$, $P_{\rm orb} < 10$ days) from the NASA Exoplanet Archive (as of April 2025), restricted to F–M main-sequence stars (log g > 4) with Gaia DR3 parameters and measured rotation periods. As a comparison sample, we adopted 200 field stars without close-in giants from Santos et al. (2021) and Claytor et al. (2023). We then tested for rotational differences between hosts and controls using Mann–Whitney U statistics by spectral type. The resulting period distributions (Figure 1) show that while F-type hosts behave similarly to their controls, G-, K-, and M-type Hot Jupiter hosts rotate systematically faster, consistent with tidal spin-up driven by deeper convective envelopes and more efficient angular momentum dissipation. These trends support a spectral-type-dependent response to planetary tides. Upcoming missions

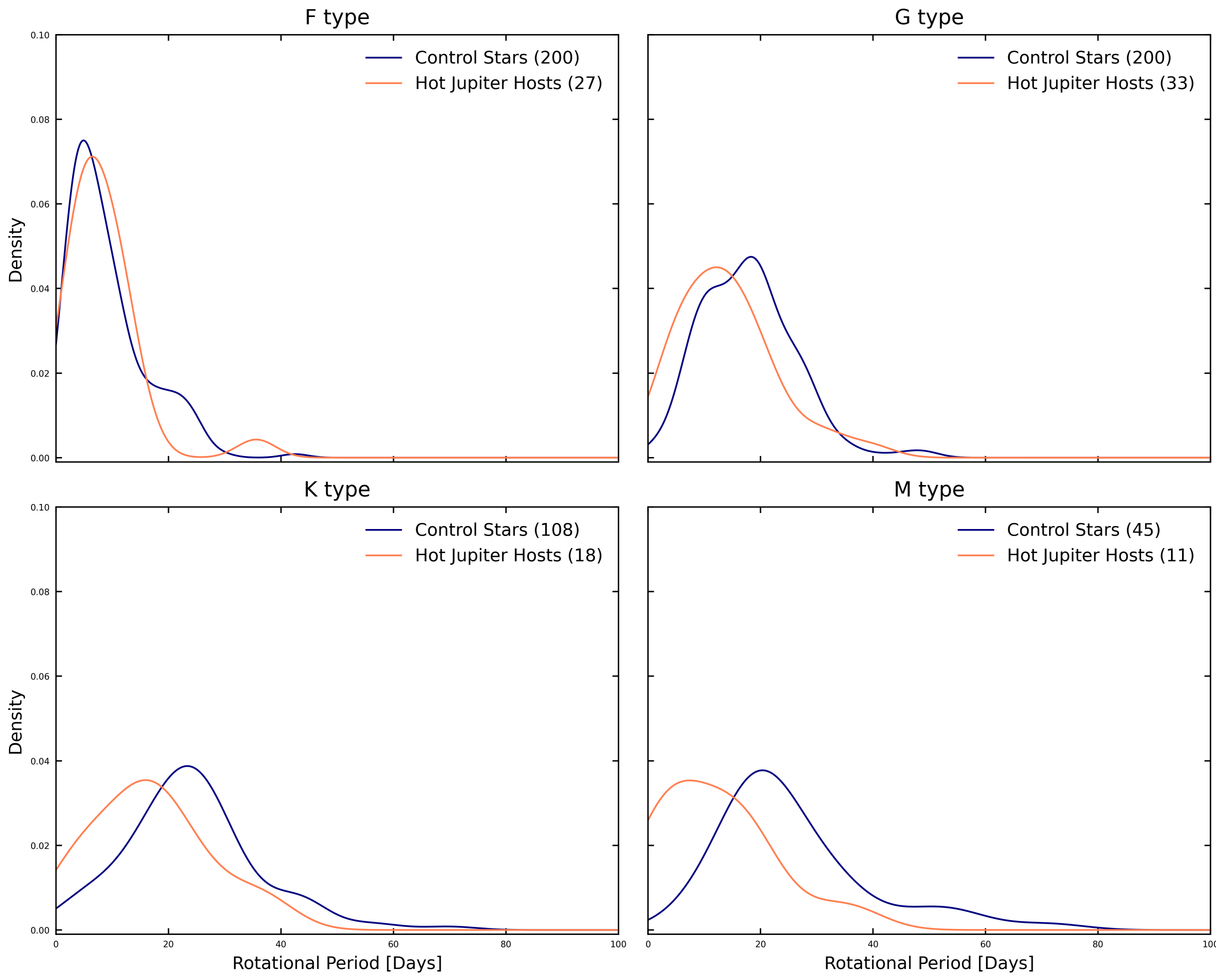

Figure 1. Kernel density estimates of stellar rotational periods for Hot Jupiter hosts (orange) and control stars (blue), separated by spectral type. While F-type stars show similar distributions, G-, K-, and M-type hosts tend to rotate faster than their control counterparts, indicating a possible influence of close-in giant planets on stellar spin.

such as PLATO will further constrain star–planet angular momentum exchange.

References

Ahuir, J., Mathis, S., & Amard, L. 2021, A&A, 644, A79
Biazzo, K., et al. 2022, Demographics of Exoplanetary Systems, Springer Nature
Claytor, Z. R., et al. 2023, AJ, 166, 47
Mathis, S. 2018, Tidal Star-Planet Interactions, Springer eBooks
Santiago, L., et al. 2024, arXiv:2404.06958
Santos, N. C., et al. 2021, A&A, 644, A79
Tassoul, J.-L. 2000, Stellar Rotation, Cambridge Univ. Press
Tejada Arevalo, R. A., Winn, J. N., & Anderson, K. R. 2021, ApJ, 919, 138
Zahn, J.-P. 1977, A&A, 57, 383