Measuring 34,030 Rotation Periods of Kepler Field Stars with a New Autocorrelation Method and the Planet Connection

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Abstract

The long-baseline, high precision light curves from the Kepler space mission are revolutionizing the study of stellar rotation. However, standard approaches used to measure periodicity based on Fourier decomposition, are not well suited to signals that evolve in phase and amplitude, and may be affected by instrumental systematics. We have therefore developed an alternative algorithm, based on the autocorrelation function (ACF) of the light curve. Because the ACF measures only the degree of self-similarity of the light curve at a given time lag, the period remains detectable even when the rotational modulation evolves significantly, and when systematic effects and long term trends are present.
We analyzed three years of data from the Kepler space mission to derive rotation periods of main-sequence stars. Our automated autocorrelation-based method detected rotation periods between 0.2 and 70 days for 34,030 (25.6%) of the 133,030 main-sequence Kepler targets (excluding known eclipsing binaries and Kepler Objects of Interest), making this the largest sample of stellar rotation periods to date. The upper envelope of the period distribution is broadly consistent with a gyrochronological age of 4.5 Gyr, based on the published isochrones. We examined the amplitude of periodic variability for the stars with detected rotation periods, and found typically higher amplitudes for shorter periods and lower effective temperatures.
We also analyzed the light curves of the Kepler planet-host candidates (KOI) and derived stellar rotation periods for _˜1500 of them. The comparison between the orbital and rotational periods reveals a striking lack of close-in planets around fast rotators. We further compared the rotational amplitudes of the KOIs with those corresponding to single stars, and found that in the hottest temperature range (higher than 6000 K) the KOIs show lower rotational amplitudes than the stars without transits. This is probably due to the non-alignment of the rotational and orbital axes of hot stars.

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