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Gyrochronology of Wide Binaries in the Kepler K2 Campaign 5 Field

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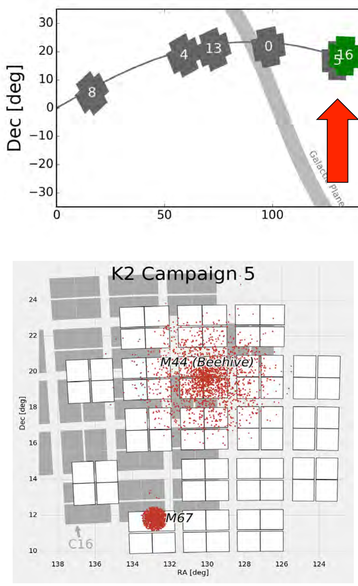
Abstract

We are determining rotation periods for an ensemble of over 100 wide non-interacting binary stars in the K2 Campaign 5 field that contain two main sequence dwarfs, as well as a smaller sample containing at least one white dwarf component. Observations of such coeval pairs provide the basis for our new investigation of rotation-based age determinations. Such "gyrochronology" ages can achieve a precision that exceeds most other current method of stellar age determination. Here we present a status report on our analysis of the light curves extracted from the K2 Campaign 5 field.

Binaries in the Kepler K2 Campaign 5 Field



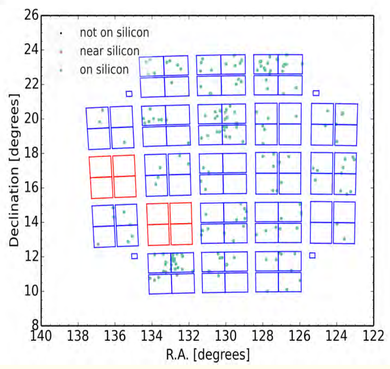


Fig. 1 – The Kepler K2 fields:
(top) Sequencing of the fields; a red arrow marks the Campaign 5 field. Kepler was on this field from April 27 – July 10, 2015.
(lower left) Detail of the C5 field centered on RA: 08:40:38, DEC: +16:49:47. Note the prominent M44 (age ~0.6 Gyr) and M67 (age ~4.6 Gyr) clusters.
(lower right) Our selected binaries for K2 Campaign 5. Only targets that fall on the silicon are shown (267 systems, respectively). Note some are in M44 and M67.

Raw Data Extractions

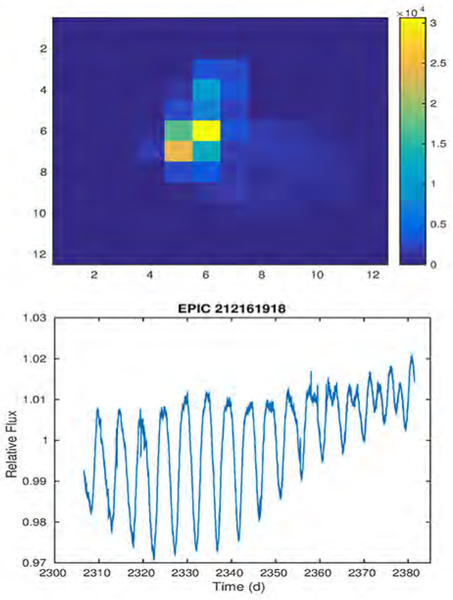


Fig. 2 – Image extractions and light curves:
(top) Typical mean image for one of our binary components (EPIC 212161918).
(bottom) Extracted raw light curve for this star.

Period Determinations

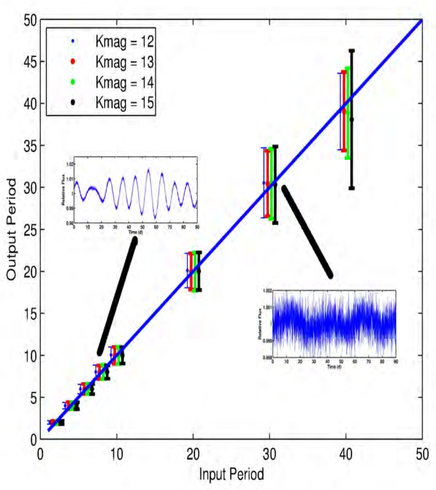


Fig. 3 – Simulations comparing input periods from models by Buzasi et al. (2016, JSpW&SpCl 6, 38) to the resulting measured periods using our Discrete Fourier Transform (DFT) algorithm. Colors indicate K2 magnitudes, with offsets for clarity. Insets are simulated time series for K_{mag} = 14.9 with P_{rot} = 8d (left) and 25.4d (right).

Variable Stars in C5

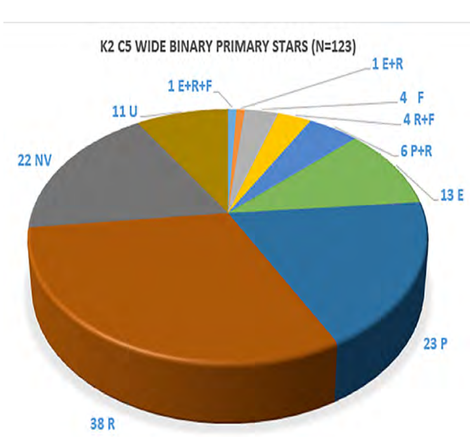


Fig. 4 - Preliminary light curve classifications of the first 123 wide binary targets extracted from our K2 Campaign 5 field.

Key:
E= eclipses
F= flares
P= pulsations
R= rotation
U= unusable/underexposed

Light Curves

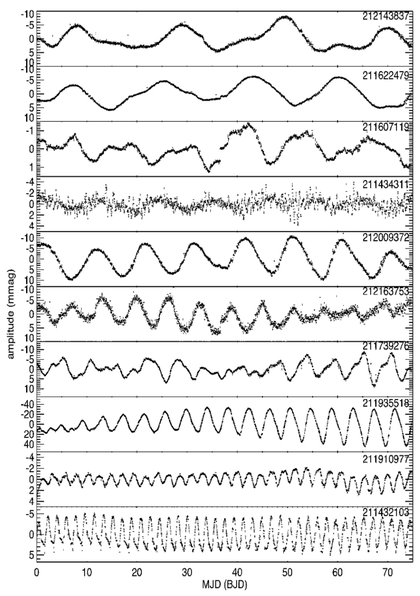


Fig. 5 – Typical normalized light curves of C5 wide binary primary components (123 have been extracted and processed so far; 50 have rotation modulation). Horizontal axis is Modified Julian Day. Vertical axis units are milli-magnitudes (~0.1 percent).

Periods

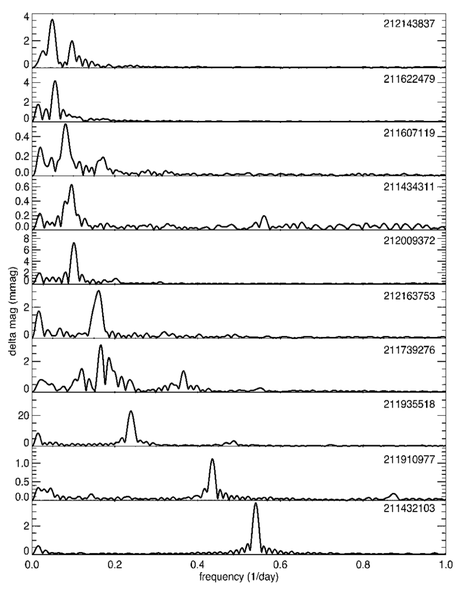


Fig. 6 – DFT spectra for objects in Fig. 5. Periods range from ~ 2 < P_{rot} < 20 days. Variability of shorter and longer periods caused by pulsations, unresolved tertiary components, flaring, spot cycles (phase changes), etc., are also evident.

Acknowledgments

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Preliminary Gyrochronology of C5 Binaries

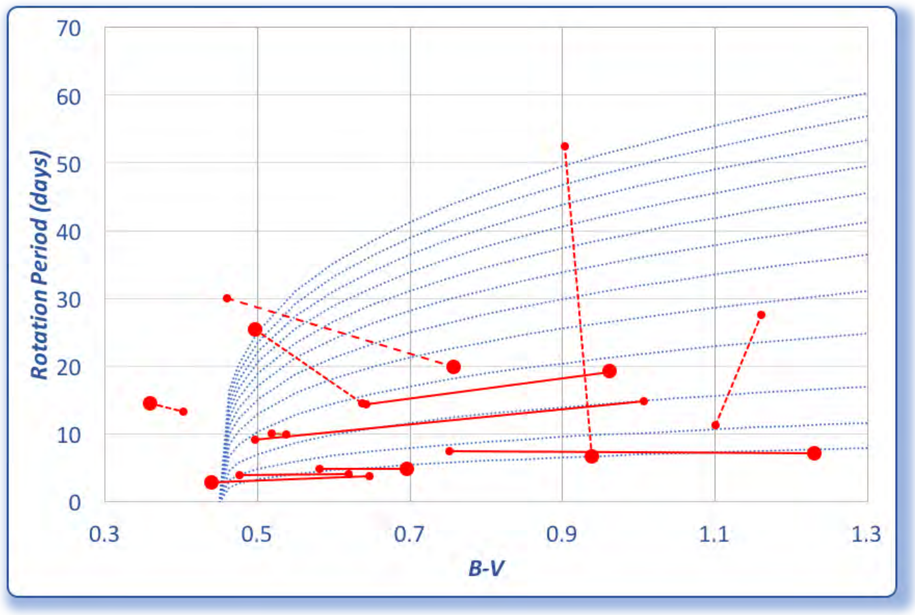

Fig. 7 – Rotation period vs. *B-V* (a proxy for mass) for 12 binaries in the C5 field. From bottom, dashed blue lines are constant gyrochrones for 0.25, 0.50 and 1 to 10 Gyr (in 1 Gyr increments) from Angus et al. (2015, MNRAS 450, 1787). Large dots are stars with *B-V* data; small dots indicate *B-V* values estimated from *ugriz* data. Solid/dashed lines connect components with/without consistent rotation ages, respectively. Similar results were obtained by Janes et al. (2016 ApJ, in press, arXiv #1612.00070). We are conducting ground-based time-series observations on pairs that appear to have P_{rot} > 20d, which are poorly constrained by the K2-C5 time window.