2017

Gyrochronology of Wide Binaries in the Kepler K2 Fields

Alexander Stone-Martinez
Embry-Riddle Aeronautical University, stonemaa@my.erau.edu

Gustavo Villarroel
Embry-Riddle Aeronautical University, villarg2@my.erau.edu

Patrice Majewski
Embry-Riddle Aeronautical University, majewskp@my.erau.edu

Tomomi Otani
Embry-Riddle Aeronautical University, otanit@erau.edu

Terry Oswalt
Embry-Riddle Aeronautical University, oswaltt1@erau.edu

See next page for additional authors

Authors

Alexander Stone-Martinez, Gustavo Villarroel, Patrice Majewski, Tomomi Otani, Terry Oswalt, and Andrew McNaughton

Gyrochronology of Wide Binaries in the Kepler K2 Fields

Alexander Stone-Martinez[1], Gustavo Villarroel[1], Patrice Majewski[1], Tomomi Otani[1], Terry Oswalt[1], Andrew McNaughton[1]

1. Embry-Riddle Aeronautical University, Department of Physical Sciences

231ST MEETING AMERICAN ASTRONOMICAL SOCIETY WASHINGTON, DC • 8-12 JANUARY 2018

Abstract

Gyrochronology is the method of determining a stars age based on its rotation period and mass. A cool main sequence star loses it's angular momentum as it ages, so the rotation rate slows down. Gyronchronology has been tested on star clusters in previous studies and now we are applying the theory to binary stars. Components of a binary should be the same age, so Gyrochronology should return the same age for both stars in binary systems. We examined the rotation periods for 290 wide binary main sequence stars in the Kepler K2 fields. These observations are part of a continuing investigation of Gyrochronology. Using the determined rotation periods and color index (a proxy for mass), we estimated ages for ~20 binary pairs. Presented here is a status report on our analysis of data from the K2 and the calculated ages of the studied binaries.

K2 Fields

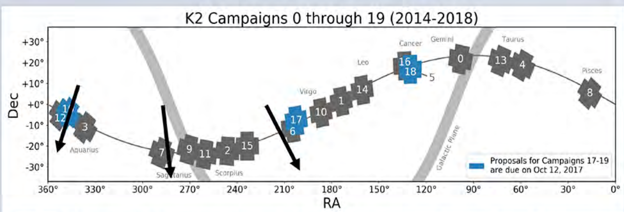

Fig. 1 – All K2 fields. Arrows mark the fields used in this study: C6, C7, and C12. (https://keplerscience.arc.nasa.gov/k2-fields.html) Target data was downloaded from the MAST archive (https://archive.stsci.edu/k2/).

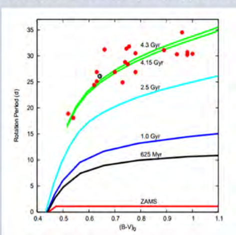

Fig. 2 – Previous Gyrochronology studies used the old cluster M67 shown to validate the oldest gyrochrone to date. (cf. Barnes et al.; van Saders et al.). Note large scatter imposed by the faintness of the stars.

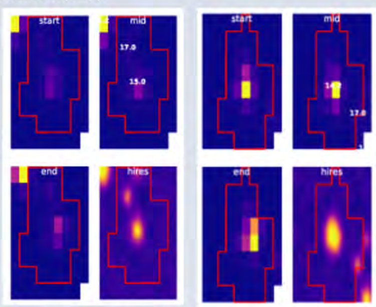

Fig. 3 & 4 – Example aperture images for Epic 212684812 (Left) and Epic 212684586 (Right) which are a binary pair (MAST archive).

Acknowledgments

Support for this project from NASA grant NNX15AV60G and the Florida Space Grant Consortium grant NXX15_005 to Embry-Riddle Aeronautical University is gratefully acknowledged.

Sample Light Curve

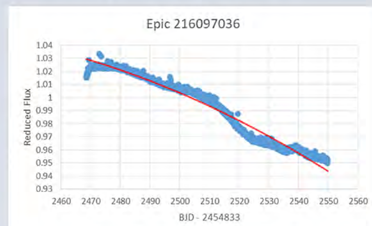

Fig. 5 – Raw light curve for the star Epic 216097036 in C7. Using MATLAB, a second order polynomial (Shown as red line) is fitted to the data and the curve is removed.

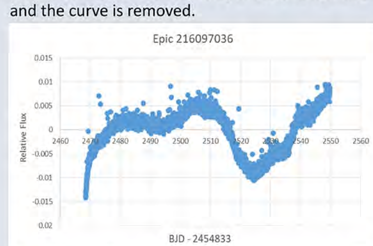

Fig. 6 – Light curve after correction for instrumental biases using MATLAB flattening program

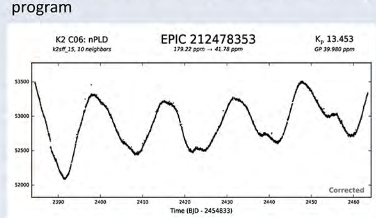

Fig. 7 – Fully calibrated light curve. The data is reduced using the period-finding algorithm Period04 from which the star's rotation periods is obtained (Lenz, P. & Breger, M.).

Period-Color Results

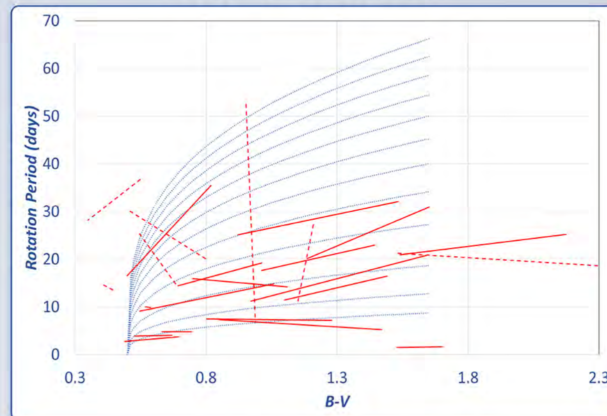

Fig. 8 – Rotation period vs. B-V Color index (mass proxy) for binaries in the K2 fields. The color indexes were obtained from TESS input catalog (https://archive.stsci.edu/k2/) . Dashed Blue lines are constant age isochrones for 0.25, 0.5, 1 to 10 Gyr (1Gyr increments) from Angus et al. (Angus et al. 2015). Red lines connect binary pairs of stars. Solid/Dashed lines components of pairs with/without consistent rotation age respectively. Since the K2 observation period for each campaign is ~80 days, rotation periods longer than 40 days could not be obtained. Some of the K2 targets are currently being observed from ground based telescopes after their K2 observation runs so that longer rotation periods can be detected.

References

Angus, R., Aigrain, S. Foreman-Mackey, D. & McQuillan, A., 2015, MNRAS, 450, 1787.

Barnes S. A., et al. 2016 ApJ 823, 16

Lenz, P. & Breger, M., 2005, Comm in Asteroseismology, 146

Van Saders et al. 2016 Nature 529 181