Leibniz-Institut für Astrophysik Potsdam

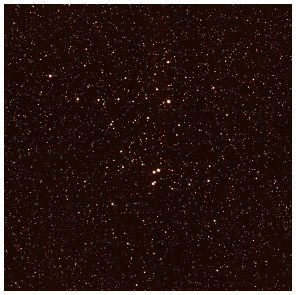
NGC 6709: A Faint Zero-Age Main Sequence Open Cluster

Elizabeth Cole-Kodikara[1], Sydney Barnes[1], Jörg Weingrill[1], Dario Fritzewski[1], David Gruner[1]

1 Leibniz-Institut für Astrophysik Potsdam (AIP), Germany

Motivation and Observations

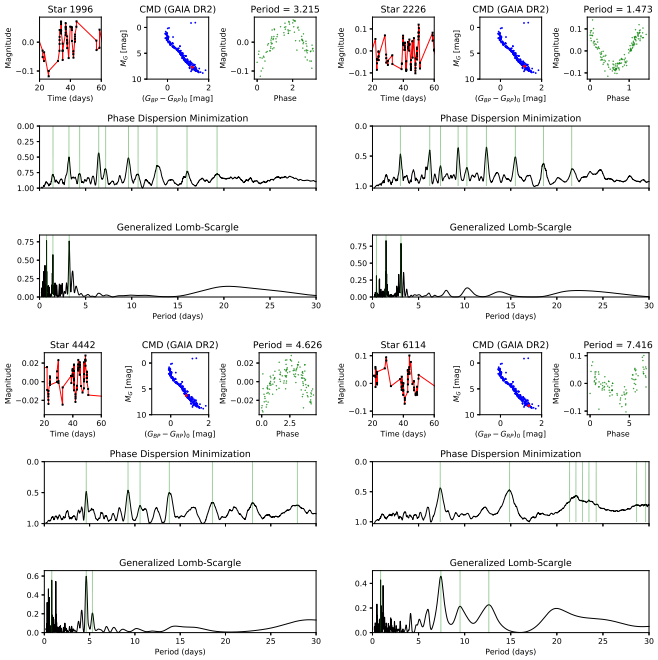
Gyrochronology is the study of stellar rotational evolution with time. Open clusters provide ideal candidates to calibrate the dependence of rotation rates on stellar mass and age due to their mostly homogeneous nature.



NGC 6709 is about 150 Myrs and at a distance of 1 kpc away with solar metallicity. Observations are taken with STELLA1 at the Izana Observatory in Tenerife, Spain. The cluster is observed over several months to search for rotation periods of up to 30 days.

Methods

DAOPHOT II (Stetson 1987) is used to analyze multiple frame by utilizing point-spread function photometry. Membership is based on *Gaia* EDR3 (Gaia Collaboration et al. 2020) proper motions and Cantat-Gaudin et al. (2018). Periods are searched for in the resulting light curves using four methods: the Phase Dispersion Method, the String Length Method, the Clean method, and the Generalized Lomb-Scargle method. The members are cross-referenced with *Gaia* EDR3 observations to obtain the color, a proxy for mass.



Sample of light curves of four stars and two statistical methods. The phase light curve is shown with the dominant period.

Acknowledgements

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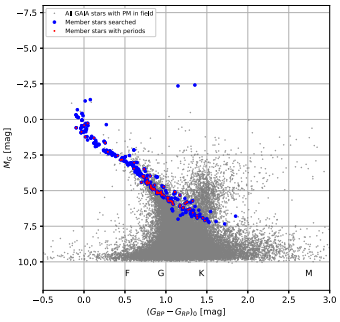
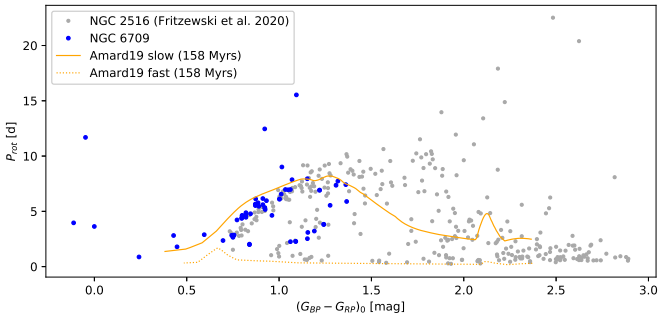
Results

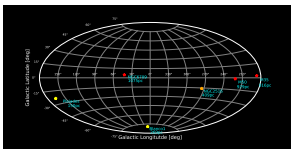


Color-Magitude Diagram of open cluster and background and foreground stars using *Gaia* EDR3 data. Red dots indicate members with found periods. We use isochrones from gyrochronology models of Amard et al. (2019).

Periods were found for binaries and G–K type stars. NGC 6709 shows similar features in the color-period diagram (CPD) to the similarly aged open cluster NGC 2516. There is sequence of slow rotators with rotation periods that increase with redder stars and a small clump of rapidly rotating cool stars and a gap between the two. The rotation distribution based on stellar type for clusters of similar ages appears to be the same regardless of location or distance.



CPD for NGC 6709 and comparison cluster NGC 2516 with isochrones by Amard et al. (2019) for both fast and slow rotating stars.



Galactic latitude and longitude of open clusters in this poster and Fritzewski et al. (2020). All these open clusters have almost identical CPDs, giving support to the lack of variation of stellar activity between clusters of similar ages.

For more information on NGC 2516 and to see the comparison with other open clusters, please visit the poster *Are the rotation period distributions in zero-age main sequence open clusters alike?* by Dario Fitzewski. For an example of the rotation periods for an older cluster, please visit the poster *Rotation periods for cool stars in the open cluster Ruprecht 147 (NGC 6774)* by David Gruner.

References

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