New Coronae and Stellar Associations Revealed by a Clustering Analysis of the Solar Neighborhood

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Introduction

The study of nearby young associations is more relevant than ever to understand stellar evolution and to detect exoplanets systems and isolated planetary-mass objects. In opposition to most of the literature that seems to be limited in finding such associations in the Solar Neighborhood, this surveys reveals an unprecedented clustering within 200 pc of the Sun using 6 dimensional kinematics, such as cartesian position XYZ and their respective cartesian velocities YVW.

Methodology

We used Gaia Early Data Release 3 kinematics for stars with radial velocity measurements as well as a clustering algorithm called HDBSCAN over the 6-dimentional-kinematics previously mentioned.

Analysis

Not only were we able to recover all current known associations, but we were able to find some spatial extension to current stellar associations as well a new stellar streams in our neighborhood. We recovered 241 over-densities in XYZUVW space, which we named Crius groups.

Projection Issue

One of the biggest issue faced while looking for nearby associations are projection issues in galactic coordinate, which limited KC19 from clustering young associations within 100 pc of the Sun[1]. To counter this problem, we used the kinematics in the Cartesian plane, where XYZ are the position and UVW their respective velocities.

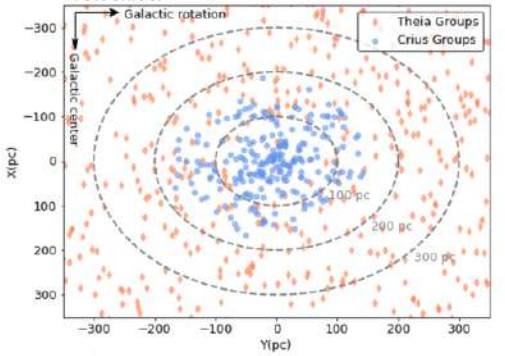

Figure 1. Comparison of the clustering in the median galactic coordinates XY with Theia Groups and the clustering in cartesian coordinates with the Crius Groups

Coronae

Spatial extension of stellar streams are key to understand stellar evolution. Moreover, the stars composing coronae that are closer to us can be further analyse to detect the presence of exoplanets and planemos.

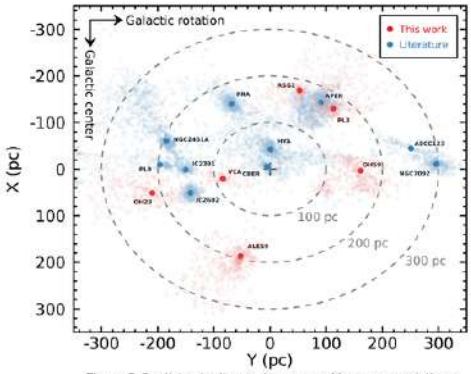

Figure 2. Spatial extention and coronae of known associations

New Associations

A number of 31 Crius groups passed our quality cut without being associated to any known cluster, which consisted into filtering all groups that show median absolute deviation in the UVW coordinates > 3km/s, as well as removing groups which overall properties are consistent with very old ages or halo stars.

For now, these new stellar streams are only defined by their members with radial velocity measurement, but with the Gaia DR3 (Data Release 3), we will be able to complete the lists of member for these new groups and assign them much more precise ages based on the color-magnitude diagram positions of their M-type members.

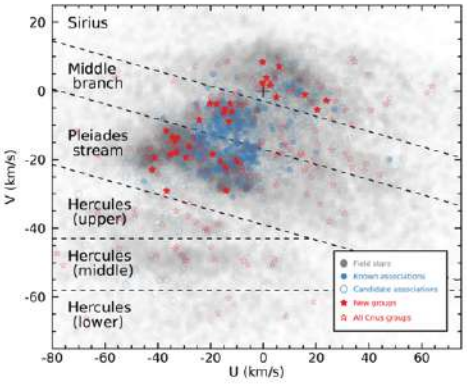

Figure 3. Median UV space velocities of all Crius groups (open red stars), and new candidate associations presented here (filled red stars) compared with other known young associations in the literature (blue circles) and field stars within 100 pc of the Sun in Gaia-EDR3 (grey circles.

Conclusion

Despite the lack of radial velocity measurement for a numerous amount of stars, using this kinematic data alongside galactic position, proper motion and parallax allowed us to better characterize the Solar Neighbourhood.

Related Literature [1] Kounkel, M., & Covey, K. 2019, AJ, 158, 122

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