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LOOKING FOR OPEN CLUSTERS BY USING THE CONVERGENT POINT VERSION OF HERSCHEL'S METHOD

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RESUMEN

Los movimientos propios son los mejores y más rápidos discriminadores en la búsqueda de cúmulos abiertos. En este sentido, las observaciones profundas tienen una doble cara, traen beneficios y problemas. Mientras que por un lado nos aportan más estrellas, por otro lado, densifican el campo de representación, $1'' \times 1''$ en área, en el que trabaja el método del Punto-Vector. El Punto Convergente basado en el Método de Herschel permite extender a la totalidad de la esfera celeste el campo de representación del movimiento propio estelar. La correcta interpretación de la geometría introducida por Herschel permite explotar el papel natural que juegan las propiedades cinemáticas de las estrellas.

ABSTRACT

Proper motions are the best and fastest screening tool to look for open cluster members, but when dealing with deep observations, crowdiness and small-size proper motions become troublesome. In general, the vector-point diagram can be applied on small areas of the sky and the proper motion errors impose a limit on the smallest proper motions that are significant. Moreover, the deeper the data, the further the star, and the smaller its proper motion. Herschel's Convergent Point method is an alternative way to study proper motions that uses the whole celestial sphere to represent them. A correct interpretation of the geometry introduced by this method is necessary to exploit all the kinematical information contained in the proper motions.

Key Words: astrometry — open clusters and associations — proper motions

1. THE CONVERGENT POINT APPLIED TO EXTENDED CELESTIAL AREAS

Position and motion represent a great circle or "trajectory" and both star and its motion, can be substituted by their corresponding pole, a point on the sky corresponding to the orthogonal direction of the above mentioned great circle. This is the so-called polar version of Herschel's convergent point method. Figure 1 shows the clear difference between the use of the polar version of the convergent point method and the vector-point diagram, applied on the whole Hipparcos catalogue.

This method also gives us the necessary formulation to find important parameters of the motion, since the magnitude of the proper motion vector depends on the angular distance star-apex. This dependence is very useful when applying this method to extended areas of the sky. Topics like the solar motion (Abad et al. 2003) or trends of motion in the solar neighborhood along preferential directions (Abad et al. 2005) have been investigated with this method, confirming similar results by others (e.g. Famay et al. 2005).

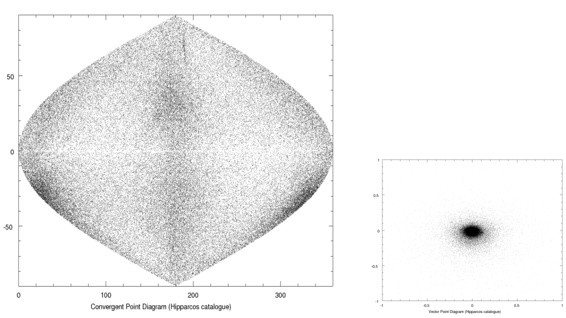

Fig. 1. Left panel: Polar Convergent Point. Right panel: Vector-Point Diagram. Data from the Hipparcos catalogue.

2. POLAR VERSION OF THE CONVERGENT POINT APPLIED TO SMALL AREAS OF THE SKY

Data used in all the figures of this poster are taken from the Hipparcos catalogue. While Figure 1 uses the whole catalog, Figure 3 uses about

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a thousand stars contained in a small area around the Hyades cluster, as an illustrative example.

Conditions are different when the research is confined to small areas of the sky. Variations over the angular distance star-apex are too small to be useful or significant. Then, finding the apex becomes of the outmost importance. An example of such situation can be found on Galli et al. (2012), where they have looked for points in the sky with the highest probability of being an apex. Poles of star members of a cluster are aligned in a great circle whose pole is the apex of the cluster as shown in Figure 2.

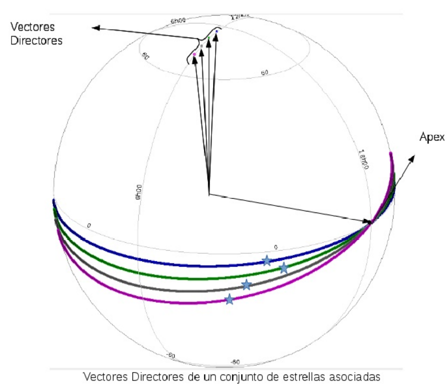

Fig. 2. Stars sharing a common motion have their poles aligned on a great circle and the pole of this circle is the apex of the association.

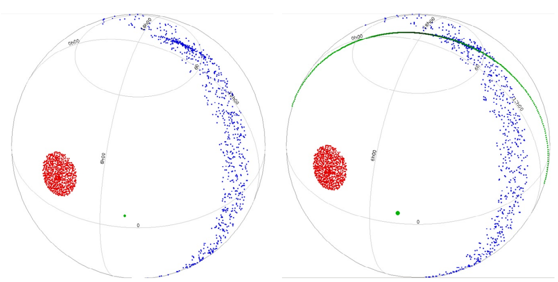

Fig. 3. For a given circular area in the sky, the poles of the stars in it fall into a band of width equal or less than the diameter of the area. Poles of cluster members will be aligned, crossing the band when the apex is external to the cluster. The pole of the great circle generated by the poles of cluster members will be the apex. This point will be external or internal to the selected area if the great circle associated with their poles partially crosses the band of poles, or whether it is completely enclosed in it.

3. SOME CLUES AS TO WORK

This work is in progress, and we are not in a situation to present definitive results yet, but we would like to show some preliminary clues, based on the work done so far.

The cross product of two poles represents the intersection of their associated great circles. The cross product of a selected pole with the rest of poles represents the totality of the intersection points with the trajectory selected.

Figure 4 clearly shows both distributions. In most cases, the distributions will be overlapping and sometimes there could be multiple distributions.

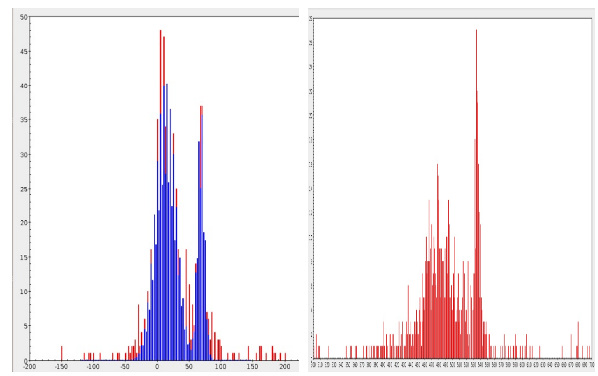

Fig. 4. Left panel: For a given chosen star, if it is not a member of the cluster, the cross product will yield a random background distribution of intersections. But if the star is a member of the cluster, a second distribution of intersections will appear, centered at the cluster's apex and with a dispersion related to the proper motion dispersion of the cluster. The figure shows clearly both distributions. In most cases, the distributions will be overlapping and sometimes there could be multiple ones. Right panel: Statistical techniques may be applied to bring out the cluster's intersections from the background's ones. The central point of the cluster's distribution represents a point on the sky that could be the apex of the cluster.

The central point of a normal distribution represents a point on the sky, which could perhaps be identified as the possible apex of the cluster.

Finally, we can associate the probability of a star belonging to a cluster as the proximity of its pole to the fitted great circle.

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