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MOVING CLUSTERS IN THE GALACTIC HALO: ASSESSING THE PHYSICAL REALITY OF THESE GROUPS

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RESUMEN

El estudio de los grupos cinemáticos es importante porque nos dará información sobre la historia dinámica y de agregación de nuestra galaxia. En este trabajo buscamos cúmulos cinemáticos entre 480 estrellas del catálogo de Schuster et al. (2006) utilizando los valores de las constantes de movimiento energía E, y componente z del momento angular h así como la metalicidad [Fe/H] de cada estrella. Un método numérico nos permite obtener las mejores agrupaciones de las estrellas en paralelepípedos de tamaño dE, dh, d[Fe/H]. Utilizamos un método Montecarlo para calcular el número de grupos esperado por azar y compararlo con el número de grupos obtenido. También calculamos la probabilidad de que un grupo situado en un punto específico del espacio E, h, [Fe/H] se deba al azar. Estos cálculos son relevantes para establecer la realidad física de los grupos encontrados.

ABSTRACT

The study of moving clusters is important because it provides information about the dynamical and merger history of our Galaxy. In this work we search for moving clusters among 480 stars of the catalogue of Schuster et al. (2006) using the values of the constants of motion, energy E, and z component of the angular momentum h, as well as the metallicity [Fe/H] for each star. By means of a numerical method we obtain the best groupings of stars in parallelopipeds of size dE, dh, d[Fe/H]. We use a Montecarlo method to calculate the expected number of random groups, and we compare this number with the number of groups obtained. We also calculate the probability that a group situated on a specific point in the space E, h, [Fe/H] is due to random effects. These computations are relevant to establish the physical reality of the groups found.

Key Words: Galaxy: formation — Galaxy: halo — Galaxy: kinematics and dynamics — methods: numerical — stars: kinematics

1. INTRODUCTION

According to the "ΛCDM"cosmological model self-graviting systems form in hierarchic order by mass aggregation and mergers. On galactic scales one can look for observational evidence to sustain this formation process by studying satellite galaxies, galactic mergers and moving clusters.

The member stars of a moving cluster are believed to have a common origin in a cluster that was destroyed by tidal forces and/or dynamical friction in the parent galaxy. Moving clusters are ensembles of stars with very similar metallicities, velocities and orbital characteristics, but not gravitationally bound.

In this work, probable members of moving clusters in the galactic halo were searched for in the catalogue of Schuster et al. (2006), which contain distances, kinematical data and metallicities for a large number of high-velocity metal-poor stars.

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2. THE METHOD

We used a three-dimensional space in which each star is represented by its energy, angular momentum and metallicity (*E, h,* [Fe/H]), to find groupings of stars with similar characteristics. The selection of halo stars was made according to the prescription $[Fe/H] < 0.0079 * h - 0.3724$ (Schuster et al. 2006). There are 480 halo stars in the SN catalog.

To find groups, the stars were enclosed in volumes defined by dE*dh*d[Fe/H]. As a reference for reasonable values of *E, h,* this work takes the differences found for both components of the wide physical binary LDS 519 (Allen, Poveda, & Hernández-Alcántara 2007).

As a first step, empirical frequency distributions for the Schuster et al. (2006) catalogue stars were constructed using the Von Neuman Montecarlo method. The empirical stellar distributions consist of histograms for each variable *E, h,* [Fe/H].

Next, groups were searched for among the random realizations of the catalog, using the volumes dE, dh, d[Fe/H] as defined above. Typically, we obtained 10,000 random realizations of the catalog.

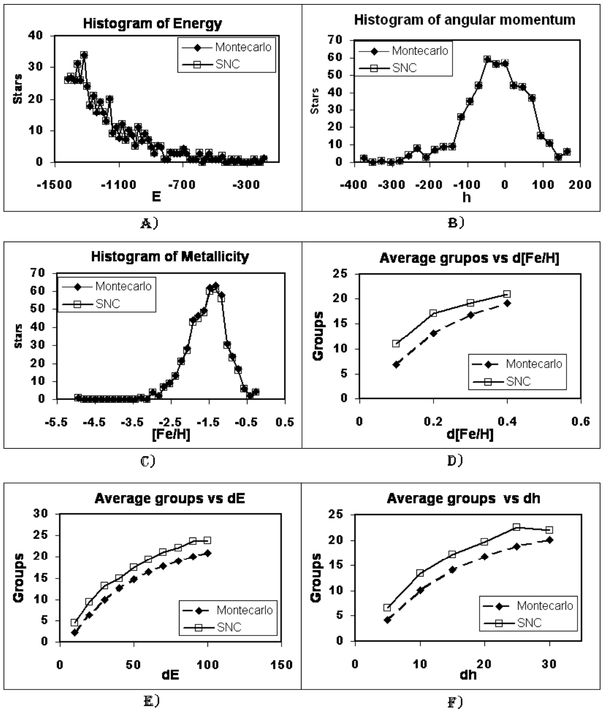

Fig. 1. Panels A, B and C show the empirical distribution in E (100 km^2 s^{-2}), h (10 kpc km s^{-1}), [Fe/H]([Sun]) of the 480 halo stars of the Schuster catalog (SC) and their agreement with the distributions obtained by Montecarlo simulations of the catalogue. Panels D, E and F compare the group numbers found in the SC with the averange group numbers obtained from Montecarlo realizations.

The groups so found were then compared with the groups obtained from the Schuster et al. (2006) catalog (SC), to find the probability that one group of the (SC) is the result of a random distribution.

3. RESULTS

As first result, varying the parameters of the grouping (dE, dh, d[Fe/H]) between (20,5,0.1) and (100,30,0.3) we obtain Figure 1 which clearly shows, in panels D, E, F, that there are more groups in the original catalog that in the Montecarlo simulations for all values of dE, dh, d[Fe/H] in the chosen interval.

The second result compares the expected number of groups among the random realizations with the number of groups found in the SC having the same number of stars in each group. This result is shown in Table 1.

Finally, using the centroid of each group, we identify groups among the random realizations having the same "position" of the groups of the SC and, counting the number of coincidences, we obtain the probability that a group of the SC is the result of a random association. These results are displayed in Table 2.

TABLE 1

EXPECTED AND OBTAINED GROUPS

Expected groups over obtained groups						
Parameters			Number of stars in the group			
dE	dH	d[Fe/H]	4	5	6	7
5	40	0.3	2.3693	0.02789	0.0227	0.0021
...	...	...	6	0	0	0
10	30	0.2	2.5278	0.2969	0.0283	0.0018
...	...	...	5	1	0	0
15	20	0.1	0.567	0.033	0.002	0.0001
...	...	...	3	0	0	0

TABLE 2

PERCENT PROBABILITY THAT A GROUP IS DUE TO RANDOM EFFECTS

Percent probability							
Parameters			Real group number				
dE	dH	d[Fe/H]	1	2	3	4	5
5	40	0.3	0.08	9.85	0.69	1.17	1.89
10	30	0.2	0.42	3.45	0.47	2.61	1.76
15	20	0.1	0.32	0.37	0.35	...	...

4. PRELIMINARY CONCLUSIONS

A method to find candidate member stars to moving clusters has been implemented. The Montecarlo simulations lead us to believe that physical moving clusters do exist among the halo stars of the Schuster et al. (2006) catalog. Future work will consist in identifying our candidate member stars with those of moving clusters previously proposed in the literature (Allen et al. 2007).

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