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NUMERICAL TAXONOMY FOR OPEN CLUSTERS

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RESUMEN. Informamos sobre las potencialidades y progresos del estudio de cúmulos abiertos empleando métodos propios de la Taxonomía Numérica. Estos, aplicados a cúmulos abiertos de nuestra galaxia, permitirían en principio, investigar la realidad de supercúmulos abiertos. Con una juiciosa elección de caracteres sería posible, en el futuro, trazar cuadros más realistas sobre la formación de estos objetos y, finalmente, mejorar nuestro conocimiento sobre la evolución misma de las estrellas.

ABSTRACT. Taxonomic methods are applied to the study of open clusters. The power of the approach is illustrated with some preliminary results, the goal of this effort being that of investigating the existence of possible superclusters, wich in turn should provide interesting insights into the details of stellar evolution.

Key words: CLUSTERS-OPEN

I. INTRODUCTION

It is suggested that new stars are being created within stellar aggregations according to a law, the "initial mass function", that also governs the process of formation of these aggregations (Reddish, 1978). Indeed, observations tend to confirm the hypothesis that contraction of interstellar clouds results in the creation both of stars and of star-aggregations. It is thus natural to associate the process of formation of open cluster with the idea of even greater stellar structures, the so called superclusters.

In this vein, Turner et al. (1980) have investigated similitudes in the Carina nebula, while Lyngå and Wramdemark (1984) did the same with 7 open clusters located within 500 parsecs from the sun. Eigenson and Yatsyk (1987, 1988) have studied the galactic distribution of 361 open clusters by recourse to similitude matrices, with a preordained notion of the distance between components as the basic taxonomic ingredient, which ca be criticized on the grounds of not being realistic enough. These kind of studies is restricted to small groups of clusters, where, for instance, the metallicity is known.

It is our aim to undertake systematic taxonomic studies of groups of clusters on the basis of Lyngå's Open Clusters Catalogue (1983), which lists some 1200 clusters in the Milky Way, together with their main characteristics. However, it must be pointed out that less than 400 objects possess an abundant set of attributes (coordinates, distances, diameters, age, integrated colours and magnitudes, absortion, etc).

With these attributes we build up an N-dimensional "space", within which a similitude matrix can be constructed. This, in turn, should allow one to ascertain possible. Our idea is that of determining under what conditions these associations arise and correllate them with the distribution of clouds in the galactic disk.

II. THE TAXONOMIC APPROACH

In order to taxonomically process the pertinent clusters we have designed an appropriately specialized software, on the basis of phenetic relationships that are constructed out of the similitudes existing in the pertinent data sample (Sneath, 1978). In the case of open clusters we deal with galactic coordinates, l° and b°, distances to the sun, diameters, log τ , etc (the characters) that are subjected to a normalization procedure that enables one to express the concomitant data matrix in standard deviation units (Crisci and Armengol, 1983). Taxonomic distance between the objects of our sample are determined in terms of "similitude coefficients" corresponding to a 5-dimensional space, one dimension per character. The distance coefficient upon which the similitude relations are based is the so-called "Taxonomic distance" (Sokal, 1961) TD

$$TD_{jk} = \{ \sum_{i=1}^{n} (x_{ij} - x_{ik})^2 \}^{1/2}$$

where

x_{ij} is the value for the character "i" in the j-cluster

x_{ik} is the value for the character "i" in the k-cluster

n is the number of characters.

Cluster analysis (Crisci and Armengol, 1983) is invoked so as to obtain taxonomic associations based upon the TD. The resulting groups possess an exclusive characters. At a given level, no object can belong to more than one group.

Starting with N clusters, a hierarchy of subgroups results. They order themselves at various levels in larger and larger subgroups until, at the last one, we end up with a group of N objects.

The taxonomic structure that arises after processing 312 clusters is represented by a so-called phenogram (Fig. 1) Groups formed starting at the similitude level corresponding to the association of 276 clusters (structures J1 and J2 are depicted).The remaining correspond to a higher level.

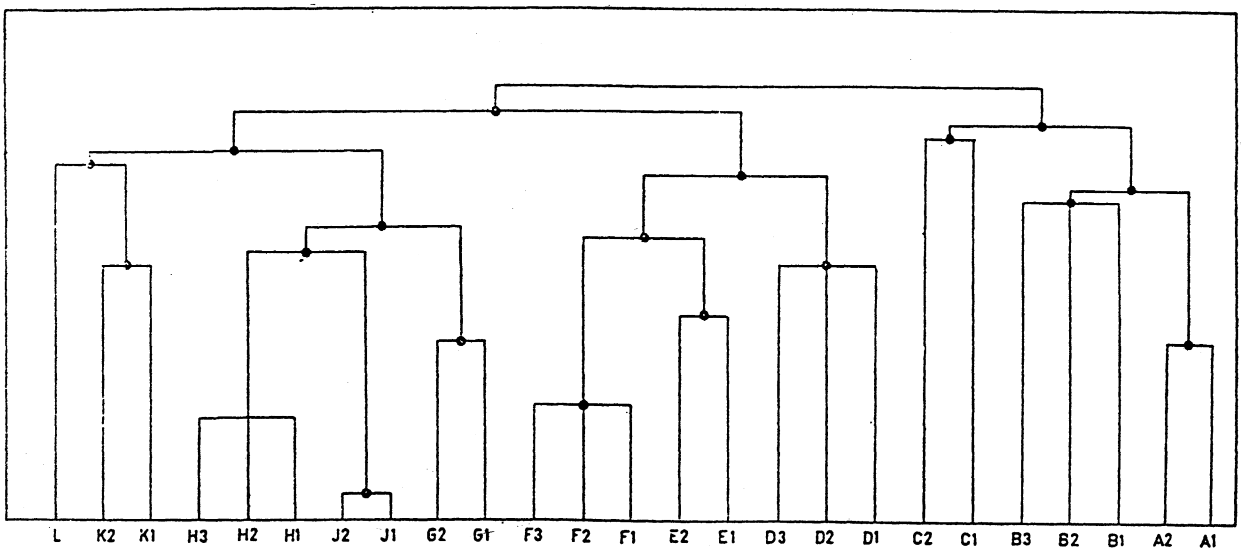

Figure 1: The phenogram of 312 open clusters

I. PRELIMINARY RESULTS

We have employed as characters the following : galactic coordinates (l° and b°), stance to the sun (parsecs), diameters (parsecs), integrated magnitudes, integrated colours, -V)t-o and age logarithm. Our sample consists of 312 open clusters.

Fig.1 exhibits 3 large clusters groups (See Table 1). To two of these belong a jority of 312 clusters. Each of these large groups contains several subgroups (A1,A2,...,B1, ..,L) in which common characteristics become apparent. These subgroups, in turn, exhibit crostructures, that contain between two (a "nucleus") and 15-20 clusters, associated to atial (location) similitudes. The analysis of these microstructures proves to be a rewarding sk. As an example, the components associated in the J1 sub-group are listed (Table 2).

Further work is proceeding along these lines.

TABLE 1. Principal Groups (PG) of the Phenogram (See Fig. 1).

PG	Sub Groups
1	A1,A2,B1,B2,B3,C1,C2
2	D1,D2,D3,E1,E2,F1,F2,F3
3	G1,G2,J1,J2,H1,H2,H3,K1,K2,L

TABLE 2. Members of J1 Subgroup

CLUSTER	l°	b°	Diam.	Dist.	Log τ
NGC 7226	101.42	-0.60	1.20	2200	8.51
NGC 7062	89.93	-2.72	3.90	1900	8.18
NGC 7243	101.37	1.87	2.90	1900	8.34
Be 65	135.84	0.27	4.80	3300	7.16
NGC 7235	102.72	0.78	4.40	3800	6.95
NGC 436	106.07	-3.91	3.80	2200	7.69
KING 14	120.72	0.36	5.50	2600	7.36
NGC 146	120.87	0.49	5.90	2900	7.36
NGC 581	128.02	-1.76	5.10	2600	7.36
NGC 1605	158.61	-1.58	4.10	2800	7.81
NGC 609	127.83	2.11	2.70	3100	7.57
NGC 103	119.80	-1.38	4.80	3000	7.77
NGC 7510	110.96	0.05	3.70	3160	7.77

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