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Fitting of King's model to young star clusters

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Abstract. It was done an analysis of a young cluster sample to investigate the cluster's inherent properties and the dynamical evolution of the stellar components. Particularly, the parameters from King's model measured for clusters. Using consolidated algorithms, as quicksort and genetic algorithm, we developed a series of programs in C++ to organize and plot graphicaly the data of each cluster to obtain the King's profile. With the parameters of the King's mode, we tried to compare them with each other and with the fractal parameter Q.

Resumo. Fez-se uma análise de uma amostra de aglomerados de estrelas jovens com o intuito de investigar as propriedades inerentes ao agrupamento e evolução dinâmica das componentes estelares. Em especial, os parâmetros oriundos dos modelos de King medidos para os clusters. Este projeto foi focado na exploração do tema, estudo sobre os parâmetros envolvidos em nossa análise e o desenvolvimento das rotinas numéricas para o tratamento e estudo dos dados. Com o uso de algoritmos consolidados como quicksort e algoritmo genético, desenvolvemos uma série de programas em C++ que organizaram e plotaram graficamente os dados de cada cluster para enfim obter o perfil de King da cada um. Com os parâmetros do modelo de King em mãos, buscamos comparar eles entre si e com o parâmetro fractal Q.

Keywords. Stars: pre-main sequence – ISM: clouds – Methods: data analysis

1. Introduction

A very significant measurement related to the cluster structure is given by the King's profile of each cluster, which parameter is used, in this study, to find a correlation between structural parameters and other properties found in the literature.

A young cluster sample was analyzed to investigate the inherent properties to the clustering and the dynamical evolution of each star component. In this case, the parameters obtained from the measured King's models for the clusters. In previous works, we have measured the superficial density and the core's radius for a set of clusters and the results were correlated with some other clusters properties (including fractal and geometrical parameters), which show that almost half of these groups has a relation with their parental cloud. These properties can bring us to conclusions about the formation of the clusters (hot or cold collapse), initial evolution and their expected dynamical galactic evolution (crossing time).

With the adjusted parameters from King's profile, we intend to advance to a lager number of clusters and expanded the studied galactic regions through samples at different bands of coordinates.

The analyzed parameters related to the clusters, are:

Core's Radius

Radius where the density is 50% of the central density

Central Brightness

How much brightness the cluster show in its center, this parameter is important in the King's model to relate with the rest of the cluster.

Q parameter

A fractal parameter obtained with the distribution of the stars inside the cluster, and is related with its evolution. This parameter were obtained at another study (Sampa-Hetem, poster 140).

2. Methodology

The study of the early stages of the star's clusters evolution is part of a bigger subject, which includes the comprehension of the cloud-gas to cluster-star transition. As long as the data volume is great, we established a flux to treat and control these data, and execute automatically all the calculations.

With the observational data, the intermediate parameters were calculated through the development and application of numerical routines. Formally, the parameters were obtained by fitting the function that approaches the King's profile for each cluster (Equation 1).

$$\Sigma(r) = \Sigma_\circ \left[1 + \left(\frac{r}{r_c}\right)^2\right]^{-\frac{3}{2}} \tag{1}$$

3. Results

Table 1 presents used data and the obtained results. Each row shows the data of each cluster, in the order: name, two columns of its coordinates, number of members, obtained central brightness and obtained core's radius.

3.1. King's Profile

Figure 1 shows us the fitted profile of some clusters. The blue points represents the histogram of the brightness on radius bands, and the red curve is the adjusted king's profile. The parameters to produce the profile were fitted by using genetic algorithm to find the best adjusted curve for the cluster.

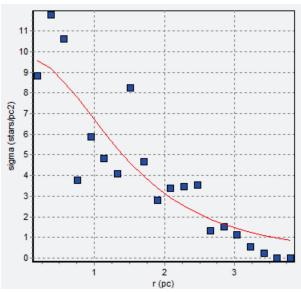
3.2. Analysis

The obtained data about both parameters of King's model were correlated with each other and with the Q parameter of the corresponding cluster, as shown at Figure 2.

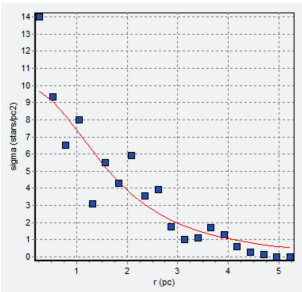
We can see some restricted regions of each graph, which boundaries are evidenced by the red lines, showing a pattern relation between the parameters. Therefore, there are exceptions of these patterns, which were highlighted with the star on the graph.

Table 1. Cluster data and results

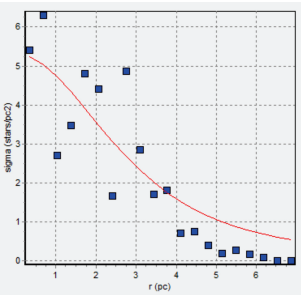
Cluster	l(gal)	b(gal)	Nstars	$\Sigma_\circ$	r_c
Berkeley 86	76,7	1,28	86	7,1644	1,5423
Collinder 205	269	-1,8	177	9,9632	1,9770
Hogg 10	291	0,08	88	5,4948	3,6688
Hogg 22	339	-1,1	98	9,8459	1,7995
Lynga 14	341	-1,1	67	9,9255	1,3138
Markarian 38	12	-0,9	58	9,9649	1,9996
NGC 2244	206	-2,1	296	2,3279	8,8475
NGC 2264	203	2,18	293	1,3307	1,0473
NGC 2302	219	-3,1	70	9,8593	2,0464
NGC 2362	238	-5,5	132	9,6249	3,6776
NGC 2367	236	-3,8	61	9,9218	1,5288
NGC 2645	265	-2,9	104	9,7338	1,8813
NGC 2659	264	-1,7	220	5,8014	4,9636
NGC 3572	291	0,2	151	9,8978	2,1512
NGC 3590	291	-0,2	81	9,9711	1,4295
NGC 5606	315	0,99	99	3,9161	4,2335
NGC 6178	338	1,21	104	3,2920	19,9665
NGC 6530	6,08	-1,3	63	4,6007	1,8835
NGC 6604	18,2	1,69	90	4,0858	4,3548
NGC 6613	14,2	-1	135	9,8757	1,0854
Ruprecht 79	277	-0,8	175	2,9387	13,2255
Stock 13	291	1,6	67	5,3127	2,0034
Stock 16	306	0,06	141	3,0532	5,4898
Trumpler 18	291	-0,1	161	5,3186	3,6053
Trumpler 28	356	-0,3	74	5,5074	3,1733



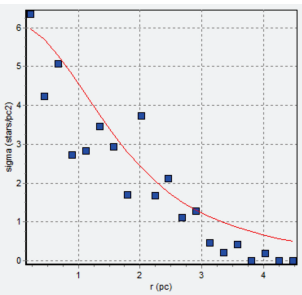
(a) NGC2244



(b) NGC6613



(c) Trumpler 18



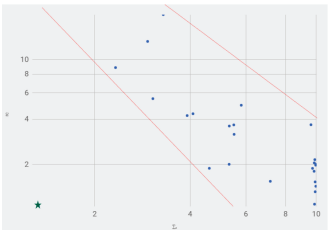
(d) Stock 13

Figure 1. Fitted King's model of 4 analyzed clusters

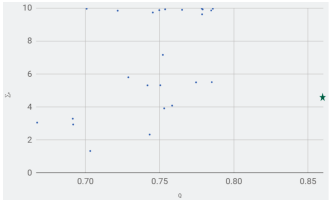
4. Conclusion

By using a series of numerical routines, it were obtained the central brightness and the core's radius value for each cluster of the sample, as shown. With these parameters, a comparative analysis was made correlating the obtained values and the Q parameter (Sampa-Hetem, poster 140).

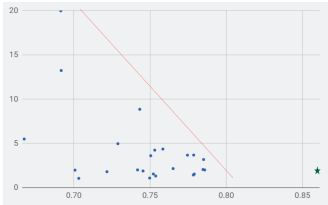
In these correlations we can observe some prohibited regions and a tendency of each parameter on dependence to the others.



(a) $r_c \times \Sigma_\circ$



(b) $\Sigma_\circ \times Q$



(c) $r_c \times Q$

Figure 2. Correlation between the parameters

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