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The Young Star Clusters Parameters in Late Type Spiral Galaxies

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Abstract. An analysis of parameters of the 566 young star clusters in the 35 late type spiral and irregular galaxies is presented. The disposition, the sizes and the colors of the star clusters are studied, based on the multicolor surface photometry data. The ages of the young star clusters are estimated using evolutionary synthesis method. A problem of taking into account the dust contribution is discussed. Most of the clusters are located in the Inner Lindblad Resonance ring and in other resonance rings. In some ring galaxies the distances between neighbouring star clusters are similar. For some of investigated galaxies, the star clusters belonging to a given galaxy have similar ages. A correlation between age and size of star forming regions exists. The younger objects have smaller average sizes. There are no single star forming regions with sizes > 550 pc. In general, the star forming regions in a given galaxy have similar sizes. A correlation between maximal diameter of star clusters and absolute blue magnitude of parental galaxy exists.

1. Observational Data and a Definition of the Parameters

A study of the young star clusters parameters is based on the analysis of both our group UBVRI surface photometry data and observational data by Sakhibov & Smirnov (2001). Our data were obtained for the nine late type spiral and irregular galaxies (NGC 3184, NGC 3726, NGC 4136, NGC 5351, NGC 5605, NGC 5665, NGC 6217, NGC 7292, and NGC 7678) with the 1-m telescope at SAO RAS (Russia), and 1-m and 1.5-m telescopes at MMO (Uzbekistan). We used the data from the ING Archive (La Palma Observatory) for NGC 3184 in addition. We discovered 71 young star clusters in these galaxies. The data by Larsen (1999) for 13 young star clusters in NGC 3184 were used also. Sakhibov & Smirnov (2001) data (color indices and diameters for 482 young star clusters in 26 late type galaxies) were included additionally in our investigation.

The seeing averaged about 0.″8 for the MMO observations and about 2.″0 for the SAO ones. It corresponds to a linear scale from 80 pc for NGC 6217 to 200 pc for NGC 7678. The exception is NGC 5351 (500 pc).

Four parameters for young star clusters were explored (age, diameter, distance to the center of a galaxy, and distance to the nearest (neighbouring) star clusters. The diameters of the young star clusters were determinated as FWHM for regions having a starlike profile, and as distance between points of a maximal light gradient for regions having diffuse profiles.

We are presenting an original method for estimation of young star clusters ages using $UBVRI$ color indices data. The ages of young star clusters were estimated by their positions in the two-color diagram using evolutionary tracks of synthetic aging stellar system by PEGASE2 code (Fioc & Rocca-Volmerange 2001). We used simple stellar population model with Kennicutt IMF and chemical abundance Z equal to 0.008, 0.02, and 0.05. A description of the method is shown in Fig. 1. An algorithm for age estimation is:

$$t_{min}^{UBV} = min(t_1, t_2, t_3) \equiv min[t(Z = 0.008), t(Z = 0.02), t(Z = 0.05)]$$

$$t_{max}^{UBV} = min(t_1, t_2, t_3) \equiv max[t(Z = 0.008), t(Z = 0.02), t(Z = 0.05)]$$

$$t_{min} = max(t_{min}^{UBV}, t_{min}^{BVR}, t_{min}^{BVI})$$

$$t_{max} = min(t_{max}^{UBV}, t_{max}^{BVR}, t_{max}^{BVI})$$

The method is valid for stellar systems with ages from 1 to 100 Myr and three color indices ($U-B$, $B-V$, and $V-I$). Also, the method will be valid for stellar systems older than 100 Myr if we know additional information for one parameter value (intrinsic absorption or Z). We verified our algorithm for estimation of ages of the young star clusters from Sakhibov & Smirnov's list (intrinsic absorption and Z are known). Our result shows knowledge of intrinsic absorption and Z are not very important for age estimation.

2. Results

We confirmed and defined more precisely a dependence between a maximal diameter of star forming regions in late type spiral galaxies and an absolute blue magnitude of parental galaxy. A correlation by our data is

$$logD_{max} = -(1.22 \pm 0.08) - (0.19 \pm 0.03)M_B$$

This confirms the result by Elmegreen et al. (1996) for late type galaxies:

$$logD_{max} = -(1.47 \pm 1.72) - (0.22 \pm 0.09)M_B$$

We found a small correlation between age and size of star forming regions, the younger objects have the smaller average sizes. More detailed study of the correlation requires additional data for star formation history of the investigated objects.

For some of the investigated galaxies, the star clusters belonging to a given galaxy have similar ages. There are no single star forming regions with sizes >

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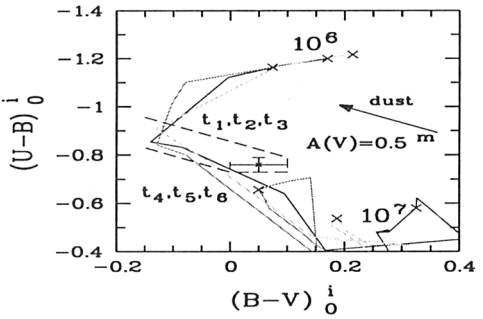

Figure 1. A description of the method of ages estimation for star clusters by their color indices and a position on the two-color diagram. Evolutionary tracks of synthetic aging stellar systems with Z=0.008, 0.02, and 0.05 are shown.

550 pc in the galaxies. A distribution of the star forming regions by diameter does not confirm a hierarchical scale of star formation theory. We didn't find obvious local minima in the histogram of diameter distribution. A possible reason is non-homogeneousness of our young star clusters sample (our list of objects and data by Sakhibov & Smirnov).

In some galaxies all star forming regions are equidistant from the galactic center. Probably, these distances are radii of Inner Lindblad Resonance ring and other resonance rings for the galaxies. However, galaxies exist (including ring galaxies), in which star forming regions are found with different distances from the center. In some ring galaxies the distances between neighbouring young star clusters are similar. In general, young star clusters are situated in distinct places in galaxies. A special scale for distances from the center of a parental galaxy to the young star clusters and for distances between neighbouring young star clusters exists.

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