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Star Complexes in Nearby Galaxies

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Abstract. A method for identification of star complexes in nearby galaxies is applied. The presented method for identification of star complexes was tested for nearby galaxy M33. The data for stellar associations, HII regions and star clusters were used. These objects have a hierarchical structure both in space and time. We apply a correlation technique to compare different populations in M81. Our results show the existence of a strong correlation between OB associations and HII regions, which trace the regions of massive star formation. Stellar associations, HII regions and star clusters probably originate from nearby sites of star formation. We consider this fact as a ground for identification of 35 star complexes in M81 and - 18 in the Milky Way. Based on the search algorithm in the Sect. 2 and the data of Cepheids [1] were found star complexes of Milky Way with space (3D) density 5.0σ density peak with an excess of about ten objects. There is a considerable difference between the mean sizes of star complexes in 8 nearby galaxies and the Milky Way. This result is shortly discussed.

1 Introduction

M81 is a nearby galaxy of early-type Sab type. The inclination between its galactic disk and the plane of sky ($i = 59°$) is suitable for studying the star complexes. [2] defines the star complex as a stellar group of young stars formed together through fragmentation of a dense molecular cloud due to large-scale gravitational instability. A star complex consists of different stellar objects with total mass of about $10^7 M_\odot$. The aim of the present paper is to propose a method for identification of star complexes in M81 by using of observational data for HII regions [3], stellar associations [4] and star clusters [5]. Embedded massive OB stars ionize the gas in HII regions. On the other side, HII regions are physically associated with young star clusters. We suppose those stellar associations; HII regions and young star clusters indicate massive star formation in the star complexes. There is evidence that Cepheids build up large-scale groups as star complexes [2]. Data for Cepheids in M81 are published by [6]. They are members of star complexes too. Based on the search algorithm in the Sect. 2 and the data of Cepheids [1]were found 18 star complexes of the Milky Way in Sect. 3 using space (3D) density 5.0σ density peak with an excess of about ten objects. The results on sizes of star complexes were worthily discussed in Sect.5.

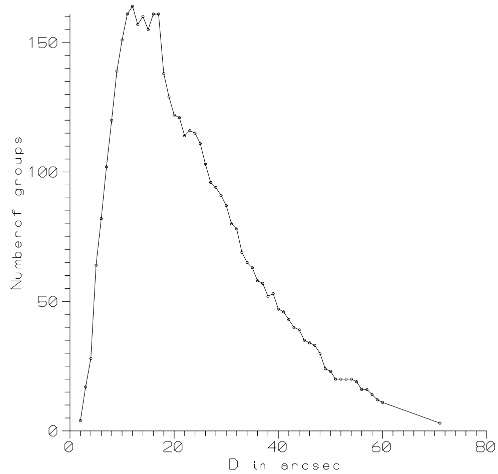

Figure 1. The number of stellar groups versus the scale neighbor distance d_l in arcsec of OB stars in M33.

2 Search Algorithm for Star Complexes in the Milky Way

The clustering method for the identification of stellar groups in nearby galaxies is described in [7]. The nearest neighbor angles

$$d_{i,j} = 3600\sqrt{((15(x_i - x_j)\cos y_i)^2 + (y_i - y_j)^2)}i, j = 1....N, i \neq j, \quad (1)$$

Then the nearest neighbor angles d_l of stars and the mean neighbor angle $< d >$, of each group in galaxies, with density δ, are obtained by equations 1, 2 and 3. In the present study we combine the surveys of stellar associations, HII regions and star clusters in M 81. In order to compare the distributions of these objects, we apply a correlation technique for comparison of populations in galaxes which was published in the Apendix of [9]. Let N1 objects of one population in M81 have surface density δ_1 while another population of N2 objects has a surface density δ_2. The two-dimensional angular distance between the objects of the k-th object couple is $\mathrm{d_k}$ as defined in the Appendix of [8]. Supposing a random distribution of the objects in the galaxy M81, then the probability:

$$\mathrm{P_{12}(k)} = [(1 - \exp(-\pi \mathrm{d_k^2}\delta_1)][(1 - \exp(-\pi \mathrm{d_k^2}\delta_2)], \quad (2)$$

is a measure for associated objects. In case when the associated objects are selected by criterion $\mathrm{P_{12}(k)} < 0.05$, the number of associated couples is indicated with equation 3 as N5. A stronger criterion for selecting associated objets from foreground couples is imposed, if the individual probabilities of the couples $\mathrm{P_{12}(k)} < 0.01$. In this case, the number of associated couples is denoted

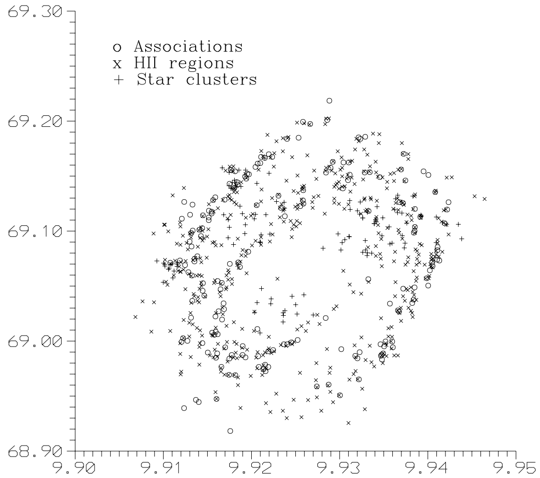

Figure 2. Star complexes in M 81.

with $N1$. A simple way to evaluate the correlation between two populations is to obtain the percentage of associated objects:

$$\mathrm{R5} = \mathrm{N5/N}; \qquad \mathrm{R1} = \mathrm{N1/N}, \tag{3}$$

where N is total number of objects of the two populations $N = N_1 + N_2$ The ratios R1 and R5 given by equation 3 are very suitable measures for correlation between the stellar populations. If all stars of two populations are coincided (fully associated) with each other, then $\mathrm{R5} = 1$ and $\mathrm{R1} = 1$. In the opposite case (no associated stars at all), $\mathrm{R5} = 0$ and $\mathrm{R1} = 0$. The ratios, given by Eq. 3, are analogous to the conventional coefficient of correlation in the statistics.

3 Star Complexes in M81

The correlation between populations in M81 can be interpreted as an evidence of a good correlation between OB associations and HII regions. About 66 % of the OB associations are associated with the center of HII regions. There is a weak correlation between star clusters and HII regions. Probably a fraction

Table 1. General information on M81 galaxy

Coordinates of the center (nucleus):	R.A.$_{2000} = 9^h55^m08.5^s$
	Dec.$_{2000} = +69°07'59.1''$
Distance modulus:	$m - M = 27^m.8$ [6];
	Distance $\approx$ 3.6 Mpc

of young massive clusters that excite the HII regions is not detected. On other side there is no correlation between associations and star clusters because of HST observations of [5] for star clusters do not cover the total area of the galaxy M81. These correlation between populations in M81 are expected. The criterion suggests that the objects will be assigned to the one and the same group if their surface density has a statistical peak above the level of neighbor objects. In other words, the surface density is the main quantity through which one can isolate a star complex from the surrounding objects. The data show that there is real physical connection between the populations of M81. Thus we identify star complexes as regions of physically associated associations, HII regions and star clusters with a peak density, 5 times above the density in the surroundings objects. As the location of a density peak is determined, we take into account the surface density of additional objects like Cepheids in the boundary of the star complexes. The Cepheids do not show considerable concentration toward the star complexes in M81 but many Cepheids fall within the star complexes. The criterion in the Sect. 3 is applied for the objects in M81. HII regions, associations and star clusters were assigned to the one and the same complex if their surface density has a statistical peak above the level of neighbor objects. The data for star complexes in M81 are given in Table 2.

Efremov [2] discusses the existence of two distance scales of star formation. The largest scales that is that of star complexes while the smaller scale is that for OB associations and open clusters. The star complex consists of one or more OB associations, several open clusters, about ten Cepheids and some WR stars. The high density of the respective objects with similar ages delineates the complexes. Coordinates of open clusters, OB associations, Cepheids and WR stars may single the star complexes. We find 18 Star complexes. Each complex in Table 3 contains about 5-10 Cepheids. The mean effective diameter of complexes is $\sim 600pc$. The periods of Cepheids are similar in the same star complex. This is important result is connected with the similarity of ages of members in the star complexes.

4 Star Complexes of the Milky Way

First, we obtain a surface density (2D) peaks above 5σ the background distribution in preliminary. We have to select in a Cepheid candidate star complexes with density 5σ deviation above the background Cepheids of the Milky way. The criterion in Sect. 2 proposes that the Cepheids will be assigned to one candidate star complex if they form a group with density (δ) peak obtained by equation 3 with 5.0 σ deviation above the background and have an excess of ~ 10 stars. This first step is helpful to obtain the density peaks in surface (2D) density above 5σ above the background. In this way were found 31 Cepheid groups. The second step was to combine 2D density peak with a space density peak take into account the distance to Cepheids in a cone angle $d_{i,j}$ of the group obtained by

Table 2. Star complexes in M81: Column 1 gives a running number of star complexes according to increasing right ascensions; Columns 2 and 3 give the right ascensions and declinations for equinox 2000.0; Columns from 4, 6, and 8 give the number of populations within the star complex; Columns from 5, 7 and 9 give the density peaks of objects within the star complex compared to background ones.

1 No	2 R.A.(2000)	3 Dec.(2000)	4 HII_N	5 HII_F	6 Ass_N	7 Ass_F	8 Cl_N	9 Cl_F
1	9.918000	69.141000	8	3.9	3	9.9	8	10.2
2	9.911300	69.068500	6	3.9	4	4.8	0	7.4
3	9.917500	69.157000	7	7.5	3	8.9	3	10.9
4	9.914600	69.098000	9	5.4	4	4.4	3	5.7
5	9.919300	69.152000	4	7.4	5	8.7	4	5.7
6	9.921800	69.169000	5	9.8	4	13.8	1	0
7	9.925900	69.198000	4	35.4	3	0 0		0
8	9.928400	69.201000	4	3.5	2	13.9	0	0
9	9.917300	69.113500	7	12.1	6	4.3	6	7.6
10	9.919900	69.113500	7	13.2	5	5.2	6	7.9
11	9.914300	69.058500	10	7.9	1	17.0	1	13.5
12	9.923900	68.997500	10	6.6	5	9.1	0	0
13	9.922100	68.989500	8	12.2	7	4.7	0	0
14	9.921250	68.975000	7	9.2	5	9.2	0	0
15	9.918250	68.984500	11	12.3	6	11.7	0	0
16	9.916650	69.047600	6	11.0	2	20.0	1	15.8
17	9.913650	69.041000	5	37.3	1	142.3	0	0
18	9.915750	69.006000	6	7.9	4	21.3	1	0
19	9.921100	69.088000	12	5.6	1	2.3	3	11.5
20	9.919250	69.080000	4	6.6	2	6.2	0	0
21	9.924700	69.105000	6	7.1	0	0	2	4.4
22	9.925500	69.125000	12	7.6	4	6.9	5	4.7
23	9.930150	69.143000	11	6.2	1	2.4	1	2.4
24	9.934200	69.111900	8	6.4	1	7.6	0	8.4
25	9.934700	69.096000	6	4.0	1	2.4	5	16.1
26	9.933160	69.079000	7	4.8	0	0	4	13.8
27	9.939160	69.113800	8	9.6	1	49.1	0	8.1
28	9.940700	69.074000	12	6.6	3	26.4	0	0
29	9.933300	69.153000	13	6.8	7	8.5	0	0
30	9.938900	69.077000	13	7.4	1	2.7	1	5.0
31	9.935700	68.997500	5	12.7	5	5.7	0	0
32	9.938300	69.046500	5	8.8	2	5.1	0	0
33	9.928700	69.157700	12	5.6	3	5.7	0	0
34	9.923700	69.122300	14	5.8	4	12.9	2	8.9

equation 1. We then by varying the low and the high distance limits in the space angle (cone) around the 2D cluster center were defined the number of Cepheids within a space volume and when obtain the possible maximum 3D density of the group. In this way we may receive Cepheid space density peak $> 5\sigma$ deviation above the neighboring objects in space. These density centers we call Cepheid complexes. The effective diameter of Cepheid complexes is equivalent to the space volume occupy by Cepheids. The mean diameter of Cepheid

Table 3. Star complexes of Milky Way: Columns 2–3 give the galactic coordinates of the center of the group; Column 4 gives the distance to the center of group in kpc obtained by Cepheids; Column 5 gives the mean period of Cepheids in star complex
Column 6 gives the effective diameter of the complex in kpc.; Columns 7-8 give the number of Cepheids, and WR stars within the complex; Column 9 gives the cone angle $d_{i,j}$, obtained by equation 1 around the star complex; Column 10 gives the designation are of the related objects to star complexes are as following: [11] for association, [12] for open clusters, [1] for Cepheid

1	2	3	4	5	6	7	8	9	10
SC	L	B	$d_{\odot}(kpc)$	$\bar{P}$	$Diam.$	N_{ceph}	N_{WR}	$d\alpha$	Rel. Obj.
1	23.26	-0.08	0.65	5.8	0.639	11	3	18.2	Sgr 8
2	28.03	-0.02	1.69	5.4	0.528	10	-	10.2	C 1839-063
3	68.38	-0.06	0.66	1.7	0.581	10	27	21.7	Vul 4 *
4	86.85	-0.01	1.79	6.2	0.733	12	-	9.8	Cygnus X **
5	116.59	0.00	3.07	3.2	0.639	12	-	5.6	V 407 Cas
6	125.96	-0.02	1.89	1.3	0.799	14	1	9.1	Cep 4, 8; Cas 6
7	163.77	0.03	1.99	2.8	0.643	5	1	12.1	IRC1 + WR
8	205.76	0.00	1.40	1.8	0.515	5	-	16.4	C0611-128
9	206.82	0.02	2.24	2.0	0.704	7	-	10.2	V 465 Mon
10	240.84	0.03	3.38	3.5	0.684	5	-	8.5	BN Pup
11	267.34	-0.08	1.09	4.8	0.867	10	2	21.5	C1057-600; C1054-589; VELA 1A,B+IRC2
12	286.38	-0.02	1.96	1.6	0.499	7	2	8.9	NGC 3766;Car 1A,B,D;Car2
13	289.04	0.01	3.97	6.3	0.436	7	1	4.3	C1059-595;C1045-598
14	293.32	-0.01	1.58	10.7	0.551	9	1	11.1	C1054-589; Cen 1B
15	294.87	-0.04	1.05	6.1	0.330	5	1	11.0	C1057-600
16	297.22	-0.03	3.09	2.5	0.387	5	-	6.9	LV Cen
17	310.59	-0.04	0.61	1.9	0.486	12	-	20.5	Nor1
18	328.9	-0.03	1.54	3.5	0.554	5	-	14.9	IRC3

*SC 3 contains 11 WR stars. The 27 WR stars referred to the region one diameter around the complex.
** SC 4 contains four clusters of [13] and 3 HII regions of [10].

complexes is about 600 pc. The WR stars were found within the complex boundaries. The data of WR stars are from VisieR On-line Data Catalog: I/239/hip/. We also found three IR clumps within the boundaries of star complexes. We call them candidate clusters in star complexes.The data for them are given in Table 4. Some star clusters, associations and WR stars are not in the radius of preliminary Cepheid complex but they are in the distance equal to one effective diameter from the complex center. These objects are referred in the last column of Table 3 as related objects to the star complex. The density peaks of all objects (Cepheids + open clusters, association, WR stars) is significantly above $> 5\sigma$ the background of these objects. The selected objects in this way form the star complex. The data of star complexes of Milky Way are given in Table 3. There are 5 pure-Cepheid complexes, which contain only Cepheids. In these complexes are shown as the related objects the Cepheids nearby to the center of complex in the last column of Table 3. Figure 2 shows the distribution of 455 Cepheids in

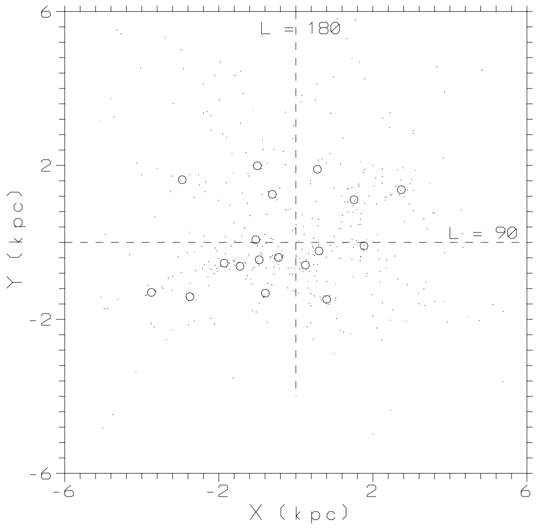

Figure 3. Star complexes on the plane of the Milky Way.

18 star complexes on galactic plane. There are two large regions, which contain several Cepheid complexes. The largest region is identical with the spiral arm Car-Sgr that consists of complexes with numbers from 12 to 18. The spiral arm Per-Cas contain complexes from 5 to 7. The possible Cygnus arm is outlined by complexes with numbers 3 and 4. The position of Cepheid complexes 4 and 17 is not clear. Cepheid complex No 4 may be a part of Perseus arm, while that of No 17 belongs to Car-Sgr. The similarity of mean periods of Cepheids in complexes reflects the nearby ages of different regions in Milky Way. The data in Table 3 show the complexes, except Cepheids, contain other stellar objects as WR stars open clutters and OB associations. The effective diameter of complex is obtained as diameter equivalents to the space volume occupy by Cepheids and other members of the complex. We select the other stellar objets around the Cepheid complexes. We were assigned some open clusters, associations and WR stars if these objects fall within the radius of Cepheid complex. We find many of these objects in Cepheid complexes. In these way Cepheid complexes become real star complexes.

Efremov [2] discusses the existence of two distance scales of star formation. The largest scales that is that of star comlexes while the smaller scale is that for OB associations and open clusters. The star complex consists of one or more OB associations, several open clusters, about ten Cepheids and some WR stars. The high density of the respective objects with similar ages delineates the complexes. Coordinates of open clusters, OB associations, Cepheids and WR stars may single the star complexes. We find 18 Star complexes. Each complex in Table 3 contains about 5–10 Cepheids. The mean effective diameter of complexes is $\sim 600pc$. The periods of Cepheids are similar in the same star complex. This is important result is connected with the similarity of ages of members in the star complexes.

5 IR Clumps in Star Complexes

The largest scales are that of star complexes while the smaller scale for OB associations and open clusters. The star complex consists of few OB associations, open clusters and about ten Cepheids. In present section is reported the results of a search of IR clumps in star complexes defined in Table 3. The near infrared wavelengths (J, H and K_S are suitable for a systematic search in the regions of active star formation in Milky Way as star complexes. The near infrared wavelengths (J, H and K_S make use the 2MASS survey to search stellar density peaks in the Galaxy towards the regions suspected as active star formation regions. The JHK_S data were obtained by means of the 2MASS Survey facility in the web interface http://visier.u-strasburg.fr/. The data in circular area of 30 arcmin in star complexes were examined for density peaks, which was define as the ratio of total number of stars comparing with neighbor background stars. Our experiments on the fields of star complexes give the stellar density $\sim 5\sigma$ deviation above the background, combined with a colour criterion $J - K_S < 1.1$. We use quite small areas within complexes with radius from 1 to 4 arcminutes. The color criterion $J - K_S < 1.1$ is good for eliminating the most of infrared background objects. We compare color-magnitude diagrams (CMDs) in the region of stellar density peak and in the same area of neighboring background field. Such comparison provide an additional test that criterion $J - K_S < 1.1$ is good for selection blue stars where domate MS stars. We combine the stellar density peaks which exceed $\sim 5\sigma$ above background stars which have colors $J - K_S < 1.1$ in different field of star complexes. In this way we found 22 regions with stellar density peaks 5σ deviation above the background. We store the total number of stars, the magnitudes K_S and colors $J - K_S$ in 22 regions. We suppose that some of them are probable clusters embedded in known star complexes in Table 3. The cloud-magnitude diagram in density peak regions shows that possible OB stars appear at $K_S \sim 12$. It means that we expect the OB stars in a probable open cluster would be weaker than $K_S \sim 12$. We search for clusters as follows: (i) density peaks 5σ deviation above the background in small areas ii) density peak with an excess of about 100 stars. From 22 IR clumps the method of Dura & Bica (2001) was applied. We found three groups for which the distances are nearby to that of star complexes. We call them candidate clusters. The data for three candidate open cluster are given in Table 4.

Table 4. Reddening and distances of candidate IR clusters by method of Dutra and Bica [13]. The contents of the table are as follows: Columns 2–3 give the right ascension and declination of the cluster centre for equinox 2000.0; Column 4 gives the mean magnitude K_S of the 10th brightest star, supposing that it is MS star; Column 5 gives colour excess of candidate cluster $E_{J-K_S} = (J - K_S) - (J - K_S)_0$, where the $(J - K_S)$ is colour of the 10th brightest star; Column 6 gives a distance to the candidate cluster by method of Dutra and Bica [13]; Column 7 gives the angle in degree from the center of the related complex in Table 3; Column 8 gives the designation of related star complex

1	2	3	4	5	6	7	8
IRC No	RA	Dec	K_S	$E_{(J-K)}$	$d_{\odot}(kpc)$	$d\alpha$	SC No
1	04:50:39.6	40:36: 01	12.64	0.46	2.83	0.0	SC7
2	10 :57:52.0	-59 :44:17	11.79	0.87	1.76	0.0	SC11
3	15:19:39.8	-59 :35:00	10.49	1.44	0.77	0.3	SC18

6 Discussion

Figure 2 shows the locations of the star complexes in M81. Their boundaries are delineated using the peaks of surface density of associations and HII regions. The coordinates of the center of the complexes and the surface density of the objects within the star complex are given in Table 2. The most of star complexes occupy the regions of the two main spiral arms. They usually contain stellar associations and bright HII regions. There is observational evidence for a strong concentration of OB stars toward the centers of bright HII regions. The overlapping of OB stars' groupings and HII regions in one and the same star complex is a good indicator for the age of the complex. We suppose that the complexes outline the extended regions with the youngest objects in of M81.The complexes outline clearly the two main spiral arms. The star complexes absent in the central region of M81. The galactic regions, occupied by star complexes, can be considered as sites of active star formation.

6.1 Size of star complexes as distance indicator

The dimensions of star complexes measured along the major axis fall in the range from 12 arcsec to 1 arcmin. The mean dimension of star complexes is 21.6 arcsec. If we accept the distance 3.6 Mpc [6] the mean size of star complexes is $\approx 400pc$. Most of HII regions occur in star complexes. The average content is 8 HII regions per complex and 2-3 associations and star clusters per complex. The star complexes in M81 are outlined mainly by HII regions. This fact suggests that M81 be in a state of active star formation. We carried out an experiment to compare the mean size of star complexes of M81 with other nearby galaxies. Some authors attempted to use the superassociations as distance indicators, They have a length scales of $\sim 500pc$, similar to star complexes. The results for star complexes are given in Table 4. For three galaxies M33, NGC 6946 and our

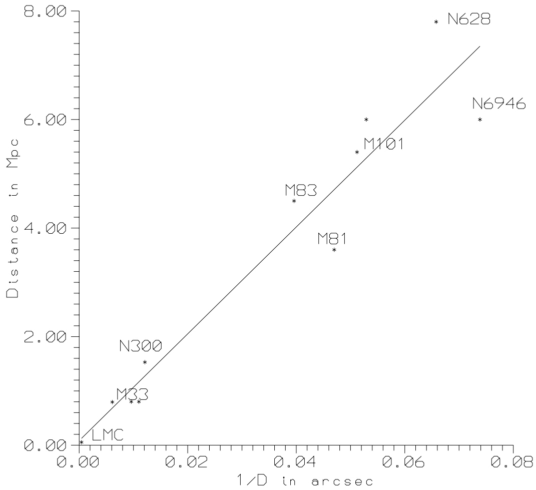

Figure 4. The distance to the galaxies versus the reciprocal average size of star complexes.

Galaxy the mean size of star complexes was obtained using the different objects outlined the star complexes. If we suggest that the mean size of star complexes is a universal unit $\sim 500pc$, it is possible to obtain the distances to the galaxies. However our data in column 6 of Table 4 show a considerable dispersion of $\sim 0.7Mpc$ in the calculated distances. We conclude that the mean sizes of star complexes in galaxies are not suitable as distance indicator to galaxies. On the other side the size of star complexes may depend onthe rate of star formation. The size of star complexes in M33 is about 600 pc in outer region and about 300 pc in the central region. This fact is some hint that the mean size of star complexes depends on the rate of star formation of the galaxy.

6.2 Supernonae in M33

The boundaries of star complexes in M33 was outlined using the peaks of surface density in OB stars, WR stars, HII regions, RSGs, supernovae and supernova remnants (SNs) of [25] are given in Figure 5. Almost 98 & of SNs are within the star complexes. The coordinates of the center of complexes and the number of the objects within the star complex are given in Table 5. Substantial members of complexes are Red supergiants (RSGs), SNs, HII regions, WR stars, and Cepheids. Most of them about 80 % falls in the same star complex. The tight correlation between RSGs and SN confirms that the disposition of the two populations on the nearby sites in the galaxy. The stars which dispose on remote regions in the galaxy have a negligible influence of our correlation parameters between SN and RSGs. Take into account the data for RSGs and WR stars

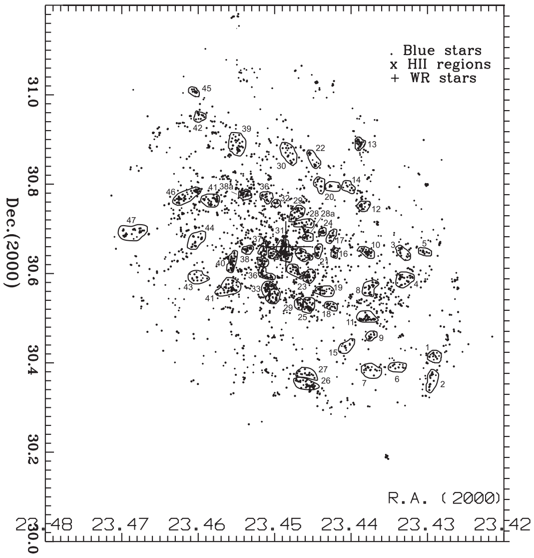

Figure 5. Star complexes in M33

Table 5. Supernonae in Star complexes of M33. The contents of the table are as follows: Column 1 gives a running number of star complexes according to increasing right ascensions; Columns 2 and 3 give the right ascensions and declinations for equinox 2000.0. in degree; Columns 4-8 give the number of populations within the star complex; Column 9 gives the number of star complex, denoted in Figure 5.

1 No	2 R.A.(2000)	3 Dec.(2000)	4 HII_N	5 WR_N	6 RSG_N	7 $Ceph_N$	8 SN_N	9 SC
1	23.4332	30.6400	129	22	52	73	4	5
2	23.4375	30.3817	61	4	22	18	7	8
3	23.4380	30.6470	138	24	51	70	4	10
4	23.4422	30.6467	138	25	52	73	4	16
5	23.4422	30.6800	133	38	54	47	8	17
6	23.4428	30.5250	105	30	40	104	4	18
7	23.4429	30.5560	124	48	57	112	6	19
8	23.4455	30.7150	112	38	45	75	5	24
9	23.4459	30.6895	124	34	55	56	8	28
10	23.4502	30.5540	127	47	53	99	9	33
11	23.4511	30.6580	146	36	56	70	5	34
13	23.4512	30.5986	131	38	50	76	4	36
14	23.4535	30.6560	143	36	54	77	4	38
15	23.4555	30.8875	61	0	15	11	4	39
16	23.4579	30.7615	97	22	41	109	4	41
17	23.4600	30.9449	37	2	8	8	8	42
18	23.4607	30.6802	130	37	59	73	5	44
19	23.4678	30.6875	110	30	58	5	5	47

Table 6. Star complexes in nearby galaxies. The contents of the table are as follows: Column 1 gives the name of galaxy; Column 2 gives the distance to the galaxy; Column 3 gives the sizes of star complexes in arcsec along the major axis of galaxy; Column 4 gives the sizes of star complexes in parsecs along the major axis of galaxy; Column 5 gives the sizes of star complexes in parsecs along the major axis of galaxy; Column 6 gives the distance to the galaxy if we suggest that the mean size of star complexes is 500 pc; Column 7 gives the number of star complexes determined in each galaxy; Column 8 gives the sources of observational data as follows: 1= data were obtained by means of the 2MASS Survey facility in the web interface http://visier.u-strasburg.fr/; 2= Blue stars of [15], HII regions of [16], WR stars of [17], Supernona of citegor; 3= OB stars of [18]; 4 = RSG from 2 MASS catalog of [19]; 5 = HII regions of [20]; 6 =HII regions [3] , star clusters of [5]; 7 =HII regions of [21]; 8= HII regions of [22]; 9=HII regions of [23]; 10= OB stars of [24]; 11 = HII regons of [26]; 12 = OB star based on Hiparcos catalog: VizieR On-line Data Catalog: $I/239/hip_main/$; 13 = Cepheids of citeberd

1	2	3	4	5	6	7	8
No	galaxy	Distance in Mpc	Size in arcsec	Size in pc	Calc. in Mpc	N_{sc}	Ref.
1	LMC	0,055	2330	620	0.044	169	1
2	M33	0.795	161	620	0.64	126	2
3	M33	0.802	91	350	1.13	3	3
4	M33	0.802	104	440	0.99	51	4
5	NGC 300	1.53	82.8	600	1.24	21	5
6	M 81	3.6	21.2	400	4.86		6
7	M 83	4.5	25.2	460	4.09	7	7
8	M 101	5.4	19.5	570	5.8	35	8
9	NGC 6946	6.0	18.9	550	5.4	25	9
10	NGC 6946	6.0	13.54	400	7.6	16	10
11	NGC 628	7.8	14.1	490	7.3	3	11
Galaxy	-	-	-	450	-	120	12
Galaxy	-	-	-	600	-	18	13

in Table 5 we conclude that RSGs in M33 with masses $15-20M_{\odot}$ evolve to WR stars and the most massive of the RSGs evolve to SN. The star complex SC 31 in the center of M33 indicates the extended central region of M33 with the youngest objects of the galaxy M33 . If our sample of RSGs have masses in the range of $120M_{\odot}$, we expect to find the both RSGs WR stars and SNs. We can conclude from the stellar populations of star complexes that predictions of [14] for the influence of metalisity over the star's lifetime are confirmed by observations. The chemical composition in star complexes of M33 is better defined than in other galaxies. However, if should take into account the local inhomogeneities in the abundance of heavy elements which may explain the vary the number of SNs, WR stars and RSGs from various star complexes.

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