

STELLAR ASSOCIATIONS IN NGC 6946

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Abstract. A catalogue of 41 OB associations in NGC 6946 is proposed. The distance to the galaxy is derived (about 6 Mpc) from the mean size of the stellar associations.

1. INTRODUCTION

NGC 6946 is a Scd type galaxy (Tully 1988) with two well pronounced spiral arms. The distance to it is 5.5 Mpc (Tully 1988). The spiral arms are dominated by significant number of stellar groups and HII regions. The stellar associations in NGC 6946 are not yet identified. However, this galaxy is a suitable object for identification of OB associations.

2. OBSERVATIONAL DATA

The CCD observations were made on October 9, 1990 in the standard photometric system BVR. The size of the CCD chip is 512 x 512 pixels, one pixel corresponding to 0.61 x 0.81 arcsec. The exposure time in each filter was 900 sec. The stellar associations were identified by means of PCVISTA image processing programs for IBM-PC (Trefferes and Richmond 1989). We located 41 stellar groups that are more than 3σ brighter than the local background. The calibration curves were constructed using the CCD photometry of the open cluster NGC 7790 (Cristian et al. 1985). The mean errors of our calibrations are 0.13 in B, 0.02 in V and 0.05 in R-passband. The integral magnitude V and the integral colour index V-R were obtained for each group.

The contents of Table 1. are as follows: Column 1 gives the sequential number of the associations (see Fig. 1) arranged by increasing right ascension. Columns 2 and 3 give the equatorial coordinates of the associations. Column 4 gives the size of the association in arcsec. Column 5 gives the number of member stars. Column 6 gives the designating number of the HII region(s) which coincide(s) with the association.

3. DISCUSSION

The seeing of our observation (2 arcsec) enables discrimination between blue stars in stellar associations and foreground Galactic stars. The mean visible size of the associations depends on the distance to the galaxy. It is difficult to demarcate their boundaries in a remote galaxy due to resolution problems.

Table 1. Stellar associations in NGC 6946.

No	R.A. 1950	Dec. 1950	V	V-R	SIZE	Nst	No of HII ident.
1	20 33 19.8	60 0 13	20.22	2.90	2.4	3	605
2	20 33 21.3	60 0 17	19.05	1.33	4.1	5	597
3	20 33 22.6	60 0 25	18.37	1.86	4.1	4	589
4	20 33 28.6	59 58 5	15.86	0.96	5.1	5	541
5	20 33 31.7	60 0 60	19.97	1.79	2.0	4	524,525
6	20 33 32.5	60 1 7	18.84	1.19	2.4	4	518
7	20 33 33.6	59 57 55	19.15	0.38	2.4	4	495
8	20 33 33.7	60 1 21	18.41	1.66	5.1	7	501
9	20 33 34.5	59 59 13	16.69	0.39	3.0	3	497
10	20 33 36.3	59 58 51	18.47	2.15	1.6	3	471
11	20 33 45.0	59 57 31	19.72	1.94	3.0	5	386
12	20 33 45.3	60 0 15	16.66	0.88	2.4	5	393
13	20 33 45.7	59 57 54	18.46	1.66	4.1	4	377
14	20 33 46.4	59 57 36	19.04	2.12	3.0	5	376
15	20 33 47.5	60 2 17	20.28	1.76	2.0	3	371
16	20 33 47.8	59 57 21	18.45	1.48	4.1	3	354
17	20 33 48.5	59 59 57	18.63	1.12	2.0	4	-
18	20 33 48.7	60 2 17	20.33	2.32	2.2	4	-
19	20 33 48.8	59 57 3	18.36	1.55	4.1	3	342
20	20 33 50.0	59 56 50	17.88	1.49	4.1	7	324
21	20 33 50.0	60 2 22	16.33	1.19	4.1	7	334
22	20 33 50.9	59 56 55	16.74	0.91	4.1	5	324
23	20 33 51.5	60 0 6	18.37	0.51	1.4	3	313
24	20 33 51.6	60 0 15	17.33	1.17	1.2	3	299,314
25	20 33 51.8	59 57 17	18.67	1.49	2.8	3	293
26	20 33 53.1	60 2 23	17.73	1.02	1.0	3	290,301
27	20 33 53.2	60 0 31	17.63	1.11	3.7	5	288
28	20 33 54.7	60 0 26	16.65	1.02	4.1	7	277
29	20 33 56.5	59 58 1	18.80	1.55	7.1	8	247
30	20 33 56.6	59 58 23	17.95	1.01	4.1	5	250
31	20 33 58.7	59 58 39	17.51	0.63	4.1	5	234
32	20 34 0.7	60 0 32	19.76	2.04	1.2	3	215
33	20 34 2.2	60 0 30	17.83	1.21	3.0	5	181
34	20 34 3.5	60 0 35	16.63	1.36	2.4	4	174
35	20 34 5.5	60 0 49	17.90	1.33	3.0	5	170
36	20 34 6.3	59 59 8	17.17	1.56	3.5	5	159
37	20 34 7.7	59 58 55	18.47	1.54	3.0	5	148
38	20 34 8.2	59 58 33	18.46	1.92	2.0	4	138
39	20 34 9.0	59 58 38	18.56	1.88	3.0	5	124
40	20 34 9.0	59 58 48	18.23	1.81	5.1	7	136
41	20 34 9.5	59 58 11	18.37	2.18	3.5	4	119

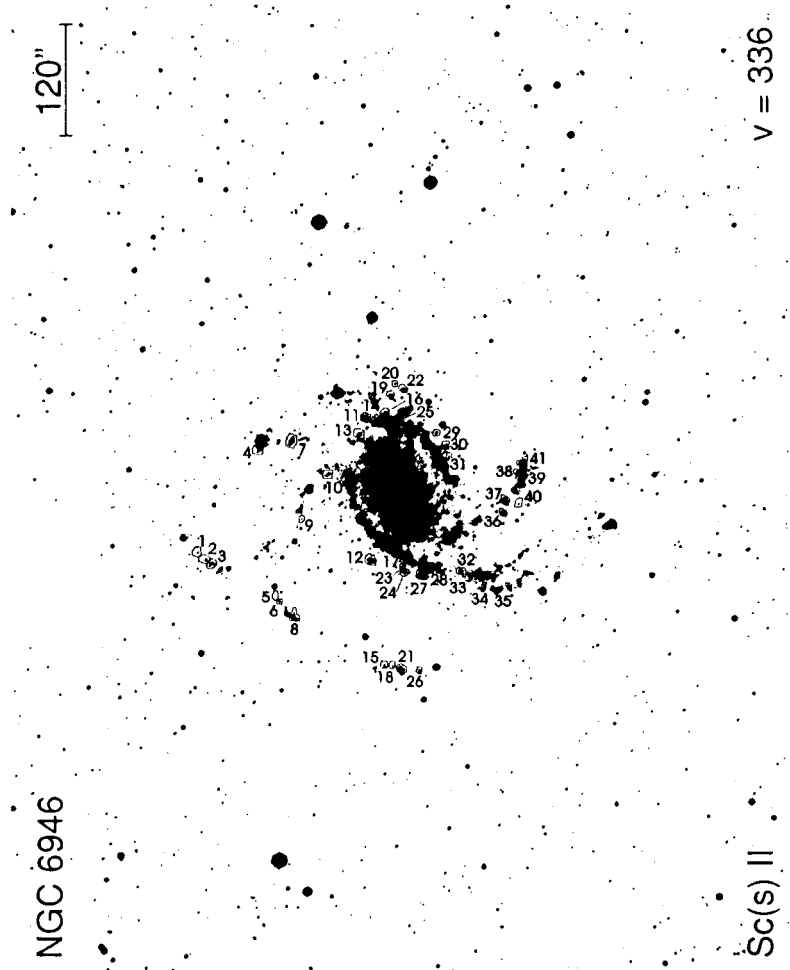


Fig. 1. Stellar associations in NGC 6946.

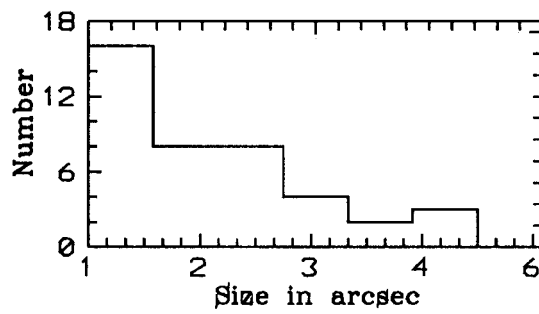


Fig. 2. Size distribution of the stellar association in NGC 6946.

Some of our stellar groups exhibit two or three cores which are resolved into stars. In that case, one deals perhaps with two or more sub-associations. The size and the number of member stars of the studied groups are typical for the stellar associations. Part of the associations are located in severely crowded regions of the spiral arms. In order to test if these are real associations, we performed visual inspection of the Atlas of Sandage and Bedke (1988) and found evident similarity between the selected stellar groups and those identified as OB associations in other nearby galaxies like Magellanic clouds, M31 and M33. Therefore one has to classify them as OB associations.

The size of associations was measured on our CCD frames as well on the maps of Sandage and Bedke (1988). It seems that the seeing of the Atlas is the same as that of our observations. We compared the locations of the associations with those of the HII regions studied by Bonnarel et al. (1984). The majority of the HII regions are ionized by cluster of OB stars in associations and not by a single O star. When the distance to a galaxy is more than 5 Mpc, the stellar clusters could not be resolved into stars. However, the size distribution of our objects shown in Fig. 2. is typical for the stellar associations. Thus the OB associations probably can not be mistaken for other groupings like aggregates and star complexes whose size distributions have their maximum shifted toward larger sizes. The mean size of the aggregates and of stellar complexes is respectively three and ten times larger than that of stellar associations (Ivanov 1987). Supposing that the mean size of a stellar association is about 80 pc (Ivanov 1987), one could obtain the distance of the galaxy. The size distribution of the associations identified with 6 m telescope is shown in Fig. 2. The mean size is 2.9 arcsec which gives a distance to NGC 6946 of about 6 Mpc. This estimate is close to the value from the catalogue of Tully (1988).

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References

- Bonnarel, F., Boulesteix, J. and Marcelin, M.: 1986, *A&AS*, **66**, 149.
 Cristian, C.A., Adams, M., Barnes, J.V., Butcher, H., Hages, D.S., Mould, J.R. and Siegel, M.: 1985, *PASP*, **97**, 363.
 Ivanov, G.R.: 1987, *A&SS*, **136**, 113.
 Trefferes, R.R. and Richmond, M.W.: 1989, *PASP*, **101**, 725.
 Tully, R.B.: 1988, *Nearby Galaxies Catalog*, Cambridge University Press, Cambridge.
 Sandage, A. and Bedke, J.: 1988, *Atlas of Galaxies Useful for Measuring of the Cosmological Distance Scale*, NASA, Washington DC.