

A study of the Shk40 compact galaxy group

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Abstract

A compact group represents a specialized type of galaxy system where member galaxies are separated by distances roughly equivalent to the size of galaxies themselves. The intense interactions among these galaxies make compact groups ideal laboratories for investigating the environmental impacts on galaxy evolution. In this study, we aim to investigate the Shk40 cluster from the Shahbazian catalog of compact groups of galaxies.

Keywords: *galaxy; Galaxy compact group*

1. Introduction

Galaxies are the building blocks of the visible universe, inhabiting a variety of environments from isolated fields to dense galaxy clusters. Observations show that over half of the galaxies are located in group systems, which have members ranging from a few to dozens (Huchra & Geller, 1982, Yang et al., 2007). Among the various clusters and groups of galaxies, significant attention is given to compact clusters or groups composed of compact galaxies. These systems are particularly noteworthy due to the minimal redshift dispersion observed among the brightest and most compact galaxies within them. A compact group represents a specialized type of galaxy system where member galaxies are separated by distances roughly equivalent to the size of the galaxies themselves. The intense interactions among these galaxies make compact groups ideal laboratories for investigating the environmental impacts on galaxy evolution. Both simulations (Brasseur et al., 2009), and observations (Lee et al., 2004) have shown that the fraction of early-type galaxies in compact groups is significantly higher than in normal groups. Galaxies within compact clusters exhibit a systematically larger concentration index and higher surface brightness, suggesting that star-forming galaxies are more likely to be quenched in such environments clusters (Coenda et al., 2012).

The study of compact groups of compact galaxies was initiated at the Byurakan Observatory during the 1960s. The first catalog of 30 compact groups of compact galaxies was published by Shakhbazyan (1973). Between 1973 and 1979, Shahbazian, Petrossian, and their colleagues, using red maps from the Palomar Sky Survey, found and published ten lists of compact groups of compact galaxies. In 1998, the HEASARC included a related database table, SHK GALAXY, which contains data on the individual galaxies in the Shakhbazian Compact Groups. This catalog is a compilation of the ten lists and includes 377 groups of compact galaxies. It provides identifications, equatorial coordinates, numbers of constituent galaxies, magnitudes of the brightest member, sizes of the groups, and coefficients of relative compactness: VizieR On-line Data Catalog: VII/89B (Stoll et al., 1998).

2. Observation

The images of group Shk40 were obtained in 2023 with the 1-m Schmidt telescope of Byurakan observatory, which was upgraded during 2013 – 2015 and equipped with CCD detector. Reworked 4K×4K Apogee (USA) liquid-cooled CCD camera was used as a detector with a pixel size of 0.868" and field of view of about 1 square degree, which is suitable for the study groups of galaxies (Dodonov et al., 2017). Wide-band filter centered on 6200 Å to 7000 Å, were used. Such data ensure the successful classification of objects and measurement of redshifts by analysis of energy distribution in the objects spectra. Bad weather conditions did not make it possible to observe the Shk40 group with different filters and for different periods of time.

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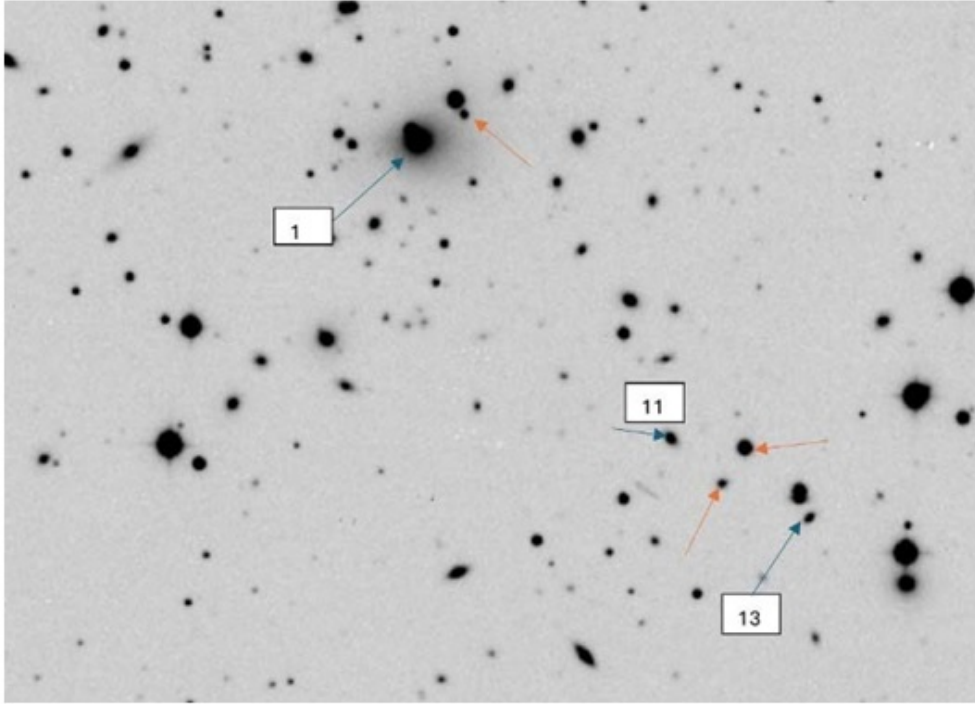


Figure 1. Image of Shk40 taken with 1m telescope BAO

3. Results

The images of group Shk40 taken in 2023 with the 1-m Schmidt telescope of Byurakan Observatory were processed using the standard IDL package, which includes bias subtraction, cosmic ray removal, and flat fielding using “super flat-field”, constructed by several images. The image of Shk40 is given in the picture. Galaxies Shk40-17 and Shk40-59 are not visible in the image, and members Shk40-9, Shk40-21, Shk40-22, Shk40-40, Shk40-53 and Shk40-54 are barely visible. Shk40 is a relatively rich and compact galaxy cluster, originally cataloged with 60 galaxies. Our objective was to identify the galaxies within this cluster, accurately determine their coordinates using Gaia DR3 data, and discover any additional galaxies that belong to the cluster but were not included in the original catalog. We include the 4 newly discovered galaxies marked in red in the Figure 1, which data are given in Table 1. The corrected coordinates of galaxies the Shk40 compact group, Gaia DR3 and 2MASS photometric data are given in Table 2.

Table 1. Newly Discovered Galaxies in Shk40

Galaxy ID	RAJ200 "h:m:s"	RAJ2000 "d:m:s"	GaiaDR3	G mag	2MASS mag	J mag	H mag	K mag	Z Redshift	Galaxy identification
Shk40-61	01 24 50.81	+08 37 43.32	Gaia DR3 2578884117559664768	21.21	01245081+0837432	15.79	15.15	14.78	0.04136	WINGS J012450.82+083743.3
Shk40-62	01 24 31.25	+08 38 24.42	Gaia DR3 2578881403140332672	21.13	01243126+0838244	15.06	14.38	14.03	0.04719	WINGS J012431.24+083824.4
Shk40-63	01 24 49.86	+08 38 12.28	Gaia DR3 2578887072497163904	21.21	01244986+0838122	11.17	10.53	10.3	0.050719	[TSK2008] 2056
Shk40-64	01 25 05.29	+08 42 20.66	Gaia DR3 2578889168441231232	21.27	01250576+0842314	12.16	11.69	11.64	-	LEDA 138365

4. Summary

During the study of group Shk40, we performed the following steps:

- *Identification of Galaxies:* We began by cross-referencing the original catalog with current astronomical databases to confirm the listed galaxies' identities and properties
- *Coordinate Determination:* Utilizing the high-precision data from Gaia DR3, we precisely determined the celestial coordinates of each galaxy in the cluster. This data provided us with accurate positions, which are crucial for detailed astronomical studies.
- *Search for Additional Members:* We conducted a thorough search within the region of the cluster to identify potential cluster members that were not included in the original catalog. This involved analyzing photometric and spectroscopic data to confirm their membership.
- *Catalog Update:* Finally, we have updated the Shk40 catalog (which data are given in Table 2.), and include the 4 newly discovered galaxies marked in red in the Figure 1, which data are given in Table 1.

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References

- Brasseur C. M., McConnachie A. W., Ellison S. L., Patton D. R., 2009, [Mon. Not. R. Astron. Soc.](#) , **392**, 1141
- Coenda V., Muriel H., Martínez H. J., 2012, [Astron. Astrophys.](#) , **543**, A119
- Dodonov S. N., Kotov S. S., Movsesyan T. A., Gevorkyan M., 2017, [Astrophysical Bulletin](#), **72**, 473
- Huchra J. P., Geller M. J., 1982, [Astrophys. J.](#) , **257**, 423
- Lee K. H., Lee H. M., Fahlman G. G., Sung H., 2004, [Astron. J.](#) , **128**, 2838
- Shakhbazyan R. K., 1973, *Astrofizika*, **9**, 495
- Stoll D., Tiersch H., Braun M., Cordis L., 1998, VizieR Online Data Catalog: Shakhbazian compact groups of galaxies (Stoll+ 1993-97), VizieR On-line Data Catalog: VII/196. Originally published in: 1993AN....314..225S; 1993AN....314..317S; 1994AN....315...11S; 1994AN....315...97S; 1996AN....317..239S; 1996AN....317..315S; 1996AN....317..383S; 1997AN....318....7S; 1997AN....318...89S; 1997AN....318..149S
- Yang X., Mo H. J., van den Bosch F. C., Pasquali A., Li C., Barden M., 2007, [Astrophys. J.](#) , **671**, 153

Table 2. Corrected Coordinates and Photometric Data for Shk40 Galaxies

Shk40	RAJ200 "h:m:s"	RAJ2000 "d:m:s"	GaiaDR3	G mag	2MASS mag	J mag	H mag	K mag	Z redshift
Shk40-1	01 25 07.63	+08 41 57.11	GaiaDR3 2578889168441231744	19.71	01250762+0841576	12.87	12.27	11.83	0.0501
Shk40-2	01 25 03.04	+08 42 45.02	GaiaDR3 2578889237160675968	20.09	01250304+0842450	15.2	14.61	14.28	0.0601
Shk40-3	01 24 59.25	+08 42 07.18	GaiaDR3 2578887725332188800	19.4	01245925+0842070	14.14	13.42	13.05	0.0479
Shk40-4	01 24 58.46	+08 42 16.13	GaiaDR3 2578887931490618624	20.57	01245846+0842160	15.68	15.02	14.74	-
Shk40-5	01 25 00.24	+08 41 31.20	GaiaDR3 2578887725331667968	20.29	01250024+0841311	15.45	14.94	14.53	-
Shk40-6	01 24 58.78	+08 40 39.76	GaiaDR3 2578887617957441408	20.82	01245878+0840396	15.55	14.97	14.67	0.0514
Shk40-7	01 24 55.19	+08 41 20.44	GaiaDR3 2578887690972682112	21.13	01245518+0841204	15.82	15.22	15.03	0.0494
Shk40-8	01 24 56.12	+08 40 02.27	GaiaDR3 2578887519173981568	19.31	01245612+0840022	14.21	13.57	13.21	0.0467
Shk40-9	01 24 53.74	+08 39 57.27	GaiaDR3 2578887484813505536	21.06	01245373+0839573	16.00	15.27	15.09	-
Shk40-10	01 24 54.10	+08 39 17.96	GaiaDR3 2578887484814259968	21.86	01245413+0839180	16.27	15.78	14.81	0.0501
Shk40-11	01 24 53.62	+08 38 16.27	GaiaDR3 2578884151919622272	20.08	01245362+0838162	15.05	14.46	13.99	0.0528
Shk40-12	01 24 50.81	+08 37 43.32	Gaia DR3 2578884117559664768	20.37	01245081+0837432	15.79	15.15	14.78	-
Shk40-13	01 24 46.14	+08 37 19.75	Gaia DR3 2578886969418168704	20.82	01244615+0837196	15.78	14.96	14.89	-
Shk40-14	01 24 40.89	+08 36 32.19	Gaia DR3 2578881059542951296	19.79	01244089+0836322	13.85	13.20	12.75	0.0481
Shk40-15	01 24 42.78	+08 39 55.42	Gaia DR3 2578887347375068800	20.47	01244277+0839554	15.22	14.47	14.23	0.0466
Shk40-16	01 24 41.13	+08 40 46.75	Gaia DR3 2578888206368526976	20.07	01244112+0840467	15.84	15.12	14.61	0.0484
Shk40-17	01 24 54.21	+08 36 56.21	Gaia DR3 2578884044544635136	21.44	01245422+0836565	16.48	15.96	15.60	0.0437
Shk40-18	01 24 57.59	+08 35 24.50	Gaia DR3 2578883670883285760	19.88	01245759+0835245	14.22	13.59	13.24	0.0426
Shk40-19	01 25 04.46	+08 36 24.18	Gaia DR3 2578883052407994880	20.06	01250445+0836241	14.63	13.90	13.46	0.0521
Shk40-20	01 25 10.82	+08 38 45.12	Gaia DR3 2578884323718124416	20.57	01251081+0838450	15.85	15.12	14.74	0.0488
Shk40-21	01 25 15.33	+08 39 01.37	Gaia DR3 2578885835546811136	20.74	01251534+0839015	15.55	14.84	14.32	0.0486
Shk40-22	01 25 16.70	+08 38 27.07	Gaia DR3 2578883602163817344	20.45	01251670+0838271	15.37	14.63	14.45	0.0501
Shk40-23	01 25 11.94	+08 39 20.69	Gaia DR3 2578884358078061056	20.17	01251193+0839207	14.13	13.49	13.14	-
Shk40-24	01 25 05.90	+08 40 41.00	-	-	-	-	-	-	-
Shk40-25	01 25 09.73	+08 40 52.00	GaiaDR3 2578886110424517760	20.19	01250972+0840520	14.99	14.43	14.07	0.0499
Shk40-26	01 25 11.80	+08 40 41.00	-	-	-	-	-	-	-
Shk40-27	01 25 11.83	+08 42 00.78	GaiaDR3 2578886316582947328	19.05	01251182+0842007	14.75	14.0	13.74	-
Shk 40-28	01 25 11.10	+08 41 53.05	GaiaDR3 2578886213503732352	19.32	01251109+0841529	14.93	14.2	13.99	-
Shk40-29	01 25 22.71	+08 41 39.19	GaiaDR3 2578886007345302400	19.34	01252271+0841392	15.25	14.57	14.24	0.0435
Shk40-30	01 25 23.48	+08 40 31.39	GaiaDR3 2578885217071520000	20.79	01252349+0840313	15.51	14.82	14.48	0.0457
Shk40-31	01 25 22.44	+08 40 01.68	GaiaDR3 2578885217071320960	16.65	01252243+0840016	15.44	15.15	14.88	-
Shk40-32	01 25 20.46	+08 39 29.85	GaiaDR3 2578885113992106240	16.76	01252046+0839298	14.52	13.92	13.67	-
Shk40-33	01 25 26.49	+08 37 36.97	GaiaDR3 2578884731739404800	20.83	01252649+0837370	15.86	14.97	14.54	0.0769
Shk40-34	01 25 31.32	+08 36 50.95	GaiaDR3 2566875148481711488	16.55	01253132+0836509	15.33	14.95	14.91	-
Shk40-35	01 25 32.83	+08 37 04.55	GaiaDR3 2566875079762450304	20.1	01253283+0837046	15.38	14.69	14.3	0.0497
Shk40-36	01 25 25.23	+08 39 48.90	GaiaDR3 2578885148351844352	17.27	01252522+0839489	15.37	14.83	14.82	-
Shk40-37	01 25 28.16	+08 41 17.20	GaiaDR3 2578885625092618752	17.42	01252816+0841172	15.81	15.18	15.39	-
Shk40-38	01 25 26.06	+08 41 36.45	GaiaDR3 2578886385302424576	19.51	01252607+0841365	15.38	14.69	14.33	0.0462
Shk40-39	01 25 29.44	+08 42 45.20	GaiaDR3 2578886522741577472	19.41	01252943+0842453	14.16	13.54	12.97	0.0451
Shk40-40	01 25 27.43	+08 42 22.88	GaiaDR3 2578886419662370304	21.24	01252743+0842229	16.41	15.9	14.91	-
Shk40-41	01 25 23.29	+08 42 46.99	GaiaDR3 2578886454021442176	18.37	-	-	-	-	-
Shk40-42	01 25 24.46	+08 43 12.14	GaiaDR3 2578886488381838976	21.22	01252446+0843121	15.08	14.36	13.88	0.0326
Shk40-43	01 25 24.37	+08 43 52.36	GaiaDR3 2578886797619282176	20.73	01252439+0843523	15.67	15.05	14.7	-
Shk40-44	01 25 24.15	+08 44 06.74	GaiaDR3 2578886797619281920	19.39	01252415+0844069	14.39	13.64	13.27	0.0462
Shk40-45	01 25 27.13	+08 44 17.50	GaiaDR3 2578886797619281792	20.09	01252713+0844175	15.15	14.5	14.28	0.0484
Shk40-46	01 25 18.40	+08 43 29.64	GaiaDR3 2578886728899806080	17.51	01251842+0843298	16.34	15.85	15.39	-
Shk40-47	01 25 13.76	+08 42 58.84	GaiaDR3 2578886350942684416	19.14	01251374+0842587	14.74	14.00	13.72	0.0493
Shk40-48	01 25 11.84	+08 43 38.96	GaiaDR3 2578889305880183296	19.31	01251183+0843388	14.38	13.74	13.47	0.0492
Shk40-49	01 25 11.84	+08 43 38.96	GaiaDR3 2578889305880183296	19.31	-	-	-	-	-
Shk40-50	01 25 08.75	+08 44 28.73	GaiaDR3 2578889580758089472	20.17	01250874+0844286	15.37	14.62	14.41	0.0458
Shk40-51	01 25 10.61	+08 45 49.10	GaiaDR3 2578889993075152000	20.57	01251059+0845491	15.46	14.86	14.54	0.4582
Shk40-52	01 25 07.52	+08 47 52.04	GaiaDR3 2578890989507360640	20.92	-	-	-	-	0.0505
Shk40-53	01 25 07.85	+08 48 12.37	-	-	-	-	-	-	-
Shk40-54	01 25 05.48	+08 47 27.68	-	-	-	-	-	-	0.0528
Shk40-55	01 25 04.17	+08 45 11.92	GaiaDR3 2578889649477006976	20.8	01250417+0845119	15.72	15.33	14.94	0.0494
Shk40-56	01 25 01.01	+08 44 25.51	GaiaDR3 2578889615118020608	20.05	01250100+0844254	14.6	13.97	13.63	0.0459
Shk40-57	01 24 57.50	+08 44 30.55	GaiaDR3 2578890267953049472	19.83	01245750+0844305	13.92	13.28	12.91	0.0472
Shk40-58	01 24 43.61	+08 46 34.82	GaiaDR3 2578902328221216128	21.35	01244361+0846350	15.45	14.77	14.36	0.0518
Shk40-59	01 24 45.26	+08 45 35.56	GaiaDR3 2578890577190694400	21.08	01244526+0845357	16.2	15.49	15.04	-
Shk40-60	01 24 46.77	+08 42 45.95	GaiaDR3 2578888618684860672	18.63	01244675+0842456	14.93	14.2	14.05	-