

# 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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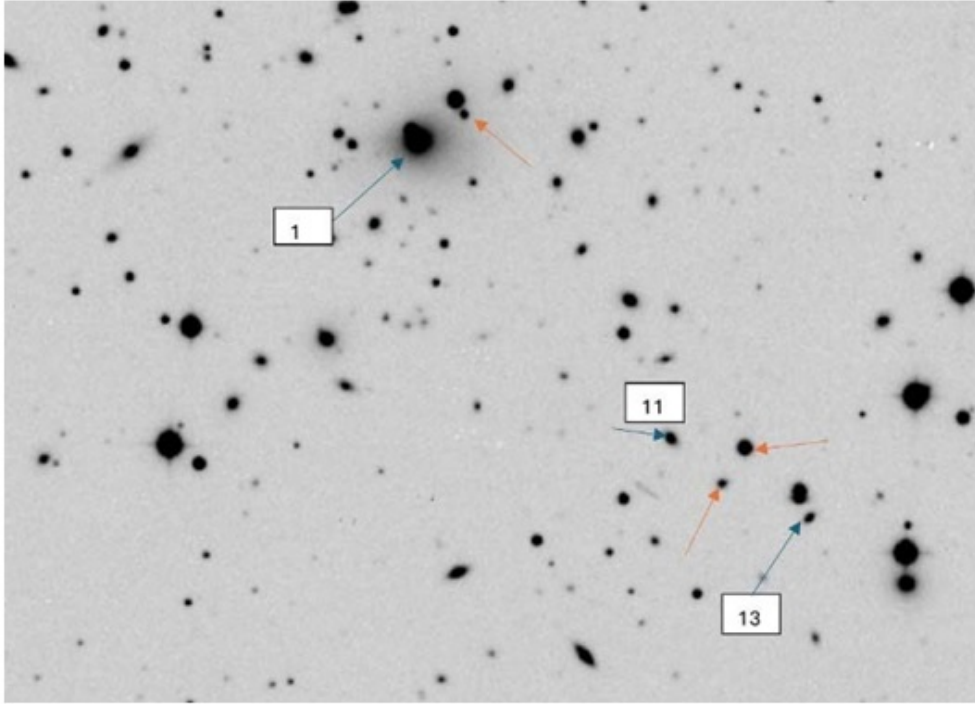


Figure 1. Image of Shk40 taken with 1m telescope BAO

### 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<br>"h:m:s" | RAJ2000<br>"d:m:s" | GaiaDR3                      | G<br>mag | 2MASS<br>mag     | J<br>mag | H<br>mag | K<br>mag | Z<br>Redshift | Galaxy<br>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.

## Acknowledgements

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Table 2. Corrected Coordinates and Photometric Data for Shk40 Galaxies

| Shk40     | RAJ200<br>"h:m:s" | RAJ2000<br>"d:m:s" | GaiaDR3                      | G<br>mag | 2MASS<br>mag     | J<br>mag | H<br>mag | K<br>mag | Z<br>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    | -             |