

# Astronomical Surveys and Active Galaxies

A. M. Mickaelian\*, H. V. Abrahamyan†, G. M. Paronyan‡, G. A. Mikayelyan§, R.R.Andreasyan ¶, A. G. Sukiasyan||, L. A. Hambardzumyan,\*\*V. K. Mkrtchyan,††and A. A. Gasparyan‡‡

NAS RA V. Ambartsumian Byurakan Astrophysical Observatory (BAO), Armenia

## Abstract

Astronomical Surveys are the main source for discoveries in astronomy. We are giving the most important parameters the significance of the surveys, their main products: images, photometric, spectroscopic and other data. Among the surveys, namely extragalactic ones, most important are those for Active Galaxies (both Active Galactic Nuclei (AGN) and Starburst (SB) Galaxies), and particularly the AGN. These objects reveal many spatial and physical characteristics helping understanding the Universe. We give a brief review of our searches and studies for Active Galaxies.

**Keywords:** *Multiwavelength Astronomy – Astronomical Surveys – Big Data in Astronomy – Active Galaxies – Active Galactic Nuclei – Starburst Galaxies*

## 1. Astronomical Surveys

Most of astronomical discoveries in old times happened by chance. Having relatively narrow fields of view, astronomers, planning their observations could not make pre-selections among the vast number of objects. The invention of the wide-field telescope by Bernd Schmidt in 1930 led to construction of Schmidt telescopes with Field of Views (FoV) of several degrees (the area covering a few dozens of degrees) and systematic study of large fields, Astronomical Surveys. 8 big Schmidt telescopes were built in 1940s-1970s, and 4 modern ones were built in recent decades. The Byurakan Astrophysical Observatory (BAO) installed a 1m Schmidt telescope which was operational in 1960-1991 with its 3 objective prisms, the largest at the time. It was re-operated in 2015 with a new equipment for multi-band photometry and digital receiver.

The Importance of Astronomical Surveys is very high. Here are the main arguments and justifications:

- Discovery of new cosmic objects
- Distinguishing types of cosmic objects and their abundance in the Universe
- Spatial distribution: Stellar (Galactic) Astronomy and Extragalactic Astronomy (including Cosmology); as well as kinematics and dynamics
- The geometry of Space
- Luminosity functions of Cosmic objects, their evolution
- The development of Multiwavelength and Multimessenger Astronomy
- Statistics of different objects and their properties

---

\*aregmick@yahoo.com, Corresponding author

†abrahamyanhayk@gmail.com

‡paronyan\_gurgen@yahoo.com

§gormick@mail.ru

¶randreasyan@gmail.com

||andranik.sukiasyan.1995@mail.ru

\*\*hambardzumyanlian@gmail.com

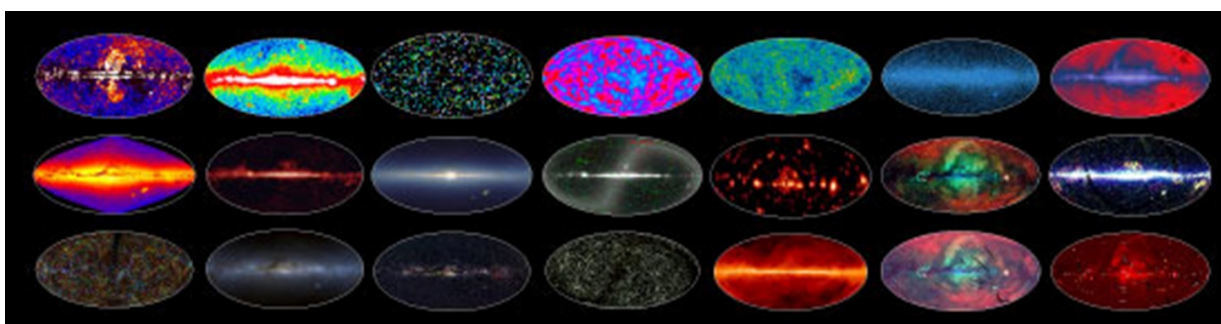
††varduhi.mkrtchyan.99@bk.ru

‡‡gasparyananna1997@mail.ru

- Revelation of astrophysical laws and regularities based on large statistics

The main parameters of Astronomical Surveys are:

- Method (photometric, multiband, multiwavelength, spectroscopic: objective prism, polarimetric), methodology
- Sky area: location and coverage (all-sky, large area, deep surveys in small areas)
- Wavelength range (otherwise, given in energies – for high-energy range, or frequencies – mostly for radio)
- Spatial and spectral resolution, spectral dispersion
- Sensitivity (in fluxes, energies, etc.) / limiting magnitude
- Completeness (detection limit, classification limit)



## 2. Wide Field Plate Data Base (WFPDB)

In the WFPDB ([www.skyarchive.org](http://www.skyarchive.org)), there are 414 archives, 2,204,725 plates from 125 observatories, obtained between 1879 and 2002 (the digital observations started in early 1990s and now they are active in all modern telescopes). They include 2,128,330 direct and 64,095 objective prism plates. Among the biggest plate collections there are: Harvard (USA) – 600,000 plates; Sonnenberg (Germany) – 270,000; Italy (all Italian archives) – 87,000; Kyiv (Ukraine) – 85,000; SAI (Moscow, Russia) – 50,000; etc. BAO archive has a collection of 37,500 plates.

Among the wide field observations and all-sky and/or large area astronomical surveys, one should mention the Palomar Observatory Sky Surveys (POSS), namely POSS1 and POSS2. Based on these observations, a number of catalogs and databases were built (APM, MAPS, USNO, GSC, etc.).

## 3. Multiwavelength Astronomy

### 3.1. Gamma-ray Astronomy and cosmic gamma-ray sources

Among gamma-ray observatories, one should mention the CGRO – Cosmic Gamma Ray Observatory, 1990 that provided ~1300 discrete gamma-ray sources; and its 2704 BATSE detected gamma-ray bursts.

Later on, GLAST (Fermi, 1873 sources), INTEGRAL (723 sources), Swift (9387 sources), BeppoSAX (1087 sources) and some others were launched and provided more gamma-ray sources. Many of them are still unknown.

### 3.2. X-ray Astronomy and cosmic X-ray sources

ROSAT is among the most important X-ray telescopes and X-ray surveys, especially if considering the importance of all-sky surveys. ROSAT made an all-sky X-ray survey in 0.1-2.4 keV energy range and resulted in these catalogs:

- ROSAT All-Sky Survey Bright Source Catalogue (ROSAT BSC). 18,806 sources (Voges et al. 1999)

- ROSAT All-Sky Survey Faint Source Catalogue (ROSAT FSC). 105,924 sources (Voges et al. 2000)

In Table 1, we give the most important X-ray surveys and projects, mostly the all-sky and large area ones.

| Telescope                | Country        | Years      | Energy (keV)  | Results                                  | Number of sources |
|--------------------------|----------------|------------|---------------|------------------------------------------|-------------------|
| <b>Uhuru (SAS-1)</b>     | USA            | 1970-1973  | 2 - 20        | Sky survey                               | 339               |
| <b>HEAO-1</b>            | USA            | 1977-1979  | 0.25 - 10 000 | Sky survey                               | 842               |
| <b>Einstein (HEAO-2)</b> | USA            | 1978-1981  | 0.2 - 20      | Pointed deep observations                | 1435              |
| <b>EXOSAT</b>            | ESA            | 1983-1986  | 0.04 - 80     | Sky survey                               | 1210              |
| <b>Granat</b>            | France, Russia | 1989-1999  | 2 - 100 000   | Pointed deep observations,<br>Sky survey | 1551              |
| <b>ROSAT</b>             | Germany        | 1990-1999  | 0.07 - 2.4    | Sky survey                               | 124 730           |
| <b>ASCA (Astro-D)</b>    | Japan          | 1993-2001  | 0.4 - 10      | Sky survey,<br>spectral observations     | 1190              |
| <b>Rossi XTE (RXTE)</b>  | USA            | 1995-2012  | 2 - 250       | Sky survey                               | 321               |
| <b>BeppoSAX</b>          | Italy          | 1996-2002  | 0.1 - 300     | Gamma bursts,<br>broad-band spectroscopy | 253               |
| <b>Chandra (CXO)</b>     | USA            | 1999-pres. | 0.07 - 10     | Pointed deep observations                | 380 000           |
| <b>XMM-Newton</b>        | ESA            | 1999-pres. | 0.25 - 12     | Pointed deep observations                | 372 728           |
| <b>INTEGRAL</b>          | ESA            | 2002-pres. | 15 - 10 000   | Pointed deep observations                | 1126              |
| <b>Swift</b>             | USA            | 2004-2008  | 0.2 - 150     | Sky survey, gamma bursts                 | 1256              |

Table 1. The list of the most important X-ray surveys and projects.

The list of known types of cosmic X-ray sources is the following:

- Solar System bodies
- bright stars
- stellar hot coronae
- late-type (M) dwarfs
- white dwarfs (WD) and hot subdwarfs
- X-ray binaries
- intermediate mass X-ray binaries
- cataclysmic variables (CV)
- magnetars
- Supernovae remnants (SNR)
- bright galaxies
- Active Galactic Nuclei (AGN)
- blazars
- clusters of galaxies

### 3.3. UV Astronomy and cosmic UV sources

In Ultraviolet (UV), less surveys have been carried out, however, the NASA Galaxy Evolution Explorer (GALEX) was rather efficient and productive; it observed the sky in two wavelength bands; Far-UV (FUV) and Near-UV (NUV) and provided the catalogs AIS (All-sky Imaging Survey) and MIS (Medium-depth Imaging Survey), totaling in 82,992,086 UV sources (Bianchi et al. 2017). The immediate neighboring to optical short UV wavelength range was observed by Hubble Space Telescope (HST), however no systematic all-sky survey was made.

### 3.4. IR Astronomy and cosmic IR sources

Among the most important ones are:

- Two Micron All Sky Survey (2MASS) (Cutri et al. 2003). J(1.25), H(1.65), and  $K_s$ (2.17), brighter than 1mJy sources (to a 3 sigma limiting sensitivity of 17.1, 16.4 and 15.3 mag in the three bands, respectively), resolution 2", 470,992,970 sources, including  $\sim 300,000,000$  stars and 1,650,000 galaxies
- IRAS Point Source Catalog (PSC): all-sky, 12, 25, 60, 100  $\mu\text{m}$  (0.4, 0.5, 06, 1.0 Jy sensitivity limit), 245,889 sources (IRAS Catalog of Point Sources, 1986)
- IRAS Faint Source Catalog (FSC): high galactic latitudes, 180,000 sources (Moshir et al. 1990)
- AKARI (ASTRO-F or IRIS – InfraRed Imaging Surveyor, Feb 2006), 68.5 cm telescope, wavelength range 2-180  $\mu\text{m}$ , 13 bands.
- Infrared Camera (IRC), 9 and 18  $\mu\text{m}$ , sensitivity  $\sim 50$  and 120 mJy. Spatial resolution is about 9.4", 877,091 sources (851,189 observed at 9  $\mu\text{m}$  and 195,893 at 18  $\mu\text{m}$ )
- Far-Infrared Surveyor (FIS), 65, 90, 140, and 160  $\mu\text{m}$ ,  $\sim 430,000$  sources
- Wide-Field Infrared Survey Explorer (WISE). NASA, 14.12.2009. 40 cm (16 inch), Four infrared wavelength bands at 3.4, 4.6, 12 and 22 $\mu\text{m}$ . The FoV is 47 arcmin wide. 747,634,026 sources

We give in Table 2 the list of the most important IR surveys and projects and in Table 3, the IR ranges and their characteristics, as well as cosmic objects that radiate in the given wavelength range.

| Telescope or project | Countries | Years | $\lambda(\mu)$   | Results                    | Number of sources |
|----------------------|-----------|-------|------------------|----------------------------|-------------------|
| <b>IRAS</b>          | USA       | 1983  | 8-120            | sky survey                 | 405 769           |
| <b>ISO</b>           | Europe    | 1996  | 2.5-240          | IR spectra                 | $\sim 30\ 000$    |
| <b>Spitzer</b>       | USA       | 2003  | 3-180            | IR deep images and spectra | 4 261 028         |
| <b>AKARI</b>         | Japan     | 2006  | 7-180            | sky survey                 | 1 298 044         |
| <b>Herschel</b>      | Europe    | 2009  | 55-672           | far IR                     |                   |
| <b>WISE</b>          | USA       | 2010  | 3-28             | sky survey                 | 563 921 584       |
| <b>DENIS</b>         | Europe    | 1996  | 0.82, 1.24, 2.16 | Southern sky survey        | 355 220 325       |
| <b>2MASS</b>         | USA       | 2003  | 1.24, 1.66, 2.16 | sky survey                 | 470 992 970       |

Table 2. The list of the most important IR surveys and projects.

| Spectral range | $\lambda(\mu)$      | T (K)                    | Studied cosmic objects                                                                                     |
|----------------|---------------------|--------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Near IR</b> | (0.76-1) - 5        | 740 - (3000-5200)        | cold red stars,<br>stellar envelopes,planetary nebulae                                                     |
| <b>Mid IR</b>  | 5 - (25-40)         | (92.5-140) - 740         | planets, comets and asteroids,<br>stellar radiation heated dust,<br>protoplanetary disks, gas-dust nebulae |
| <b>Far IR</b>  | (25-40) - (200-350) | (10.6-18.5) - (92.5-140) | cold gas radiation, central regions of galaxies,<br>very cold molecular clouds                             |

Table 3. IR ranges and their characteristics, as well as cosmic objects that radiate in the given wavelength range.

### 3.5. Radio Astronomy and cosmic radio sources

Radio astronomy has been mainly done from ground-based observations. Here are the most important radio all-sky surveys:

- **GB6:** 6cm (4.85GHz),  $0 < \text{DEC} < 75$ ,  $S \geq 18\text{mJy}$ , 75,162 sources

- **87GB:** (Gregory et al. 1991), also 6cm (4.85GHz), 54,579 sources
- **Westerborck Northern Sky Survey (WENSS, WN):** (de Bruyn et al. 1998), 92cm (330MHz), 229,420 sources
- **NVSS:** (Condon et al. 1998): all-sky at 21cm (1.4GHz),  $S > 2.5\text{mJy}$ , 1-7 arcsec ( $>15\text{mJy}$ - $2.5\text{mJy}$ ), 1,773,484 sources
- **FIRST:** 10,000 sq.deg., 21cm (1.4GHz),  $S > 1\text{mJy}$ , 5 arcsec, high galactic latitudes ( $>30\text{deg}$ ), 811,117 sources (White et al. 1998)
- **8C:** A deep 38-MHz radio survey of the area declination  $> +60\text{ deg}$  (Rees 1990)

At present astronomers distinguish the *sub/mm* and *mm* wavelength range between IR and radio. A few telescopes worked in this range (ex. James Clerk Maxwell Telescope (JCMT) in Hawaii, 15m diameter) and later on a few large facilities were built, most important among them – ALMA (Atacama Large Millimeter/submillimeter Array, ESO) in Chile, an interferometer array of  $54 \times 12.0\text{m}$  and  $12 \times 7.0\text{m}$  antennas.

#### 4. The overall picture of the astronomical surveys

In Figure 1 we give the distribution of astronomical surveys by number of objects and limiting magnitude. Gaia has provided a catalog with the largest number of objects, 1.8 billion objects. A few others also have more than 1 billion objects (ex. USNO-B1.0). They provide objects till 22-23 magnitude. On the other hand, we have deep surveys (HDF, HUDF, SDF, FDF, GOODS, COSMOS) providing smaller number of objects but with limiting magnitudes up to 30 and fainter.

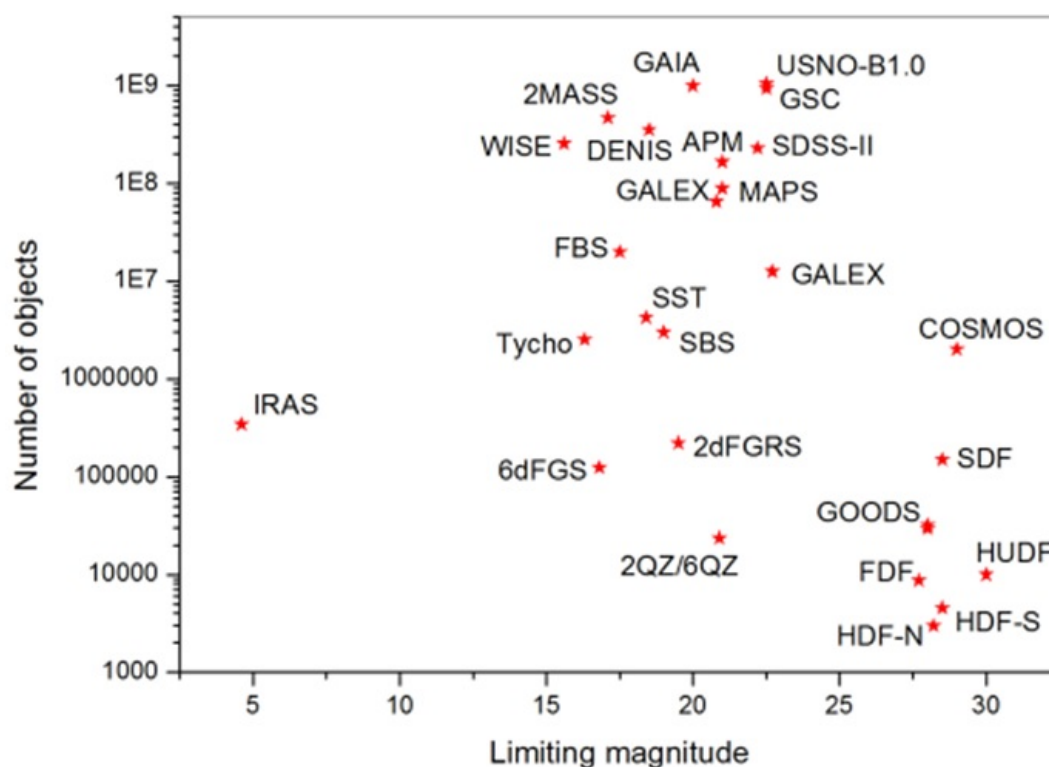


Figure 1. The distribution of astronomical surveys by number of objects and limiting magnitude.

Table 4 gives the list of all-sky and large-area astronomical catalogs in increasing wavelength range from gamma-rays to radio built on the basis of surveys (both ground-based and Space) and their main parameters: name, years, spectral range, sky area covered, sensitivity (limiting magnitude) and the number of sources. Though 44 catalogs are listed, the list is still not complete.

We give in Table 5 and Figure 2 the numbers of catalogued astronomical objects at different wavelength ranges and their distribution. Though the figure is in logarithmic scale, however the numbers are so different that some ranges are not even seen. But not only the number of objects is important and not only the



**Velocity** - in this context, the speed at which the data is generated and processed to meet the demands and challenges that lie in the path of growth and development. Big data is often available in real-time.

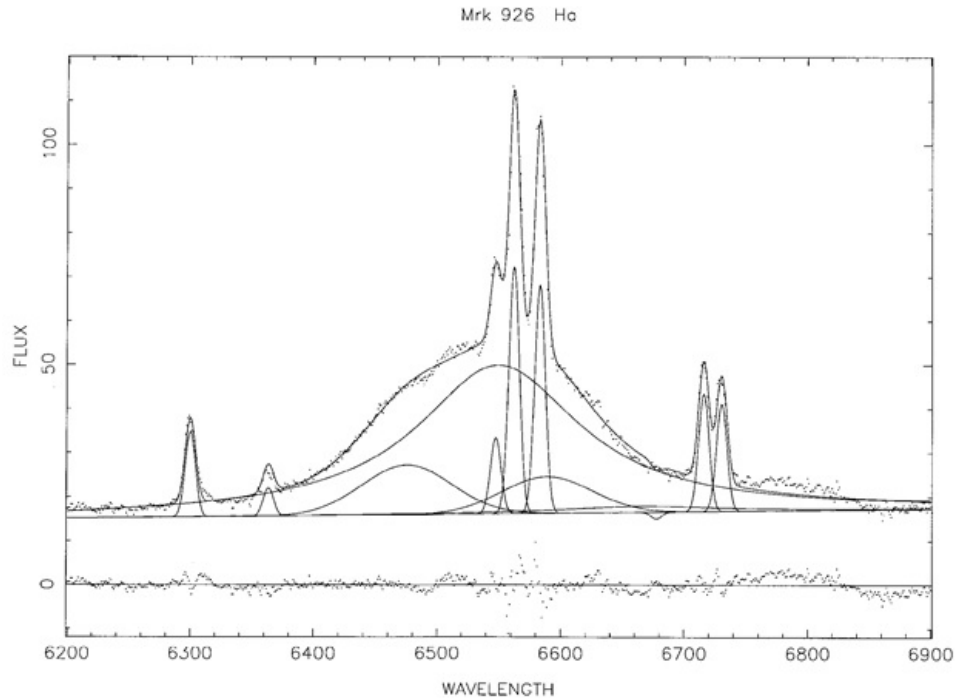


Figure 4. Decomposition analysis of the spectral lines for Mrk 926 H-alpha region with one of the solutions, where H-alpha summarizing profile is presented as having 3 broad line components and 1 narrow line.

**Veracity** - the data quality of captured data can vary greatly, affecting the accurate analysis.

In Astronomy, all these criteria are well met; we have the largest amount of data coming from the Universe, there is a wide variety of them, the velocity of accumulation is rather high as well and the veracity is maintained by astronomical standards, Virtual Observatory (VO) methods, etc. To give an understanding of data volumes in Astronomy, we give in the Table 6 a number of important astronomical projects with their information volumes.

## 6. Active Galaxies

Most of the surveys given above have tight relation to Active Galaxies, especially the non-optical ones, as many Active Galaxies strongly radiate in gamma-ray, X-ray, UV, IR and radio.

We can substantiate the importance of Active Galaxies as follows:

- The origin and evolution of galaxies
- Morphology
- Interacting and Merging galaxies
- Star Formation in galaxies
- Luminosity function of galaxies
- Radiation mechanisms
- Radiation mechanisms
- Presence of relativistic jets
- The theory of Super-Massive Black Holes (SMBH)

- Energetic resources
- The cosmological role of active galaxies

## 7. Recent Results related to Studies of Active Galaxies in Byurakan

Studies for Active Galaxies have been for many years one of the main research topic in Byurakan. Since 1990s, we have introduced the multiwavelength approach to these studies and many new interesting results appeared. In Table 7, we give the list of all our group works related to multiwavelength search and studies of active galaxies. The consecutive columns present: years of the projects, authors involved, survey name or description and its short name, objectives and number of objects discovered/revealed or studied.

These studies reveal many important characteristics of AGN and SB, as well as allow revealing outliers at different distributions and diagrams, which very often appear to be unique or rare objects.

### Acknowledgements

This work was partially supported by the Republic of Armenia Ministry of Education and Science (RA MES) State Committee of Science, in the frames of the research projects No. 15T-1C257 and 21AG-1C053 (2021-2026). This work was made possible in part by research grants from the Armenian National Science and Education Fund (ANSEF) based in New York, USA (PS-astroex-2597, 2022-2023).

## References

- Abdollahi S., et al., 2020, *Astrophys. J. Suppl. Ser.*, **247**, 33
- Abrahamian H. V., Mickaelian A. M., 1993, *Astrophysics*, **36**, 306
- Abrahamian H. V., Mickaelian A. M., 1994a, *Astrophysics*, **37**, 27
- Abrahamian H. V., Mickaelian A. M., 1994b, *Astrophysics*, **37**, 117
- Abrahamian H. V., Mickaelian A. M., 1996, *Astrophysics*, **39**, 315
- Abrahamyan H. V., Mickaelian A. M., 2016a, in Mickaelian A. M., Khosroshahi H. G., Harutyunian H. A. E., eds, Proceedings of Armenian-Iranian Astronomical Workshop (AIAW). pp 208–212
- Abrahamyan H. V., Mickaelian A. M., 2016b, in Mickaelian A., Lawrence A., Magakian T., eds, Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data. p. 193
- Abrahamyan H. V., Mickaelian A. M., Knyazyan A. V., 2015, *Astronomy and Computing*, **10**, 99
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., Gyulzadyan M. V., 2018a, *Astronomy and Computing*, **25**, 176
- Abrahamyan H. V., Mickaelian A. M., Mikayelyan G. A., Paronyan G. M., 2018b, *Communications of the Byurakan Astrophysical Observatory*, **65**, 1
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., 2018c, *Izvestiya Glavnoj Astronomicheskoy Observatorii v Pulkove*, **222**, 5
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., Gyulzadyan M. V., 2019a, *Communications of the Byurakan Astrophysical Observatory*, **66**, 1
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., 2019b, *Astronomische Nachrichten*, **340**, 437
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., Gyulzadyan M. V., 2019c, *VizieR Online Data Catalog (other)*, **0620**, J/other/A+C/25
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., 2020a, *Astrophysics*, **63**, 322
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., 2020b, *VizieR Online Data Catalog (other)*, **0160**, J/other/Ap/63
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., Sukiasyan A. G., 2021, *Communications of the Byurakan Astrophysical Observatory*, **68**, 441
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., 2022, *Communications of the Byurakan Astrophysical Observatory*, **69**, 340
- Abrahamyan H. V., Mickaelian A. M., Paronyan G. M., Mikayelyan G. A., Sukiasyan A. G., 2023a, *Astrophysics*, **66**, 11
- Abrahamyan H. V., Mickaelian A. M., Mikayelyan G. A., Paronyan G. M., Sukiasyan A. G., Mkrtchyan V. K., Hambardzumyan L. A., 2023b, *Communications of the Byurakan Astrophysical Observatory*, **70**, 83
- Abramyan G. V., Mickaelian A. M., 1993a, *Astrophysics*, **35**, 363
- Abramyan G. B., Mickaelian A. M., 1993b, *Astrophysics*, **36**, 62
- Mickaelian A. et al.  
doi: <https://doi.org/10.52526/25792776-23.70.2-261>

- Abramyan G. B., Mickaelian A. M., 1994, [Astrophysics](#), **37**, 224
- Abramyan G. V., Lipovetskii V. A., Mickaelian A. M., Stepanyan D. A., 1990a, [Astrophysics](#), **33**, 418
- Abramyan G. V., Lipovetskii V. A., Mickaelian A. M., Stepanyan D. A., 1990b, [Astrophysics](#), **33**, 493
- Abramyan G. V., Lipovetskii V. A., Mickaelian A. M., Stepanyan D. A., 1991, [Astrophysics](#), **34**, 7
- Almeida A., et al., 2023, [Astrophys. J. Suppl. Ser.](#) , **267**, 44
- Ambartsumian V. A., 1958, in *La structure et l'évolution de l'univers*. pp 241–249
- Ambartsumian V. A., 1961, [Astron. J.](#) , **66**, 536
- Arakelian M. A., 1975, *ComBAO*, **47**, 3
- Baier F. W., Petrosyan M. B., Tiersch H., Shakhbazyan R. K., 1974, *Ap*, **10**, 327
- Balaian S. K., Akopian S. A., Mickaelian A. M., Burenkov A. N., 2001, [Astronomy Letters](#), **27**, 284
- Baumgartner W. H., Tueller J., Markwardt C. B., Skinner G. K., Barthelmy S., Mushotzky R. F., Evans P. A., Gehrels N., 2013, [Astrophys. J. Suppl. Ser.](#) , **207**, 19
- Bennett C. L., et al., 2013, [Astrophys. J. Suppl. Ser.](#) , **208**, 20
- Bianchi L., Herald J., Efremova B., Girardi L., Zobot A., Marigo P., Conti A., Shiao B., 2011, [Astrophys. Space. Sci.](#) , **335**, 161
- Bird A. J., et al., 2010, [ApJS](#), **186**, 1
- Bottacini E., Ajello M., Greiner J., 2012, [Astrophys. J. Suppl. Ser.](#) , **201**, 34
- Cirimele G., et al., 2008, in , *Digitized First Byurakan Survey*. pp 19–37
- Condon J. J., Cotton W. D., Greisen E. W., Yin Q. F., Perley R. A., Taylor G. B., Broderick J. J., 1998, [Astron. J.](#) , **115**, 1693
- Cutri R. M., et al., 2003, *VizieR Online Data Catalog*, [p. II/246](#)
- Cutri R. M., et al., 2013, *Explanatory Supplement to the AllWISE Data Release Products*, *Explanatory Supplement to the AllWISE Data Release Products*, by R. M. Cutri et al.
- Ebisawa K., Bourban G., Bodaghee A., Mowlavi N., Courvoisier T. J. L., 2003, [Astron. Astrophys.](#) , **411**, L59
- Erastova L. K., Mickaelian A. M., 2016, in Mickaelian A., Lawrence A., Magakian T., eds, *Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data*. p. 242
- Erastova L. K., Mickaelian A. M., 2017, *Astronomical and Astrophysical Transactions*, **30**, 261
- Eritsyan M. A., Mickaelian A. M., 1993, [Astrophysics](#), **36**, 126
- Evans I. N., et al., 2010, [Astrophys. J. Suppl. Ser.](#) , **189**, 37
- Fischer J. U., Hasinger G., Schwope A. D., Brunner H., Boller T., Trümper J., Voges W., Neizvestnyj S., 1998, [Astronomische Nachrichten](#), **319**, 347
- Forman W., Jones C., Cominsky L., Julien P., Murray S., Peters G., Tananbaum H., Giacconi R., 1978, [Astrophys. J. Suppl. Ser.](#) , **38**, 357
- Gaia Collaboration 2022, *VizieR Online Data Catalog*, [p. I/356](#)
- Geach J. E., et al., 2017, [Mon. Not. R. Astron. Soc.](#) , **465**, 1789
- Gigoyan K. S., Mickaelian A. M., 1999, [Astrophysics](#), **42**, 37
- Gregory P. C., Condon J. J., 1991, [Astrophys. J. Suppl. Ser.](#) , **75**, 1011
- Gregory P. C., Scott W. K., Douglas K., Condon J. J., 1996, [Astrophys. J. Suppl. Ser.](#) , **103**, 427
- Gyulzadyan M. V., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., 2016a, in Mickaelian A. M., Khosroshahi H. G., Harutyunian H. A. E. , eds, *Proceedings of Armenian-Iranian Astronomical Workshop (AIAW)*. pp 227–229
- Gyulzadyan M. V., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., 2016b, in Mickaelian A., Lawrence A., Magakian T., eds, *Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data*. p. 162
- Gyulzadyan M. V., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., 2017, in Mickaelian A. M., Harutyunian H. A., Nikoghosyan E. H., eds, *Astronomical Society of the Pacific Conference Series Vol. 511, Non-Stable Universe: Energetic Resources, Activity Phenomena, and Evolutionary Processes*. p. 192
- Gyulzadyan M. V., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., Paronyan G. M., 2018, [Communications of the Byurakan Astrophysical Observatory](#), **65**, 392
- Hales S. E. G., Riley J. M., Waldram E. M., Warner P. J., Baldwin J. E., 2007, [Mon. Not. R. Astron. Soc.](#) , **382**, 1639
- Heckman T. M., 1980, *A&A*, **87**, 152
- Mickaelian A. et al.  
doi: <https://doi.org/10.52526/25792776-23.70.2-261>

- Helfand D. J., White R. L., Becker R. H., 2015, [Astrophys. J.](#) , 801, 26
- Herschel Point Source Catalogue Working Group et al., 2020, VizieR Online Data Catalog, [p. VIII/106](#)
- Hoffmeister C., 1929, [AN](#), 236, 233
- Hovhannisyan A., Sargsyan L. A., Mickaelian A. M., Weedman D. W., 2011, [Astrophysics](#), 54, 147
- IRAS 1986, Joint IRAS Science W.G., IRAS Catalog of Point Sources, Version 2.0
- Ishihara D., et al., 2010, [Astron. Astrophys.](#) , 514, A1
- Kazarian M. A., Mickaelian A. M., 2007, [Ap](#), 50, 127
- Kazarian M. A., Adibekyan V. Z., McLean B., Allen R. J., Petrosian A. R., 2010, [Ap](#), 53, 57
- Khachikian E. Y., Weedman D. W., 1974, [ApJ](#), 192, 581
- Lasker B. M., et al., 2008, [Astron. J.](#) , 136, 735
- Lyke B. W., et al., 2020, [Astrophys. J. Suppl. Ser.](#) , 250, 8
- Markarian B. E., Stepanian J. A., Erastova L. K., 1987, IAU S121, [p. 25](#)
- Markarian B. E., Lipovetsky V. A., Stepanian J. A., Erastova L. K., Shapovalova A. I., 1989, Soobshcheniya Spetsial'noj Astrofizicheskoy Observatorii, [62](#), 5
- Massaro E., Mickaelian A. M., Nesci R., Weedman D., 2008, The Digitized First Byurakan Survey
- Massaro E., Maselli A., Leto C., Marchegiani P., Perri M., Giommi P., Piranomonte S., 2015, [Ap&SS](#), 357, 75
- Mauch T., Murphy T., Buttery H. J., Curran J., Hunstead R. W., Piestrzynski B., Robertson J. G., Sadler E. M., 2003, [Mon. Not. R. Astron. Soc.](#) , 342, 1117
- Mazzarella J. M., Balzano V. A., 1986, [ApJS](#), 62, 751
- McMahon R. G., Irwin M. J., Maddox S. J., 2000, VizieR Online Data Catalog, [p. I/267](#)
- Mickaelian A. M., 1995, [Astrophysics](#), 38, 349
- Mickaelian A. M., 2000a, [Astronomical and Astrophysical Transactions](#), 18, 557
- Mickaelian A. M., 2000b, [Astrophysics](#), 43, 309
- Mickaelian A. M., 2001a, [Astrophysics](#), 44, 33
- Mickaelian A. M., 2001b, [Astrophysics](#), 44, 185
- Mickaelian A. M., 2002, [Astrophysics](#), 45, 288
- Mickaelian A. M., 2003a, in IAU General Assembly. p. E1
- Mickaelian A. M., 2003b, [Astronomical and Astrophysical Transactions](#), 22, 753
- Mickaelian A. M., 2003c, in Proceedings of JENAM-2002. pp 76–80
- Mickaelian A. M., 2004a, [Baltic Astronomy](#), 13, 655
- Mickaelian A. M., 2004b, [Astrophysics](#), 47, 361
- Mickaelian A. M., 2004c, [Astron. Astrophys.](#) , 426, 367
- Mickaelian A. M., 2008, [Astron. J.](#) , 136, 946
- Mickaelian A. M., 2012, [Baltic Astronomy](#), 21, 331
- Mickaelian A. M., 2015, [Iranian Journal of Astronomy and Astrophysics](#), 2, 1
- Mickaelian A. M., 2016a, [Baltic Astronomy](#), 25, 75
- Mickaelian A. M., 2016b, [Astronomy Reports](#), 60, 857
- Mickaelian A. M., 2016c, in Mickaelian A., Lawrence A., Magakian T., eds, Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data. p. 117
- Mickaelian A. M., 2016d, in Mickaelian A., Lawrence A., Magakian T., eds, Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data. p. 203
- Mickaelian A. M., 2017, [Communications of the Byurakan Astrophysical Observatory](#), 64, 15
- Mickaelian A. M., 2020, [Communications of the Byurakan Astrophysical Observatory](#), 67, 159
- Mickaelian A. M., 2021a, in Mickaelian A. M., ed., , Byurakan Astrophysical Observatory - 75 years of outstanding achievements. p. 116
- Mickaelian A. et al.
- doi: <https://doi.org/10.52526/25792776-23.70.2-261>

- Mickaelian A. M., 2021b, [Communications of the Byurakan Astrophysical Observatory](#), **68**, 174
- Mickaelian A. M., Gigoyan K. S., 1998a, [Astrophysics](#), **41**, 161
- Mickaelian A. M., Gigoyan K. S., 1998b, [Astrophysics](#), **41**, 232
- Mickaelian A. M., Sargsyan L. A., 2004a, [Astrophysics](#), **47**, 91
- Mickaelian A. M., Sargsyan L. A., 2004b, [Astrophysics](#), **47**, 213
- Mickaelian A. M., Sargsyan L. A., 2010, [Astrophysics](#), **53**, 483
- Mickaelian A. M., Sinamyanyan P. K., 2010, [Mon. Not. R. Astron. Soc.](#) , **407**, 681
- Mickaelian A. M., Eritsyan M. A., Abramyan G. V., 1991, [Astrophysics](#), **34**, 186
- Mickaelian A. M., Gigoyan K. S., Russeil D., 1997, [Astrophysics](#), **40**, 379
- Mickaelian A. M., Akopian S. A., Balaian S. K., Burenkov A. N., 1998, [Astronomy Letters](#), **24**, 635
- Mickaelian A. M., Gonçalves A. C., Véron-Cetty M. P., Véron P., 1999, [Astrophysics](#), **42**, 1
- Mickaelian A. M., Balayan S. K., Hakopian S. A., 2001a, [Astronomical and Astrophysical Transactions](#), **20**, 315
- Mickaelian A. M., Gonçalves A. C., Véron-Cetty M. P., Véron P., 2001b, [Astrophysics](#), **44**, 14
- Mickaelian A. M., Hakopian S. A., Balayan S. K., Dodonov S. N., Afanasiev V. L., Burenkov A. N., Moiseev A. V., 2002a, [Bulletin of the Special Astrophysics Observatory](#), **53**, 144
- Mickaelian A. M., Balayan S. K., Hakopian S. A., 2002b, in Green R. F., Khachikian E. Y., Sanders D. B., eds, [Astronomical Society of the Pacific Conference Series Vol. 284, IAU Colloq. 184: AGN Surveys](#). p. 217
- Mickaelian A. M., Hakopian S. A., Balayan S. K., 2002c, in Green R. F., Khachikian E. Y., Sanders D. B., eds, [Astronomical Society of the Pacific Conference Series Vol. 284, IAU Colloq. 184: AGN Surveys](#). p. 220
- Mickaelian A. M., Hovhannisyan L. R., Sargsyan L. A., 2003, [Astrophysics](#), **46**, 177
- Mickaelian A. M., Hovhannisyan L. R., Engels D., Hagen H. J., Voges W., 2006, [Astron. Astrophys.](#) , **449**, 425
- Mickaelian A. M., et al., 2007, [Astron. Astrophys.](#) , **464**, 1177
- Mickaelian A. M., Mikayelyan G. A., Sinamyanyan P. K., 2011, [Mon. Not. R. Astron. Soc.](#) , **415**, 1061
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Harutyunyan G. S., 2013, [Astronomische Nachrichten](#), **334**, 887
- Mickaelian A. M., Paronyan G. M., Abrahamyan H. V., Gyulzadyan M. V., Mikayelyan G. A., 2016a, in Mickaelian A. M., Khosroshahi H. G., Harutyunian H. A. E. , eds, [Proceedings of Armenian-Iranian Astronomical Workshop \(AIAW\)](#). pp 170–177
- Mickaelian A. M., Paronyan G. M., Harutyunyan G. S., Abrahamyan H. V., Gyulzadyan M. V., 2016b, [Astronomical and Astrophysical Transactions](#), **29**, 333
- Mickaelian A. M., Paronyan G. M., Abrahamyan H. V., Gigoyan K. S., Gyulzadyan M. V., Kostandyan G. R., 2016c, [Astronomical and Astrophysical Transactions](#), **29**, 451
- Mickaelian A., Paronyan G., Abrahamyan H., 2016d, [IAU Focus Meeting](#), **29B**, 91
- Mickaelian A. M., Astsatryan H. V., Knyazyan A. V., Mikayelyan G. A., 2017a, [BAOJ Physics](#), **2**, 8
- Mickaelian A. M., et al., 2017b, [Communications of the Byurakan Astrophysical Observatory](#), **64**, 102
- Mickaelian A. M., Gyulzadyan M. V., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., 2017c, in Mickaelian A. M., Harutyunian H. A., Nikoghosyan E. H., eds, [Astronomical Society of the Pacific Conference Series Vol. 511, Non-Stable Universe: Energetic Resources, Activity Phenomena, and Evolutionary Processes](#). p. 149
- Mickaelian A. M., Harutyunyan G. S., Sarkissian A., 2018a, [Astronomy Letters](#), **44**, 351
- Mickaelian A. M., Abrahamyan H. V., Gyulzadyan M. V., Paronyan G. M., Mikayelyan G. A., 2018b, [Astrophys. Space. Sci.](#) , **363**, 237
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., Gyulzadyan M. V., 2019, [Communications of the Byurakan Astrophysical Observatory](#), **66**, 173
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., Gyulzadyan M. V., 2020, [Communications of the Byurakan Astrophysical Observatory](#), **67**, 149
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., 2021a, in Mickaelian A. M., ed., , [Byurakan Astrophysical Observatory - 75 years of outstanding achievements](#). p. 133
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., 2021b, [Frontiers in Astronomy and Space Sciences](#), **7**, 82
- Mickaelian A. M., Andreasyan R. R., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., Sukiasyan A. G., Mkrtchyan V. K., 2021c, [Astronomical and Astrophysical Transactions](#), **32**, 331

- Mickaelian A. M., Mikayelyan G. A., Abrahamyan H. V., Paronyan G. M., 2021d, [Communications of the Byurakan Astrophysical Observatory](#), **68**, 163
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., 2022a, [Communications of the Byurakan Astrophysical Observatory](#), **69**, 179
- Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., Paronyan G. M., 2022b, [Communications of the Byurakan Astrophysical Observatory](#), **69**, 10
- Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Mikayelyan G. A., Andreasyan R. R., Sukiasyan A. G., Hambardzumyan L. A., Mkrtchyan V. K., 2023, [Communications of the Byurakan Astrophysical Observatory](#), **70**, 68
- Mikayelyan G. A., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., 2018, [Communications of the Byurakan Astrophysical Observatory](#), **65**, 13
- Mikayelyan G. A., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Gyulzadyan M. V., 2019a, [Astrophysics](#), **62**, 452
- Mikayelyan G. A., Mickaelian A. M., Abrahamyan H. V., Paronyan G. M., Gyulzadyan M. V., 2019b, [Communications of the Byurakan Astrophysical Observatory](#), **66**, 31
- Monet D., Canzian B., Harris H., Reid N., Rhodes A., Sell S., 1998, VizieR Online Data Catalog, [p. I/243](#)
- Monet D. G., et al., 2003, [Astron. J.](#) , **125**, 984
- Moshir M., et al. 1990, IRAS Faint Source Catalogue, [p. 0](#)
- Oke J. B., Gunn J. E., 1974, [ApJL](#), **189**, L5
- Osterbrock D. E., 1981, [ApJ](#), **249**, 462
- Osterbrock D. E., Pogge R. W., 1985, [ApJ](#), **297**, 166
- Paronyan G. M., Mickaelian A. M., 2015, [Izvestiya Glavnoj Astronomicheskoy Observatorii v Pulkove](#), **222**, 77
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., 2016, in Mickaelian A., Lawrence A., Magakian T., eds, [Astronomical Society of the Pacific Conference Series Vol. 505, Astronomical Surveys and Big Data](#). p. 189
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., 2018a, [Communications of the Byurakan Astrophysical Observatory](#), **65**, 412
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., 2018b, [Izvestiya Glavnoj Astronomicheskoy Observatorii v Pulkove](#), **226**, 52
- Paronyan G. M., Mickaelian A. M., Harutyunyan G. S., Abrahamyan H. V., Mikayelyan G. A., 2019, [Astrophysics](#), **62**, 147
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., 2020, [Astrophysics](#), **63**, 166
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., 2021a, [Astrophysics](#), **64**, 277
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., Sukiasyan A. G., 2021b, [Communications of the Byurakan Astrophysical Observatory](#), **68**, 528
- Paronyan G. M., Mickaelian A. M., Abrahamyan H. V., Mikayelyan G. A., Sukiasyan A. G., Hambardzumyan L. A., Mkrtchyan V. K., 2023, [Communications of the Byurakan Astrophysical Observatory](#), **70**, 88
- Paturel G., Petit C., Rousseau J., Vauglin I., 2003, [Astron. Astrophys.](#) , **405**, 1
- Planck Collaboration et al., 2016, [Astron. Astrophys.](#) , **594**, A26
- Rees N., 1990, [Mon. Not. R. Astron. Soc.](#) , **244**, 233
- Revnivtsev M., Sazonov S., Jahoda K., Gilfanov M., 2004, [Astron. Astrophys.](#) , **418**, 927
- Sabzali V., Davoudifar P., Mickaelian A. M., 2016, in Mickaelian A. M., Khosroshahi H. G., Harutyunian H. A. E. , eds, [Proceedings of Armenian-Iranian Astronomical Workshop \(AIAW\)](#). pp 233–238
- Sanders D. B., Mirabel I. F., 1996, [Ann. Rev. Astron. Astrophys.](#) , **34**, 749
- Sargsyan L. A., Mickaelian A. M., 2006, [Astrophysics](#), **49**, 19
- Sargsyan L. A., Mickaelian A. M., Weedman D., Houck J., 2007, in [JENAM-2007, “Our Non-Stable Universe”](#). pp 50–50
- Sargsyan L., Mickaelian A., Weedman D., Houck J., 2008, [Astrophys. J.](#) , **683**, 114
- Sargsyan L. A., Mickaelian A. M., Weedman D. W., Houck J. R., 2010, in Harutyunian H. A., Mickaelian A. M., Terzian Y., eds, [Evolution of Cosmic Objects through their Physical Activity](#). pp 231–237
- Sargsyan L., Weedman D., Lebouteiller V., Houck J., Barry D., Hovhannisyan A., Mickaelian A., 2011, [Astrophys. J.](#) , **730**, 19
- Schmidt M., 1963, [Nature](#), **197**, 1040
- Schmitt J. L., 1968, [Nature](#), **218**, 663
- Mickaelian A. et al.  
doi: <https://doi.org/10.52526/25792776-23.70.2-261>

- Seyfert C. K., 1943, [ApJ](#), **97**, 28
- Sinamian P. K., Mickaelian A. M., 2006, [Astrophysics](#), **49**, 333
- Sinamyan P. K., Mickaelian A. M., 2008a, [Astrophysics](#), **51**, 37
- Sinamyan P. K., Mickaelian A. M., 2008b, [Astrophysics](#), **51**, 226
- Sinamyan P. K., Mickaelian A. M., 2009, [Astrophysics](#), **52**, 76
- Sinamyan P. K., Sargsyan L. A., Mickaelian A. M., Massaro E., Nesci R., Rossi C., Gaudenzi S., Cirimele G., 2007, in JENAM-2007, “Our Non-Stable Universe”. pp 82–82
- Strittmatter P. A., Serkowski K., Carswell R., Stein W. A., Merrill K. M., Burbidge E. M., 1972, [ApJ](#), **175**, L7
- Talezade Lari M. H., Davoudifar P., Mickaelian A. M., 2016, in Mickaelian A. M., Khosroshahi H. G., Harutyunian H. A. E. ., eds, *Proceedings of Armenian-Iranian Astronomical Workshop (AIAW)*. pp 213–217
- Terlevich R., 1997, *RMAA*, **6**, 1
- Terlevich R., 2000, In: *Advanced Lectures on the Starburst-AGN Connection*, Eds. Aretxaga, I.; Mújica, R.; Kunth, D., World Scientific, p. 279
- Thuan T. X., Martin G. E., 1981, [ApJ](#), **247**, 823
- Véron-Cetty M. P., Véron P., 2010, [A&A](#), **518**, A10
- Véron-Cetty M. P., et al., 2004a, [A&A](#), **414**, 487
- Véron-Cetty M. P., et al., 2004b, [Astron. Astrophys.](#) , **414**, 487
- Véron P., Gonçalves A. C., Véron-Cetty M. P., 1997, [A&A](#), **319**, 52
- Verrecchia F., in’t Zand J. J. M., Giommi P., Santolamazza P., Granata S., Schuurmans J. J., Antonelli L. A., 2007, [Astron. Astrophys.](#) , **472**, 705
- Voges W., et al., 1999, [Astron. Astrophys.](#) , **349**, 389
- Voges W., et al., 2000, *IAU Circ.*, **7432**, 3
- Webb N. A., et al., 2020, [Astron. Astrophys.](#) , **641**, A136
- Weedman D. W., 1977, *Vistas in Astronomy*, **21**, 55
- Wood K. S., et al., 1984, [Astrophys. J. Suppl. Ser.](#) , **56**, 507
- Yamamura I., Makiuti S., Ikeda N., Fukuda Y., Oyabu S., Koga T., White G. J., 2010, *VizieR Online Data Catalog*, [p. II/298](#)
- Zickgraf F. J., Engels D., Hagen H. J., Reimers D., Voges W., 2003, [A&A](#), **406**, 535

| Survey,<br>Catalogue | Years     | Spectral<br>range | Sky area<br>(deg <sup>2</sup> ) | Sensitivity<br>(mag/mJy) | Number of<br>sources |
|----------------------|-----------|-------------------|---------------------------------|--------------------------|----------------------|
| Fermi-GLAST          | 2008-2014 | 10MeV-100GeV      | All-sky                         |                          | 3,033                |
| CGRO                 | 1991-1999 | 20keV-30GeV       | All-sky                         |                          | 1,300                |
| INTEGRAL             | 2002-2014 | 15keV-10MeV       | All-sky                         |                          | 1,126                |
| Swift                | 2004-2008 | 14-150keV         | All-sky                         |                          | 84,979               |
| XMM-Newton           | 1999-2014 | 0.25-12keV        | Pointed                         |                          | 372,728              |
| Chandra              | 1999-2014 | 0.07-10keV        | Pointed                         |                          | 380,000              |
| ROSAT BSC            | 1990-1999 | 0.07-2.4keV       | All-sky                         |                          | 18,806               |
| ROSAT FSC            | 1990-1999 | 0.07-2.4keV       | All-sky                         |                          | 105,924              |
| GALEX AIS            | 2003-2012 | 1344-2831Å        | 21435                           | 20.8"                    | 65,266,291           |
| GALBX MIS            | 2003-2012 | 1344-2831Å        | 1,579                           | 22.7"                    | 12,597,912           |
| APM                  | 2000      | opt b, r          | 20,964                          | 21.0"                    | 166,466,987          |
| MAPS                 | 2003      | opt O, E          | 20,964                          | 21.0"                    | 89,234,404           |
| USNO-A2.0            | 1998      | opt B, R          | All-sky                         | 21.0"                    | 526,280,881          |
| USNO-B1.0            | 2003      | opt B, R, I       | All-sky                         | 22.5"                    | 1,045,913,669        |
| SuperCOSMOS          | 2001      | opt B, R, I       | All-sky                         | 22.5"                    | 1,900,000,000        |
| GSC 2.3.2            | 2008      | opt j, V, F, N    | All-sky                         | 22.5"                    | 945,592,683          |
| FBS                  | 1965-1980 | 3400-6900Å        | 17,056                          | 17.5"                    | 20,000,000           |
| SBS                  | 1978-1991 | 3400-6950Å        | 965                             | 19.0"                    | 3,000,000            |
| HQS                  | 1985-1997 | 3400-5300Å        | 14,000                          | 19.0"                    | 16,000,000           |
| HES                  | 1990-1996 | 3400-5300Å        | 9,000                           | 18.0"                    | 5,000,000            |
| Tycho-2              | 1989-1993 | opt BT, VT        | All-sky                         | 16.3"                    | 2,539,913            |
| SDSS photo           | 2000-2015 | opt u, g, r, i, z | 14,555                          | 22.2"                    | 932,891,133          |
| SDSS spectro         | 2000-2015 | 3000-10800Å       | 14,555                          | 17.7"                    | 4,355,200            |
| DENIS                | 1996-2001 | 0.8-2.4μm         | 16,700                          | 18.5"                    | 355,220,325          |
| 2MASS PSC            | 1997-2001 | 1.1-2.4μm         | All-sky                         | 17.1"                    | 470,992,970          |
| 2MASS ESC            | 1997-2001 | 1.1-2.4μm         | All-sky                         | 17" 1                    | 1,647,599            |
| WISE                 | 2009-2013 | 3-22μm            | All-sky                         | 15.6"                    | 747,634,026          |
| AKARI IRC            | 2006-2008 | 7-26μm            | 38,778                          | 50mJy                    | 870,973              |
| Spitzer              | 2003-2009 | 3-180μm           | Pointed                         | 0.6μJy                   | 4,261,028            |
| IRAS PSC             | 1983      | 8-120μm           | 39,603                          | 400mJy                   | 245,889              |
| IRAS FSC             | 1983      | 8-120μm           | 34,090                          | 400mJy                   | 173,044              |
| IRAS SSSC            | 1983      | 8-120μm           | 39,603                          | 400mJy                   | 16,740               |
| AKARI FIS            | 2006-2008 | 50-180μm          | 40,428                          | 550mJy                   | 427,071              |
| Herschel             | 2009-2013 | 55-672μm          | Pointed                         | 6mJy                     | 340,968              |
| ALMA                 | 2011-2014 | 0.3-9.6mm         | Pointed                         | 50μJy                    |                      |
| Planck               | 2009-2011 | 0.35-10mm         | All-sky                         | 183mJy                   | 33,566               |
| WMAP                 | 2001-2011 | 3-14mm            | All-sky                         | 500mJy                   | 471                  |
| GB6                  | 1986-1987 | 6cm               | 20,320                          | 18mJy                    | 75,162               |
| NVSS                 | 1998      | 21cm              | 33,827                          | 2.5mJy                   | 1,773,484            |
| FIRST                | 1999-2015 | 21cm              | 10,000                          | 1mJy                     | 946,432              |
| SUMSS                | 2003-2012 | 36cm              | 8,000                           | 1mJy                     | 211,080              |
| WENSS                | 1998      | 49/92cm           | 9,950                           | 18mJy                    | 229,420              |
| 7C                   | 2007      | 198cm             | 2,388                           | 40mJy                    | 43,683               |
| VLA LFSS             | 2007      | 406cm             | All-sky                         | 700mJy                   | 92,963               |

Table 4. The list of all-sky and large-area astronomical catalogs in increasing wavelength range from gamma-rays to radio and their main parameters.

| <b>Wavelength range</b> | <b>Number of objects</b> |
|-------------------------|--------------------------|
| Gamma-ray               | 10 000                   |
| X-ray                   | 1 500 000                |
| UV                      | 100 000 000              |
| Optical                 | 2 400 000 000            |
| NIR                     | 600 000 000              |
| MIR                     | 600 000 000              |
| FIR                     | 500 000                  |
| Sub-mm/mm               | 100 000                  |
| Radio                   | 2 000 000                |

Table 5. The numbers of catalogued astronomical objects at different wavelength ranges.

| <b>Surveys, Projects</b>                                              | <b>Short</b> | <b>Range</b> | <b>Information Volume</b> |
|-----------------------------------------------------------------------|--------------|--------------|---------------------------|
| <b>Digitized First Byurakan Survey</b>                                | DFBS         | opt          | 400 GB                    |
| <b>Digital Palomar Observatory Sky Survey</b>                         | DPOSS        | opt          | 3 TB                      |
| <b>Two Micron All-Sky Survey</b>                                      | 2MASS        | NIR          | 10 TB                     |
| <b>Green Bank Telescope</b>                                           | GBT          | radio        | 20 TB                     |
| <b>Galaxy Evolution Explorer</b>                                      | GALEX        | UV           | 30 TB                     |
| <b>Sloan Digital Sky Survey</b>                                       | SDSS         | opt          | 140 TB                    |
| <b>SkyMapper Southern Sky Survey</b>                                  |              |              | 500 TB                    |
| <b>Panoramic Survey Telescope and Rapid Response System, expected</b> | PanSTARRS    | opt          | 40 PB                     |
| <b>Large Synoptic Survey Telescope, expected</b>                      | LSST         | opt          | 200 PB                    |
| <b>Square Kilometer Array, expected</b>                               | SKA          | radio        | 4.6 EB                    |

Table 6. Data volumes in big astronomical projects.

| <b>Years</b> | <b>Authors</b>                                    | <b>Survey</b>                                             | <b>Short</b>                 | <b>Objectives</b>                          | <b>Number</b> |
|--------------|---------------------------------------------------|-----------------------------------------------------------|------------------------------|--------------------------------------------|---------------|
| 1986-2001    | H. Abrahamian,<br>A. Mickaelian                   | First Byurakan Survey,<br>2nd Part                        | FBS BSOs                     | QSOs and Seyferts                          | 1103          |
| 1994-2010    | A. Mickaelian et al.                              | Byurakan-IRAS Galaxies                                    | BIG                          | IRAS galaxies                              | 1278          |
| 2001-pres.   | A. Mickaelian                                     | Bright AGN                                                | AGN                          | Statistical studies<br>of bright AGN       | 10 000        |
| 2002-2006    | A. Mickaelian et al.                              | Byurakan-Hamburg-<br>ROSAT Catalogue BHRC                 | BHRC                         | ROSAT sources                              | 2791          |
| 2003-2010    | A. Mickaelian et al.                              | Spitzer ULIRGs                                            | Spitzer                      | ULIRGs                                     | 32            |
| 2010-pres.   | A. Mickaelian et al.                              | Markarian galaxies                                        | Mrk                          | Markarian galaxies                         | 1544          |
| 2010-pres.   | G. Paronyan,<br>A. Mickaelian, et al.             | HRC/BHRC AGN<br>content                                   | X-ray AGN                    | X-ray AGN                                  | 4253          |
| 2015-pres.   | H. Abrahamyan,<br>G. Mikayelyan,<br>A. Mickaelian | IRAS PSC/FSC<br>Combined Catalog<br>extragalactic sources | IRAS                         | IRAS galaxies                              | 145 902       |
| 2013-2018    | H. Abrahamyan,<br>A. Mickaelian et al.            | Variable radio sources<br>at 1400 MHz                     | NVSS/FIRST                   | Variable radio<br>sources                  | 6301          |
| 2013-pres.   | A. Mickaelian,<br>G. Paronyan, et al.             | Search for X-ray/<br>radio AGN                            | ROSAT/NVSS                   | X-ray/<br>radio AGN                        | 9193          |
| 2014-pres.   | H. Abrahamyan,<br>A. Mickaelian et al.            | MW study of Blazars                                       | BZCAT                        | Blazars                                    | 3561          |
| 2018-pres.   | G. Mikayelyan,<br>A. Mickaelian et al.            | IRAS PSC/FSC<br>Combined Catalogue<br>ULIRG/HLIRG         | ULIRG/<br>HLIRG              | High luminosity<br>IR galaxies             | 114           |
| 2001-2007    | A. Mickaelian, et al.                             | Fine analysis of<br>AGN spectra                           | Bright AGN                   | Physical<br>properties of AGN              | 90            |
| 2002-pres.   | A. Mickaelian, et al.                             | Search for new<br>AGN in DFBS                             | DFBS AGN                     | New bright<br>active galaxies              | 10 000        |
| 2006-pres.   | A. Mickaelian, et al.                             | Fine classification of<br>active galaxies                 | Mickaelian<br>classification | Active galaxies<br>accurate types/subtypes | 10 000        |

Table 7. The list of BAO “Astronomical Surveys” research department projects related to multiwavelength search and studies of active galaxies.