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Areg M. Mickaelian
David B. Sanders

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COVER ILLUSTRATION:

Multi-band image of an active galactic nucleus (AGN) showing different parts of the host galaxy in different colours combined with the photo of Benjamin Markarian, who was the first to conduct a systematic survey for active galaxies.

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Edited by

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Preface

The **IAU Symposium #304 “Multiwavelength AGN Surveys and Studies”** took place in Yerevan, Armenia on 7-11 October 2013. It was the largest symposium ever held in Armenia both by the number of its participants and represented countries and its international significance. The International Astronomical Union (IAU), National Academy of Sciences of the Republic of Armenia (NAS RA), Byurakan Astrophysical Observatory (BAO) and the Armenian Astronomical Society (ArAS) were the organizers. The scientific sessions were held at the main Conference hall of NAS RA.

The Symposium was dedicated to B. E. Markarian’s 100th anniversary. Beniamin Markarian (1913-1985, <http://markarian.aras.am/>) was the first to conduct and accomplish a large-area (17,000 deg²) spectroscopic survey to search for active galaxies. Markarian survey is until now the largest objective-prism spectroscopic survey, it was the first systematic search for active galaxies using a new method of UV-excess, it resulted in the discovery of 1515 UVX galaxies (Markarian galaxies), including many AGN and Starbursts (SB), the first classification of Seyferts into Sy1 and Sy2, and the definition of Starburst galaxies.

The **symposium subject “Multiwavelength AGN surveys and studies”** included all surveys from historical to recent ground-based and space ones, future projects, the unification and other models of AGN, accretion modes, the structure of nearby AGN, AGN feedback in galaxies and clusters, host galaxies and the AGN environments, binary AGN and merging Super-Massive Black Holes (SMBH), unique AGN, variability and the phenomena of activity. AGN surveys are the source for the most interesting objects in the extragalactic Universe: QSOs, Seyfert galaxies, blazars, radio galaxies, LINERs, etc. They are important for understanding the variety of extragalactic sources and their interrelationship, as well as understanding the evolution of the Universe. Recent ground-based and space missions give vast amount of new multiwavelength (MW) data, which are being put together to discover many new AGN. Virtual Observatories (VOs) help in accomplishment of complex research programs using all these data. A combined study of these data also gives the overall picture of the AGN and answers some of the most important questions:

- understanding the possible evolutionary and/or physical connection between the different classes of AGN, i.e. their consistency with the unification model,
- the relation of AGN to their host galaxies,
- understanding the true fraction of heavily obscured AGN in order to determine the true AGN luminosity function and its variation with redshift.

The **scientific topics** of the symposium were presented by the following 10 sessions (each of them typically lasted half a day):

- Historical surveys: spectral and colorimetric surveys for AGN, surveys for UV-excess galaxies
- AGN from IR/submm surveys: 2MASS, IRAS, ISO, AKARI, SCUBA, SST, WISE, Herschel
- AGN from radio/mm surveys: NVSS, FIRST, ALMA, Planck, and others
- AGN from X-ray/gamma-ray surveys: ROSAT, ASCA, BeppoSAX, Chandra, XMM, INTEGRAL, Fermi, HESS, MAGIC, VERITAS, NuSTAR
- Multiwavelength AGN surveys, AGN statistics and cross-correlation of multiwavelength surveys

- Unification and other models of AGN, accretion modes, understanding of the structure of nearby AGN from IFUs on VLT and other telescopes
- AGN feedback in galaxies and clusters, AGN host galaxies and the AGN environments
- Binary AGN and Merging Super-Massive Black Holes
- Study of unique AGN, AGN variability and the Phenomena of Activity
- Future large projects

There was a representative **SOC** of 18 members from 10 countries: Felix Aharonian (Ireland/Germany, Co-chair), Roger Blandford (USA), George Djorgovski (USA), Malcolm Longair (UK), Laura Maraschi (Italy), Enrico Massaro (Italy), Areg Mickaelian (Armenia, Co-chair), Felix Mirabel (France/Argentina), Ray Norris (Australia), Paolo Padovani (Germany), Bradley Peterson (USA), Elaine Sadler (Australia), David Sanders (USA, Co-chair), Helene Sol (France), Tadayuki Takahashi (Japan), Yervant Terzian (USA), Megan Urry (USA), Lutz Wisotzki (Germany).

Altogether, **128 astronomers from 26 countries** attended the meeting. In addition, together with the SOC members there were 141 official participants representing 28 countries, including also Argentina and Ireland. The list of all represented countries with the number of participants: Argentina (1), Armenia (18), Australia (4), Canada (2), Chile (1), China (4), Colombia (2), Denmark (1), France (4), Germany (19), Greece (2), India (3), Iran (1), Ireland (1), Israel (1), Italy (11), Japan (4), Mexico (3), Netherlands (2), Poland (1), Russia (4), South Africa (1), South Korea (1), Spain (7), Switzerland (1), UK (6), Ukraine (4), USA (32). (<http://iaus304.aras.am/participants.html>)

The **scientific program** consisted of **28 invited and 51 contributed talks and 60 posters**. A few invited reviews were given at the beginning of each session followed by a few more contributed talks. Poster sessions included posters on various matters related to AGN surveys and studies. A number of outstanding scientists were invited to give review talks, including the SOC members. (<http://iaus304.aras.am/program.html>)

A number of excellent **review talks** were given on various topics of AGN and many new excellent results were presented. Among them, one could mention the ones by Zeljko Ivezic on Optical selection of quasars and AGNs: SDSS and LSST, by Amy Barger on Obscured AGN, by Bob Becker on A Massive Sample of Radio Spectral Indices for AGN in the JVLA FIRST Survey, by Cristian Vignali on Obscured accretion from AGN surveys, by Marcello Giroletti on VLBI observations: the closest look at the cores of AGN, by Helene Sol on Very High Energy gamma-rays from blazars, by Yoshihiro Ueda on Evolution of X-ray Selected AGNs, by Luigi Spinoglio on AGN surveys to study galaxy evolution along cosmic times, by Nick Scoville on Large Scale Structure and AGN from COSMOS, by Lisa Kewley on Photoionization, line emission diagnostics, by Sylvain Veilleux on Powerful Molecular Outflows in Nearby Active Galaxies, by Joe Mazzarella on AGN and Starbursts in Dusty Galaxy Mergers: Insights from the GOALS Survey, and others. A number of outstanding contributed talks were presented, such as by Amy Reines on Dwarf Galaxies with Optical Signatures of Accreting Massive Black Holes, by Hartmut Winkler on A spectral re-examination of the Markarian AGN, by Ismael Botti on Obscured quasars at high redshift in the UKIDSS Ultra-Deep Survey, by Susan Ridgway on The Luminosity Function of Obscured and Unobscured Quasars from a MIR Selected Survey, by Megan Gralla on AGN in the Atacama Cosmology Telescope Survey Data, by Elizabeth Mahony on Unveiling the high-frequency radio galaxy population, by Gabriele Giovannini on Radio and Gamma-ray emission in nearby BL Lacs, Giulia Migliori on Young Radio Sources in the High Energy Band, by Amy Kimball on Identifying the

Most Luminous QSOs in the Universe from Multiwavelength Sky Surveys, by Angela Bongiorno on Accreting SMBH in the COSMOS field and the connection to their host galaxy, by Laura Trouille on Identifying Obscured AGN: X-ray and Optical Spectral Properties, Sarah Gallagher on The Persistence of Winds in Quasars, and others. A general review of all contributions was given in the Summary Talk by David Sanders.

At the end, a general discussion was organized by the SOC co-chairs David Sanders and Areg Mickaelian. The Symposium provided a good opportunity to further discuss a strategy, based on acquired experience, for planning future surveys, and to coordinate follow-up observations with the new large ground-based and space telescopes.

This symposium was especially rich with **social events**, including the main touristic attractions of Armenia: Welcome Reception at Ani Plaza hotel, weekend excursions (Yerevan City Tour; Garni temple and Geghard monastery; Lake Sevan and the biggest cross-stones collection at Noradus; Khor Virap monastery, Noravank church and the ancient observatory Karahunge), evening visits to the museum of ancient manuscripts Matenadaran, Armenian religious center Ejmiatsin Cathedral and its Museum, symphonic concert at Yerevan State Opera House, visit to BAO and social dinner with Armenian national songs and dances, and Meeting Banquet with horse riding for the guests. In addition, the Ambassadors of UK and India in Armenia invited participants from their countries for receptions at their residences.

The **Local Organizing Committee (LOC)** consisted mainly of young BAO scientists. In addition, some 30 students made up the LOC Supporting Teams, who were ready to assist the participants with any practical matters. They have been selected from Yerevan State University (YSU) Departments of Physics, Radiophysics, Romance and Germanic Philology, International Relations, and Journalism, Yerevan State Linguistic University (YSLU) and Armenian Tourism Institute (ATI). **LOC Supporting Teams** were responsible for arrivals and departures, local transportation, accommodation, registration, meeting hall and poster area, Internet, lunches and coffee/tea breaks, social events, mass media and PR.

The IAU Symposium #304 was the 6th IAU meeting held in Armenia. The previous 5 meetings were: IAU S29 in 1966 (“Non-Stable Phenomena in Galaxies”), IAU S121 in 1986 (“Observational Evidence of Activity in Galaxies”), IAU S137 in 1989 (“Flare Stars in Star Clusters, Associations and Solar Vicinity”), IAU S194 in 1998 (“Activity in Galaxies and Related Phenomena”), and IAU C184 in 2001 (“AGN Surveys”). Moreover, one of the regular Byurakan International Summer Schools (BISS) in 2010 was combined with the 32nd IAU International School for Young Astronomers (ISYA). (<http://www.aras.am/Meetings/meetingsIAU.html>)

We acknowledge all organizations and sponsors supporting the meeting (see the list of organizers and sponsors). We would like to thank all participants of the meeting and contributors to this volume, SOC members for their important work on setting up the program of the meeting, LOC and LOC supporting team members for their efforts to make the symposium successful. We also thank Sona Farmanyan for her help in editing and preparation of this book.

Editors

Areg Mickaelian and David Sanders

May, 2014

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Dedication

Very few astronomers with their contribution in the observational astronomy can be compared with Benjamin Markarian. After the distinguished scientist Viktor Ambartsumian he is very likely the greatest person of Armenian astronomy. His survey and Markarian galaxies are known to each astronomer. So far many astronomers and world observatories work on investigations of Markarian galaxies.

The meeting was dedicated to the 100th anniversary of Benjamin Markarian and we dedicate this volume to his memory.

Benjamin Markarian (1913–1985) was one of the greatest observing astronomers of the 20th century. He was the author of the famous Byurakan surveys (First Byurakan Survey, FBS or Markarian survey and Second Byurakan Survey, SBS) and the discoverer of ~1500 UV-excess galaxies (Markarian galaxies).

Markarian was born on November 29, 1913 in Shulaver (at present Shahumyan) of the district of Marnueli in Georgia. In 1933 he entered and in 1938 with a diploma of excellence graduated from the faculty of Physics-Mathematics of Yerevan State University (YSU). In 1938–1941 he worked as a senior lecturer of higher mathematics at Yerevan Pedagogical Institute. In 1939 Markarian entered the post-graduate fellowship of the Armenian branch of the USSR Academy of Sciences by the specialty of astrophysics and went to Leningrad University. But his studies were interrupted by World War II and in 1941 after returning to Armenia he was called up to the Army. After the Army he was a senior researcher at the Yerevan Astronomical Observatory (1942–1946). In May 1944 under the academician Viktor Ambartsumians supervision Markarian successfully defended his candidate thesis on a subject “The fluctuations observed in the visible distribution of stars and the cosmic absorption”. Since 1946 (since the day of foundation) he was a senior researcher at the Byurakan Astrophysical Observatory (BAO), in fact being one of its founders. Markarian actively participated in the selection of the site of the new observatory, which needed serious work for further effective observations. Markarian personally mounted and put almost all telescopes of the Byurakan Observatory into operation, thus making basis for the development of observational astronomy in Armenia.

In 1953–1956 Markarian worked as a deputy director on science of BAO. He was appointed as the Head of the Department of Investigation of Stars from 1957 to 1962, then of the Department of Galaxies from 1962 to 1985. In 1943–1956 he also worked as a lecturer of astronomy at YSU. He was elected a corresponding member of the Academy of Sciences of the Armenian SSR (1965), a full member of the Academy of Sciences of the Armenian SSR (1971). He was awarded a title of Honored Scientist of the Armenian SSR (1961). Markarian was elected a member of Astronomical Council of the USSR Academy of Sciences (1964), member of the International Astronomical Union (IAU, 1955), Vice-President of the IAU Commission on Galaxies (1973–1976) and its President (1976–1979).

Markarian’s scientific works refer to the physics of stars, stellar clusters and galaxies. He took part in working out of the theory of fluctuations observed in the distribution of stars taking into consideration the interstellar absorption. On the basis of observational data he has confirmed that the stellar associations expand. Markarian has worked out a new classification of stellar clusters and in 1952 he has compiled and published “An atlas



Figure 1. Left: Benjamin Markarian in early 1960s. Right: Markarian with colleagues Valentin Lipovetskiy and Jivan Stepanian, who together with him accomplished the First Byurakan Survey (FBS or Markarian survey).

of different types of stellar clusters”. In 1963 he revealed 73 galaxies with an unusual color to their spectral class. He has worked out a special method (for selecting galaxies with UV-excess) on the basis of which 1965–1980 a spectral sky survey was obtained at BAO. He revealed 1500 objects of special class which are called by his name (Markarian galaxies or galaxies with UV-excess). Since 1968 with the help of large telescopes of the USSR and the USA, spectral observations of these galaxies were carried out and a great number of active galaxies were discovered among them essentially changing our understanding on the population of the Universe and the activity of galaxies. Later from 1978 to 1991 also on Markarian’s initiative the Second Byurakan Survey (SBS) was conducted in which a great number of quasars and other active galactic nuclei were revealed. The catalog of Markarian galaxies was published after his death by his colleagues in the USA in 1986 and in the USSR in 1989.

Markarian has published more than 100 scientific papers. He was a USSR State Prize winner (1950). He was awarded the orders “Sign of Honor” (1955) and “Peoples’ Friendship” (1983), as well as a number of medals and diplomas of the Presidiums of the Academies of Sciences of the USSR and Armenia and of the Supreme Council of Armenia.

Benjamin Markarian passed away on September 29, 1985 in Yerevan. Till the end of his life, in spite of his poor health, he actively worked doing the main job of his scientific life, the Byurakan Surveys.

Areg Mickaelian and David Sanders, Editors