Physics – Uspekhi **66** (1) 103 – 105 (2023)

PERSONALIA

PACS number: **01.60.+q**

Yurii Yur'evich Balega (on his 70th birthday)

DOI: https://doi.org/10.3367/UFNe.2023.01.039311

January 8, 2023 was the 70th birthday of academician of the Russian Academy of Sciences (RAS) Yurii Yur'evich Balega, one of the leading astrophysicists of our country, a prominent specialist in observations of celestial objects with a high angular resolution.

Yu Yu Balega was born in the village of Kol'chino, Mukachev area, in the Transcarpathian region of the Ukrainian SSR. The family lived in a small village house with a straw roof. His parents were philologists: his father was a teacher of Ukrainian language and history at Uzhgorod University, and his mother was a schoolteacher of the Russian language. The family spoke two languages: Russian and Ukrainian. Transcarpathia is a multinational area. Little Yura's neighbors were Hungarians, Czechs, Poles, and Slovaks, and therefore, when meeting his friends, he had to speak different languages. As a result, Yurii Yur'evich perfectly mastered these and several other languages — English, French, and German.

When Yura and his younger brother Volodya were a bit older, the family moved to Uzhgorod, where the boys went to a school situated on the bank of the very beautiful Uzh River. Being an active and talented child, Yura did not waste time: he went in for sports, was successful in classical wrestling, and attended the arts studio at the House of Pioneers. Yurii Yur'evich likes drawing and oil painting and is a member of the Russian Academy of Arts. Having a good ear for music, Yura taught himself to play the piano and guitar. As a student, he worked at the Uzhgorod Philharmonic, led the ensemble *Yuventus* ('Youth' from the Latin). The ensemble received prizes at many competitions in Ukraine. Then Yurii headed the pop band *Perpetuum Mobile* at his native physics department at Uzhgorod University.

In 1974, Yu Yu Balega graduated from university and became a professional astronomer. For some time, he worked at the Uzhgorodpribor plant as an industrial engineer at a transformer workshop.

The period of the 1960s–1970s was the beginning of the space era. Artificial Earth satellites began to appear. Of great importance for determining satellite orbits was their observation from optical telescopes. The Soviet Union created an extensive network of tracker stations all over the world, of which three were situated in the USSR: in Uzhgorod, Riga, and Zvenigorod (near Moscow). Beginning with his first year at university, Yurii worked at the Uzhgorod station as a night observer. There, he took a great interest in the problem of optical instability of Earth's atmosphere and its influence on astronomical observations. When a fifth year university student, he published his first scientific work in the journal *Kinematika i Fizika Nebesnykh Tel* (*Kinematics and Physics of Celestial Bodies*).

Uspekhi Fizicheskikh Nauk **193** (1) 111 – 112 (2023)
Translated by A N Tsaplin

Yurii Yur'evich Balega

In December of 1974, Yurii Balega arrived at the Special Astrophysical Observatory (SAO) in the village of Nizhnii Arkhyz of the Zelenchuk region in Karachay-Cherkessia, where the largest telescope in the world, the Big Telescope Altazimuth (BTA), was at the last stage of preparation before being put into operation. Yurii Yur'evich recalled: "I was so much impressed by the giant telescope that I decided to throw everything aside and get a job at the observatory. ...Two months later, I was already working as a senior laboratory assistant in the group of astronomical climate studies under the general guidance of Ivan Mikheevich Kopylov. The task was to examine the thermal regime of the dome and telescope, first and foremost its main mirror, in order to improve the quality of the obtained images."

In 1975, Yu Yu Balega became involved in speckle-interferometry. That same year, he got acquainted with the pioneering study of the French astronomer Antoine Labeyrie describing the principles of speckle interferometry. Having constructed a rather simple optico-mechanical device, Balega realized his method using the BTA. A series of photographs of

stars made with short exposures was processed in a laboratory with a coherent laser setup. This was the first work in our country and one of the first in the world in star speckle interferometry: it was the first time that the components of the bright binary star Capella were separated and the angular diameter of the red supergiant Betelgeuse was measured. The paper by Yu Yu Balega and N A Tikhonov was published in the journal *Pis'ma v Astronomicheskii Zhurnal* (*Soviet Astronomical Letters*).

Yu Yu Balega devoted his life to solving a broad spectrum of astrophysical problems. The main spheres of Yu Yu Balega's interests are the investigation of fundamental characteristics of components of multiple star systems using interferometric methods, the origin and evolution of stars, first and foremost the nearest dwarfs in the vicinity of the Sun, young massive stars in star-formation complexes, and the structure of their gas-dust shells. Yu Yu Balega has paid great attention in his work to creating new systems of recording and processing astronomical photos in the optical and infrared bands. To restore an image by autocorrelation functions, a digital system of processing in real time was worked out. The system has no equivalent in the world and was developed exclusively on the basis of Russian microelectronics. The original algorithms based on calculating bispectral functions are now being widely used by astronomers and specialists in aero-optics.

Yu Yu Balega's scientific results are as follows:

— The basic elements of optical speckle interferometry for enhancing the resolution of large telescopes have been elaborated, and methods and means of observations at the largest 6-meter telescope (BTA) have been created;

— Multiple star systems with small-mass components, including brown dwarfs, and components of very large masses have been examined; their fundamental parameters have been determined;

— The structure of circumstellar envelopes around the forming young stars and stars at the final stage of evolution has been investigated; models of the systems have been constructed.

The speckle-interferometric method for recovering images distorted by the optical inhomogeneity of Earth's atmosphere was developed and realized for the first time in the world by Yurii Yur'evich and his French and German colleagues in observations using the BTA — the largest telescope of the 1970s–1980s. This allowed the angular resolution of the BTA to be increased 50 to 100 times compared to the classical methods of astronomical observations. Speckle interferometry became the basis for designing adaptive optical systems exploited today at all large telescopes in the world.

The image of the circumnuclear region of the active galaxy NGC 1068 was obtained and the radial velocities of gas clouds around its nucleus were measured for the first time using the speckle-interferometric method, which cast a great deal of light onto the physical nature of active galaxies and quasars.

Over 100 close binary and multiple star systems were discovered by Yu Yu Balega using interferometry with the 6-meter BTA. Observations of the orbital motion of such stars made it possible to measure masses of the components of the systems and to determine their basic characteristics.

Studies of the fundamental properties of dwarf star systems in the nearest neighborhood of the Sun have great importance. This stellar population makes up the bulk of stars in the Galaxy, but their basic characteristics, for instance, the mass dependence of luminosity, have not been thoroughly examined.

Studies of brown dwarfs, i.e., objects intermediate in mass between planets and stars, are especially significant. The BTA observations revealed the triple dwarf Gliese 569B, for which the masses of components (50 Jupiter masses) were directly measured for the first time. This confirmed the contemporary theoretical estimates.

Interferometry was used to establish that all young massive stars born in the star-formation complex in the Orion constellation are multiple systems. For example, the brightest hot star Theta[1] Orionis C, only 100 thousand years of age, turned out to be a binary system with an orbital motion period of about three years, and its orbit monitoring allowed the masses of components to be 'weighed' with 5% accuracy. The obtained result is of fundamental importance for an explanation of the origin and evolution of massive stars.

Yu Yu Balega and his co-authors published a large number of papers investigating the structure of gas-dust shells of massive stars at the final stage of evolution. Models of the extensive atmospheres of these stars that enrich space with heavy chemical elements have been constructed.

Yu Yu Balega participated in developing new means of image recording (photonics). New astronomic receivers allowed recording very weak images of distant cosmic objects. In 1991, Yu Yu Balega and a team from the All-Union Research Institute of Television (St. Petersburg) were awarded the USSR State Prize for creating digital television systems with quantum-limiting sensitivity for examining extremely weak astronomic objects using the BTA. Later on Yu Yu Balega received the Russian Federation (RF) Prize for constructing an astronomic facility on Terskol peak in the mountains of Kabardino-Balkaria and introducing restored energy sources to ensure SAO RAS's functioning.

For almost a quarter of a century (1993–2015), Yu Yu Balega headed SAO RAS at Nizhny Arkhyz. There, two largest telescopes in our country operate: the optical BTA with a mirror 6 m in diameter and the RATAN-600 radio telescope with a circular 600-m antenna. Yu Yu Balega's activity as director took place during the hard 1990s. Despite the problems of those times, Yu Yu Balega managed to retain the scientific and engineering staff, as well as ensure an uninterruptible operation of the country's most important astronomical instruments. In the same period, the BTA was completely re-equipped: the entire stock of scientific instruments was replaced and digital methods for recording, processing, and storing images were introduced. Since 2015, Yurii Yur'evich has been the research supervisor of SAO RAS.

Since 1997, Yu Yu Balega has been a corresponding member and, since 2016, a full member of RAS elected in the RAS Division of Physical Sciences (DPS). From 2017 to 2022, Yu Yu Balega was vice president of RAS, supervising the budget sphere and the property of RAS, international activities, and the activity of the Physical Sciences Division of RAS.

As the vice president of RAS, Yu Yu Balega consistently advocated for the need for a substantial increase in funding for scientific institutions and an increase in the role of scientists in the management of science: ''Until scientists themselves decide how science will develop, I think the situation will not change. I am sure that if such a decision is made, this will be the strongest answer to any sanctions. And

further on the science will be able to quickly and efficiently solve any problems we have because we have thousands of world-class researchers. The Russian Academy of Sciences is one of the main brands of the country. It cannot be lost.''

Currently, Yu Yu Balega is the head of the Department of Infocommunication Technologies of Astrophysics and Astroinstrument Engineering of the St. Petersburg National Research University of Information Technology, Mechanics and Optics (ITMO). He is a professor in the Department of Theoretical and Mathematical Physics of the Faculty of Physics and Technology of the North-Caucasus Federal University (NCFU) and professor at the High Engineering and Technical School Institute.

Yu Yu Balega is the author of over 350 scientific papers, of which nearly 200 were published in leading world journals and are well known to specialists; he is the editor-in-chief of the journal *Astrophysical Bulletin*.

Yu Yu Balega was elected member of the RAS Presidium, was Deputy Chairman of the RAS Council for Space (till 2019), is a member of the Bureau of the Scientific Council of the Physical Sciences Department of the Russian Academy of Sciences for Astronomy, is a member of the Bureau of the National Committee of Russian Astronomers, is a member of the Coordinating Council of the long-term (2021–2030) Program of Fundamental Scientific Research in RF, is deputy chair of the Presidium of the Southern Scientific Center RAS, is chair of a commission of the RAS Presidium for the formation of the list of programs of fundamental research in priority areas determined by the RAS Presidium, and is chair of a commission for the development of recommendations on the amount of funds provided in the federal budget for the next financial year to finance fundamental and exploratory scientific research.

Since 2018, Yu Yu Balega has been a member of the Russian Pugwash Committee, has received an honorary doctorate from St. Petersburg Polytechnic University, has been an honorary professor of Stavropol State University, has been a member of the supervisory board of NCFU, has been a member of the International Astronomical Union (IAU), in different periods was also vice president of the IAU Commission for Binary and Multiple Stars, and has been a member of the Astronomical Methods and Instruments Commission.

In 1985 and 1991, he was elected people's deputy of the Karachay-Cherkess Autonomous Region, and in 2008, he was elected president of the scientific society of Karachay-Cherkess Republic.

He was awarded the Medal of the Order For Merit to the Fatherland II degree, the Order of Friendship, the Order of Honor, and the Medal For Labor Valor, is a laureate of the State Prize of the USSR and the Prize of the Government of the Russian Federation, and received the A A Belopol'sky Prize of RAS for a series of papers ''Determining the Fundamental Characteristics of Main-Sequence Stars from Interferometric Observations with the 6-meter BTA.''

Celebrating the wonderful birthday of Yurii Yur'evich, numerous colleagues, disciples, and friends wish the hero of the day good health, prosperity, and further creative success for the benefit of his beloved science!

D V Bisikalo, G G Valyavin, V V Vlasyuk,
L M Zelenyi, N R Ikhsanov, O I Korablev,
K A Postnov, I I Romanyuk, O V Rudenko,
E E Filippova, A M Cherepashchuk, B M Shustov