

Nikolai Semenovitch Kardashev (on his 80th birthday)

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Academician Nikolai Semenovitch Kardashev, distinguished astrophysicist, Head of the Astro Space Centre of the Lebedev Physical Institute (FIAN), Chairman of the Scientific Council on Astronomy of the Presidium of the Russian Academy of Sciences (RAS), was born 80 years ago, on 25 April 1932.

N S Kardashev was born in Moscow into a family of professional revolutionaries. After the revolution his father, Semen Karlovich Brike, rose to important posts in the Soviet Communist (Bolshevik) Party hierarchy. His mother, Nina Nikolaevna Kardasheva, also joined the Bolshevik Party before the 1917 October Revolution. In due times he graduated from the Moscow Higher Women's Courses and later the Institute of Red Professors. In the years of Stalin's brutal repressions (1937/38), both his parents were arrested: his father was shot, and his mother spent many years in labor camps. Little Kolya was sent to an orphanage; after a struggle with authorities, his mother's sister was able to take him to live in her house. After the WWII, he lived for many years alone in a room in a huge communal flat. Only in 1956 was his mother allowed to return to Moscow, after years in labor camps and subsequent exile to the town of Murom. By that time, her son had already graduated from university.

Nikolai Kardashev grew very keen on astronomy while still a fifth-grade schoolboy. During his school years he attended the astronomy hobby group at the Moscow planetarium, as did many future astronomers in the USSR.

In 1950, N S Kardashev enrolled in the astronomy division of the Mechanics and Mathematics Department of Moscow State University (MGU (*Russ. abbr.*)). Here, he focused his interests on radio astronomy, which at the time was a new and rapidly developing branch of astrophysics; this was the field to which he later devoted all his life.

After graduating from MGU in 1955, Nikolai Semenovitch found work at the recently organized Department of Radio Astronomy at the P K Sternberg State Astronomical Institute of MGU (GAISH MGU), headed by the pioneer of radio astronomy in the USSR, the young professor Iosif Samuilovich Shklovskii. The ensuing fruitful cooperation between the teacher and his disciple lasted for more than 30 years, until the untimely death of I S Shklovskii in 1985.

Under I S Shklovskii's supervision, N S Kardashev completed his annual university coursework and graduation thesis, and in 1963 he submitted and maintained his PhD thesis. Another successful step in his scientific carrier, this time N S Kardashev's Habilitation thesis, was taken at the GAISH Learned Council in 1965.

In this thesis, Nikolai Semenovitch treated the evolution of the spectra of sources of synchrotron radio emission. He was



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able to show that the shape of the spectrum of such sources carries information on their age; it was in this manner that the author, together with A D Kuzmin and S I Syrovatskii, succeeded in obtaining for the first time an experimental estimate of the age of one of the radio galaxies. It is interesting to note that this same thesis also included the results of the analysis of the problem of generation of recombination radio lines by highly excited hydrogen atoms that N S Kardashev had already published in 1958. This publication stimulated launching a program of dedicated observations with FIAN's RT-22 radio telescope and BPR, the Large Pulkovo Observatory Radio Telescope. The observations resulted in the spectacular discovery in 1964 of recombination radio lines in the spectrum of the galactic nebula Omega, and later in the expansion of the new field of study in the physics of the interstellar medium.

In 1964, Nikolai Semenovitch published an interesting paper on changes in the magnetic field of a collapsing star: the collapse ends with the formation of a neutron star having a magnetic field up to 10^{12} G. He thus anticipated the existence of pulsars which were discovered only in 1967, even though with the different magnetic field structure.

Roughly during the same years, N S Kardashev, along with L I Matveenko and G B Sholomitskii, suggested a new scheme of recording signals on separate aerials of radio interferometers—a scheme which, in principle, made it possible to eliminate limitations on the size of the interferometer baseline. This spectacular idea engendered progress in the technology of radio interferometry with very long baselines, creating the feasibility of building intercontinental radio interferometers. The angular resolution of such systems at wavelengths of about 3 cm is approximately 0.3 milliarcseconds, which is thousands of times better than the resolution of large optical telescopes.

In 1960, N S Kardashev and V I Slysh started their pioneering work on the study of radio emission from cosmic objects at ultralow frequencies (i.e. at wavelengths longer than 30 m), which are totally blocked by Earth's ionosphere. Observations were made with automatic interplanetary spacecraft (Mars and Venera series). These experiments allowed astronomers for the first time to detect low-frequency radio waves of terrestrial and solar origin, and subsequently fruitfully explore Earth's radiation belts, the outer solar corona, and the interplanetary medium.

After N S Kardashev left MGU GAISH for the Space Research Institute (IKI) of the USSR Academy of Sciences, he headed a laboratory in the Astrophysics Department, and some time later rose to Deputy Director of IKI.

In 1990, FIAN's Director, Academician L V Keldysh, invited part of the IKI Radioastronomy Department under the leadership of Nikolai Semenovich to relocate to FIAN. Here, N S Kardashev became Head of the specially created research unit with the standing of FIAN research division: the Astro Space Centre (AKTs FIAN) which absorbed FIAN's Pushchino Radio Astronomy Observatory with all its unique radio telescopes and closely related research preferences.

At FIAN, N S Kardashev focused his energy on building the compound ground- and space-based radio interferometer, RadioAstron. The idea of the project, which Nikolai Semenovich first proposed as far back as the 1970s, was to launch into high-apogee orbit a satellite equipped with high-accuracy 10-m parabolic antenna. Operating at 1.3-cm wavelength jointly with the largest ground-based radio telescopes in the interferometric mode, this antenna would provide unprecedented angular resolution of a few microarcseconds!

After several decades of project R&D, manufacturing equipment, and conducting ground tests of the space radio telescope and of all the necessary scientific instruments, the Spektr-R spacecraft was successfully launched into orbit from the Baikonur spaceport on 18 July 2011; the orbit's apogee, 360,000 km, is almost equal to the distance from Earth to the Moon. At this moment, the unique RadioAstron radio interferometer, with the 10-m antenna aboard the Spektr-R space vehicle, started working in collaboration with the largest ground-based radio telescopes of the U.S.A., Germany, Japan, Australia, Ukraine, and Russia, and generating unique scientific results. All the huge scientific information from the space leg of the interferometer is received by the ground tracking station (based on the RT-22 radio telescope of FIAN's Pushchino Radio Astronomy Observatory) and is sent through digital communication channel to the Processing Center located in the FIAN AKTs in Moscow.

N S Kardashev is never satisfied with what has already been achieved; he now supervises with enviable energy the next space mission, Millimetron, aimed at solving further pressing problems in astrophysics and cosmology.

N S Kardashev combines his Director's duties at AKTs FIAN with his work at the RAS Astronomy Council as Chairman; for many years he was Vice President of the International Astronomical Union (IAU), and Deputy Secretary-Academician of the Division of General Physics and Astronomy of RAS.

Nikolai Semenovich is one of the most active enthusiasts of the observational SETI programs, a pioneer in the work on the newest challenging ideas in astrophysics: wormholes and invisible matter in the Universe (dark matter and dark energy). N S Kardashev has authored more than 150 research papers and served as editor of a large number of domestic and international conference proceedings and collections of papers. He is constantly surrounded by a crowd of young colleagues. His students work in many institutes and observatories in Russia and abroad. In 1994, Nikolai Semenovich was elected Full Member of the Russian Academy of Sciences. He twice won the honor of the USSR State Prize (in 1980 and 1988), and was awarded the RF Order of Honor in 2011.

We heartily wish Nikolai Semenovich Kardashev all the best and wish him many years of fruitful work for the benefit of science in Russia and on the world scene.

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