Remembering Nikolay Kardashev

David Jauncey, Kelvin Wellington and Philip Edwards CSIRO Space and Astronomy

Nikolai Semyonovich Kardashev was born on April 25th 1932, and died August 3rd 2019. He is remembered for his many contributions to astrophysics, SETI research, and for leading the RadioAstron space VLBI mission.

Early career and SETI

Nikolai graduated from the Department of Astronomy at Moscow State University in 1955. He was fortunate to have attended the first class to hear lectures on Radio Astronomy given by the young and energetic Iosif Shklovsky, and was captivated by those lectures and the lecturer. In 1963 he presented his dissertation which covered several areas which became the topics of his early scientific publications. Kardashev (1964) "Transmission of Information by Extraterrestrial Civilizations" had a lasting influence on the SETI community internationally. He recognized three levels of achievement that alien civilizations might reach:

Type I, like our own, harnessing energy from their sun & planet, 4 x 10^12 Watts

Type II, harnessed the power of their sun, 4 x 10^26 Watts

Type III, harness the power of their galaxy, 4 x 10^37 Watts.

Nikolai retained a strong lifetime interest in the search for extraterrestrial intelligence, SETI, and co-authored, along with Carl Sagan, Frank Drake and Freeman Dyson, presentations at the 1971 Conference "Communications with Extraterrestrial Intelligence (CETI)" held at the Byurakan Astrophysical Observatory, Yerevan, in September 1971.

He also made the point that any advanced civilization wishing to transmit signals across the Universe, in order to achieve the strongest signal via the lowest noise on reception, would choose to shape the overall spectrum of the transmitted signal as the inverse of the noise spectrum outside the confines of the Earth's atmosphere. This would translate to an overall peaked radio spectrum. He also noted that there were already several very compact catalogued radio sources, designated CTA 21 and CTA 102.

At that time, Sholomitsky was using a space tracking antenna in Crimea to study the variability at 32.5 cm wavelength of a large group of radio sources including CTA 21 and CTA 102. He reported finding variability of about 30% in CTA 102 on a timescale of 100 – 120 days from his two years of observations (Sholomitsky 1965) Such large variations with such a short timescale, were quite remarkable, and seemed to imply that the variations were so intense that the source was likely to self-destruct.

Kardashev and Shklovsky also began speculating that the variable radio signal from CTA 102 might be the signal from an extraterrestrial civilization. They held a press conference that was attended by Soviet as well as foreign media. The press took their speculations seriously, and the 14 April 1965 edition of Pravda reported that aliens were signalling the Earth! The news quickly spread around the world with front page stories in many places. In the process CTA 102 became almost famous, as well as the only quasar to be immortalized in song, by the Byrds!

In the west the Sholomitsky claim was not taken seriously until Hunstead (1972) reported on his 408 MHz observations, made over the period 1967 – 1972, of four variable radio sources, one of which was CTA 102. Thus, Sholomitsky's observed CTA 102 variability was confirmed. In the decades since, it has been shown that such low frequency variability is relatively common in flat-spectrum radio sources and is evidence that such sources are not only very compact, but that they are "twinkling" in the interstellar medium.

Figure 1: The 10 m RadioAstron space telescope as seen by the RadioAstron International Steering Committee during their visit to the Lavochkin Association facility in October 2008. Nikolai is the fifth person from the right-hand side.

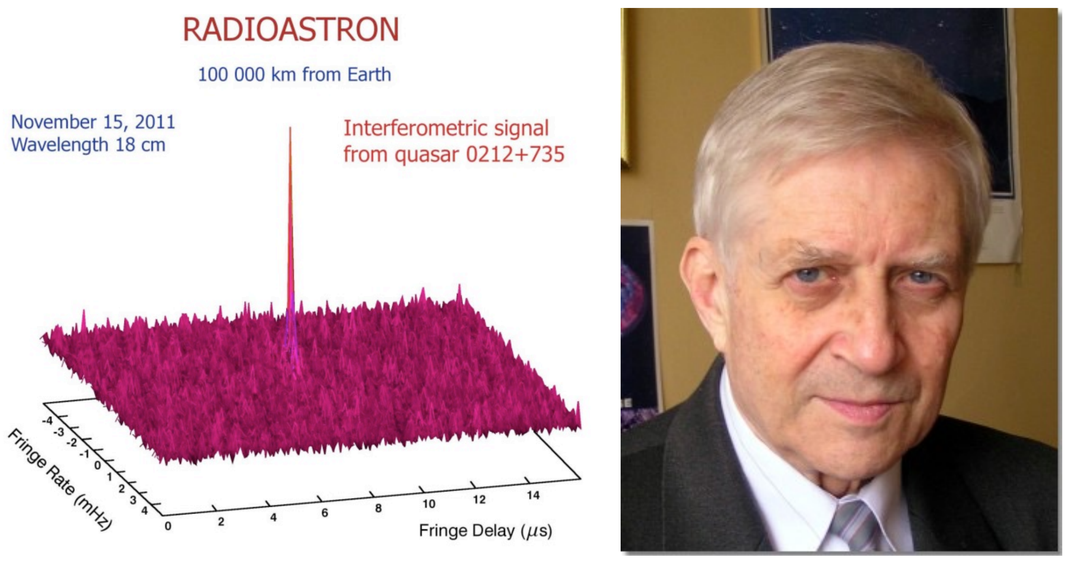

Figure 2: (Left) The first fringes from the Earth to the spacecraft on quasar 0212+735 on the 8,100 km baseline between RadioAstron and the 100-m MPIfR radio telescope near Effelsberg, Germany, were observed on November 15, 2012, at 1.66 GHz. (Right) Nikolay Kardashev.

VLBI and RadioAstron

Australian scientific collaboration with the then Soviet Union and Professor Kardashev, began in 1975 with the signing of a Collaborative Science Agreement. At the time Nikolai was Professor at the Space Research Institute, becoming Deputy Director in 1977. One of the first joint experiments was the undertaking of the first around the world VLBI experiment in 1976 between Australia, the US and Crimea, to observe H2O maser sources at 1.35 cm wavelength with an angular resolution of 0.1 milliarcseconds (Batchelor et al., 1976).

Soon afterwards, in 1978 Nikolai commenced the study for the space VLBI program RadioAstron, for which he worked hard for more than four decades. The aim of the RadioAstron project was to make it possible to obtain a record-high angular resolution of a few micro-arcseconds, orders of magnitude higher resolution than was attainable at any other wavelength. The mission was designed to operate at four frequencies, 0.33, 1.66, 4.6 and 22 GHz, in an orbit with an apogee of up to 350,000 km, thereby yielding angular resolutions of 530, 100, 35 and 7 micro-arcseconds respectively. The individual low noise receivers were to be supplied by different international participants. Australia, through CSIRO, supplied the 1.66 GHz Receiver which, incidentally, provided the lowest noise level of the four systems.

Throughout the mission development Nikolai continued his wide-ranging research both into the astrophysics of the potential target extragalactic radio sources, and through his strong interest in SETI. After thirty years of development this remarkable Space VLBI project, developed by scientists and engineers at the Astro Space Centre and across the world, the 3660 kg RadioAstron spacecraft was finally launched from the Baikonur Cosmodrome on July 18, 2011, and then placed in its highly elliptical orbit extending out beyond 300,000 km with an 8~10 day period.

Kardashev et al. (2017), "RadioAstron Science Program Five Years After Launch", provides a detailed and comprehensive coverage of the status of the findings of the RadioAstron program at that time. The publication is co-authored by the members of the research team, and the abstract is presented here.

"The RadioAstron ground-space interferometer provides the highest angular resolution achieved now in astronomy. The detection of interferometric fringes from quasars with this angular resolution on base-lines of 100–200 thousand km suggests the brightness temperatures which exceed the Compton limit by two orders of magnitude. Polarimetric measurements on ground-space baselines have revealed fine structure testifying to recollimation shocks on scales of 100–250 μas and a helical magnetic field near the base of radio emission in BL Lacertae. Substructure within the scattering disk of pulsar emission on interferometer base-lines (from 60000 to 250000 km) was discovered. This substructure is produced by action of the interstellar interferometer with an effective baseline of about 1 AU and the effective angular resolution of better than 1 μas. Diameters of scattering disks were measured for several pulsars, and distances to diffusing screens were evaluated. The ground-space observations of sources of the maser radiation in lines of water and Hydroxyl, have shown that the maser sources in star-forming regions remain unresolved on baselines, which considerably exceed the Earth diameter. These very compact and bright features with angular sizes of about 20–60 μas correspond to linear sizes of about 5–10 million km (several solar diameters)."

The future continuation of this highly successful mission will be the Millimetron project, on which Nikolai was actively working in recent years.

Until the very last days, Nikolai Semyonovich Kardashev continued to generate bold scientific ideas.

For more details please see
https://www.atnf.csiro.au/people/David.Jauncey/NikolaiKardashev-ASA2022.pdf

FOR FURTHER INFORMATION

David Jauncey
Space and Astronomy
David.Jauncey@csiro.au

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