Physics – Uspekhi **37** (5) 523 – 525 (1994)

PACS numbers: 01.60. + q

Valer'yan Ivanovich Krasovskii

Valer'yan Ivanovich Krasovskii — an outstanding investigator of the Earth's upper atmosphere, Professor, Doctor of Physicomathematical Sciences, Russia's honoured worker in science and engineering, Laureate of the State Prize of the USSR, Member of the International Association for Geomagnetism and Astronomy (IAGA), Member of the International Astronomical Union (IAU), ex-vice-president of the Working Group of the International Committee for the Study of Cosmic Space (COSPAR), Academician and founder of the International Academy of Astronautics (IAA), honorary member of the International Astronautic Federation (IAF), and member of the editorial board of the journal *Planetary and Space Science* (England) — died on 4th December 1993. All the above achievements were due to his own distinctive talents.

Krasovskii was born on 14th June 1907 in Sevsk in the Orlov Province into the family of a priest. In 1923 he graduated with distinction from the Nine-Year School in Maloarkhangel'sk of the Orlov Province. After the Krasovskii family had been deprived of their electoral rights in the middle of 1920s and the father had been subjected to persecution, the son escaped from the 'Red Wheel' to Central Asia where he struggled for existence in most fantastic ways. Krasovskii ended the Central Asian stage of his life by becoming a radio technician at the Tashkent radio station. In 1930 he managed to move to Leningrad, where he worked intensively in the field of vacuum electronics and became acquainted with S I Vavilov, who became interested in Krasovskii's investigations and subsequently always helped him.

Krasovskii may be regarded as one of the creators of the Soviet vacuum image converter (IC) — a device which converts an IR image into a visible one. Similar studies were also carried out in other countries but were given no publicity because of their applied nature. Specimens of the converters for army night vision devices were constructed in Krasovskii's laboratory at the 'Svetlana' factory at the beginning of the Second World War. In December 1941 Krasovskii's laboratory was evacuated by air from the besieged Leningrad to Moscow, where the production of the ICs was immediately initiated at the Moscow Electrical Factory. The night vision devices and IR-transmitting glasses constructed there for headlights helped in the night guidance of tanks towards the end of the battle of Stalingrad. After the night vision devices had been demonstrated to Stalin in April 1943, S I Vavilov was appointed director of optical works by the State Defence Committee on Krasovskii's recommendation. Krasovskii was awarded the 'Badge of Honour' order in January 1944 for the mass production of these devices and a year later he was granted the Stalin Prize. In 1946, Krasovskii passed the minimum standard examinations for the degree of Candidate of Science (equivalent to PhD), defended a dissertation on the subject of work concerned with defence, and received the scientific degree of Candidate of Technical Sciences and the title of Senior Scientific Worker. In 1950, Krasovskii was confirmed by the Supreme Attestation Commission (Russian abbreviation VAK) as member of the Scientific Council of the Research Institute 801 (Russian abbreviation NII-801), where his laboratory was transferred in 1946.

In the search for applications of the ICs after the war, Krasovskii proved to be the only developer of the ICs to whom occurred the idea of viewing the night sky through a telescope with this sensitive receiver of IR radiation. In

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Uspekhi Fizicheskikh Nauk **164** (5) 555 – 557 (1994)
Translated by A K Grzybowski

1948, he observed in the vicinity of Moscow the bright radiation from low-temperature stars and the intense IR glow of the night sky. Having assembled a home-made spectrograph, Krasovskii established that this IR glow is localised in a broad spectral band. S I Vavilov, G A Shain, and the Crimean astronomers helped Krasovskii to continue his observations at the Simeiz Observatory, where he observed in 1949 a series of molecular bands in the radiation from the night sky, instead of a single band, which very soon made it possible to identify them with the emission due to hydroxyl (OH). In 1949 in Simeiz, Krasovskii observed the central swelling of the Milky Way in the IR range, which is concealed in the visible region by the absorbing interstellar matter.

Krasovskii's studies at the end of the 1940s stimulated the development of electron telescopy in Russia and abroad. In 1951, Krasovskii suggested that the ICs be used to count individual quanta, which was achieved decades later. In 1951, Krasovskii defended a Doctoral dissertation based on his results in observing the emission from the night sky. In 1952, he moved to the Geophysical Institute of the Academy of Sciences (Geofian), where he became concerned with the physics of the upper atmosphere. During this period, Krasovskii directed two students in the Department of Astronomy of Moscow State University to develop a contact photographic method. Instead of the first ICs, devices tens of times more sensitive than before were created. All the aeronomic IR observations were performed with their aid in the subsequent decades and the weak light of galaxies and quasars began to be investigated on the modest Russian-produced telescopes. After the Geofian had been divided, Krasovskii directed from 1955 the Division of the Physics of the Upper Atmosphere at the Institute of the Physics of the Atmosphere (IFA) of the Academy of Sciences.

In response to the development of new aspects of research, Krasovskii became actively involved in 1956 in the preparations for the International Geophysical Year (IGY). Appreciating the fact that even the best IC combined with a poor spectrograph cannot yield first class results, he requisitioned the development at the State Optical Institute (GOI) of high-luminosity geophysical spectrographs of three types — for the UV, visible, and IR regions. The GOI coped with this task extremely well and produced the SP-48, SP-49, and SP-50 spectrographs, the characteristics of which were tens of times better than those of the devices of the Simeiz period. The recording of the hydroxyl emission and of the spectra of polar lights with the aid of the above devices, which to this day remain the principal instruments in Russian aeronomy, was immediately begun in the observation stations engaged in the IGY programme. The study of the glow of the upper atmosphere corresponding to the OH bands, the detection of the H_α night sky glow and of the twilight helium IR fluorescence, observations of the geocorona (the glow of atomic hydrogen at great heights), and the studies of the broad hydrogen lines in the spectra of polar lights constitute a far-from-complete list of the results of aeronomical observations carried out during the IGY under Krasovskii's supervision with the aid of the new technique which he created.

Studies on the spectra of aurorae long before the IGY convinced Krasovskii that the intense electron and proton streams have a decisive effect on the upper atmosphere in the region of aurorae after solar flares. Therefore, in 1956 he began to prepare an experiment for the detection of 'solar corpuscular streams' on an artificial Earth satellite (ISZ). On the Soviet ISZ-III, Krasovskii and his coworkers first observed in May 1958 powerful streams of electrons over the regions of aurorae with energies of the order of 10 keV, while in the middle and low latitudes they observed streams of higher energy electrons captured by the geomagnetic trap. This was the principal contribution to the discovery of the phenomenon subsequently called the Earth's radiation belts. The result of the experiment on the ISZ-III and the studies during the IGY were published by Krasovskii not only in Russian scientific journals but also abroad, which was not easy at that time. During these years, he trained a team of young geospace investigators. In 1959, the Supreme Attestation Commission awarded Krasovskii the title of Professor. His students and colleagues created the first model of the density of the upper atmosphere, on the basis of which they calculated the orbits of satellites. For this work, the Praesidium of the Academy of Sciences of the USSR awarded Krasovskii a medal for "the contribution to work concerned with man's first excursion into space".

In 1960, Krasovskii prepared a programme of satellite research on the 'geoactive corpuscles' including magnetic storms and aurorae. As a result of his outstanding organising ability, S B Korolev's Design Bureau constructed two 'small' satellites, while the radio factory in Darnitsa constructed five sets of on-board scientific apparatus and in April – May 1962 experiments were begun on the 'Kosmos-3' and 'Kosmos-5' satellites. During two months of observations, it proved possible to detect 'fresh' photoelectrons, generated in the ionosphere by the hard solar UV radiation, and, at low geomagnetic latitudes, streams of ions with energies of hundreds of eV to a few keV. Krasovskii was the first to propose a mechanism of their formation involving the interaction of the satellite with the ionospheric plasma. It was established that, in the internal 'proton' radiation belt, the streams of captured electrons exceed by several orders of magnitude the proton streams, while in the regions of polar lights the streams of electrons and protons enter the upper atmosphere. These studies of the 'natural' geospace were interrupted by the American 'Starfish' 1.4 megatonne nuclear explosion, carried out on 9th July 1962 at a height of 430 km. A flash of γ-radiation far below the horizon relative to the site of the explosion was recorded already in the first second. The size of the cloud of hot radioactive plasma and the form of the belt of hard radiation produced were later determined. The reports by Krasovskii and his coworkers on the consequences of the explosion at conferences with military and technical specialists and also at Soviet and international conferences made an enormous contribution to the creation of a favourable atmosphere for the conclusion in 1963 of an agreement between the USSR and the USA about the prohibition of nuclear explosions in three media. Other manifestations of high-altitude nuclear explosions also did not escape Krasovskii's attention. In 1961, he developed a method for their detection from observations of the emission by the products of the explosions in the Earth's upper atmosphere and he supervised the creation on the territory of the USSR of a network of monitoring stations, which worked successfully for more than 20 years. In 1964 – 1965, an experiment

designed to detect geoactive corpuscles on the high-apogee satellites 'Elektron-1' and 'Elektron-3' was carried out under Krasovskii's supervision. Powerful electron beams over the regions of aurorae and the ring current were investigated and the half-life of the belt due to the 'Starfish' explosion was established.

Towards the end of the first decade of the space age, Krasovskii became one of the few Soviet geophysicists whose work in the field of aeronomy and in the study of geospace was recognised by leading foreign investigators. He had enormous scientific authority in the worldwide aerospace community and he commendably represented abroad this aspect of Soviet scientific research. Therefore, on the creation in 1966 of the Institute of Space Research of the Academy of Sciences, the structure of geophysical laboratories and their tasks, proposed by Krasovskii, were adopted and it was suggested that he should assume the duties of director of the Geophysical Division. However, Krasovskii declined this distinguished position when it became evident that it would be necessary to abandon the field of research into the optical emissions from the upper atmosphere, a field that he created. He transferred to the Institute of Space Research the entire young scientific team which he trained, whilst he himself concentrated on more profound research into the upper atmosphere at the Institute of the Physics of the Atmosphere.

At the beginning of the 1970s, Krasovskii began to investigate the rapid variations of the temperature of the Earth's upper atmosphere using the latest achievements of the photometric technique. He found that they are caused by internal gravity waves arising in active meteorological formations in the troposphere. Krasovskii's work concerning the determination of the properties of the internal gravity waves received wide international recognition and has been registered as discovery number 209 from 21st December 1978. In 1977, Krasovskii was awarded the title "honoured worker in science and engineering in the RSFSR" for his outstanding scientific achievements. During the last years of his life, Krasovskii prosecuted his own lines of research at the IPA. In particular, in a number of studies he criticised the conclusions reached by the well-known American investigator L Franc that the water in the Earth's oceans is meteoric in origin, reached after the analysis of the space photographs of the upper atmosphere from the 'Dynamic Explorer' satellite. After a series of discussions published in recent years, the scientific community tends towards the view put forward by Krasovskii.

Until his last days, Krasovskii retained the lucid mind and enthusiasm of the true scientist. One month before his death, he received the Soros grant for his work during the three previous years. Death found him a thinking and entranced man with an inflexible will.

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