

## Commemoration of the centenary of the birth of Academician S N Vernov (Joint scientific session of the Physical Sciences Division of the Russian Academy of Sciences and the Department of Physics of M V Lomonosov Moscow State University, 16 June 2010)

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On 16 June 2010, a joint scientific session of the Physical Sciences Division of the Russian Academy of Sciences (RAS), Joint Physical Society of the Russian Federation, Scientific Council of the Department of Physics of Moscow State University (MSU), Scientific Council of the MSU SINP, RAS Council on Space Research, Coordination Scientific and Technical Council of the Federal Space Agency, RAS Scientific Council on the Integrated Problem of Cosmic Rays and RAS Scientific Council on Physics of Solar–Terrestrial Relations took place at the R V Khokhlov central physics auditorium of the MSU Department of Physics. The session was devoted to the 100th anniversary of the birth of Academician Sergei Nikolaevich Vernov.

The agenda of the session announced on the website [www.gpad.ac.ru](http://www.gpad.ac.ru) of the RAS Physical Sciences Division listed the following reports:

**Ryazhskaya O G** (RAS Institute for Nuclear Research, Moscow) “Opening address”;

(1) **Matveev V A** (RAS Physical Sciences Division, Moscow) “A few words about S N Vernov”;

(2) **Sadovnichy V A** (M V Lomonosov Moscow State University, Moscow) “S N Vernov as a scientist at Moscow State University”;

(3) **Trukhin V I** (M V Lomonosov Moscow State University, Moscow) “S N Vernov as a professor in the MSU Department of Physics”;

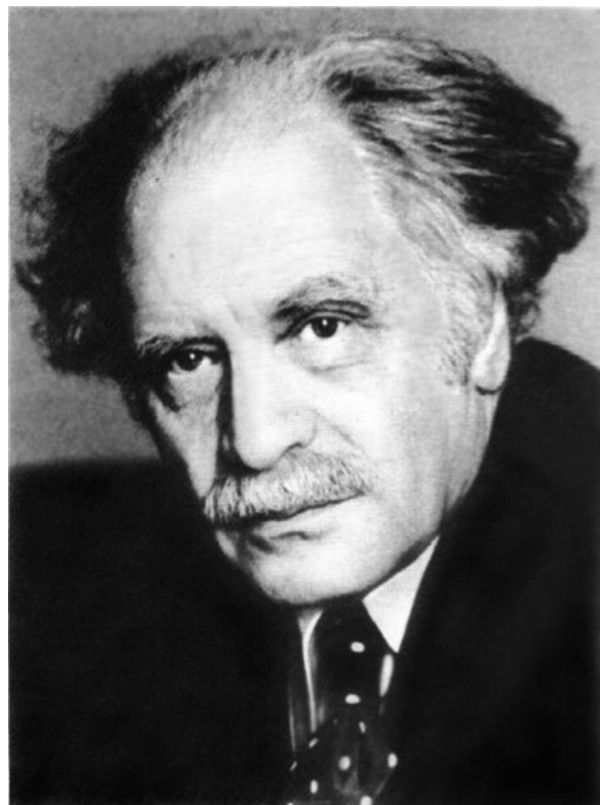
(4) **Panasyuk M I** (D V Skobeltsyn Institute of Nuclear Physics of M V Lomonosov Moscow State University, Moscow) “Cosmic ray astrophysics before and after 1957”;

(5) **Dergachev V A** (RAS A F Ioffe Physical-Technical Institute, St. Petersburg) “S N Vernov and space physics: Apatity–Leningrad, 1968–1983”;

(6) **Stozhkov Yu I** (P N Lebedev Physical Institute, RAS, Moscow) “S N Vernov and ground-breaking studies of cosmic rays in the stratosphere”;

(7) **Berezhko E G, Krymsky G F** (Yu G Shafer Institute of Cosmophysical Research and Aeronomy of the SB RAS Yakutsk Scientific Center, Yakutsk) “S N Vernov and cosmic ray research in Yakutia”.

Texts of the articles based on the reports presented are printed below.



Sergei Nikolaevich Vernov  
(11.07.1910–26.09.1982)

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### Opening address

O G Ryazhskaya

The date 11 July 2010 marks the 100th anniversary of the birth of the outstanding Russian scientist, Academician Sergei Nikolaevich Vernov.

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S N Vernov was one of those who stood at the origins of space physics. His name is inseparable from the breakthroughs and important achievements of space research in the USSR. His work started with cosmic ray physics. The physics of cosmic rays is the field having organic links to other fields of science. The origin of cosmic rays and the processes in which they acquire enormous energies are questions whose solutions can only be found in close contact with astrophysics, radio astronomy, and cosmology. The energy spectrum of cosmic rays extends from 0.1 to  $10^{11}$  GeV, i.e., there exist particles whose energies exceed that of particles generated in modern accelerators by a factor of several tens and hundreds of millions. The study of the interaction between such particles and nuclei led to the creation of elementary particle physics and high-energy physics, with whom the cosmic ray physics continues to maintain a very close link. Cosmic rays throw a bridge between the space and the microcosm.

S N Vernov's span of interests in science was very broad. He carried out a number of fundamental studies in cosmic ray physics and in fields related to them, like elementary particle physics, plasma phenomena, astrophysics, and geophysics, and he was one of the founding fathers who established the foothold in space studies and exploration. Sergei Nikolaevich was the first in the world to develop the methodology of high-altitude automatic studies of cosmic rays using stratospheric radiosondes. With this technique, he measured the flux of cosmic rays in the stratosphere as a function of geomagnetic latitude and proved that most of the energy of cosmic rays is associated with charged particles. Sergei Nikolaevich studied in detail the electron–photon, muon, and nuclear-active components of cosmic rays in the stratosphere, measured the east–west asymmetry in the fluxes of primary cosmic rays, proved that the primary component consists mainly of protons, established the mechanism of production of secondary particles, and obtained indications that the  $\pi$  meson existed. In the 1950s, a unique facility was built under S N Vernov's guidance at MSU for studying ultrahigh-energy cosmic rays, and the energy spectrum of cosmic rays with energies up to  $10^{17}$  eV was obtained. An inflection point was found experimentally at about  $10^{15}$  eV in the energy spectrum of cosmic rays. The establishment of this phenomenon was recorded as a discovery. Its authors were S N Vernov, G B Khristiansen, G V Kulikov, V I Solov'eva, A T Abrosimov, and B A Khrenov.

Many important experiments, first on geophysical rockets and then on artificial Earth satellites and interplanetary probes, were conducted since the late 1940s under S N Vernov's leadership. Using instruments on the first artificial Earth satellites, S N Vernov, A E Chudakov, Yu I Logachev, E V Gorchakov, and P V Vakulov discovered Earth's outer radiation belt and found an explanation for the nature of the inner belt. Detailed studies performed under the guidance of S N Vernov on the sputniks (the Elektron and Kosmos series) led to understanding the structure and dynamics of the Earth radiation belts and to the development of the theory of the belts' origin. Further progress in these studies under S N Vernov's scientific leadership resulted in establishing a number of fundamental laws of solar physics, physics of interplanetary medium, and Earth's magnetosphere and ionosphere. S N Vernov was one of the creators of space materials science and of the study of problems related to radiation safety in the course of piloted space flights.

S N Vernov was an outstanding science administrator. Our ancestors used to say: “For obtaining a good result it is

necessary to find the right person at the right time.” Sergei Nikolaevich possessed this gift. Owing to his leadership, various research avenues created in space physics continue to produce valuable results.

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## A tribute to S N Vernov

V A Matveev

### 1. Introduction

We have gathered here today to give credit to the memory of an outstanding Soviet scientist, a science and physics education organizer, and Full Member of the USSR Academy of Sciences, Sergei Nikolaevich Vernov.

S N Vernov's name is inseparable from the era of the inception and maturation of the physics of cosmic rays, nuclear physics, and space research.

We pay tribute to the memory of a Russian scientist who built a world-famous scientific school, whose students and followers work actively in many areas of modern fundamental and applied physics, both in this country and abroad.

Sergei Nikolaevich chose which direction to pursue in his research at the beginning of the 1930s when, as a postgraduate at the Radium Institute, he began to study cosmic rays. Only very few people could have foreseen that the study of cosmic rays would become fundamentally important for science and turn new pages in elementary particle physics, as well as in the physics of interplanetary space and interstellar-matter physics. From the very first years of S N Vernov's life in science he was guided in his work by Academician D V Skobel'syn and worked in close contact with him; time showed that S N Vernov was one of D V Skobel'syn's most talented disciples.

### 2. Study of cosmic rays in the stratosphere

The area that S N Vernov started to attack with all his energy was the study of cosmic rays at high altitudes. This meant that experiments inevitably excluded human presence and hence any active participation of the experimentalist in the operation of the equipment. In 1935, S N Vernov realized for the first time in world practice the transmission of information on cosmic rays by radio from balloon probes. This opened a future full of promise for stratospheric, and later for still higher altitude rocket studies [1].

In 1935, S N Vernov went to work for a Doctor's degree at the P N Lebedev Physical Institute (FIAN in *Russ. abbr.*), where his style of research was much influenced by S I Vavilov and D V Skobel'syn: a combination of daring experiment and profound theoretical analysis.

In 1945 and later S N Vernov launched large-scale stratospheric studies, having set up FIAN's stratospheric station and a special research team at Moscow State

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