

CONFERENCES AND SYMPOSIA

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Forty years of the Institute for Nuclear Research
(Scientific session of the Physical Sciences Division of the Russian Academy of Sciences, 22 December 2010)

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On 22 December 2010, the scientific session of the Physical Sciences Division of the Russian Academy of Sciences (RAS), devoted to the 40th anniversary of the Institute for Nuclear Research, RAS, was held at the Institute for Nuclear Research, RAS in Troitsk.

The agenda of the session announced on the website www.gpad.ac.ru of the RAS Physical Sciences Division listed the following reports:

(1) **Matveev V A** (Institute for Nuclear Research, RAS, Moscow) "Introductory word";

(2) **Gavrin V N** (Institute for Nuclear Research, RAS, Moscow) "Contribution of the SAGE results to the understanding of solar physics and neutrino physics";

(3) **Domogatsky G V** (Institute for Nuclear Research, RAS, Moscow) "Baikal neutrino experiment";

(4) **Tkachev I I** (Institute for Nuclear Research, RAS, Moscow) "Observation of the Greisen–Zatsepin–Kuz'min effect at the Telescope Array Observatory";

(5) **Kudenko Yu G** (Institute for Nuclear Research, RAS, Moscow) "Neutrino T2K experiment: the first results";

(6) **Sadykov R A** (Institute for Nuclear Research, RAS, Moscow) "Fields of study of condensed media at the neutron facility at the INR, RAS";

(7) **Zhuikov B L** (Institute for Nuclear Research, RAS, Moscow) "Production of isotopes at the INR, RAS: reality and prospects."

The papers written on the base of reports 1–5 and 7 are published below.

In addition, the paper "High-power diode-pumped alkali lasers" by A M Shalagin is published. The paper is based on the report presented at the scientific session of the General Assembly of the Physical Sciences Division, RAS (13 December 2010) devoted to the 50th anniversary of the laser, the main materials of the session having been published in *Usp. Fiz. Nauk* **181** (8) 867 (2011) [*Phys. Usp.* **54** 837 (2011)]

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Institute for Nuclear Research of the Russian Academy of Sciences turns 40

V A Matveev

The Institute for Nuclear Research (INR), RAS was founded by the USSR Covernment's decision of December 1970 on the initiative of N N Bogoliubov and M A Markov supported by M V Keldysh, the President of the Academy of Sciences of the USSR, with the aim of creating the modern experimental base and pursuing research activities in the fields of the physics of elementary particles, fundamental nuclear physics, the physics of cosmic rays, and neutrino astrophysics.

The director of the Institute from the day of its foundation until 1986 was Academician A N Tavkhelidze.

In 1978, the Institute began to build on the territory of the Scientific Center of the USSR Academy of Sciences in Troitsk, Moscow region, a facility based on a high-current linear accelerator of protons and negative hydrogen ions with the rated energy up to 600 MeV and average beam current up to 0.5 mA. At present, construction of the Center of Neutron

Administration and laboratory wing of INR, RAS in Troitsk.

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and Isotopic Research and the Proton Therapy Complex is being completed on the base of this facility.

The Institute provided the construction of the Baksan Neutrino Observatory in the Elborus region of the Kabardino-Balkarian Republic in the Northern Caucasus with a set of neutrino telescopes in deep underground laboratories and above-ground large-area facilities for studying extensive air showers and high-energy cosmic rays. In 1978, an underground scintillation telescope, the largest in that time, was commissioned here for studying atmospheric neutrino fluxes penetrating through the thickness of Earth and for searching for neutrino radiation produced during the collapse of massive stars in the Galaxy.

On 23 February 1987, a neutrino signal generated by the explosion of the 1987A supernova in the Large Magellanic Cloud at a distance of about 150 kpc from Earth was first detected with this telescope and simultaneously with three other large-scale neutrino telescopes: Kamiokande-II (Japan), IMB (Irvine–Michigan–Brookhaven) (USA), and the LSD (Liquid Scintillation Detector) Russian–Italian telescope under Mont Blanc, Italy).

In 1991, the construction of the unique Gallium–Germanium Neutrino Telescope with a liquid-metal gallium target of a mass close to 60 t, which has no counterparts anywhere in the world, was accomplished at the underground laboratory (the site depth is 4800 m of water equivalent) of the Baksan Neutrino Observatory. The investigation of solar neutrino fluxes performed by Russian and American scientists for more than 20 years on this telescope [Soviet–American Gallium Experiment (SAGE)] confirmed experimentally for the first time the thermonuclear nature of solar energy and made an important contribution to the discovery of the fundamental phenomenon of neutrino oscillations.

The Institute constructed the world's first stationary deep-sea neutrino telescope in Lake Baikal at a depth of more than 1 km for studying natural high-energy neutrino fluxes and searching for new heavy particles, such as superheavy magnetic monopoles, and neutralinos. Based on this telescope, a project is being developed at present for constructing a deep-sea neutrino telescope with a volume of up to 1 km^3.

The Institute is one of the acknowledged leaders in the investigations of problems of neutrino astrophysics, the physics of superhigh-energy cosmic rays, and studies of interrelations between the physics of elementary particles, astrophysics, and cosmology.

Along with the telescopes mentioned above, the 100-t Collapse scintillation facility located in salt mines in Artemovsk (Ukraine) is well known around the world. This facility was a prototype of the large-scale neutrino Large Volume Detector (LVD) developed in cooperation between the Russian Academy of Sciences and the Instituto Nazionale di Fizica Nucleare (INFN) (Italy) and located at underground Gran Sasso laboratory.

The record-sensitive Troitsk-ν-Mass Setup for searching the mass of an electron antineutrino in precision studies of the decay spectrum of gaseous tritium with a wide-aperture superconducting magnetic spectrometer is also well known in the scientific world. Today, this setup is being modernized to increase its sensitivity to the neutrino mass to a value of better than 1 eV.

The scientific schools of N N Bogoliubov, M A Markov, A N Tavkhelidze, I M Frank, G T Zatsepin, and A E Chudakov have been established at the Institute, and are conducting active studies at present. The impressive advances of theorists at the Institute include, notably, the prediction of the spectrum cut-off for superhigh-energy cosmic rays (the Zatsepin–Kuzmin–Greisen effect), the discovery of the specific features of neutrino oscillations in matter (the Mikheyev–Smirnov–Wolfenstein effect), the theoretical discovery of the monopole catalysis of proton decay (the Rubakov effect), the discovery of the properties of power asymptotics of exclusive processes (the Matveev–Muradyan–Tavkhelidze quark counting formulas), calculations of multiloop radiative effects in quantum chromodynamics (Chetyrkin, Tkachev, Kataev, Larin), the study of the baryon asymmetry of the Universe and, in particular, the consideration of the nontrivial structure of the ground state in the theory of quantized gauge fields (Kuzmin, Rubakov, Shaposhnikov), the study of the orthopositronium problem (Gninenko, Krasnikov), and the investigation of the enigmas of the physics of superhigh-energy cosmic rays (Berezinsky, Kuzmin, Rubakov, Troitsky, et al.)

INR scientists have made an important contribution to the study of rare decays of pions and kaons on the basis of the large Istra facility constructed by them using the beam of the U-70 proton accelerator at the Institute of High-Energy Physics in Protvino, and also to the study of problems of relativistic nuclear physics using the beams of accelerators at the Joint Institute for Nuclear Research (Dubna) and the SPS (Super-Proton Synchrotron) at CERN. Investigations are under way on the parameters of neutrino oscillations in the OPERA (Oscillation Project with Emulsion-tRacking Apparatus, Italy) and K2K (KEK-to-Kamioka, Japan) experiments and cosmic rays in the Caucasus, Tibet, the Transbaikal region, Japan, and the USA.

The Institute for Nuclear Research, RAS began to collaborate with CERN in 1993, taking part in the NOMAD (Neutrino Oscillation MAgnetic Detector) experiments and making a contribution to the construction of an electromagnetic spectrometer. At present, the Institute is actively participating in the CMS (Compact Muon Spectrometer), ALICE (A Large Ion Collider Experiment), and LHCb (Large Hadron Collider beauty) experiments at the Large Hadron Collider (LHC), the NA61 and NA62 experiments at the SPS, and the CAST (CERN Axion Solar Telescope) experiments.

In 2002, INR, RAS founded the International Academician Markov Prize for work that has made an outstanding contribution to fundamental physical studies in the fields of science closely related to the scientific program of the Institute.

In the 40 years since its foundation, the Institute has become one of the leading scientific centers in Russia and the world in the fields of fundamental and applied nuclear physics, one of the pioneers of 'underground and deep-sea neutrino physics', which has actively been developed throughout the world over the last decades.[1]

The scientists of the Institute have obtained fundamental results in the fields of elementary particle and nuclear physics, neutrino astrophysics, theoretical physics, and cosmology.

The 40th anniversary marks a mature age. The Institute and its collective body have big plans of development in accordance with the new challenges of fundamental science and the demands of innovation development of economics in our country — the economics of knowledge.

I would like to wish the collective body of the Institute great new enterprises and scientific discoveries.

[1] More detailed information on INR, RAS is presented on the websites www.inr.ru and www.inr.ac.ru.