

FACES AND PLACES

ANNIVERSARY

LAL celebrates 50 innovative years



An aerial view of the Laboratoire de l'accélérateur linéaire on 5 October 1957.



Guy Wormser, LAL director (left), and Mario Calvetti, LNF director, with the plaque celebrating the first collisions between electrons and positrons with the ADA storage ring.

Celebrations to mark the 50th anniversary of the Orsay Linear Accelerator Laboratory (LAL) took place on 8–9 June, beginning with an opening ceremony attended by Michel Rocard, former prime minister of France and son of LAL's founder, Yves Rocard. The event featured an outstanding array of speakers and attendees with two Nobel laureates, the director and the president of the French National Centre for Scientific Research, and many directors of major particle-physics laboratories, including CERN, DESY, Fermilab, the Laboratori Nazionali di Frascati (LNF) and SLAC. Colleagues and former collaborators came from many parts of the world to congratulate LAL for its leadership in particle physics and its pioneering experimental work.

Construction of the linear accelerator at Orsay began in 1956 under the direction of Yves Rocard and Hans Halban. Designed by physicists of the Ecole Normale Supérieure and engineers of the Compagnie générale de télégraphie sans fil, it became one of the world's most powerful accelerators during the 1960s. The intense beam with its small spot size allowed studies of the structure of matter through electron-scattering experiments.

However, the accelerator's main role turned out to be as a powerful injector for e^+e^- storage rings, a story that began in 1962 when the AdA storage ring, built in Frascati under the visionary leadership of Bruno Touschek, arrived in Orsay. The following year,

in December 1963, collisions between electrons and positrons were observed for the first time, a world premiere of great significance. A new ring, ACO, started operation at LAL in 1966, producing a large proportion of the early results on low energy e^+e^- collisions. It ceased functioning in 1988 and was transformed into a museum and registered on the inventory of historic buildings. ACO can be considered as the ancestor of the synchrotron light source SOLEIL, currently under construction at Saclay. An even larger ring, DCI, was constructed at LAL in 1976 and this hosted the DM2 detector, which for many years studied the largest J/ψ sample in the world.

During the 50th anniversary event, a plaque celebrating the first e^+e^- collisions was unveiled by Guy Wormser, director of LAL, and Mario Calvetti, director of the LNF. Also, a huge experimental hall was renamed Hall André Lagarrigue, commemorating the great scientist whose team discovered neutral currents in 1973 with the Gargamelle bubble chamber at CERN. Lagarrigue was LAL's director from 1969 until his untimely death in 1975. CERN has also renamed a road Route André Lagarrigue on its site at Preessin.

Many other great achievements at LAL were discussed during the two-day event, including the construction of the LEP Injector Linac, the first accelerator at CERN entirely provided by another laboratory. LAL also

participated in the discovery and the study of the W and Z bosons in the experiments UA2, ALEPH and DELPHI at CERN, and played a pioneering role in the BaBar experiment at SLAC, paving the way for much larger international participation there. As in many other laboratories in the world, in the 1990s physicists at LAL became keenly interested in experiments in astroparticle physics and cosmology, making key contributions to the VIRGO gravitational-wave interferometer in Cascina, Italy, and the Planck satellite to measure the cosmic microwave background with unprecedented accuracy.

The value of a fundamental research laboratory such as LAL in fostering innovation was a recurring theme of the anniversary celebration. As current director, Wormser's first priority now is to maintain and enhance the excellent international reputation of LAL. "In the next decade, we will have the very exciting opportunity of answering the fundamental questions raised in our field – 'What is the origin of mass?', 'What is dark matter and dark energy?', 'What is the number of space dimensions of the universe?' – with new tools such as the LHC [Large Hadron Collider] that offer unique possibilities to answer them. LAL will no doubt continue to play a pioneering role in this magnificent endeavour."

● For more information see www.lal.in2p3.fr/ and <http://sciences-aco.lal.in2p3.fr>.

NEUTRINOS

KM3NeT Collaboration gets going

Scientists from 37 research institutes in eight European countries gathered at the physics institute of the Friedrich-Alexander University of Erlangen-Nuremberg on 11–13 April to launch the three-year design study for a cubic-kilometre-scale neutrino telescope (KM3NeT) and platform for deep-sea sciences at a clear-water site in the Mediterranean. The €20 m design study, partly funded under the research infrastructure portion of the European Community's 6th Framework Programme, will finish in 2009 with a detailed technical design report allowing construction of the telescope to commence swiftly.

KM3NeT's mission is to detect high-energy neutrinos, which are expected to be created in a variety of astrophysical sources including active galactic nuclei, pulsars, supernova remnants, black holes and quasars. The detection of such neutrinos may be key to understanding the most violent objects in the universe and, in conjunction with experiments sensitive to charged cosmic rays and photons at a variety of wavelengths in the electromagnetic spectrum, will open the era of multi-messenger astronomy.

The detection of these neutrinos, which can travel intergalactic distances and pass through intervening dust clouds and magnetic fields without interaction or deflection, requires a huge detector target. KM3NeT will instrument at least 1000 megatonnes of deep-sea water with thousands of sensitive light detectors. Occasionally a neutrino will interact with an atomic nucleus close to the detector, producing a charged muon. Moving through the water at close to the speed of light, the muons will generate a detectable blue wake of Cherenkov radiation.

KM3NeT will complement the sky coverage of the IceCube cubic-kilometre-scale telescope currently deployed in the deep Antarctic ice (*CERN Courier* May 2006 p24). It will be sensitive to the region of the sky containing the galactic centre and galactic plane, in which many exciting ultra-high-energy gamma-ray sources have recently been detected by the HESS imaging air Cherenkov telescope in Namibia (*CERN Courier* January/February 2005 p30).

The KM3Net collaboration reflects a convergence of effort from the three smaller-

scale Mediterranean projects: ANTARES near Toulon (*CERN Courier* June 2003 p22), NEMO near Catania and NESTOR near Pylos (*CERN Courier* May 2003 p5). In addition to their role as pilot neutrino-telescope projects, these sites will form part of the proposed ESONET/EMSO chain of sea-floor observatories.

The infrastructure of KM3NeT will provide an instrumentation platform for ocean sciences that include marine biology, geology and geophysics. These sciences will benefit from long-term fixed-site measurement of deep-sea environmental parameters such as water purity, undersea currents, bioluminescence, biosedimentation studies and sea-floor seismometry.

There has been strong support for KM3NeT, which promises an eventful future, from the European Community, the University of Erlangen-Nuremberg (which is the project coordination centre for the design study) and a growing community of participating institutes.



EXHIBITION

Science unites nations in Geneva

The Science Bringing Nations Together exhibition was on display in the Palais des Nations of the UN office in Geneva on 25–28 April to celebrate the 50th anniversary of the establishment of the Joint Institute for Nuclear Research (JINR), Dubna, on 26 March 1956. The poster exhibition developed jointly by CERN and JINR has previously been displayed in Oslo, Paris, Brussels, Moscow, Bucharest, Dubna, Yerevan and Thessaloniki.

The scientific activities of the two international centres, CERN and JINR, their collaboration in global projects on modern elementary-particle physics and the application of high-energy physics in various aspects of life were main themes of the event.



Alexei Sissakian, director of JINR, speaking at the opening of the exhibition in Geneva.

Addressing a press conference before the opening of the exhibition, CERN's director-general Robert Aymar and JINR's director Alexei Sissakian, spoke about scientific research at JINR and CERN, including joint projects and future experiments in high-energy physics at the Large Hadron Collider at CERN. At the opening event, Sergei Ordzhonikidze, UN director-general in Geneva, and Valery Loshchinin, the Russian Federation

ambassador to the UN in Geneva, as well as Aymar and Sissakian, addressed the delegates.

The exhibition covered the achievements of joint research in high-energy particle physics by CERN and JINR, as well as progress in nuclear physics, condensed-matter physics and applied research. A film was shown about the joint scientific programmes of the two organizations, and booklets and souvenirs for JINR's 50th anniversary were also available.

AWARDS

Markov prize goes to Lake Baikal physicists

The Markov prize for 2006 has been awarded to Grigory Domogatsky and Christian Spiering for their leading roles in creating the Lake Baikal neutrino telescope, NT200+, and for their outstanding contributions to high-energy neutrino astrophysics. Grigory Domogatsky started his career in theoretical astroparticle physics and has been held the position of spokesman of the Baikal collaboration since 1980. Christian Spiering led significant German contributions to the Baikal project from 1988 and is currently spokesman for the IceCube collaboration.

The Baikal telescope was the first successful realization of an idea proposed by Moisey Alexandrovich Markov more than 40 years ago: the exploitation of water in oceans or lakes for neutrino detection. NT200+ is the second-largest existing neutrino telescope, after AMANDA at the South Pole. Both



Grigory Domogatsky, left, and Christian Spiering during their lectures at the Markov award ceremony, which took place in May.

detectors have pushed the limits on cosmic fluxes from diffuse or point-like sources of energetic neutrinos to more than an order of magnitude below earlier results from underground detectors. AMANDA is currently being incorporated in the cubic-kilometre array, IceCube, which has nine of its

80 strings already deployed (*CERN Courier* May 2006 p24). There are also plans to expand NT-200+ to the gigatonne scale, to observe regions of the sky not observable by IceCube, with a much better sensitivity than the present NT200+ detector.

The prize diplomas were handed to the laureates on the occasion of the Markov Readings, held in Moscow on 11–12 May. This annual mini-conference commemorates Markov, the outstanding Russian scientist who initiated and promoted many lines of research in elementary-particle physics, gravitation and cosmology. The readings were organized by the Lebedev Physical Institute, the Institute for Nuclear Research, the Petersburg Institute for Nuclear Physics and the Joint Institute for Nuclear Research, Dubna – all institutions where Markov worked for many years.

ATLAS collaboration rewards top suppliers

In a ceremony on 5 May, three companies showing excellence in mechanics, electronics and cryogenics received awards for their contributions to the ATLAS experiment.

Alu Menziken Industrie AG of Switzerland was honoured for the production of 380 000 aluminium tubes for the monitored drift tube (MDT) chambers, which were delivered on time with an extraordinary quality and precision. Between October 2000 and January 2004 1300 km of tubes were supplied in time for the production of the MDT chambers. The average straightness, even for the long tubes, is around 0.05 mm, never exceeding 0.15 mm.

The Franco-Italian firm STMicroelectronics was rewarded for developing and producing about 40 000 radiation-hard voltage regulators for different ATLAS subsystems. The regulators are used mainly in the liquid-argon front-end electronics and in the power distribution of the pixel detector and the transition radiation tracker. ATLAS required radiation-hard voltage regulators able to deliver a sufficient current, but there was no such component available on the market. A



Representatives of the three award-winning companies, alongside members of ATLAS.

collaboration between CERN and STMicroelectronics was thus initiated. Despite several subtle technical problems linked to transistor modelling, STMicroelectronics completed the project very successfully.

SB Verksted AS of Norway received its award for supplying four 50 000 l cryogenic-liquid storage tanks and two valve boxes for the ATLAS liquid-argon calorimeters. The work was supported financially by the Norwegian

ATLAS project and by a technical collaboration between the Norwegian University of Science and Technology, SB Verksted and CERN. Two of the high-pressure tanks are situated on the surface at the ATLAS experimental area and the other two in the cavern. The design of the argon tanks was completed within stringent safety, installation and operating conditions and met a high purity level.

Japan commends KEK induction acceleration team

A research group led by Ken Takayama was awarded the Commendation for Science and Technology from the minister of education, culture, sports, science and technology in a ceremony in Japan on 18 April. The award was presented to recognize the group's "research on induction acceleration in a high-energy circular accelerator". This was developed at the Japanese High Energy Accelerator Organization, KEK, originally for the experimental demonstration of an induction synchrotron.



Left to right: Kunio Koseki (KEK), Akira Tokuchi (Nichicon Kusatsu Co), Ken Takayama (KEK), Kota Torikai (National Institute of Radiological Sciences) and Yoshito Shimosaki (KEK).

HERA theses win DESY prizes

Bogoliubov Prize seeks candidates



Ingo Bloch, left, and Ulrike Elschenbroich, after receiving their prizes earlier this year.

The 2006 PhD prize of the Association of the Friends and Sponsors of DESY goes to Ulrike Elschenbroich of Geneva University and Ingo Bloch of Hamburg University, for their theses on research at DESY's electron-proton collider, HERA.

Elschenbroich's thesis describes work with the HERMES experiment. She was the first to succeed in gathering detailed information about the transverse spin effects and structures that allow a better understanding of the role of the orbital angular momentum of

the quarks in the proton – a milestone in the understanding of the proton structure.

In his PhD thesis, Bloch developed for the first time at HERA a largely model-independent analysis of the production of heavy beauty quarks, leading to a better understanding of the discrepancy between experiment and theory. Also, his investigation of the background radiation in the ZEUS detector contributed to solving the background problems in runs at HERA, making possible more-efficient experiment operation.

The Joint Institute for Nuclear Research (JINR) announces the competition for the 2006 NN Bogoliubov Prize for Young Scientists. The prize, established in 1999 in memory of the eminent physicist and mathematician Nikolai Nikolaevich Bogoliubov, is awarded to young researchers (up to 33 years old) for outstanding contributions in theoretical physics related to Bogoliubov's scientific interests – nonlinear mechanics, statistical physics, quantum field theory and elementary-particle theory.

The prize is awarded to a scientist who has shown early scientific maturity and whose results are recognized worldwide. Applicants should try to emulate Bogoliubov's skill in using sophisticated mathematics to attack specific physics problems.

To take part in the competition, send a curriculum vitae and a one- to two-page abstract of submitted papers in electronic form to V.I. Zhuravlev, scientific secretary in the Directorate of the Bogoliubov Laboratory of Theoretical Physics of JINR (Joliot-Curie str. 6, 141980 Dubna, Moscow Region), e-mail: bltp@theor.jinr.ru, not later than 10 September 2006. The winners of the competition will be announced on 3 October during the seminar dedicated to the 50th anniversary of the Laboratory of Theoretical Physics.

ART AND SCIENCE

Breathing Room exhibition looks into the relationship between the body and space

An exhibition at the Galerie Thaddaeus Ropac in Paris by British sculptor Antony Gormley opened on 31 March with a discussion on mathematics, physics and philosophy. The exhibition featured a major new installation by Gormley called *Breathing Room*. Created specifically for this show, it is constructed from square aluminium tubing formed into seven interlocking space frames that the viewer can enter, thereby activating the space and turning the viewer into part of the artwork.

Gormley's interest in the relationship between the internal state of the human body and the infinity of space provided the background for the discussions, which involved particle physicist Michael Doser from CERN, as well as Gormley himself and Catherine Ferbos, art historian and curator.



Sculptor Antony Gormley (left), with Catherine Ferbos, and Michael Doser (right) at the round-table discussion, with Gormley's installation, *Breathing Room*, visible in the background.

OUTREACH

Discovering the Quantum Universe: 21st-century particle physics for non-experts

The High Energy Physics Advisory Panel in the US has launched a new publication to explain the excitement of 21st-century particle physics to audiences who are not science experts. *Discovering the Quantum Universe*

describes the role of particle colliders, nowadays the basic tools of particle physics, in answering fundamental questions about the universe. It is a companion publication to the earlier report, *Quantum Universe* (2004).

In short chapters and with an attractive layout, the report presents mysteries and discovery scenarios in simple language. Copies may be ordered or downloaded for free online at www.quantumuniversereport.org.

NEW PRODUCTS

e2v scientific instruments is launching SiriusSD, a new product range in X-ray detection. SiriusSD is an electrically cooled solid-state silicon drift chamber with a new electronic design. Directly compatible with existing systems, the range includes designs for integration with scanning electron microscopes and X-ray fluorescence systems. For further information see www.e2v.com.

Hidden Analytical Ltd has introduced the HPR 20 QIC Plus gas analysis system to the QIC series which offers fast response, sensitivity, stability and flexibility. The system is PC

operated and handles all features, including data acquisition, gas stream switching and calibration. For more details tel: +44 1925 445225, e-mail: info@hidden.co.uk or see www.HiddenAnalytical.com.

Kulite has announced the world's smallest combined pressure and temperature sensor, the HKL/T-1-235 (M). The high-pressure transducer (covering 1.7 to 250 bar) and platinum RTD temperature sensor (covering -55 to +175 °C) are designed to operate independently. The devices weigh 15 g without cable. For further information contact Stéphane

Beaufront, +33 472 83 90 83, email: stephane@kulite.fr or visit www.kulite.com.

Lake Shore Cryogenics has introduced the Model 325, the latest in its line of dual-channel temperature controllers. The Model 325 can support nearly any diode, RTD or thermocouple temperature sensor, allowing accurate measurement and control of temperatures from 1.4 K to more than 1500 K. It includes both IEE-488 and serial (RS-232C) computer interfaces. For more details tel: +1 614 891 2244, e-mail: info@lakeshore.com or see www.lakeshore.com/325.html.

OBITUARIES

Yuval Ne'eman 1925–2006

Yuval Ne'eman, the pioneer of particle physics in Israel died on 26 April 2006 in Tel-Aviv.

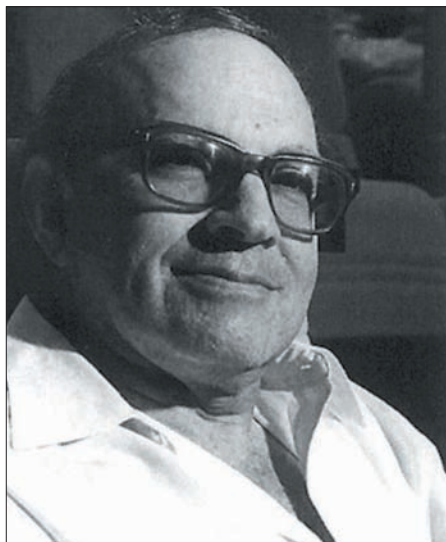
During the course of a life shaped by the extraordinary times in which he lived, Yuval in turn also shaped events in a career that was a mixture of physics research and public life.

Yuval was born on 14 May 1925 in Tel-Aviv, to a family that had lived in the country since 1803. At 15 he finished high school and soon enrolled in engineering studies at the Technion in Haifa as one of its youngest students ever. He graduated in 1946. His original intention was to join the family pump factory, however the tides of the time made him enlist in the Haganah, the organization that later became the nucleus of Israel's army. Eventually Yuval postponed all of his plans for studying physics and mathematics for full-time service in the Israeli Army, through the war of 1948. After the war he served in several top-level positions, culminating in 1955 as acting chief of military intelligence.

In late 1956 Yuval felt it was his last chance of becoming a scientist. Moshe Dayan, the then army chief of staff, suggested that he could pursue his goal by becoming defense attaché in London, at that time a mostly ceremonial job, which should have left him enough time to pursue his graduate studies. Dayan gave him a strong letter of recommendation and he was accepted in 1958 to join Abdus Salam's group at Imperial College.

Events in 1958 made the attaché job more demanding than was anticipated, so in May 1960, at the age of 35, Yuval chose to quit the army and became a full-time graduate student. By October he had achieved his first major result: the discovery of the "eightfold way", utilizing the adjoint representation of the SU(3) group as a classifying symmetry of hadrons. Simultaneously and independently Murray Gell-Mann came up with the same classification. Yuval loved to classify everything, so classifying hadrons came naturally to him.

According to the SU(3) multiplets of Gell-Mann and Ne'eman, the nucleons were members of an octet representation, rather than the defining triplet. In addition to the octet, higher-mass multiplets also contained several yet to be discovered states, including



the illustrious Ω^- in the decuplet. Its discovery in 1964 with the predicted properties provided a triumphant validation of the SU(3) classification scheme and particle physicists then rushed to study group theory.

So began Yuval's impressive contribution, spanning more than 45 years, to a large number of aspects of theoretical physics, from high-energy, through supersymmetry, supergravity, astronomy and cosmology. He collaborated with many physicists, from all over the world and in many cases was a visionary ahead of his time.

A prescient paper in *Nuovo Cimento* in 1963 with H Goldberg-Ophir was the first to suggest that an operator with baryon number $1/3$ plays an essential role in constructing hadron representations. Yuval also realized that SU(3)-breaking cannot be due to the strong interaction. In today's language, this is the observation that QCD forces are flavour-blind. A year later, Yuval was already toying with the application of the Kaluza–Klein approach to several problems in hadron physics. He continued his excursions into algebraic applications with the introduction of spectrum generating algebras with the late Y Dothan and Gell-Mann.

The geometrization of physics fascinated Yuval. He was very fond of the non-Riemannian alternative model that he had introduced to advance his quantum-

gravity work. Very early on, he and collaborators also identified the enormous potential of the rich structure of space-time supersymmetry. Subsequently Yuval played an important role in the early stages of supergravity research. He also had a deep interest in history and philosophy of science and published on numerous subjects, from foundations of quantum physics to the role of science in the evolution of human societies.

Yuval set up theoretical high-energy physics in Israel, founded the physics department at Tel Aviv University in 1963, started the first astrophysics research group in Israel and created the Wise Observatory in the Negev in 1971. He also played a key role in building research in other Natural Sciences at Tel Aviv University. Early on he was a very strong supporter of Israel's involvement in CERN and established the Israeli Committee for High Energy Physics for that purpose.

Furthermore, Yuval was deeply involved in the struggle of Jewish scientists in USSR for the right to emigrate.

Yuval was also involved in scientific administration and in Israeli politics. In particular, he served as Tel-Aviv University president (1971–75), minister of science (1982–84, 1990–92), minister of energy (1990–92) and chair of Israel's Space Agency (1983–2005).

He had an insatiable curiosity and thirst for knowledge. For example, he found that the first scientific grant awarded to a scientist by the society in which he lived was awarded by the citizens of Abdera to the particle physicist Democritus. According to Socrates' student Anisthenes, the amount of the grant was truly staggering – 500 talents, which was equivalent to \$75 million in 1990.

Yuval saw himself as a disciple of the Pythagorean tradition in theoretical physics. Pythagoras had discovered that frequencies of a vibrating string are described by a series of integers. Yuval saw this discovery as a manifestation of the "Music of the Spheres", a belief that he held dear – that physical phenomena can be described by simple and beautiful mathematics. Yuval's own work is a prime example of the strength of this principle. *Yuval's friends.*

Sergei Slavatskiy 1927–2006

Sergei Slavatskiy, a renowned leader in cosmic-ray and high-energy physics, died on 13 February 2006 aged 78. For many years, as leader of the Pamir International Collaboration and chair of the International Emulsion Committee of the IUPAP Cosmic Ray Commission, he played a prominent role in developing emulsion-chamber experiments, studying very-high-energy cosmic-ray interactions at mountain altitudes.

Slavatskiy was born in Moscow in 1927 and entered Moscow State University in 1944. Near the end of his course Slavatskiy studied cosmic rays and in 1947 he visited the new Pamir high-altitude scientific station of the Lebedev Physical Institute in Chechekty in the Eastern Pamirs. There he joined extensive air-shower experiments being conducted by D V Skobel'syn, N A Dobrotin and G T Zatsepin, among others. This research established the major role of nuclear cascades in the formation of extensive air showers and led to the discovery of several laws of multi-particle production in high-energy cosmic-ray interactions.

Slavatskiy proved to be a talented student, contributing to his first scientific paper in 1949. The following year he began the postgraduate course of the Lebedev Physical Institute and joined the group of N G Birger, G B Zhdanov and others involved in cosmic-ray studies using cloud chambers. Full of enthusiasm, Slavatskiy spent several winters in high isolated mountains, increasing his skills in experimental techniques and novel instrumentation. Slavatskiy's PhD thesis in 1953 contained data on energy spectra and effective cross-sections of secondary particles, as well as an analysis of neutral V-shaped events, later attributed to Λ -hyperon production.

In 1960 the group moved from the Pamirs to the Tien Shan where a new high-altitude scientific station was under construction. As first director of the station, Slavatskiy exhibited a remarkable organizing talent managing the construction and installation of numerous facilities in extreme conditions. The main experimental set-up combined a large cloud chamber ($100 \times 50 \times 40 \text{ cm}^3$) in a 0.7 T magnetic field with an ionization calorimeter. This unique arrangement allowed important



observations at primary proton energies in the range 0.1–1.0 TeV. Slavatskiy also observed a significant fraction of asymmetric showers favouring the hypothesis of the production of massive mesonic fireballs in the pionization region accompanied by baryonic (nucleonic) clusters in the fragmentation region.

To meet the challenge of colliders and to continue pioneering studies of cosmic-ray interactions at higher energies, in the early 1970s Slavatskiy and Dobrotin initiated an ambitious project using large X-ray emulsion chambers (XRECs) at high mountain altitudes. These proved effective in studying cosmic-ray interactions at energies above 10 TeV. The project required emulsion chambers up to 1 km^2 .

In 1971 Slavatskiy and colleagues returned to the Eastern Pamirs to set up an experimental site near a high mountain pass, Ak-Arkhar. There they deployed the world's largest array of XRECs and initiated the Pamir emulsion-chamber experiment to study interactions of hadrons with light nuclei in the

atmosphere over an energy range of 100 TeV–100 PeV. Slavatskiy became the leader of the large Pamir Collaboration of 10 scientific institutions from Russia, Georgia, Kazakhstan, Tajikistan, Uzbekistan and Poland, and managed to maintain a collaborative spirit despite divergent opinions and conflicting ethnic ambitions.

In 1980 Japanese physicists were invited to the annual Pamir Collaboration workshop to discuss recent emulsion-chamber results with respect to progress in high-energy accelerator physics. Thus a biennial symposium series was launched, bringing together cosmic-ray and accelerator physicists. The symposia, later expanded to include frontier subjects of astrophysics, are now held under the auspices of the Cosmic Ray Commission of IUPAP.

During the 1980s a series of successful joint exposures at both the Pamirs and Mt Chacaltaya in Bolivia led to the formation of the Pamir-Chacaltaya Collaboration. Slavatskiy played a decisive role in setting up this collaboration, which promoted emulsion-chamber experiments and yielded many results that are still difficult to interpret within the Standard Model. More recently he channelled much energy into a challenging new project at the Tien Shan High Altitude Station, involving a new hybrid arrangement combining emulsion-chamber techniques with the observation of extensive air-showers using electronic detectors.

Slavatskiy was also an exceptional mentor of young scientists, greatly appreciated as a teacher. He leaves behind a generation of young physicists inspired by his all-embracing devotion to science, his enthusiasm and his profound vision of physics problems. Late in his life he became an honorary professor of the Moscow Institute of Physics and Technology. In 1993 he was elected a member of the Russian Academy of Natural Sciences.

Slavatskiy is remembered by his many friends and colleagues for his cheerful character, as well as for his kindness. He possessed a wide spectrum of interests, being fond of the arts, classical music and poetry. He also enjoyed mountain skiing and canoeing along Russian rivers and lakes. *AS Borisov and colleagues, P N Lebedev Physical Institute.*

Karen Avetovich Ter-Martirosyan 1922–2005

Karen Avetovich Ter-Martirosyan, who died on 19 November 2005, was an outstanding theoretician. He spent most of his scientific career at the Institute of Theoretical and Experimental Physics (ITEP) in Moscow, where during five decades, he made remarkable contributions to our understanding of high-energy physics phenomena. He also created new trends in the theory of strong interactions, and founded the Elementary Particle Physics chair of the Moscow Institute of Physics and Technology and the Laboratory of Hadron Physics at ITEP.

Born in Tbilisi, Karen graduated from Tbilisi State University in 1943 and, after two years of teaching physics at the Tbilisi Railroad Institute, started postgraduate studies at the Leningrad Physico-Technical Institute (now the A F Ioffe Physico-Technical Institute in St Petersburg). He completed his candidate's (PhD) thesis under the supervision of Yakov Frenkel and in 1949 accepted a position in the Theory Division, where he met Lev Landau. Their very active working relationship continued in Moscow, when Karen moved in 1955 to join the Theory Division of ITEP led by Isaak Pomeranchuk. Two years later Karen received the Doctor of Science (professor's) degree in theoretical physics.

In his scientific work, Karen frequently selected problems that others had not worked on and gave correct, straightforward and useful solutions. He attacked each problem in his own way, which soon became the standard way.

In 1952 he created a theory of the Coulomb excitation of atomic nuclei, which led to the discovery of nonsphericity in certain heavy nuclei. Soon after, in 1952–54, he solved the quantum-mechanical three-body problem with a point-like interaction; the Skornyakov–Ter-Martirosyan equation was later generalized by L Faddeev and became a major tool in nuclear and atomic physics. In quantum field theory he formulated, together with I Dyatlov and V Sudakov, the method of parquet equations for summing planar diagrams.



Karen Ter-Martirosyan (right), pictured celebrating his 80th birthday with Michael Danilov.

Karen invested a tremendous amount of effort in the theory of high-energy hadron interactions. In the 1960s, together with Vladimir Gribov and Pomeranchuk, he developed the theory of branch points in the complex angular-momentum plane. He also discovered processes with multi-reggeon kinematics and set down the theoretical description of rising cross-sections. Together with A Migdal and A Polyakov he developed a theory of critical and supercritical pomerons. In these investigations of high-energy interactions, a profound theoretical understanding comes together with the analysis of the bulk of experimental data from the new big accelerators, including the rise of total cross-sections. For self-consistency, theory had to comprise multi-particle processes as well, and Karen created a theory of the hadron multiplicity distribution at high energy.

In the 1980s Karen developed a model of quark–gluon string production and fragmentation, which became the basis for a realistic theory of particle production in hadron–hadron and hadron–nuclear collisions. It provided a high-precision description of all available experimental hadron-inclusive spectra and to this day remains the valid phenomenological theory of hadron interactions at high energy, naturally

incorporating ideas in QCD.

Karen received his most recent honour in 1999 with the award of the Pomeranchuk Prize, and in 2000 he was elected a corresponding member of Russian Academy of Sciences. B-meson physics and Standard Model extensions were a recent major focus of his interest, and his last talk at the ITEP seminar, in 2005, concerned neutrino physics.

A gifted teacher, Karen loved teaching and his students, to whom he was available no matter how busy he was, loved him. Karen and M Voloshin co-authored the textbook *Gauge Theory of Elementary Particle Interactions*, which remains a delight and inspiration to students and established theorists alike.

Never short on new insights, Karen did much to launch international contacts for Soviet physics. It was on his initiative that the ITEP Theory Division began collaborations with Oxford and Orsay, and in the 1960s he organized famous International Schools in Nor-Hamberd and Yerevan in Armenia.

Karen remained active and surrounded by talented young physicists until his last days. Perhaps his most lasting legacy will be in the many scientists who struggled to meet his exacting standards and who now populate elite research centres worldwide. *His friends from ITEP and from CERN.*

MEETINGS

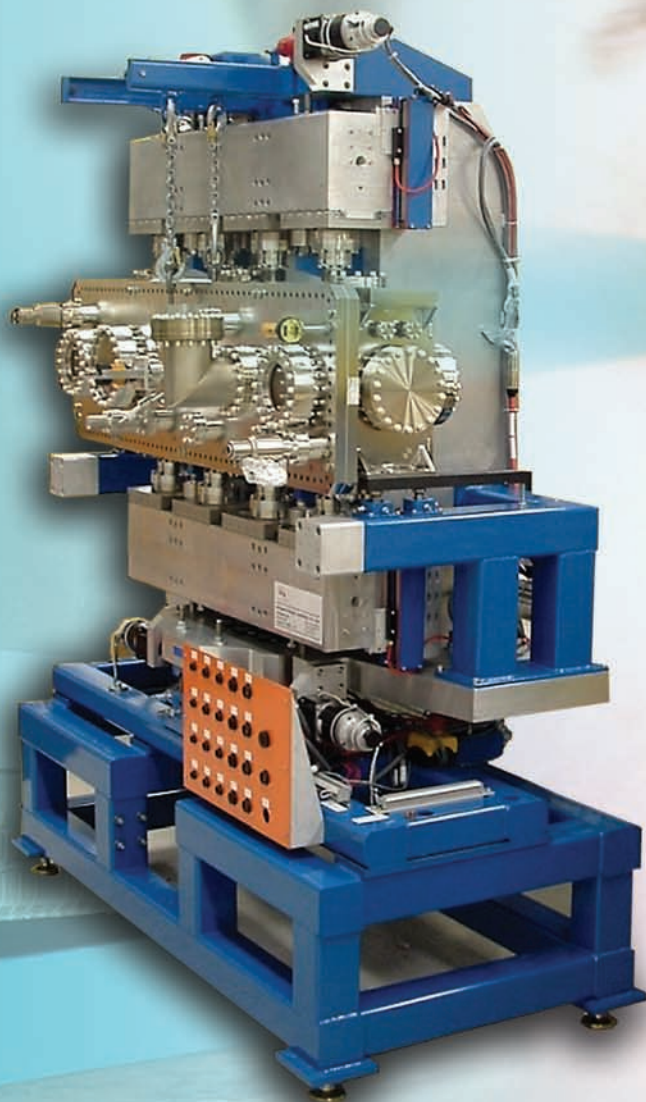
The Hadronic Shower Simulation

Workshop will take place on 6–8 September at the Fermi National Accelerator Laboratory. The aim for the workshop is to bring together

world experts in a collaborative effort that will lead to a better understanding and simulation of hadronic showers for hadron calorimetry at the ILC and Large Hadron Collider, neutrino

fluxes and atmospheric showers. For further information and details about registration (deadline 28 August) see <http://conferences.fnal.gov/hss06/>.

X-25 Cryo-Ready In-Vacuum Undulator



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- 18 mm period and 5.6 gap
- Glow discharge cleaning system
- The vacuum chamber is rectangular and opens to the front to facilitate magnetic field measurements and shimming in situ
- Four axis control
- Dual encoder position feedback allows SUB MICRON positioning
- Integrated over head crane facilitates chamber cover for easy removal

Committed to Supplying the Best Synchrotron Radiation Equipment

- In-Vacuum Undulators
- Elliptical Polarization Undulators
- Wiggler Insertion Devices
- Planar Undulators
- Undulator/Insertion Device Magnetic Measurement Systems
- Super Conductive Devices Coming Soon

Recent Undulator Deliveries

Undulator System	Customer	Period	Length	Type
Elliptical Polarization - Apple II	MAX-Lab	46.6 mm	2 m	PPM
Planar	MAX-Lab	53.2 mm	2 m	PPM
Elliptical Polarization *	MAX-Lab	69.1	2 m	PPM
X-25 In-Vacuum	BNL/NSLS	18	1 m	PPM
Planar	SRC	41.6	1 m	PPM

* Waiting for Shipment

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Insertion Devices Catalog



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