Annual Report 2005
Department of Physical Sciences
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Much planning and great changes characterized 2005. These alter the functioning of our University and also that of our Department with respect to research, education, administration and especially personnel management. These happenings concern in part administrative decisions and their implementation and in part the cost-effectiveness projection for the period 2007 – 2009.

In 2005, 365 years had elapsed from the foundation of the University of Helsinki in 1640. This jubilee year ran concurrently with the United Nations World Year of Physics in honour of the annus mirabilis 1905 when Einstein published several epoch-making articles. Many happenings and occasions connected with this Year of Physics have attracted the interest of the great public. Relativity theory has been given much attention and the Helsinki Science Forum commenced the year with the theme “Relativity”. At the end of the year the LERU (League of European Research Universities) Kids University happening gathered more than a thousand pupils from Finnish schools to acquaint themselves with our Department. At the main railway station there was a happening called “Fysaa assalla” - physics at the station – and in the Finnish Science Centre Heureka a Night of Physics. The success of these and many other events has required the intense voluntary contribution of our personnel.

As for happenings connected with research the year brought many things affecting the direction of our activity. The evaluation of research accomplished in May meant a lot of toil for the Department to collect and collate the immense amount of material available and necessary. The evaluation of the Department was a part of the evaluation of the whole University. The overall report based on over 20 expert panels will be finalized in the beginning of 2006. This will furnish our Department with the evaluation and a written assessment.

In the early autumn research collaboration was given new impetus by the arrival on the Kumpula campus of the Finnish Meteorological Institute and the Finnish Institute of Marine Research, both housed in Dynamicum. The Department of Physics with the Finnish Meteorological Institute founded the Kumpula Space Research Centre towards the end of the year.

The consultative committee of the Kumpula campus accepted a strategy for scientific computation for the years 2005 – 2010. Pursuance of this program implies considerable development of scientific computational potential catalyzing progress in many areas of research. A prestigious leading group for carrying out this strategy was appointed by the consultative committee. The construction of the necessary computer and data storage capacities for the data produced by the new collider in CERN involves collaboration with the Helsinki Institute of Physics.

The research activity of the Department has increased from the previous year. As one example of this we can state that the number of peer reviewed scientific articles has risen from 258 to 312. In 2005 the Academy of Finland has included one more research group of our Department among its units of excellence. The esteem of research performed in our Department is reflected also in Professor Kurlmala’s nomination as doctor honoris causa of the University of Stockholm. Nominating Katri Huitu to the pool professorship of particle phenomenology from the beginning of May and the nomination of Kari Enqvist as the professor of cosmology from the beginning of 2006 strengthened the research position in these fields.

The supplementary funding principally involving finance of research diminished 10 per cent from the previous year and was about 4 million euro. However, it is almost equal to the budget funding due to the Department on the basis of the model for division of money in the Faculty. The number of person years performed on supplementary funding is more than twice that for the budget funded positions in the Department. The total number of person years 220 is 8 per cent smaller than in the previous year.

After completion of administrative measures the new two level degree formulation was initiated and represents a significant change in the educational structure. This will also mean notable changes in the work of university teachers from the point-of-view of tutoring and administration of education. Personal tutoring will be formalized and also augmented.

In producing master’s degrees our Department succeeded considerably better than in the previous year since 50 persons got an MSc degree as compared to 38 in 2004. The number of doctors diminished from the record high 26 doctors in 2004 to 18 doctors in 2005.

In the middle of 2005 changes in the administrative decree of the University came into force and delegated certain powers of decision from the dean to the departmental board and chairman. This means a great change in the administrative practice in the Faculty and the Department and applies especially to the personnel administration, i.e. nominations and resignations. The changes in the administrative decree also include a provision for yearly development discussions with the personnel.

The most radical event concerning personnel was implementing the new salary structure. The evaluation of the level of a post and the associated personal performance throughout the universities in Finland was not only a remarkable but also a taxing administrative process. Almost 180 staff members working in our Department were individually evaluated for difficulty level and their personal integrated performance level.

In spite of the great changes and the associated effort, the activity of the Department has continued in a positive way with respect to the basic tasks of a university, both quantitatively and qualitatively. As for outreach and visibility, the new third task of the University, our personnel and their interaction with society at large has created a picture of our Department as an active contributor in Finnish society.

JUHANI KEINONEN
Professor, Chairman of the Department

Photo: Seppo Andersson
Highlights of Research

New Concept of Relativistic Invariance in Noncommutative Space-Time: Twisted Poincaré Symmetry and Its Implications

A new symmetry, the twisted Poincaré, has been proposed as relativistic interpretation of noncommutative space-time. According to this new concept, while relativity means invariance of the theory under the Lorentz transformations, in quantum space-time relativistic symmetry is defined as invariance under the twisted Poincaré transformations. The new symmetry has far-reaching consequences in quantum field theory and gravity.


Cerebral blood flow heterogeneity in human ischemic stroke

Tissue perfusion determined by dynamic susceptibility contrast magnetic resonance imaging (DSC MRI) is increasingly used in the diagnosis of acute ischemic stroke. The compromised circulation is characterized by several parameters obtained with DSC MRI, including cerebral blood volume (CBV), cerebral blood flow (CBF), contrast agent mean transit time (MTT), and most recently the intravoxel distribution of CBF, also known as blood flow heterogeneity (FH). In the present study, the evolution of FH with regard to the other parameters was described during the first week of a naturally evolving ischemic stroke of ten patients, first under six hours (hyperacute phase), second at 24 hours, and third at 1 week after the onset of symptoms. Diffusion-weighted imaging was performed to esti-
magnesium diboride (MgB$_2$). Combining first-principles computational approaches with experimental x-ray Raman spectra of MgB$_2$, we have identified and separated the contributions from the π and σ electron states associated to the superconductivity. We reveal a high density of the π states and a narrow band of σ states near the Fermi level. We also show that the s symmetry states contribute only at higher energies thus confirming the crucial role of π and σ electron states in determining the superconducting properties of MgB$_2$. We have also measured the collective electron excitation i.e. plasmon dispersion using inelastic x-ray scattering, confirming the existence of a novel low energy plasmon mode related to coherent π electron charge fluctuations.


Hot summer in 2003 reduced ecosystem carbon sinks

The case of the record-breaking hot summer 2003 in Western Europe helped us to investigate how extreme summer heat and growing season rainfall deficits can alter the carbon cycling of ecosystems. The study utilized meteorologically measured CO$_2$ fluxes, remotely sensed radiation absorbed by plants, national crop yields and biosphere modelling. Overall, we find a 30% reduction in 2003 photosynthesis over Europe, which resulted in a strong anomalous net source of CO$_2$ to the atmosphere (0.5 PgC y$^{-1}$), undoing four years of mean carbon sink. Model results, corroborated by historical records of crop harvest, suggest that such a reduction in Europe’s ecosystem primary productivity is unprecedented during the last century.


Rapid formation of new sulphuric acid particles at near-atmospheric conditions

The formation of new particles has been investigated in a laboratory study starting from H$_2$SO$_4$ produced in situ via the reaction of OH radicals with SO$_2$. Newly formed particles were observed for H$_2$SO$_4$ concentrations above $7 \cdot 10^6$ cm$^{-3}$. At 293 K, a rough estimate yields a nucleation rate of 0.3 – 0.4 particle cm$^{-3}$ s$^{-1}$ for about 10$^2$ cm$^{-3}$ of H$_2$SO$_4$ (particle size $\simeq$ 3 nm). These findings are in agreement with observations from the atmosphere. The results demonstrate - for the first time - that under laboratory conditions similar to the atmosphere, particle formation occurs at atmospheric H$_2$SO$_4$ concentration levels.

Laboratory Overviews

General Division

The General Division comprises experimental and theoretical research laboratories and units for physics teacher training, electronics, medical physics, and space physics.

Physics Teacher Education Unit
http://per.physics.helsinki.fi/
HEIMO SAARIKKO

The Physics Teacher Education Unit takes the responsibility of the physics education of pre-service teachers for lower and upper secondary schools. In addition to this the education is designed to give basis for physics teaching professionals in general. The teaching solutions and strategies and their development is based on research of physics teaching and learning at the university level. Today, as a result of continued efforts the unit has innovative environments of learning and advantageous practical solutions for teaching.

The Physics Education Research is done in areas, where thorough understanding of the
physics content and important issues related to conceptualization and learning intersect. The research we are conducting takes the conceptual and methodological aspects of physics as its starting point and concentrates on the questions of understanding the nature of physics knowledge and its methodologies. During year 2005 two main approaches on experiments’ use in teaching – the generative (building meanings of concepts) and the consequential (testing the validity of concepts) – have been developed further and their advantages have been evaluated. Further research based on this completed theme is now guided towards the development of the teacher laboratories. This research has helped the unit to develop teacher laboratories to an outstanding example of research-based education of physics teachers, with a coherent and didactically well-planned curriculum as well as purposeful collection of instruments and apparatus. Also, in year 2005 the research project on models and modelling in physics education has been conducted successfully, and it is now leading to international collaboration. In addition to these ongoing projects, new openings are done in research on the role of physics based technologies in knowledge creation. Connected to this theme, the research about science and technology transfer in science organizations are continued together with researchers based at CERN.

Today, development of teaching is thus strongly based on research, and a substantial part of the personnel is engaged in research topics related to university level physics education. The high quality of our recent scientific contributions on the research in physics and science education are now gaining international acknowledgement. The solution we are developing for the integrated program for physics teacher education is innovative and an outstanding example of research-based education Unit.

Electronics Research Unit
http://electronics.physics.helsinki.fi/
HEIMO SAAKKO
Development of novel measurement methods and sensors combining ultrasonics, optics, electronics, and advanced signal processing continued. We focused on characterizing thin, porous, film-like structures.

Ultrasonics
Research (with X-ray lab and METLA) to elucidate where wood strength originates continued. The dependence of modulus of elasticity (MOE) on weight density in spruce was studied. The results indicate a strong dependence between dynamic MOE and density. Similarly, irradiation effects on carbon nanotube paper MOE were studied with the Accelerator lab.

With the Geophysics laboratory, ultrasonic- ic characterization of mechanical and structural properties of special kinds of rock samples is done. An ultrasonic burst reflection method for estimating porosity and tortuosity of rocks is being developed.

The efforts to determine the in-plane strength of thin polymer-like layers (pill- and paper coating, natural polymers) during their formation continued with our collaborators (KCL – Oy Keskuslaboratorio – Centrallaboratorium Ab, Yliruusi group, University of Helsinki, Faculty of Pharmacy, and Tenkanen group, Faculty of Agriculture and Forestry).

An acoustic hand position input device for PDA-like applications using airborne ultrasound was developed (with Nokia). The design is a low-cost device using three pairs of cheap 40 kHz transducers to obtain a 3D position estimate.

Testing and analysis of microelectronic MEMS structures was also on the agenda, as was efforts to use ultrasound to induce controlled freezing in order to improve the accuracy of a dew point meter.

Instrumentation
Our Optical Tweezers instrument was further developed for single molecule biophysics experiments, in collaboration with the Institute of Biotechnology (R. Tuma). Nanoscale force-extension measurements on single-stranded RNA were performed in the piconewton-nanometer regime. In order to maximize the signal-to-noise ratio of the experiment, in-silico studies were performed, and initial efforts to implement a noise-shaping digital feedback-loop were carried out.

Scanning white light interferometry (SWLI) was used to understand the origin of bond strength. FEM verified Quality Control (QC) results for Single-point Tape Automated Bonding (SpTAB) in an effort with the Hip detector lab. SWLI provides the bond geometry while the corresponding experimentally obtained pull force (PF) is the bond quality proxy. A non-destructive electrical method for Al-Al-wirebonding QC is being developed in parallel to the mechanical bond QC tests.

Deformation grooves in two different kinds of thin layered polymer films were investigated (with Nokia) under dynamic surface loading (plowing). The results indicate that SWLI can be used as a non-destructive method to determine mechanical properties e.g. ‘scratchability’ (abrasing resistance) of polymer surfaces.

Properties of plastic optical fibers (POF) were studied (with Nokia) using FEM and experiments where fibers were bent and pulled at different temperatures while their optical attenuation was monitored. The results indicate that use of POFs is feasible in portable electronic devices.

Collaborative effort between ERU and the CMS’ Tracker -group of HIP around the Finncrack device generated the first cosmic tracks last summer.

Yliruusi group, University of Helsinki, Faculty of Physics Teacher Education Unit has been a driving force in the operation of the LUMA centre at the Kumpula campus (http://www.helsinki.fi/LU- MA). The LUMA centre promotes Science teaching, and teaching of Mathematics and Computer science, and enhances interaction between schools, universities and business and industry, thus increasing the public outreach of the Department of Physical Sciences and the Physics Teacher Education Unit.
The Medical Physics group at the Department is engaged in academic research, teaching and clinical physics support services. Medical Physics is a branch of applied physics encompassing concepts, principles and methodology of physical sciences to medicine in clinics. Primarily, Medical Physics seeks to develop efficient and safe diagnosis and treatment methods for human diseases with highest quality assurance protocols. In Finland most medical physicists have the licensed profession of a Hospital Physicist.

The Department of Physical Sciences has started an education program for Hospital Physicists already in 1995. The educational program was updated in autumn 2004. Hospital Physicist is a necessary expert in medical usage of radiation as required in the statute of the medical usage of radiation (423/2000). The specialist training of Hospital Physicist is defined in the statute of the University degree system (464/1998) and the modification for the statute of the examinations pertaining to the humanities and the natural sciences (834/2000).

The Faculty of Science 16.9.2004 assigned the qualification board of hospital physicist for the years 2004 - 2007. Composition of the board includes 12 members of five University Hospitals and Universities including two Universities of Technology and one member of STUK - Radiation and Nuclear Safety Authority. In 2005 nine students have accomplished the licensed profession of a Hospital Physicist in Finland. The Faculty of Science has approved eight of them, and four of them have accomplished their PhD theses at the Department of Physical Sciences.

In the teaching of future hospital physicist workshops, seminars and laboratory practice is preferred to the conventional classroom teaching. The close contact to the senior students and scientists will give students a realistic insight on scientific work in hospitals. In HUCH there exists four positions for students to conduct the needed four-year clinical practice to get the profession of hospital physicists. A few positions exist also in the research projects. Working in medical physics research project twelve months of the four-year practice can be accepted as a clinical practice.

The ongoing research projects are: 1) Intra-cranial BNCT treatment in two protocols and a protocol for recurrent head&neck tumours continues, 2) For treatment planning in BNCT 15B-distribution in the target should be determined in vivo. We are studying the possibilities to use MRS imaging in 15B-distribution determination 3) In the head and neck BNCT, image fusion to co-register PET, CT and MR images, and possible fMRI data for treatment planning are still under investigation, 4) To improve the methods to co-register MR and SPECT (PET) images and MEG data, the main application being the diagnosis and treatment of epilepsy, 5) Combined MR imaging, transcranial magnetic stimulation (TMS) and EEG techniques are applied to study the neuronal connectivity of the healthy human brain, 6) Gel dosimetry studies were continued by applying a new dosimeter type for the verification of dose distributions, 7) Functional magnetic resonance imaging was used to determine the applicability of cerebral blood flow heterogeneity in human ischemic stroke, and 8) a new research project was started: Emerging solutions for dose and quality assurance in diagnostic radiology, especially, in digital radiology.

Intense research is being conducted in these fields by a large group of dedicated researchers consisting of qualified physicists, engineers and physicians. Most important collaborators are HUCH, VTT, and STUK. The medical physics research group is also functioning within the Functional Brain Research Unit, Helsinki Brain Research Center that has been granted funding and a status of excellence by the Academy of Finland for the years 2002-2007.

Researchers attended international conferences during 2005 including e.g. the 13th Scientific Meeting and Exhibition of the International Society for Magnetic Resonance in Medicine in Miami Beach, Florida, and the meeting of the International Federation for Medical and Biological Engineering, Umeå. Researchers have also worked actively in the EANM Dosimetry Committee since 2001.

Approximate subcategories of a medical physicist’s work in an average university hospital in Finland.
Kumpula Space Research Centre and the Space Research Unit

http://theory.physics.helsinki.fi/~space/

HANNU KOSKINEN

The Space Research Unit is the University’s representative in the Space Centre. Its role is to coordinate and promote the space research activities at the various Divisions of the Department of Physical Sciences. In 2005 the most active areas of space research the Unit included solar system plasma physics and cosmology at the Division of Theoretical Physics, planetary meteorology at the Division of Atmospheric Sciences, and geophysical studies of past meteorite impacts at the Division of Geophysics. Unfortunately, the end of the very successful space research programme Antares in 2004 has led to a significant reduction of external funding which has been felt particularly by the Division of X-ray Physics and the Detector Laboratory which have previously been quite active in development of high-energy astrophysics instrument development. The total amount of person years in space research at the Department of Physical Sciences in 2005 was 19.

Space research is always conducted in wide national and international co-operation. In space physics the most important national partner is the FMI and in cosmology the Helsinki Institute of Physics (HIP). There is also project co-operation with the Department of Astronomy and the space research units of University of Turku and Oulu as well as Helsinki University of Technology, including a Finnish Graduate School in Astronomy and Space Physics led by the University of Oulu. The international research efforts are closely related to ESA and NASA science missions. In 2005 work with the science payload of ESA’s future BepiColombo mission to Mercury was started. For the Department of Physical Sciences the most important contributions are to the X-ray instrument SIXS led by the Department of Astronomy. The work will be done in collaboration with Finnish industry. The FMI provides the project manager for SIXS through the Kumpula Space Centre.

The senior scientists at the Department had several positions in national and international space organizations in 2005. Prof. Hannu Koskinen is a member of the Finnish Delegation of the ESA Science Programme Committee, the chairman of the Finnish National Committee of COSPAR, representative of Finland in the COSPAR Council and a member of the Management and Operations Working Group of the Living With a Star program of NASA, and a corresponding member of the International Academy of Astronautics. Prof. Lauri Pesonen continued to represent Finland in the European Science Foundation’s Impact programme and Prof. Hannu Savijärvi is a member of the International Commission of Planetary Atmospheres and their Evolution. Dr. Rami Vainio is a co-chair of one of the working groups in the EU/ESF COST action on space weather.

The Kumpula Campus is presently the foremost space research hub in Finland after the Finnish Meteorological Institute (FMI) moved to the Campus in mid-September 2005. On October 25, 2005, the Chairman of the Department of Physical Sciences and the Director General of the FMI undersigned the joint agreement for the Kumpula Space Centre. The activities of the Space Centre are based on research projects at the University and FMI. Its primary goal is to facilitate the most efficient use of the expertise and facilities within the host institutes. The Centre will also offer services to other parties, e.g. project management and technological support for space instrument development and operations as well as data reception and processing facilities.
Ion and nanocluster beams and computer simulations are used to understand and predict physical processes in modification of materials, to manufacture and modify materials for desired functionality, and to characterize materials.

The substantial efforts in the construction of new equipment have continued during 2005. The new facilities enabling novel research in materials- and nanoscience are expected soon to be fully operational. The nanocluster deposition system based in the Nano hall delivered its first beams of copper clusters at the end of 2005.

The time-of-flight elastic recoil detection analysis (TOF-ERDA) method was extensively utilized also during the year 2005 for materials characterization. Altogether about 300 samples, mainly thin films, were analyzed. The project for the inter-comparison of data analysis software continues under the auspices of the Physics Section of the IAEA. Our laboratory participates in a new international research collaboration project, coordinated by the Nuclear Data Section of the IAEA, which was commenced to develop a reference data base of reaction cross sections for ion beam analysis.

As part of the national research programme on the future electronics devices, we collaborated in the QUEST consortium coordinated by the Tampere University of Technology and studied effects of ion irradiation on dynamic properties of InGaAs / GaAs quantum wells (QW). Heavy ions (Ni+, Ne+) and light ions (He+, H+) were used for irradiation and a femtosecond time-resolved up-conversion technique to obtain that the carrier lifetime in a QW decreases as the irradiation dose and the deposited nuclear energy increases.

Studies in an interesting and technologically important topic of nanoptics, namely the luminescence in wide-band-gap diodes, have been continued as collaboration with the University of Göttingen. Catho-doluminescence and photoluminescence in silica after ion implantation of photoactive ions (mainly group-IV elements: Si, Ge, Sn; or rare earth elements) show intense blue or violet luminescence light, if the samples are properly processed, for instance via thermal annealing under certain gas atmospheres. Through the intense efforts we have succeeded to investigate luminescence and epitaxy in quartz in a fairly systematic manner.

Tungsten has been proposed for first-wall material in thermonuclear reactors, like the next step fusion device ITER. Studies on its behaviour in the presence hydrogen containing plasma irradiation at elevated temperatures have been continued as a part of the Finnish collaboration in the European fusion research. Deuterium induced defects in polycrystalline tungsten were studied by implanting deuterium ions and analyzing retained D-concentration with nuclear reaction analysis and secondary ion mass spectrometry.

The diffusion studies employing radioactive ion beams at CERN/ISOLDE were continued with ion-implanted GaAs and Si, Ge samples having special interest from spintronics point of view. Also the effect of GaAs material growth technique is studied in order to verify the role of excess Ga vacancies in the diffusion process. Implantation of radioactive Be ions to Ge, Si, Ge, glassy carbon and several metals was carried out partly related to the ion source development work done at ISOLDE. The on-line irradiation/positron annihilation spectroscopy facility was finalised in collaboration with the positron spectroscopy group at the Helsinki University of Technology. The facility is being further extended enabling research aiming at improvement of radiation hardness of silicon particle detectors via on-line detection of the irradiated detector leakage current. The closest collaborator in this research is the CMS Tracker Project at CERN.

The experimental activities of the laboratory have been complemented by computer simulations of nanostructures, compound semiconductors, and fusion reactor materials. Especially the activities in modelling of nanocluster formation and deposition were much increased in 2005. We began systematic dynamic simulation studies of how nanoclusters form in an inert gas aggregation source, with the aim to understand compound nanocluster formation. The first results showed that the time to form a cluster of given size is inversely proportional to the inert gas pressure, which was explained with an analytical model based on kinetic gas theory. We also systematically examined the deposition of nanoclusters of five face-centered cubic elements on substrates of the same type, and showed that the main mechanism by which the clusters become epitaxial is by the unfaulting of stacking fault grain boundaries. The studies of carbon nanotubes, performed in the framework of the national ELENA collaboration consortium, gave new insights into how nanotubes can be modified with dopants to modify their electrical properties. Defect cluster sizes in the compound semiconductor GaAsN were studied as part of the national QUEST consortium. The results showed that the experimentally observed change in electrical properties due to irradiation and annealing can be understood based on the formation and self-annealing of large defect clusters. A reactive interatomic potential for the W-C-H ternary system recently developed by us was in 2005 used to understand the chemical and physical sputtering of tungsten carbide under fusion reactor conditions. This model, along with density-functional theory and kinetic Monte Carlo methods was also used to explain the large dif-
ference between how implanted H and He form blisters in W. The difference was shown to be due to the different self-trapping behaviour of these gases in W.

In the laser physics we continued to study nonlinear dynamics of optically coupled lasers. The lasers of interest are surface-emitting semiconductor lasers (VCSELs) and diode-pumped solid-state lasers. The dynamics is explored experimentally utilising optical spectra, intensity noise spectra and through time-series measurements. In addition to direct integration of the laser equations, bifurcation analysis has been introduced when modelling the experiments. A correct modelling asks for a proper determination of the laser parameters and specifically the relation between the refractive index and the gain of the laser-material is of importance. This relation has been established for both laser types utilising several different experimental methods. Hereby a comparison of the methods was performed giving useful insights concerning benefits and drawbacks of the methods.

The Socrates/Erasmus Intensive Programme “Ion Beam, Photon and Nuclear Methods in Studies of Nanostructured Materials” held 8-17 May in Madrid, was co-ordinated by the laboratory.

Computer simulation of a carbon peapod, i.e. a nanotube-fullerene composite, doped with potassium by ion implantation.
The Theoretical Group of the High Energy Physics Group has a broad area of research interests, covering Quantum Field Theory, Noncommutative Geometry, Gauge and String Theory, Higher Dimensional Theories, Quantum Chromodynamics QCD and Particle Phenomenology in the Standard and beyond the Standard Model.

The Theoretical High Energy Physics

MASUD CHAIChIAN

The group has continued its studies of quantum field theory on noncommutative (NC) space-time. A breakthrough has been made by showing that, although NC QFT violate the Lorentz invariance, they have a twisted Poincaré symmetry, whose generators are the same as the usual Poincaré generators. Therefore, the particles in NC space-time are classified, according to their mass and spin. This new symmetry has given justification to all the previous treatments and calculations, made in the literature in a formally Lorentz invariant form in spite of its violation. Such a symmetry has lead to a new concept of the Special Relativity which leads also to the general coordinate transformations and to the General Relativity for the noncommutative space-time. Research along these lines including the supersymmetric extension, are continuing.

In hadron physics one focus has been on the spin dependence of Deep Inelastic Scattering. We have considered the possibility that the helicity of the struck quark is changed by soft rescattering in the target. Such an effect could arise due to effects, which break chiral symmetry in QCD. We have also studied the dynamics of Deeply Virtual Compton Scattering in the semi-exclusive limit where the mass of the final hadronic system is much larger than the nucleon mass.

Another focus has been on questions related to QCD at long distances, where the non-trivial vacuum structure is important. We have studied the effects of a constant field on fermion propagation. Propagators that are “dressed” by the external field do not appear as asymptotic states. This approach may allow addressing questions related to analyticity and unitarity in situations where the fundamental fields do not appear as asymptotic states.

In beyond the Standard Model -phenomenology the focus has been in supersymmetric models. For nonuniversal boundary conditions we have studied the neutralino and chargino mass sum rules, as well as the Higgs detection for heavy Higgsinos decaying to neutralinos and charginos, and for heavy neutralinos decaying to Higgs bosons and light neutralinos. The nonuniversality was found to have a large effect for detection possibilities. In the so-called split supersymmetry model we considered the interesting possibility to have a fixed point solution for the top quark Yukawa coupling. We found that requiring fixed-point disfavours these models strongly.

Violation of CP-symmetry is one of the big mysteries in the Standard Model. We have constructed a supersymmetric model where CP-symmetry and also the so-called R-parity are determined by the properties of the vacuum of the model. With the broken R-parity, also neutrinos have a tiny mass, as observed in experiments. In the Standard Model, neutrinos are strictly massless. In our model, we can fulfill both constraints on the mass differences and mixing angles in the neutrino sector.

The Theoretical High Energy Physics Group maintains close research and scientific contacts with the Helsinki Institute of Physics (HIP), several theoretical high energy groups in Europe and in other Nordic countries, as well as with CERN and various research centres in USA and Japan.

Experimental High Energy Physics

RISTO ORAVA

The group is responsible for constructing and testing the T2 tracking stations of the TOTEM experiment and participates in the design of silicon sensors and mechanical structures (microstations) for forward proton tagging at the LHC. The physics analysis activities focus on acceptance and trigger studies for forward proton tagging, simulation of signatures for new physical phenomena, including Higgs and particles beyond the standard model and physics of diffraction.

In the CDF experiment at Fermilab, the group concentrates on the analysis of experimental data delivered by the TEVATRON accelerator. As such it has a dual role: It is currently the only data taking particle physics experiment with Finnish participation and attains the highest available centre of mass energy, making it a unique laboratory for studying the properties of the top quark. In addition, it serves as a training ground for young experimentalists in the field, preparing them for realistic data-taking conditions and analysis techniques applicable to the LHC, which will start operations in the end of 2007.

The physics scenario of TOTEM is based on (1) short special high statistics runs which begin during the running-in stages of the machine, and (2) forward physics runs in conjunction with the CMS experiment with the nominal low-$p_T$ machine conditions. The TOTEM collaboration focuses on physics that is complementary to the
general purpose experiments at the LHC, and therefore has had to invest heavily in designing, developing and testing instrumentation that will be capable of meeting the challenge of recording data in the very forward region. After seven years of effort, the base line TOTEM experiment has been configured as described in the TOTEM TDR and comprises Roman Pot detectors for the leading proton measurement, and the two tracking stations (T1 and T2) in the forward region of the CMS.

In addition to developing the special detector techniques required, the TOTEM collaboration has extensively analyzed the physics reach of its forward physics installation. The analysis foresees later stage low-β* runs, and also the well-known Central Exclusive Diffractive interaction: pp → p + H + p which is considered as a benchmark process, with an exclusive access to the J^e_s structure of the Higgs boson.

To reach the physics goals discussed below, it is fully realized that TOTEM has to be integrated in the trigger and data recording systems of the CMS experiment, and in case of the signatures depending on the central CMS detectors (e.g. the CED Higgs process), a common plan of utilization of the two experimental set-ups should be agreed on. During 2005, the Helsinki group has been responsible for the elaborate level-1 trigger studies required both for the planned searches of the Higgs boson in the central exclusive diffracion (CED) and for the forward physics program of the TOTEM experiment.

In 2005, the Helsinki group has launched the manufacturing and validation of the Gas Electron Multiplier based TOTEM T2 detectors in Helsinki. Altogether 50 triple-GEM’s will be constructed in the Detector laboratory in Kumpula. Based on this project, the Helsinki group has gained a position of a leading detector group in GEM based technologies.

In addition to its responsibilities in manufacturing the TOTEM T2 spectrometer and preparing the TOTEM trigger scenarios, the Helsinki group has key positions in preparing the physics program of the Totem experiment and in establishing search strategies for the Higgs boson in the CED processes detected by the 420m leading proton detectors.

The group, supported also by the Helsinki Institute of Physics, is finalizing its physics analysis based on LEP-DELPHI e⁺e⁻ data sets, participates in top-quark investigation at the Fermilab proton-antiproton collider experiment (CDF), and prepares for a unique forward physics experiment at the CERN LHC (TOTEM).

The group uses the detector laboratory for developing, manufacturing and testing of novel gaseous and silicon based sensors, readout systems and data acquisition modules for future experiments in high energy physics, fusion diagnostics and space research.
In particle cosmology, the studies of the nature of the primordial density fluctuations of the universe have been continued. In particular, we have considered limits on non-gaussianities of the cosmic microwave background in various models. A possible enhancement of non-gaussianity during preheating was pointed out and applied to string-motivated inflaton models with a tachyonic instability, where bounds on the string scale and string coupling were obtained. In curvaton models the well-known limit on non-gaussianities was shown to weaken considerably when curvaton self-interactions are included. The discrepancy between two different formalisms for computing non-gaussianities, the second order perturbed Einstein equations and the separate universe approach, was settled in case of hybrid inflation.

Cosmological perturbation has also been considered in extended theories of gravity assuming the Palatini variational principle, for which the metric and connection are independent variables. Evolution equations were derived for perturbations in a late universe filled with cold dark matter and accelerated by curvature corrections. Such corrections were found to induce effective pressure gradients, which are problematical in the formation of large-scale structure.

One of the most demanding tasks in the study of cosmic microwave background radiation is the conversion of the immense amount of measurement data streamed from satellites to meaningful physical form. Our task in the European Planck satellite project is to develop methods for making full-sky maps of the microwave background and to determine the cosmological parameters from them. A map-making code written by us has now been incorporated in the Planck Data Processing Center data analysis pipeline. We also participated in the testing of the 70 GHz detectors for Planck, which were made in Finland by Elektrobit Microwave, in order to fully understand the data from that instrument once the satellite flies. Present activities of our working group include comparison of different map-making codes, gaining understanding of the expected errors in the maps and investigating the effects of sub-pixel structure and detector beam shape on the maps.

An ongoing grand project has been the determination of the sixth order non-perturbative term in the perturbative expansion of the free energy of hot quark-gluon plasma. This plasma is remarkable in that its perturbative expansion, which due to asymptotic freedom could be expected to be very accurate at very high temperatures, actually at sixth order contains a non-perturbative term. As any particle masses it can only be computed numerically. We have during previous years formulated a precise set-up for determining this coefficient and performed several required intermediate steps. We have now performed the required entirely numerical step. What remains is one extremely demanding but feasible analytic computation – to be done with techniques of symbolic computation. This is under way but may take years.

In the phenomenology of quark-gluon plasma produced in relativistic heavy ion collisions, we have extended the classical field model of gluon production to the computation of quark-antiquark production. This involves a significant increase in complexity since it necessitates a numerical integration of the Dirac equation in a completely general only numerically known color field. This has now been carried out for the full 1+3 dimensional case. The complexity of the computation is reflected in the fact that a collection of about one billion (10^9) numbers is carried forward in time over about 500 steps. The result was also very interesting: the number of pairs was much larger than expected. In fact, it brings the number of quarks and antiquarks close to chemical equilibrium, earlier they were thought to be strongly suppressed relative to gluons. This will have important phenomenological implications to future experiments at the CERN Large Hadron Collider.

In hadron physics the study of heavy-light quark systems using lattice methods has been continued by extending the earlier work on energies and quark radial distributions in two ways. Firstly, the lattice calculations are now performed with dynamical fermions compared with the earlier quenched approximation. Secondly, emphasis is on a single heavy-light meson - a system that can be compared with recent B_s data and is ideal for modelling with potential descriptions such as the Dirac equation. On a more phenomenological level, charge symmetry and charge independence breaking has been studied in mesonic inelasticities in few-nucleon systems, e.g. searching for experimental indications in NN → dπ and reactions. Also, interaction of the eta-meson with light nuclei has been studied aiming to disentangle the question of possible bound states.
The work on a new pion-nucleon partial wave analysis is continuing. The development and testing of the codes has advanced to a phase where the actual data analysis has started. The aim is to determine the pion-nucleon coupling constant and the sigma-term with high accuracy.

The canonical quantisation of classical SU(2) Yang-Mills theory using a novel set of canonical variables has been completed. The implementation of Gauss law, which usually is problematic, is simple in these variables. The method yields a local unconstrained Hamiltonian, which decomposes into a finite Laurent series in powers of the coupling constant. This work is now being generalized to theories involving fermions and higher dimensional Lie groups.

The Division works in very close connection with the Helsinki Institute of Physics. Nationally, the contacts are close with the universities of Jyväskylä and Turku and with the Finnish Meteorological Institute. The supercomputing facilities of the Finnish Center for Scientific Computing (CSC-Tieteilinen laskenta Oy) are indispensable for many workers within the division. Graduate students are supported by the Graduate school in particle and nuclear physics, by the Graduate school in astronomy and space physics and by several private foundations. Internationally, contacts are particularly close with the Brookhaven National Laboratory, CERN, DESY, ECT* in Trento, Jülich research centre, Nordita, Saclay and Universities in Aachen, Bern, Bielefeld, Frankfurt, London, Lausanne, Liverpool, Lund, Oslo and Seattle. The Division is associated with two EU networks and one 6th framework programme Integrated Infrastructure Initiative.

The systematic error in the cosmic microwave map from two different map-making methods. In the first method (a) the error is more localized along the Milky Way, whose small-scale features are largely responsible for the error. These results were obtained using simulated Planck data for the 100 GHz channel.
The main areas of research within the Division are hard and soft condensed matter physics, biophysics and applied research including medical imaging. The emphasis of the research is on the experimental and computational study of radiation-matter interaction processes aiming on fundamental understanding of various x-ray-based characterization techniques of novel materials. In addition to the versatile laboratory-based X-ray facilities, the regular synchrotron radiation experiments play a crucial role in the research activities.

When measured in the number of publications the year 2005 was the most productive scientific year in the history of our division. The research outcome was reported in total of 39 peer-reviewed articles including several high-impact papers. The reason for this is that several demanding longer-term projects on experimental and computational activities reached the maturity to produce high quality results while several new openings were also made. The experimental resources in the laboratory got significant improved during 2005 when the new rotating anode-based small angle scattering station with a modern 2D-detector was brought to routine operations. The synchrotron radiation based experimental activities were continued with large breadth while our division continued to be the most active unit in Finland carrying out projects at the European Synchrotron Radiation Facility (ESRF, Grenoble, France). Meanwhile the utilization of various third and second-generation synchrotron radiation facilities around the globe continued as well with new opening of research program at Spring-8 in Japan.

Hard condensed matter research has been concentrated on utilization of inelastic x-ray scattering and high-resolution emission spectroscopy. Various sub-techniques requiring the use of synchrotron radiation have been exploited, namely, Compton scattering, X-ray Raman scattering, non-resonant scattering with few eV-energy loss as well as emission spectroscopy. Major efforts have also been continued to improve the theoretical and computational work on inelastic scattering technique. A several year long effort to develop a multiple scattering approach to model X-ray Raman scattering was finally rewarded producing immediately high-impact results on the studies of electronic structure of superconducting MgB2. The combined computational and experimental efforts to study the hydrogen bonding and local coordination in liquid water started to produce excellent results as well. Worth of mentioning are also a few interesting projects at extreme sample conditions, mainly at high pressure. These activities are certainly expected to expand during the next few years.

Natural and synthetic polymeric materials have continued to be major materials of interest in soft condensed matter studies. The new rotating anode based small-angle X-ray scattering setup was utilized for instance in structural studies on chlorosomes, light-harvesting antenna systems of green photosynthetic bacteria. The relationship of nanometer scale structure and elastic properties of wood, crystallization of hydrophobin proteins on surfaces, and structures of copper or nickel nanoparticles in cellulose matrix were studied using synchrotron radiation with various techniques including grazing incidence diffraction, anomalous small-angle X-ray scattering, and X-ray absorption spectroscopy techniques.

Biophysical research program is trying to address the protein motion, for example, which propels life at molecular level. Dynamics range from frequent picosecond bond librations to slow conformational changes in the ms-regime that have been inferred primarily by NMR. Recently substantial secondary structure fluctuations not witnessed before have been observed in the sub-microsecond time scale by liquid crystal NMR spectroscopy. This interpretation is now challenged by suggesting that ps-ns dynamics modulate solute-nematogen interactions sufficiently to perturb the molecular alignment from one conformation to another. Consequently it is proposed that the molecular alignment rather than the chemical structure fluctuates. Simulations and calculations show that a wobbling alignment frame would indeed reproduce the observed amount of fluctuations that vary from one medium to another depending e.g. on the surface charge of the nematogen and ionic strength of the medium. Thus is concluded that there are no major motions in the sub-microsecond regime that would affect biological process in an unknown manner.

Medical imaging projects have been continued in close collaboration with research teams at the ESRF and the Helsinki University Central Hospital. The functional lung imaging project, where the K-edge Subtraction (KES) method is used, has concentrated on studies of experimental asthma, which has been provoked by inhaled histamine aerosol. Breast cancer in excised samples has been studied with Diffraction Enhanced Imaging (DEI) and with Small-Angle X-ray Scattering (SAXS). New developments include high-resolution CT reconstruction of the tissue structure, and combination of DEI and SAXS in one experiment.
The Department’s researchers had leading positions in 77 international scientific organizations and in 23 domestic ones. These can be found in the Helsinki University Data Base at http://www-db.helsinki.fi/mut/. The Department’s researchers had 22 positions on the editorial boards of foreign scientific journals and eleven on the boards of domestic scientific journals. The researchers of our Department had altogether 156 refereeing positions in international scientific journals. Two scientists had the position of editor-in-chief of a domestic and one in an international journal. Members of our staff functioned as experts in 16 domestic boards, committees and other public bodies outside the University and in five international ones.
The main research activities of the Division of Atmospheric Sciences can be divided into: a) aerosol and environmental physics, b) micrometeorology and forest-atmosphere relations, c) dynamical and physical meteorology, and d) space physics.

The Division operates together with the Department of Forest Ecology at two field stations: the SMEAR II station (Station for Measuring Forest Ecosystem-Atmosphere Relations) in Hyytälä and the SMEAR I station in Värriö. 2005 was the first full of the new measurement station SMEAR III (urban SMEAR) in the Kumpula Campus area. The Division has possession of: a) a weather radar, b) aerosol and micrometeorological instruments for field campaigns, and c) a laboratory for research of aerosol microphysics. The development and construction of a new weather radar has been performed in collaboration with Vaisala Oyj.

The Division has great experience in numerical modelling of the atmosphere (e.g. improving radiation schemes for General Circulation Models; a mesoscale model with wide applications for Earth and Mars), and in micrometeorological flux and aerosol formation studies. During 2005 a joint project - using our experience on aerosol dynamic modelling for global climate models – starts with FMI. The aerosol and micrometeorological groups belong to the Research Unit on “Physics, Chemistry and Biology of Atmospheric Composition and Climate Change”, which is one of the Centres of Excellence of the Academy of Finland. The main objective of the Unit is to study the importance of aerosol particles on climate change and on human health. Internationally, the Research Unit has a leading position in the research area of formation of atmospheric aerosols.

Beside the national Centre of Excellence, the aerosol group belongs to the Nordic Centre of Excellence “Biosphere-Aerosol-Cloud-Climate Interactions” (coordinator M. Kulmala) and the micrometeorology group to the Nordic Centre of Excellence “Nordic Centre for studies of ecosystem Carbon exchange and interactions with a Climate System” (coordinator A. Lindroth, Lund University). Both groups form together the international NorForsk Graduate School “Carbon-Biosphere-Aerosol-Cloud-Climate Interactions”.

An international multi- and cross-disciplinary research project, “Integrated Land Ecosystem – Atmosphere Processes Study” (iLEAPS; http://www.atm.helsinki.fi/ILEAPS/) has continued its work related to land-atmosphere interactions within the framework of the second phase of International Geosphere – Biosphere Programme (IGBP). iLEAPS project aims to advance new integrated experimental and modelling research approaches needed in Earth System Science due to the complex dynamics of the Earth System.

The Division has direct working connections with more than 40 international laboratories and has participated in more than 20 EU projects. The Division has also direct connections with several Finnish research units and teams, e.g. the Departments of Chemistry and Forest Ecology (University of Helsinki), the Finnish Meteorological Institute, the Technical Research Centre of Finland, the Tampere University of Technology, the University of Kuopio, the University of Oulu, the Finnish Institute of Occupational Health, the Finnish Forest Research Institute and the European Forest Institute. These connections are established in a form common to both national and EU projects.

In 2005, based on flux measurements over various ecosystems, it was shown that high air temperatures can substantially decrease the carbon sinks and this observation must be taken into account in future scenarios of climate change. The other important, based on our long time series in atmospheric aerosol formation and data mining we were able to show that formation and subsequent growth occur when relative humidity is low and condensation sink (i.e. concentration of existing aerosol particles) is low.

Financial support from the Academy of Finland, the European Commission, Tekes, the Nessling Foundation, and the Väisälä Foundation is gratefully acknowledged.
The Division of Atmospheric Sciences is in charge of all the meteorological university research and education in Finland. In addition to that, the international postgraduate training programme of aerosol and environmental physics, which was started in the beginning of the autumn semester in 1994, was continued during 2005.
Teaching and education within the Division covers the whole field of geophysics (i.e., glaciology, hydrology, physical oceanography, geodesy, seismology, geomagnetism, and planetary geophysics). A laboratory for teaching solid earth geophysics has been created, and several field courses are arranged each year. The teaching curriculum has been revised to match the requirements of the Bologna agreement. In 2005, the Division also contributed to the information of the general public in Finland on the geophysical background of tsunami.

In 2005 the snow and ice group continued investigations in sea ice dynamics and morphology, lake ice, and snow conditions in Finland and Antarctica. In winter 2005 two members of the Division participated in the FINNARP 2004 expedition to the Finnish Aboa station in the Drønning Maud Land. The snow mapping programme continued, with groundtruthing for ENVISAT imagery. A new initiative was to examine the history of supraglacial lakes, with field data collection in the expedition and mathematical modelling. Our in situ measurements of snow properties and albedo were compared to helicopterborne radiance measurements and satellite images. An optical-microwave remote sensing programme is also ongoing based on ENVISAT data. National collaboration with the Air Quality Research of the FMI analyses the chemical properties of the snow cover and the Antarctic snow research is collaboration with the University of Sherbrooke, Quebec.

Baltic Sea ice research continued for numerical modelling of sea ice dynamics in the Gulf of Riga and Gulf of Bothnia. Also, fieldwork was done off Umeå in the fast ice zone to extend the Tvärminne database to other Baltic Sea sites.

Lake research was focused on the winter season. In the framework of the EU funded programme CLIME (Climate Impact on European Lakes) ice station data from Lammi Pääjärvi were analysed, and a general thermodynamic-mechanic lake ice-snow model was developed for climate research applications. This model has new features in the treatment of ice and snow melting and in the connections between mechanical and thermal processes. In another project, in collaboration with University of Jyväskylä, the physics of springtime ventilation of boreal lakes was examined, with Lammi Pääjärvi acting as the main research basin.

The activities of the ocean modelling and marine systems group concentrated on the application and improvement of the ice-ocean modelling system that was installed in the previous year.

Model development was conducted in three areas: (a) Alternative vertical coordinate choices for the ocean component have been explored, and a new approach that combine the traditional geopotential coordinates and terrain-following coordinates has been devised and tested in various configurations. (b) In parallel, several new algorithms for computing horizontal pressure gradient terms in generalized coordinates have been implemented and intercompared. (c) Finally, a parameterization for the melting of ice shelves along the Antarctic coasts has been added to the NEMO code. First tests show that the desired cooling and freshening of water masses on the shelf is achieved, with significant consequences for hydrography, and sea ice cover.

As a partner in the French-German-Finnish-Russian consortium DRAKKAR, the group has investigated the representation of sea ice in various global simulations (with horizontal resolutions from 0.25 to 2 degrees), both in the Arctic Ocean and around the Antarctic continent. This included the comparison with climatological satellite data, the determination if interannual variations and the quantification of trends in sea ice cover and ice thickness. A coarse resolution version of the DRAKKAR model family has been used to simulate and analyse the variability of Arctic sea ice during the past 40 years.

The study of the dynamics of marine ecosystems and their interactions with the physical environment shifted to cyanobacteria research, a topic of large national and international interest. For the first time, the life cycle of these marine organisms was investigated numerically, using an internal quota model. This new model approach provides explanations for the often sudden appearance of large cyanobacterial blooms, for aspects of their interannual and regional variability, and puts the importance of external (temperature, nutrients) and internal (life history, akinete abundance) factors into perspective.

The solid earth group focuses on studies of supercontinents, impact cratering, meteorite and asteroid physical properties, the Earth’s magnetic field and research of deep continental drill cores. The main topics in solid earth geophysics have been the study of the new Keurusselkä impact structure, the two lake Suvasvesi impact sites (forming a possible doublet), the Jänisjärvi impact, configuration of conti-
nents during the Proterozoic-Paleozoic times, the study of the physical properties of the Neuschwanstein and other meteorites and the estimation of the Earth’s magnetic field in the past. The 2005 highlights of the solid earth geophysics group are the new continental reconstructions showing global kimberlite belts at 1200 Ma and 550 Ma, respectively.

The solid earth geophysics research laboratory is now fully equipped for high quality rock magnetic, paleomagnetic and petrophysics research.

The group participated in four international research programmes: the IGCP-440 (assembly of supercontinent Rodinia), IGCP-509 (new, mesoproterozoic supercontinents), the ICDP on continental drilling and the GISP-programme on impact research. Measurements of the intensity of the Precambrian magnetic field in an international collaboration, archaemagnetic intensity determinations of recent ceramics and bricks in collaboration with the National Board of Antiquities (Museovirasto) and several international university teams in the framework of the EU-based AARCH-programme were continued. The IGCP projects are concerned with the configuration of continents during the Precambrian and are based on a global paleomagnetic approach. As a novel approach, the group started to investigate whether kimberlites, when plotted on global reconstructions, reveal evidence of mantle plumes. The Impact project was concerned with studying the ages and petrophysics of impact structures in Finland, Russian Karelia, Ukraine, South Africa and Siberia. In 2005, the group started to investigate the new Keurusselkä impact structure. The field season was very successful and a new gravity survey was conducted in the area as a joint project with the Finnish Institute of Geodesy. The group took also part in searching a new ultrasonic technique to determine the porosity of rock and meteorite samples. This work is collaboration with the Electronics Research Group of the Department.

The paleomagnetic studies of the Cambrian-Silurian period of Estonian sequences were continued in co-operation with the University of Tartu. Further paleomagnetic samples of the 1.1 Ga diabase dykes in Arizona and the 1.47 Ga diabase sills from Russian Karelia were collected and analysed.

The group continued to work in the ICDP-programme with new samples from the 65 Ma old Chicxulub impact in Mexico to study its physical properties. Also, new samples were obtained from the 1.09 Ma old Bosumtwi impact structure (Ghana) as well as from the Chesapeake structure (35 Ma) in USA, all in the framework of the ICDP continental drilling project.

Schematic of a tsunami generated by a submarine earthquake, illustrating the heightening of the amplitude in shallower water.
Basic Education

The educational program of the Department is more diverse than that of any other department of physical sciences in Finnish universities. The total number of lecture courses given yearly is about 160, 15 of which are given in Swedish and about 15 in English.

The quota of new students in physical sciences, approved by the Senate, was 160. There were 448 applicants of whom 147 have started their studies. Eleven of those entered the physics teacher line. The entrance examination was organized together with the universities of Jyväskylä, Oulu and Turku.

Evaluation of teaching

Student critique of lecture courses and other teaching was started in collaboration with the Faculty during the spring term 1995 and has been continued since then. A web-based questionnaire is in use in the Department so that students can send comments during each course. This gives rapid feedback to the teachers and encourages students to take part in the development of the teaching in the Department. However, at the end of the “biggest” courses students are also given a questionnaire on paper because it has been observed that more feedback will be obtained with this traditional method. The feedback is presented to the departmental board.

In order to increase the interest of the personnel in education “the best teacher” chosen by the students has been given a prize since 1994. In 2005 the physics student society Resonanssi arranged the voting for the 12th time and proclaimed University lecturer Edward Häggström the best physics lecturer of the year. MSc Ossi Pasanen was again thanked, this time orally.

International Student Exchange

Physics is very international by nature. In addition to this, the Department of Physical Sciences maintains an active international student and teacher exchange programme involving Erasmus/Socrates agreements and Nordplus collaboration with over twenty institutions around Europe. Over the years already 70 of our students have utilized these possibilities.

To support internationalization also at home the Department offers a wide selection of teaching in English, of which most popular among foreign students have been various theoretical and environmental physics courses. In fact, most advanced courses in the Department can be taken in English when necessary. A total of over 2400 ECTS credit points were obtained from courses given in English during 2005.

After a stable level of about ten annually the number of incoming exchange students has experienced a strong increase doubling during the last two years. In addition, there were also still many more foreigners following courses and working in individual research groups and the Helsinki Institute of Physics, HIP. Quite a few of the visiting or exchange students have applied and remained as degree students testifying the high quality of teaching as perceived by the students. Some also want to return to Helsinki after their degree in the home university to pursue graduate research here.

Another channel of internationalization for students is afforded by CERN summer trainee positions. Three undergraduate students from the Department were able to take this opportunity to gain international laboratory experience. As many students participated in intensive courses abroad. Further, research groups may send advanced or (more typically) graduate students abroad for short-term research or conference trips. Short international intensive courses are regularly arranged also in the department and attended by foreign as well as domestic students. Also foreign researchers working at the Department of HIP gave short courses on special topics.

Post-Graduate Education

The Department of Physics is responsible for post-graduate training in physics, theoretical physics, particle physics and in physics teacher training, jointly with the Department of Teacher Education.

Its size and extensive research activity enable the Department to offer an effective post-graduate training program. On the basis of the number of post-graduate degrees the Department of Physics is in the top rank in Finland. The collaboration in post-graduate education with the Helsinki Institute of Physics (HIP) and with the...
Helsinki University of Technology has a long tradition. International co-operation is pursued actively, and is seen as an essential element of postgraduate education.

In order to support and promote doctoral education the new “research education program” has been continued in the Department. In 2005 24 undergraduate students with a doctoral perspective were chosen. The total number of students in this program is now close to 200. First PhD's graduated in 2001. A traditional summer course of the research education program was organized in Hyytiälä by the Division of Atmospheric Sciences.

The nationwide researcher education programs (Graduate School, GS programs), which commenced at the beginning of 1995, form an effective platform for realizing postgraduate education. The Department is along in four nationwide programs: Materials physics GS (six persons), Particle and nuclear physics GS (three persons), Graduate School in Astronomy and Space Physics (one person), Graduate School in Information and Structural Biology (one person) and additionally one person in the University of Helsinki Graduate School.

The progress of the studies and research work of postgraduate students were encouraged by employing the most successful students in research groups, and assistantships, which have become vacant.

Lists of the students, who completed their Lic. Phil. and PhD theses in 2005 in the Department are given in the Appendix.
Outreach and Interactivity in Society

Physics is related to almost everything between earth and sky, and when there are special natural events or phenomena on or around the globe, our personnel are often asked for guidance and clarification by both individuals and the media. After the devastating tsunami on the 26th of December 2004 and the numerous hurricanes in 2005 many of our personnel were interviewed publicly. Indeed in general, our researchers are often invited to lecture to the general public on widely relevant physical phenomena, for example those in the atmosphere.

Our Department has always promoted science and research by informing and educating via the mass media, national governmental bodies and especially those seen as future students and researchers. The interaction of our Department with society proceeds through research and education and in collaboration based on interactive mutual partnership. The Department hence fortifies collaboration in research and education at both domestic and international levels and, in return, expects this interaction to promote the performance of its basic functions, i.e. scientific research and education at the highest level.

Important groups for us are the public sector and the decision makers of the society, regional activists both here and abroad, research institutes and funding bodies, the private sector, the alumni and supporters of the university, also the third sector and the whole of society. In order to establish a broad, yet versatile interaction between our Department and society, we both strengthen our bonds with our alumni and creatively facilitate this interaction.

Over the last three decades about half of our alumni have gained a further post graduate degree after their Master’s degree; 40% have defended their doctoral thesis and obtained the degree of PhD and about 10% are Licentiates of Philosophy. Most of our alumni are serving society in the public sector, 80% and 73% of the MSc and PhD graduates, respectively. More than one fifth of the doctors who have graduated from our Department, contribute in research and education at the highest level by serving society as professors in universities and research institutes. The Department has also educated hundreds of Masters and Licentiates who, in turn, pass on knowledge as teachers in schools or polytechnics or function as researchers. Many of those in research are aiming at a higher degree.

During several decades the Department has arranged a week’s supplementary course fulfilling the requirements of the employment criteria for teachers in lower and upper secondary schools (see section Physics Teacher Training Unit). This is noteworthy even nationwide. During the last few years a large number of teachers from the present colleges of advanced education have participated in these courses. Mainly teachers from the Department of Physical Sciences have given the lectures. The popularity of the course shows that such education is needed, so the procedure will be continued with an annually changing topic. In 2005, Everyday Physics - Our Daily Physics - was the theme of the course, which was attended by 90 teachers. Fifty of the participants were women. The attending teachers came from lower and upper secondary schools, institutes of technology and polytechnics.
According to the Universities Act of Finland (Finnish legislation 645/1997 and amendment 715/2004) “The mission of the university shall be to promote free research and scientific and artistic education, to provide higher education based on research, and to educate students to serve their country and humanity. In carrying out their mission, the universities shall interact with the surrounding society and promote the societal impact of research findings and artistic activities”. Recently, “the third task” of the University, mentioned in the previous sentence, has been current in discussions but defies easy definition. For almost a decade we have systematically collected information about the activities of our personnel with respect to this third task – outreach and interactivity in society.

The researchers of the Department have often been invited to give interviews or lectures of public interest both for the general public in happenings around Finland, on the radio and in TV programs. Detailed information on these can be found at http://www-db.helsinki.fi/yhti/. Altogether they were along in over 153 such happenings in Finland and 15 abroad.

In the Faculty of Science, the activity of the personnel of the Department of Physical Sciences as regards the so-called third task is quite dominant. As an example, over 60% of all the domestic appearances in the mass media and lectures for the general public from the Faculty of Science have been by our personnel; for foreign appearances, the figure is even more striking, 75%. In 2005 this may have been partly due to the celebration of the World Year of Physics. However, such activity in our Department has been increasing all throughout this millennium as can be seen from the statistics in the YHTI database at http://www-db.helsinki.fi/yhti/
World Year of Physics

The World Year of Physics 2005 was launched with an opening conference entitled “Physics for tomorrow” at the UNESCO (United Nations Educational, Scientific and Cultural Organization) headquarters in Paris, January 13 - 15. Amongst the more than 1200 participants there were many Nobel Prize winners, famous scientists and about 600 young students of physics from 70 countries. Our student participant was Heli Hietala, a student of theoretical physics. She has reported that “it was wonderful to see and hear what more there was to learn: great names expounding basic theories of physics as well as practical applications”.

The tri-annual Science Forum was organized in Helsinki on January 12 – 16 and one of the themes was WYP2005. Professor Kari Enqvist wrestled with Prof. Risto Nieminen under the theme “100 years of the theory of relativity—have we already got the overall theory in sight or does it exist at all?" “Do cosmologists know the ultimate truth?” was another topic of Enqvist.

Days of Physics for Children were arranged in the Finnish Science Centre Heureka, January 22 – 23. Prof. Keijo Hämäläinen gave lectures to children about physics phenomena related to daily things.

In March, Helsingin Sanomat, the leading newspaper in Finland, sent a reporter to interview Professors Keinonen and Enqvist about one of the treasures of our Department, the 1905 volume of Annalen der Physik. It is called the Einstein volume due to those four articles he published during the annus mirabilis. It was Einstein’s contemporary and in addition to the Professor-on-call, Keijo Hämäläinen. A special aim was to reach out with this event to such people who otherwise would not encounter physics or popularizing physics. The message was that physics can be interesting and fun and one can enjoy it even if one does not understand everything. Many attendees having seen and heard about physics phenomena will certainly remember this Flora Day. The elated expressions of many a passer-by after grasping experiments to the passers-by and to answer questions about anything. The day was a great success. It is difficult to accurately estimate the number of visitors, but certainly one can say that several thousands of people passing by in the beautiful station hall stopped to wonder and ponder about physics at least for a short while. Even those who rushed past certainly noticed what was in question because the layout was noteworthy. They could turn with their questions to the Professor-on-call, Keijo Hämäläinen. A special aim was to reach out with this event to such people who otherwise would not encounter physics or popularizing physics. The message was that physics can be interesting and fun and one can enjoy it even if one does not understand everything. Many attendees having seen and heard about physics phenomena will certainly remember this Flora Day. The elated expressions of many a passer-by after grasping new things and ideas were very rewarding to our personnel.

Some of our scientists attended the EPS 13 Conference in Bern, Switzerland, July 11 – 15. This 13th General Conference of the European Physical Society was also called “Beyond Einstein – Physics for the 21st Century” and it offered a unique opportunity to present the modern fields of research, which were opened by Einstein through his three most famous papers, which he published during the annus mirabilis. Five contributions from our Department were presented.

When September was turning into October there was a two-week tournée “Physics is fun”
aimed at the lower secondary level school pupils in Tampere, Turku, Oulu, Jyväskylä, Kuopio, Lappeenranta, Joensuu and Kirkkonummi. This was organized and realized by the duo Milla Karvonen and Ilkka Hendolin from our Department. In many cities the halls filled up well - over 1500 young ones saw the performance. The feedback from pupils was surprisingly good taking into account what a challenging audience pupils of that age are. The organizers felt that their message was received: Physics is fun!

A National Physics Day was arranged on Saturday, the 8th of October, with “open doors” in all the physics departments in Finland. In spite of fairly autumn-like weather hundreds of people visited our Department to attend interesting lectures, to ask questions from the professor-on-call or to become familiar with various research laboratories.

The second week of November our Department received nearly 1200 pupils aged 12 – 14 years with their teachers. They had a program with lots of physics and physics with a lot of fun, in the form of action with great experiences, workshops and lectures at a suitable level. The university week for children was a part of the European LERU-Kids-University project realized simultaneously in ten European universities. The event was organized by the Physics Teacher Training Unit (see pp. 4 - 5). According to Professor Heimo Saarikko, coordinator of the project in Finland, the main aim was to increase the pupils’ interest in studying natural sciences. – The LERU-Kids-University project had its culmination in Brussels on the 23rd of November in a final happening gathering program from all the universities involved. Professor Timo Vesala gave a lecture both for the children during the day and also in the gala for other public. The title of his presentation was “Will there be snow in the country of Santa Claus in 2035?”

The annual Finnish physics students’ conference, FysikerFest, was held in Helsinki Nov 17 – 20 in cooperation by Resonanssi (our student organization) and Fysikoklubben (physics student organization of the Helsinki University of Technology). In honour of the annus mirabilis students from other Baltic and Nordic countries were also invited. Professors of our Department gave lectures on space, aerosol and particle physics.

A Night of Physics was arranged and celebrated in the Finnish Science Centre Heureka. There was something for people of all ages. Demonstrations performed by physics students were very popular among children. Moments when questions could be addressed to professors of physics attracted many visitors. Our professors gave several popular talks. A full auditorium followed Kari Enqvist’s talk on Einstein and his notion of time. There were stands presenting space research, relativity theory, environmental physics and research connected with the recent Nobel Prize. Our students and personnel were competing in putting the demonstrations in action and the public had a possibility to participate workshops. The Night of Physics certainly showed to many a new person that, indeed, physics is both fun and useful. This was a worthy culmination of the World Year of Physics 2005.

In addition to the previous events with physics topics, numerous lectures, seminars, workshops and science cafés were arranged with the Finnish Academy of Sciences, and even the term and idea of amusement park physics was introduced. The WYP2005 was a nice milestone along the road of physics to the future.

Flavoured as it was, with the genius and personality of Albert Einstein the World Year of Physics 2005 has deepened the personal relationships as human beings of academics and non-academics, of adults and children, of the physical and of the human being, and interwoven a path for science and technology and society in the future where physics will increasingly be seen as our helper and sympathiser. Maybe in the future also, the closeness of physics to the health and well being of nations could be more generally appreciated. The physics of the future is not a confrontation between science and well being but a thorough partnership between the aspiration of we human beings and the realization of all such good with the enlightenment of physics thinking.
Awards and Honours

The Finnish Association of Non-fiction Writers awarded Professor Kari Enqvist the 2005 prize for non-fiction writers. Professor Enqvist received the prize at the Helsinki Book Fair 2005 on the 27th of October. Professor Enqvist has, in addition to his scientific work, written several non-fiction books and articles about physical sciences. According to the Association he is one in the important group of authors who have the skill to write about his science for the general public.

The University of Stockholm awarded Professor Markku Kulmala a Doctorate honoris causa on the 30th of September. The basis for this honour is, according to the University of Stockholm, that Prof. Kulmala has in a very short time stabilized his group as the leading unit in the field of production of aerosols in the atmosphere.

The board of the Finnish Nuclear Society has, according to the suggestion of the editorial board of the journal ATS Ydintekniikka, awarded Laboratory Manager (emer.), Lic. Phil. Olli Marttila the 2004 Erkki Laurila Prize for his article “Miksi sateilyn käyttöä puolustavan asiantuntijan ja sitä vastustavan kansalaisen näkökannat eivät kohdattaa?” (“Why do the points-of-view of the expert defending the use of radiation and that of the citizen opposing it not meet?”). The Erkki Laurila Prize is awarded yearly to the best author contributing to the journal. The prize, a book of honour and 500 Euro were donated on the Kalevala Day, the 28th of February 2005, in the Science Building in Helsinki.

On the Independence Day, the 6th of December, Professors Markku Kulmala and Heimo Saa-rikko became Knights, First Class of the Order of the White Rose of Finland.

On the 23rd of March, Rector Ilkka Niiniluoto presented to University employees 30-year, state long-service awards conferred by the President of the Republic, and among those receiving awards was Dr. Mervi Hyvönen-Dabek from the Department of Physical Sciences.

In Dipoli, Espoo, in the 39th Annual Meeting of the Finnish Physical Society, MSc Liisa Porra was awarded a prize for the best poster presenting her work “L. Porra, H. Suhonen, S. Bayat, P. Suortti and A.R.A. Sovijärvi: Imaging asthmatic airway narrowing with synchrotron radiation CT”.

Evaluation of research concerning the previous six years 1999 - 2004 was performed in the University of Helsinki. Extensive material from the Department of Physical Sciences was sent to the referees on the 28th of February 2005.
Visits

Children’s technology camp

There were so many applicants for the children’s technology camp that two camps were arranged. This was the fifth summer of such camps. They were organized by the Department of Physical Sciences in two consecutive weeks, June 6 - 10 and 13 - 17 in Physicum. During the first week there were 15 participants, 2 girls and 13 boys. The second camp was even bigger, 20 participants, 3 girls and 17 boys. The range of ages was 8 to 13 years, which, of course, was slightly problematic. The programme focused, through experimental works and tasks and self-made constructions, on both technology and pure science. The themes of the camps were observation of weather and measuring parameters connected with it, electricity as a phenomenon, electric circuits and their practical applications, flying and mechanics. The main weight was in supporting the comprehension of phenomena. The camps culminated in celebrations with an exhibition of what had been accomplished during the week. As in previous years, the feedback from the participants and their family members was very positive.

Outreach to schools

Every year an invitation by letter to visit the Department is extended to physics teachers and their pupils of Finland’s ca. 500 sixth forms. Tens of classes of sixth form pupils visit the Department of Physical Sciences with their teachers and in this way gain an understanding and orientation of what it means to read physics at the University. The visits are organized by our PR-assistant.
The Departmental Board

The Departmental Board consists of fourteen principal members and twelve vice members. Four are professors, four belong to the teaching and other personnel group, four are students and two persons are elected from outside the University.

Professor Juhani Keinonen continued as the chairman of the new Board, and the members of the Departmental Board were (with vice members in parentheses):

Prof. Masud Chaichian (Prof. Kari Enqvist)
Prof. Keijo Hämäläinen (acting Prof. Seppo Manninen)
Prof. Juhani Keinonen (chairman) (Prof. Lauri Pesonen)
Prof. Markku Kulmala (vice chairman) (Prof. Timo Vesala)

BSc Raimo Ingren (Lab. Eng. Kim Wahlström till 31.7., Lab. Eng. Birger Ståhlberg from 1.8.)
Doc. Ismo T. Koponen (Dr. Ari Hämäläinen)
Doc. Hannu Kurki-Suonio (Doc., later Prof. Katri Huhtu)
MSc Kai Rasmus (MSc Miikka Dal Maso)

Student Tiina Kilpeläinen (Student Teresa Tenhunen)
Student Eija Laatikainen (Student Olli Heino)
Student Jussi Polvi (Student Elina San)
Student Maaria Tervo (Student Elisa Piispa)

Vice Chief Director, Prof. Mikko Alestalo, Finnish Meteorological Institute
Director, M Soc Sci Ari Sipilä, Technology Industries of Finland

Dr. Aino Vahvasekä continued to function as the secretary of the Board.

Administrative posts at University and Faculty level

Professor Juhani Keinonen was a member of the Senate, and university lecturer, Docent Björn Fant was also a member of the Senate in the quota for non-professorial representatives of teaching and research. MSc Walter Rydman was a member of the Senate in the quota for students.

The Department had the following members on the Board of the Faculty of Science:

Prof. Keijo Hämäläinen (Prof. Risto Orava)
Prof. Juhani Keinonen (Prof. Jyrki Räisänen)
Prof. Markku Kulmala (Prof. Kaarle Hämeri)
Prof. Heimo Saarikko (Prof. Hannu Koskinen)
Lab. Manager Merja Blomberg (BSc Raimo Ingren)

Academy researcher Hanna Vehkamäki (Doc. Claus Montonen)
(Student Leila Konkola)
Student Harri Waltari
Resources

Funding

Outside funding is still at a level of vital importance for the Department’s research and teaching activity. Funding according to the model adopted by the University, basic budget funding, formed 50% of the whole funding of the Department; separate projects within the University contributed 2%, funds carried over from 2004 made up 3% and outside funding 45%. The resources acquired via the financing of various projects supported both an essential part of the research of the Department and, to a significant extent, its educational program. The rent for the premises of the Department of Physical Sciences was 2.1 M€. This sum is not included in the figures for funding.

Comprehensive budget funding for 2005 was 4.84 M€, 0.89 M€ of which was allocated for research and teaching equipment and for running costs, 3.95 M€ for salaries. The Department obtained 4.09 M€ from outside funds. Over half of it (54%) was granted by the Academy of Finland and the rest acquired from many different sources, the most important of which were Tekes, EU, and foundations.

Technical Support

The workshops of the Department have continued to provide high-level support for research, development and teaching.

Computing facilities

The backbone of all the computing at the Department is the extended Local Area Network of the University. This network connects all desktop computers and terminals with centrally supplied resources such as e-mail connections, mainframes, printers and Netware servers. The Department has altogether over 500 workstations, supported by some twenty servers.

The scientific computing of the Department is served by two GRID Linux computing clusters, the 132-processor AMD Opteron Linux cluster computer “ametisti” and the 64-processor AMD Linux cluster “mill”. Together these give a peak computing capacity of 800 Gflops. Both clusters are connected to the NorduGRID and thus put the Kumpula campus area in the forefront of GRID computing in Finland. The "ametisti" cluster is part of the national MGRID computing network. Applications needing specialized software or run in a massively parallel environment are performed at the National Center for Scientific Computing (CSC).

The daily work of the computational physicists is served by laboratory-level Linux networks, similar in the basic architecture to the GRID computers to enable easy transfer of codes and data between the different facilities.

In addition to workstations, dozens of computers in the Department are continuously used for collecting data from measuring instruments.
During the year there have been the following changes in the personnel. Katri Huitu was appointed to the pool professorship of particle phenomenology from the beginning of May and Kari Enqvist as the professor of cosmology from the beginning of 2006. Professor Markku Kulmala continued his leave of absence for the second year as an Academy professor with the Academy of Finland. Professor Christofer Cronström retired in the beginning of the year. Professor Dan Olof Riska resigned from his chair in the beginning of July and part-time professor Jyrki Kuikka in January. On the first of August Mika Torkkeli commenced duties as a university lecturer, specializing in nanobiomaterials. The following persons were nominated university lecturers from the beginning of 2006: Tommy Ahlgren in materials physics, Eero Rauhala in accelerator based materials physics and Hannu Kurki-Suonio in cosmology. Laboratory manager, Docent Pentti Paatero retired from the beginning of 2005 and chief technician Heikki Sepponen in the beginning of October. Satu Uurinmäki resigned from her post as a senior secretary in the beginning of January, laboratory technician Frej Torp in July and laboratory manager Kim Wahlström in August. Anne Mäkinen started getting acquainted with the tasks of the amanuensis of administration in the beginning of December. She has been appointed in the post from the first of April 2006.

Research personnel support by supplementary funding still continues to be a vital contribution to the functioning of the Department. By the end of the year there were 88 positions in the Department financed by internal university funding which is 6% fewer jobs than in 2004. 230 persons were paid by supplementary funding, 20 persons less than in 2004. The total number of person-years in the Department was ca. 223.4, which is 7% less than in 2004.

The personnel of the Department are listed below. In 2005 a total of 74.7 person-years were financed by internal university funding. In the Department of Physical Sciences four departmental professorships were partially financed by other institutes. One was financed 45% by the Finnish Meteorological Institute FMI, another 45% by the Helsinki Institute of Physics HIP, another post financed one third by the Department of Biosciences and one third by the Institute of Biotechnology and a fourth post financed 50% by the Finnish Institute of Occupational Health. Two of the professors were financed through the pool of the Helsinki University professors. Due to the ongoing changes in the structure of the teaching personnel all posts could not be kept filled during 2005. There were 27 professors (20.7 person-years) and 17.2 person-years in other senior teaching posts. There were additionally 8.0 person-years in assistant posts for guiding laboratory practicals and problem sessions. The number of person years in principally administrative posts on the staff was 12.1 and that of technical employees 15.7, in all 27.8 person-years.

Outside funding supplied the financial basis for 148.7 person-years in 2005. This included senior and junior researchers of the Academy of Finland, post-graduate students in the GS (graduate school) program, researchers financed via the EU and researchers on other projects financed by both private and state funds.

Twelve students were chosen to work outside the Department as summer trainees on separate funds. About 5.1 person-years were financed by the funds allocated to fee-for-service teachers.
Personnel 2005

(ol = on leave; This means paid by outside funds or physically absent for any reason. Doc. = Docent
mo = months)

Head of Department
Keinonen, J., prof.

Professors
(annual total 20.7 person-years)
Annila, A.
Beckmann, A.
Chaichian, M.
Enqvist, K.
Hoyer, P., ol 1.9.-31.12.
Huitu, K., from 1.5.
Hämeri, K.
Hämäläinen, K.
Kajantie, K.
Keinonen, J.
Koskinen, H., ol 1.10.–31.12., locum Doc. P. Janhunen
Kulmala, M., ol, locum 1.1.–31.3. Prof. K. Carslaw, 1.-30.6. Prof. M. Bilde, 1.–31.8. Prof. S. Pandis
Leppäranta, M.
Nordlund, K.
Orava, R., ol 9.5.–25.9.
Pesonen, L., ol 1.11.–31.12.
Räisänen, Jouni, Doc.
Torkkeli, M., Doc., from 1.8.

Administrative personnel
(annual total 12.1 person-years)
Ahonen, J., MSc, senior secretary
Andersson, S., Lic. Phil., amanuensis
Antila, U., senior secretary
Hyvönen-Dabek, M., Doc., aman.
Kivinen, M., senior secretary
Koivisto, L., senior secretary
Lahtinen, M., MSc, aman.
Louhio, M.-L., senior secretary
Montonen, C., Doc., aman., ol, locum Dr. C. Helminen
Mäkinen, A., MSc (Adm.), aman., from 5.12.
Pitkänen, T., senior secretary
Sundius, T., Doc., aman.
Vahvaselkä, A., Dr., aman.

University lecturers, doctoral assistants and assistants
(annual total 26.2 person-years)

University lecturers
(annual total 14.6 person-years)
Ahlgren, T., Doc., ol 1.1.–30.6.
Bister, M., Doc., ol, locum 1.8.–31.12. PhD B. Bonn
Fant, B., Doc.
Huitu, K., Doc., till 30.4.
Hämäläinen, A., Dr.
Keskiväkki, E., Doc., ol, locum, Doc. C. Montonen
Koponen, I.T., Doc.
Kurki-Suonio, H., Doc.
Kuronen, A., Doc.
Lehtinen, K., Dr. Tech., Doc., ol, locum Doc. I. Napari
Manninen, S., Doc., ol
Niskanen, J., Doc.
Rauhala, E., Doc.
Räsänen, Jouko, Doc.
Torkkeli, M., Doc., from 1.8.
Vainio, R., Doc.
Österberg, K., Dr.
1 vacancy till 31.7., locum Dr. J. Laukkonen

Technical personnel
(annual total 15.7 person-years)

Laboratory managers
Aalto, P., Dr.
Blomberg, M., Doc.
Hienola, J., MSc
Huukka, T., Doc.
Stählerberg, B., Doc.
Vikkanen, P., Doc.

Other technical staff
Engström, P., laboratory technician, ol 6 mo
Ingren, R., BSc, laboratory technician
Kurki, M., laboratory technician, 6 mo
Nurminen, K., laboratory technician
Pekki, I., laboratory technician
Piikala, P., laboratory technician
Sariola, S., laboratory technician
Sepponen, H., chief technician, till 30.9.
Siki, P., laboratory technician
Torpi, F., laboratory technician, till 30.6.

Supportive administrative and technical staff
(annual total 27.8 person-years)

Assistant technical staff
(annual total 2.6 person-years)
Laakso, L., MSc
Markkanen, T., Dr., 7 mo
Soininen, Aleksi, Dr.

Assistants
(annual total 8.0 person years)
Donadini, F., MSc
Galambosi, S., MSc
Koponen, J., MSc
Meinander, K., MSc
Mizohata, K., MSc
Niemelä, S., MSc, ol
Palonen, V., MSc
Peura, M., MSc
Rasmus, K., MSc

Assistants in locum positions
(annual total 1.0 person years)
Kauhanen, J., MSc, 12 mo

University lecturers, doctoral assistants and assistants
(annual total 26.2 person-years)

University lecturers
(annual total 14.6 person-years)
Ahlgren, T., Doc., ol 1.1.–30.6.
Bister, M., Doc., ol, locum 1.8.–31.12. PhD B. Bonn
Fant, B., Doc.
Huitu, K., Doc., till 30.4.
Hämäläinen, A., Dr.
Keskiväkki, E., Doc., ol, locum, Doc. C. Montonen
Koponen, I.T., Doc.
Kurki-Suonio, H., Doc.
Kuronen, A., Doc.
Lehtinen, K., Dr. Tech., Doc., ol, locum Doc. I. Napari
Manninen, S., Doc., ol
Niskanen, J., Doc.
Rauhala, E., Doc.
Räsänen, Jouko, Doc.
Torkkeli, M., Doc., from 1.8.
Vainio, R., Doc.
Österberg, K., Dr.
1 vacancy till 31.7., locum Dr. J. Laukkonen

Administrative personnel
(annual total 12.1 person-years)
Ahonen, J., MSc, senior secretary
Andersson, S., Lic. Phil., amanuensis
Antila, U., senior secretary
Hyvönen-Dabek, M., Doc., aman.
Kivinen, M., senior secretary
Koivisto, L., senior secretary
Lahtinen, M., MSc, aman.
Louhio, M.-L., senior secretary
Montonen, C., Doc., aman., ol, locum Dr. C. Helminen
Mäkinen, A., MSc (Adm.), aman., from 5.12.
Pitkäinen, T., senior secretary
Sundius, T., Doc., aman.
Vahvaselkä, A., Dr., aman.

Personnel supported by external funds
(annual total 139.6 person-years)

General Division
(annual total 12.5 person-years)

Doctoral assistants
(annual total 2.6 person-years)
Laakso, L., Dr.
Markkanen, T., Dr., 7 mo
Soininen, Aleksi, Dr.

Other technical staff
(annual total 2.6 person-years)
Engström, P., laboratory technician, ol 6 mo
Ingren, R., BSc, laboratory technician
Kurki, M., laboratory technician, 6 mo
Nurminen, K., laboratory technician
Pekki, I., laboratory technician
Piikala, P., laboratory technician
Sariola, S., laboratory technician
Sepponen, H., chief technician, till 30.9.
Siki, P., laboratory technician
Torpi, F., laboratory technician, till 30.6.

Didactical Physics Unit
(annual total 4.5 person-years)
Bressan, B., Dr., 12 mo
Hendolin, I., MSc, 12 mo
Kallunki, V., Lic. Phil., 12 mo
Kivinen, H.-M., student, 4 mo
Lehtonen, S., MSc, 2.5 mo
Mäntylä, T., MSc, 12 mo

Electronics Research Unit
(annual total 3.8 person-years)
Eskelinen, J., student, 5 mo
Karpinen, T., Lic. Phil., 12 mo
Kaskela, A., student, 0.5 mo
Kassamakov, I., PhD, 6 mo
Lassila, I., student, 7 mo
Salmi, A., student, 1 mo
Vihinen, P., MSc, 7 mo
Wallin, A., MSc, 6 mo
Österberg, M., student, 1 mo

Medical Physics
(annual total 0.3 person-years)
Heikkinen, S., Dr., 0.5 mo
Nieminen, K., student, 1 mo
Schenkel, Y., MSc (tech) 1 mo
Tenkanen, P., MSc (tech) 1 mo

Space Physics
(annual total 3.9 person-years)
Honkkila, V., MSc, 12 mo
Huttunen, E., Dr., 8 mo
Lahtinen, T., MSc, 12 mo
Muhonen, V., MSc, 12 mo
Parnoel, J., student, 2.5 mo
**Accelerator Laboratory Division**  
(annual total 15.6 person-years)

Arstila, K., Dr., 2 mo  
Berg, T., student, 3 mo  
Björkas, C., student, 5 mo  
Fordell, Th., MSc, 12 mo  
Harjunmaa, A., MSc, 12 mo  
Heinola, K., MSc, 12 mo  
Henriksson, K., Dr., 12 mo  
Juslin, N., MSc, 4 mo  
Järvi, T., MSc, 10 mo  
Kesälä, E., student, 9 mo  
Koskelo, O., MSc, 3 mo  
Kotakoski, J., MSc, 12 mo  
Laaksonlaita, S., MSc, 5 mo  
Lehtinen, O., student, 3 mo  
Lindberg, Å., Doc., 12 mo  
Nevalainen, K., MSc, 12 mo  
Pusa, P., Dr., 12 mo  
Rusanen, M., Dr. Tech, 4 mo  
Sajavaara, T., Dr., 1 mo  
Saresoja, O., student, 3 mo  
Smolander, T., student, 3 mo  
Träskelin, P., MSc, 12 mo  
Valling, S., MSc, 12 mo  
Väyrynen, S., MSc, 12 mo

**High Energy Physics Division**  
(annual total 9.1 person-years)

Carey, A., Prof., 0.5 mo  
Garcia Fuentes, F., PhD, 5 mo  
Hilden, T., MSc, 5.5 mo  
Honkavaara, T., MSc, 4.5 mo  
Järvinen, M., MSc, 12 mo  
Khoze, V., Prof., 12 mo  
Lauhakangas, R., MSc, 5 mo  
Mnatsakanova, M., PhD, 1 mo  
Nishijima, K., Academician, 1 mo  
Presnadjan, P., Prof., 3 mo  
Rüppell, T., MSc, 11 mo  
Saxell, S., MSc, 11 mo  
Tureanu, A., Dr., 12 mo  
van Remortel, N., PhD, 12 mo  
Vernov, Yu., Prof., 1 mo  
Virtanen, H., MSc, 12 mo  
Zhang, R., 0.5 mo

**Theoretical Physics Division**  
(annual total 11.7 person-years)

Collin, A., student, 3 mo  
Gynther, A., MSc, 12 mo  
Heikilä, V., student, 12 mo  
Hietanen, A., MSc, 12 mo  
Keihänen, E., Dr., 4 mo  
Keskitalo, R., student, 5 mo  
Kurkela, A., student, 5 mo  
Lappi, T., Dr., 12 mo  
Lehtola, J., student, 6.6 mo  
Martikainen, J-P., PhD, 5 mo  
Nalimov, M., DSc, 1.5 mo  
Nurmi, S., student, 7.5 mo  
Partanen, T., student, 2.5 mo  
Poutanen, T., Dr., 12 mo  
Reijonen, V., student, 3 mo  
Ristolainen, H., student, 4 mo  
Salmela, A., Dr., 12 mo  
Strickland, M., PhD, 7 mo  
Tuovinen, T., MSc, 2 mo  
Vepsäläinen, M., MSc, 12 mo

**X-ray Division**  
(annual total 16.2 person-years)

Fernández, M., MSc, 10 mo  
Hakala, M., Dr. Tech., 12 mo  
Ikonen, T., MSc, 12 mo  
Kaila, V., student, 4 mo  
Kisko, K., MSc, 12 mo  
Louhiaru, M., MSc, 11.5 mo  
Mattila, A., MSc, 12 mo  
Nygård, K., MSc, 12 mo  
Otten, R., student, 5 mo  
Pirkkalainen, K., student, 12 mo  
Porra, L., MSc, 12 mo  
Pylkkänen, T., student, 12 mo  
Rantanen, M., MSc, 12 mo  
Ruotsalainen, K., student, 3 mo  
Sakko, A., student, 7.3 mo  
Salminen, T., student, 3 mo  
Suomela, H., MSc, 12 mo  
Suortti, P., Prof. emer., 6.7 mo  
Torkkeli, M., Doc., 7 mo  
Vainio, U., MSc, 12 mo  
Würtz, P., student, 5 mo

**Division of Atmospheric Sciences**  
(annual total 74.6 person-years)

Aarflot, A., MSc, 12 mo  
Altimir Escale, N., MSc, 12 mo  
Antola, M., student, 3 mo  
Asmi, A., MSc, 12 mo  
Aura, A., student, 8 mo  
Bergman, T., student, 4 mo  
Bister, M., Doc., 3 mo  
Bogdan, A., Dr., 12 mo  
Bonn, B., PhD, 7 mo  
Boy, M., Dr., 12 mo  
Bäck, J., Doc., 6 mo  
Dal Maso, M., MSc, 12 mo  
Ehn, M., MSc, 9 mo  
Gagné, S., student, 4 mo  
Gaman, A., MSc, 12 mo  
Grönholm, T., MSc, 12 mo  
Haapanala, S., MSc (Tech), 12 mo  
Hamed, A., MSc, 7 mo  
Hannuniemi, H., student, 3 mo  
Herrmann, E., MSc, 12 mo  
Hietala, H., student, 3 mo  
Hiltunen, V., MSc, 12 mo  
Hiirsikkko, A., MSc, 12 mo  
Holopainen, J., Lic. Phil., 6 mo  
Hussein, T., Dr., 12 mo  
Hyvönen, S., PhD (Tech), 6 mo  
Hölttä, T., Dr., 12 mo  
Hönkkalu, A., PhD, 12 mo  
Junninen, H., MSc, 9 mo  
Juurola, A., student, 4 mo  
Järvi, L., student, 7 mo  
Kajos, M., student, 3 mo  
Kalakoski, N., student, 8 mo  
Karppanen, J., student, 3 mo  
Keronen, P., MSc, 6 mo  
Kinnunen, P., MSc, 8 mo  
Konikola, L., student, 3 mo  
Korhonen, L., student, 3 mo  
Kulmala, M., Acad. Prof., 12 mo  
Kulmala, Mikko, student, 1.1 mo  
Kurtén, T., MSc, 9 mo  
Kuusipalo, K., MSc, 8 mo  
Kuusti, V., student, 0.5 mo  
Kyrö, E.-M., student, 1 mo  
Laakso, H., techn, 12 mo  
Laitinen, T., student, 12 mo  
Larjomaa, J., student, 6.5 mo  
Launainen, S., student, 12 mo  
Lauri, A., MSc, 12 mo  
Lauros, J., MSc, 12 mo  
Leskinen, M., MSc, 12 mo  
Ljungberg, K., student, 7 mo  
Lushnikov, A., Prof., 12 mo  
Lyubovtseva, Yu., PhD, 12 mo  
Makkonen, R., student, 12 mo  
Mammarella, I., PhD, 10 mo  
Manninen, H., student, 4 mo  
Markkanen, T., Dr., 1 mo  
Martikainen, J., student, 10.8 mo  
Massling, A., PhD, 10 mo  
Merkanto, J., MSc, 12 mo  
Mordas, G., PhD, 12 mo  
Määtäinen, A., MSc, 12 mo  
Niemö, S., student, 10.5 mo  
Noppel, M., PhD, 12 mo  
Nousiainen, T., Dr., 12 mo  
Päätero, P., Doc., 5 mo  
Petäjä, T., MSc, 12 mo  
Pihlatie, M., MSc (Agro For), 12 mo
Thirty-eight foreign scientific visitors worked in the Department for longer than one month (altogether 232 months), 11 visited for more than two weeks (altogether 8 months) and 127 persons paid a shorter visit. Of the departmental staff 21 persons visited foreign research centres for periods longer than one month (altogether 46 months) and 27 people for more than 2 weeks (altogether 17 months). Detailed information about the visitors can be found from the University Data Base at http://www-db.helsinki.fi/muti/.

Geophysics Division
(annual total 9.0 person-years)

An, B.W., PhD, 12 mo
Elbra, T., MSc, 12 mo
Granskog, M., Dr., 1 mo
Hämäläinen, T., 12 mo
Kangas, A., student, 0.1 mo
Kanto, E., MSc, 1 mo
Kohout, T., MSc, 12 mo
Lindfors, A., MSc, 6 mo
Mattila, O.-P., student, 2 mo
Pesonen, L., Prof., Acad. res., 2 mo
Renner, A., MSc, 5 mo
Salminen, J., MSc, 12 mo
Suomi, I., MSc, 3.5 mo
Uusikivi, J., MSc, 5 mo
Wang, C., MSc, 11 mo
Wang, K., MSc, 11 mo

Teachers from other institutions
(The teachers paid by a supplementary teaching budget have given a full course.)

Aaltonen, J, Lic. Phil., Helsinki Institute of Physics HIP
Airo, M.-L., Dr. Tech., Doc., Geological Survey of Finland GTK
Arst, H., Dr.
Danski, J., Dr., Finnish Meteorological Institute FMI
Eloranta, E. H., PhD, Radiation and Nuclear Safety Authority Finland STUK
Goldstein, Prof.
Hannula, I., Dr.
Haapala, J., PhD, Finnish Institute of Marine Research FIMR
Heikkonen, J., Doc., Helsinki University Central Hospital HUCH
Honkonen, J., Doc., National Defence College
Hyvönen, T., Lic. Phil., Institute of Seismology
Kahma, K., Doc., FIMR
Kauppinen, T., Doc., HUCH
Kerminen, V.-M., Dr., Prof., FMI
Koistinen, J., MSc, FMI
Kukkonen, I, Dr Tech, GTK
Kuusisto, E., PhD, Doc., Finland’s environmental administration
Mickelsson, J., Prof., Department of Mathematics and Statistics, Univ. Helsinki
Mäntyniemi, P., MSc, Institute of Seismology
Nevanlinna, H., Doc., FMI
Nikkinen, P., Doc., HUCH
Pasanen, O., MSc
Peltoniemi, M., Prof., Helsinki University of Technology HUT
Poutanen, M., Prof., Finnish Geodetic Institute FGI
Poutanen, V.-P., Dr., HUCH
Savolainen, S., Doc., HUCH
Vermeer, M., PhD, Prof, HUT
Vihma, T., Doc., FIMR
Viljanen, A., Dr., FMI
Publications

Peer reviewed articles

In 2005 the personnel of the Department of Physical Sciences published 312 articles in esteemed scientific journals with international peer reviewing systems. A complete list of these publications is given here below. The publications are grouped according to our main research fields. The number of publications in materials and related applied physics was 97, atmospheric sciences 100, particle, mathematical and nuclear physics 88 and electronics, medical and biophysics, geophysics and space physics 27.

Books

Professor Kari Enqvist published a book called “Suhteellisuusteoriaa runoilijoille” (Relativity theory for poets, in Finnish). The author characterizes the book saying that it contains all what you have wanted to know about relativity theory but have not dared to ask.

A new edition of a textbook, Aaltoilukkeestä dualismiin in Finnish (From Wave Motion to Dualism) for university students appeared.

Research Collaboration

The Department of Physics has wide collaboration with many foreign universities and research centres. During the 3-year period 2003 – 05 peer reviewed articles involved collaboration with scientists from 323 European institutes, 125 institutes in North and 6 in South America, 34 institutes in Asia, 3 in Australia, 5 in Israel and 2 in Africa. Scientists from the Department had also collaboration with 20 foreign and 11 domestic companies, giving rise to publications during this 3-year period. The CERN collaboration with large research groups is excluded.

The research groups of the Department are in cooperation with ca. 100 university departments in Finland (University of Helsinki, 46 laboratories and departments in 6 faculties, Helsinki University of Technology 14 laboratories, Technical Research Centre of Finland 6 divisions, Universities of Jyväskylä, Kuopio, Oulu, Turku, Joensuu and Lapland, Tampere and Lappeenranta Universities of Technology, Åbo Akademi, about 20 other state or research institutes) and with re-search institutes in both physics and interdisciplinary research. Collaboration with the Helsinki Institute of Physics (HIP), of which Prof. Juhani Keinonen is a board member, is being developed both in research and post-graduate education.

Conferences attended

There were 83 invited talks, 168 other oral presentations and 131 poster presentations in international conferences and 15 invited talks, 62 other oral presentations and 62 poster presentations in domestic meetings. Detailed information about these can be found in the Helsinki University Knowledge Databases, http://www-db.helsinki.fi/osaamistietokannat/index.shtml.
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Space Physics


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Books


Textbooks

The number of ECTS (European Credit Transfer System) credits taken in the Department was 21,192 in 2005, which was 21.6% of all those taken in the Faculty of Science. (The study week concept, commonly used in Finland, is 1.5 ECTS credits.)

In 2005 50 students took their MSc degree in the Department (This was 12 degrees more than in 2004). For the 5-year period 2001-05 the median age of those finishing their Master's degree was 26.4 years, the same as the median, 26.5 years, for the 5-year period 1996–2000. The mode of the ages of those taking their Master’s degree was 25 years.

The proportion of women of those graduating from the Department in the 5-year periods 2001-2005, 2000-2004 in parentheses, were: MSc 32% (32%) and PhD 32% (33%). These similar proportions for PhD and MSc degrees indicate that the Department has to a great extent fulfilled its aim of equality of opportunity for women in researcher education.

In 2004 26 post-graduate students took the degree of Doctor of Philosophy whereas in 2005 there were only 18 doctor's degrees taken and 5 degrees of Licentiate of Philosophy. In the period 2001 – 05 the median of the age distribution of the graduating doctors in the Department was 31.0 years, a little bigger than the median 30.6 years in the period 1996 –2000. The effort to shorten the time needed to accomplish a doctor’s degree by increasing monitoring of student progress will still continue. The mode of the ages of those taking the Doctor’s degree was 30 years.

MSc theses 2005 (supervisor)

Physics

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Hirskiko, Anne, Aerosollihiuksen ja ionien kokojakaumamittauksia SMEAR II-asemalla 18 kuukauden aikana (L. Laakso, M. Kulmala)

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Koskelo, Otso, Radioaktiivisten merkkaineiden mittaaminen: Berylliumin diffuusio pigmerneerummissa (U. Räsänen)

Lassila, Ilkka, Ultraintimenmittaaminen paperin pigmenettelystä pigmenttipäällykkeen sisällössä (E. Hæggström)

Leppänen, Mikko, Ohujen levymäisten näytteiden tason suuntaisten kimmovakioiden määrittäminen ultrasuunnan (E. Hæggström)

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Mehtälä, Petteri, Top quark mass reconstruction by using the CDF experiment at the Tevatron 2 TeV p anti p collider (N. van Remortel)

Perttula, Sakari, Värilämpömittari valokuvauksen harrastajille (J. Stor-Pellinen)

Riipinen, Ilona, Monikomponenttinen titrityyminen imakehän liuosparoihin (M. Kulmala, K.E.J. Lehtinen)

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In the 2005 evaluation of the research performance of the whole University of Helsinki for the period 1999 – 2004 the Department of Physical Sciences obtained the highest grade. Only 27% of the evaluated units reached this highest level.
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Edited by Mervi Hyvönen-Dabek

ISSN 0781-4038
Helsinki 2006
Helsinki University Press
University Printing House

Artistic design and layout Päivi Talonpoika-Ukkonen