ANNUAL REPORT
1999

HELSINKI UNIVERSITY OF TECHNOLOGY
Low Temperature Laboratory

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LOW TEMPERATURE LABORATORY (LTL)

PREFACE

In the Low Temperature Laboratory (LTL) the year 1999 culminated intensive preparations for LT22, the triennial International Low Temperature Conference. In 1996 IUPAP, the Union of Pure and Applied Physics, granted the LTL the right to organize the next LT conference on the campus of Helsinki University of Technology. This was the first time in the 50 year history of LTs that the conference revisited one of the venues where it had been once before, namely when LT14 with 814 participants took place in Otaniemi in 1975. The LTL carried the full financial and organizational responsibility of the LT22; the local Organizing Committee, the chairmanship of the Program Committee and most of the Editorial Board of the Proceedings were manned by the LTL staff. I would like to thank once more all those who made this large conference of 1381 participants and 3.8 Mmk budget a success (Final Report of LT22 in Appendix 1). The LT22 Proceedings will appear in Physica B in April, 2000 (see the Preface of the Proceedings in Appendix 2).

An important tradition at the LT Conferences is the international award of Fritz London Prize. This most prestigious prize in low temperature physics is given out every third year in connection of the LT Conferences. The 1999 London Prize was presented to Professor Douglas Brewer from University of Sussex, to Professor Wolfgang Ketterle from Massachusetts Institute of Technology and to Academy Professor Matti Krusius from our laboratory. Matti Krusius received the prize for *his imaginative and pioneering use of rotation combined with nuclear magnetic resonance to study various properties of superfluid ^{3}He, including textures of the order parameter, the structure, pinning and collective behavior of several different types of vortex, the critical velocity under rotation, the effects of motion of the A-B interface and the systematics of nucleation of vorticity by neutron irradiation.* Academy Professor Krusius is already the second recipient of the Fritz London Prize in the LTL; Academician Olli Lounasmaa received the Prize in 1984.

The Brain Reseach Unit (BRU) of the LTL has pioneered the instrumentation and use of the magnetoencephalographic (MEG) method. For active areas in the brain's outer layer, the cerebral cortex, MEG provides spatial resolution of about 5 mm and an excellent temporal resolution on the order of 1 ms. In studies of temporal signal processing, the MEG method has an advantage over other functional neuroimaging methods such as functional magnetic resonance imaging (fMRI) which provides superior spatial accuracy in locating metabolic brain activity or cerebral blood flow. Our future research would benefit from a combination of the MEG and fMRI methods to obtain high accuracy in identifying brain ac-

tivations both in space and time. This approach was pointed out also by our Scientific Advisory Board in 1997.

The LTL has formed a consortium with Department of Electrical and Communications Engineering (research groups of Academy Professor Kimmo Kaski and Professor Raimo Sepponen) and Department of Engineering Physics and Mathematics for founding a 3-Tesla fMRI facility with a total budget of 25 Mmk. The funding of the facility, one of the largest basic science investments in Finland, was finally secured in the fall of 1999 when Tekes decided to support it with a 32% contribution. The rest of the money comes from the Wihuri Foundation (1 Mmk), the Academy of Finland (3.25 Mmk), and from the members of the consortium. The Facility, located in the Department of Electrical Engineering within 100 m from our MEG facility, is planned to be ready in 2001.

In low temperature physics, the studies of nuclear ordering in metals have come to an end after 20 years of successful work. In this work, the low temperature world record was broken several times while the nuclear magnetic properties of copper, silver and rhodium were mapped in detail. The latest record of 250 pK was reached with a rhodium sample in January 1999 in a new ultra low temperature cryostat. From now on, this new refrigerator will be used in search of superfluidity in ^{3}He/^{4}He mixtures well below 100 μK temperatures. The search of nuclear ordering in metals and superfluidity in mixtures are such risky experiments that they can be conducted only in a large and financially stable laboratory like the LTL.

Since 1990, the LTL has participated in the Spin Muon Collaboration (SMC) in CERN. Our laboratory has successfully designed and built the world's largest dilution refrigerator for this project which came to an end in 1999. In the final comments (http://www.cern.ch/Committees/SPSC/SPSC43.html) *the CERN Research Board congratulated the collaboration for their important contributions to the understanding of the spin structure of the nucleon.* Our CERN collaboration will continue in the COMPASS project, where we are again in charge of the refrigeration of the polarized targets.

The undersigned was invited to become a member of the Academia Europaea in its Physics and Engineering Sciences Section. The Academia, founded in 1988, is an organization of individual scolars for the whole of Europe and covers the full range of academic disciplines from humanities to engineering and mathematics. Currently it has 1800 members, nearly 40 of them from Finland. Academy Professors Riitta Hari and Matti Krusius as well as Academician Olli Lounasmaa are already members of the Academia Europaea.

Mikko Paalanen

Mikko Paalanen

Director of the LTL

SCIENTIFIC ADVISORY BOARD

The Scientific Advisory Board, nominated for the period of 1997-1999, has the following members:

Prof. Michael Merzenich	University of California, San Fransisco
Prof. Hans Mooij	Delft University of Technology, The Netherlands
Prof. Yrjö Neuvo	Nokia Ltd, Helsinki
Prof. Douglas Osheroff (chairman)	Stanford University, California
Prof. Stig Stenholm	Royal Institute of Technology, Stockholm
Prof. Semir Zeki	University College London

PERSONALIA

The number of persons working in the LTL fluctuates constantly since many scientists are employed for relatively short periods only and students often work on part-time basis.

SENIOR RESEARCHERS

Mikko Paalanen, Dr. Tech., Prof., Director of the LTL

Riitta Hari, M.D., Ph.D., Academy Professor, Head of the Brain Research Unit

Peter Berglund, Dr. Tech., Docent, Technical Manager

Marja Holmström, Lic. Phil., Laboratory Administrator

Markus Ahlskog, Dr. Tech., from Apr 1

Harry Alles, Dr. Tech.

Alexei Babkin, Ph.D., until Apr 25 and Jul 26 – Aug 20

Vladimir Eltsov, Ph.D.

Nina Forss, M.D., Ph.D.

Pertti Hakonen, Dr. Tech., Docent

Päivi Helenius, Dr. Psych.

Matti Hämäläinen, Dr. Tech., Docent

Veikko Jousmäki, Ph.D.

Jaakko Koivuniemi, Dr. Tech.

Matti Krusius, Dr. Tech., Academy Professor

Sari Levänen, Dr. Psych.

Olli Lounasmaa, Ph.D., Academician

Jussi Numminen, M.D., Ph.D., until Sep 30

Stephan Salenius, M.D., Ph.D.

Riitta Salmelin, Dr. Tech., Docent

Claudia Tesche, Ph.D., Visiting Prof.

Erkki Thuneberg, Dr. Tech., Docent

Juha Tuoriniemi, Dr. Tech.

Simo Vanni, M.D., Ph.D.

Minna Vihla, M.D., Ph.D., from Oct 1

Grigori Volovik, Ph.D., Visiting Prof.

LONG-TERM VISITORS (More than 4 weeks)

Dr. Flamine Alary	INSERM U 455, Toulouse, France, Nov 10 – Dec 31
Acad. Alexander Andreev	Kapitza Institute for Physical Problems, Moscow, Russia, Sep 1 – Oct 1
Mr. Rob Blaauwgeers	University of Leiden, The Netherlands, Jan 1 – Dec 31
Dr. Sergei Boldarev	P.N. Lebedev Physical Institute, Moscow, Russia, Jan 1 – 6, Feb 19 – Apr 20, Jul 11 – Aug 11, and Oct 5 – Dec 31
Dr. Piers Cornelissen	Newcastle University, Newcastle upon Tyne, UK, May 3 – 9, Aug 17 – 26 and Aug 29 – Oct 6
Dr. Laila Craighero	University of Parma, Italy, Apr 11 – May 12
Dr. Luciano Fadiga	University of Parma, Italy, Apr 11 – May 12
Dr. Uwe Fischer	University of Tübingen, Germany, Sep 13 – Dec 5
Prof. Muneaki Fujii	Kumamoto University, Japan, Aug 20 – Sep 20
Prof. Nobuya Fujiki	Kyoto University, Japan, Aug 13 – Dec 31
Prof. Vsevolod Gantmakher	Institute of Solid State Physics, Chernogolovka, Russia, Apr 16 – Sep 30
Ms. Liselotte Gootjess	Free University Amsterdam, The Netherlands, Feb 1 – Jul 31
Mr. Herbert Götz	University of Bayreuth, Germany, Jul 3 – Oct 3
Ms. Dorothea Hamdorf	Konstanz University, Germany, Jan 1 – Mar 31
Dr. Ole Jensen	Boston University, USA, Feb 2 – Dec 31
Dr. Reyer Jochemsen	Leiden University, The Netherlands, Jan 5 – Aug 20

Mr. James Kilner	Institute of Neurology, London, UK, Jan 19 – Feb 19, Nov 11 – 18 and Nov 29 – Dec 6
Prof. Nikolai Kopnin	L.D. Landau Institute for Theoretical Physics, Moscow, Russia, Oct 11 – Dec 31
Dr. Yung-Yang Lin	Veterans General Hospital, Taipei, Taiwan, Feb 23 – Dec 31
Dr. Norman Loveless	University of Dundee, UK, Apr 18 – Jul 18
Prof. Nobuki Murayama	Kumamoto University, Japan, Nov 1 – Dec 31
Dr. Noboyuki Nishitani	Kyoto University, Japan, until Mar 31
Acad. Alexander Parshin	Kapitza Institute for Physical Problems, Moscow, Russia, Jan 16 – Feb 15 and Jun 25 – Jul 15
Dr. Adriaan Schakel	Freie Universität Berlin, Germany, Nov 1 – Dec 18
Mr. Roch Schanen	CNRS, Grenoble, France, Jan 1 – Dec 31
Dr. Martin Schuermann	Medical University of Lübeck, Germany, Sep 13 – Oct 29
Dr. Alexander Sebedash	Kapitza Institute for Physical Problems, Moscow, Russia, Jun 15 – 18 and Oct 5 – Dec 10
Dr. Uma Shahani	Wellcome Biomagnetism Unit, Institute of Neurological Sciences, Glasgow, UK, Jul 5 – Aug 15
Ms. Cristina Simões	University of Lisbon, Portugal, Jan 1 – Dec 31
Dr. Edouard Sonin	Hebrew University, Jerusalem, Israel, Feb 1 – Mar 3, Aug 4 – 11 and Aug 25 – Oct 18
Dr. Hideki Yoshida	Tohwa University, Japan, Apr 1 – Dec 31

GRADUATE STUDENTS (Supervisors)

Sari Avikainen, M.D.
(Riitta Hari)

Rob Blaauwgeers, M.Sc.
(Matti Krusius)

Matti Kajola, M.Sc. Tech.
(Matti Hämäläinen)

Pasi Kettunen, M.D., M.Sc. Tech.
from Feb 22 – Jul 31
(Stephan Salenius, Riitta Hari)

Erika Kirveskari, M.D.
(Riitta Hari)

Tauno Knuuttila, M.Sc. Tech.
(Juha Tuoriniemi)

Tommi Raij, M.D.
(Riitta Hari)

Leif Roschier, M.Sc. Tech
(Pertti Hakonen)

Jaakko Ruohio, M.Sc. Tech.
(Matti Krusius)

Roch Schanen, M.Sc.
(Matti Krusius)

Mika Seppä, M.Sc. Tech.
(Matti Hämäläinen)

Teija Silen, M.D.
(Nina Forss, Riitta Hari)

Juha Kopu, M.Sc. Tech.
(Erkki Thuneberg)

Juha Martikainen, M.Sc. Tech.
(Juha Tuoriniemi)

Lauri Parkkonen, M.Sc. Tech.
(Matti Hämäläinen)

Jari Penttilä, M.Sc. Tech.
(Pertti Hakonen)

Marjatta Pohja, M.D.
(Stephan Salenius, Riitta Hari)

Mika Sillanpää, M.Sc. Tech.
(Pertti Hakonen)

Cristina Simões, M.Sc. Tech.
(Riitta Hari)

Topi Tanskanen, M.Sc. Psych.
(Riitta Hari)

Antti Tarkiainen, M.Sc. Tech.
(Riitta Salmelin)

Reeta Tarkiainen, M.Sc. Tech.
(Pertti Hakonen)

Viktor Tsepelin, M.Sc.
(Alexei Babkin and Harry Alles)

Kimmo Uutela, M.Sc. Tech.
(Matti Hämäläinen, Riitta Salmelin)

UNDERGRADUATE STUDENTS

Antti Finne

Samuli Hakala

Juha Heiskala

Ville Hero

Kirsi Juntunen

Katri Kiviniemi

Hanna Koivikko

Noora Kovalainen

Jan Kujala

Satu Lamminmäki

Riitta Laiho

Vesa Lammela

Rene Lindell

Johnny-Stefan Lönnroth

Lasse Palovaara

Elias Pentti

Paula Routama

Linda Stenbacka

Samu Taulu

Mervi Valta

Janne Viljas

SECRETARIAL AND TECHNICAL PERSONNEL

Teija Halme, secretary

Antti Huvila, technician

Jani Högman, assistant

Mia Illman, laboratory nurse

Arvi Isomäki, technician

Juhani Kaasinen, technician

Mark Mehtonen, assistant from May 24

Markku Korhonen, technician

Markku Lehtovuori, technician

Satu Pakarinen, project secretary

Liisi Pasanen, secretary

Kari Rauhanen, technician

Pirjo Kinanen, financial secretary	Antero Salminen, technician
Tuire Koivisto, secretary	Ronny Schreiber, technician from May 24

SHORT-TERM VISITORS (Less than 4 weeks)

Dr. Konstantin Arutyunov	University of Jyväskylä, Jun 4
Ms. Jane Aspell	Newcastle University, Newcastle upon Tyne, UK, Mar 15 – 26.
Dr. Anthony Bailey	Institute of Psychiatry, London, UK, Feb 18 – 21 and Jul 3 – 7
Dr. Stuart Baker	Institute of Neurology, London, UK, Jan 19 – 24 and Nov 12 – 15
Mr. Barry Bayliss	Open University, Milton Keynes, UK, Feb 16 – Mar 4
Dr. Sven Braeutigam	The Open University, Milton Keynes, UK, Feb 19 – Mar 2, Jul 3 – 7 and Nov 25 – 29
Dr. David Bramwell	University of Newcastle, Newcastle upon Tyne, UK, Mar 15 – 26
Dr. Peter Brown	Institute of Neurology, London, UK, Jan 4 – 8
Prof. Yuriy Bunkov	CRTBT/CNRS, Grenoble, France, May 26 – Jun 10
Dr. Alexander Calogeracos	NCA Research S.A., Greece, Jan 10 – 24
Mr. Lars Christensen	University of Copenhagen, Denmark, Oct 9 – 22
Dr. Gabriel Curio	Benjamin Franklin Clinic, Berlin, Germany, Jun 8 – 20 and Sep 6 – 17
Dr. Eduardo Gomez-Utrero	University Hospital la Princesa, University of Alcala, Madrid, Spain, Dec 6 – 21
Dr. Gary Green	Newcastle University, Newcastle upon Tyne, UK, Mar 15 – 18
Mr. Joachim Gross	Heinrich-Heine University, Germany, May 5 – 11 and Nov 18 – 29
Prof. David Haviland	Royal Institute of Technology, Stockholm, Sweden, Dec 9 – 12
Prof. Frank Hekking	CRTBT/CNRS, Grenoble, France, Jun 13 – 18
Dr. Anya Hurlbert	University of Newcastle, Newcastle on Tyne, UK, Mar 15 – 23
Dr. Gert Ingold	Augsburg University, Germany, Sep 13 – 17
Prof. Shun-Ichi Iwasaki	Tohoku University, Japan, Feb 8
Mr. Andrew Jackson	Institute of Neurology, University College of London, UK, Nov 11 – 18
Ms. Ruth Lavis	University of Newcastle, Newcastle upon Tyne, UK, May 3 – 9

Dr. Kim Lefmann	Risø National Laboratory, Roskilde, Denmark, Jun 16 – 22
Dr. Roger Lemon	Institute of Neurology, University College London, UK, Jan 19–26 and Nov 11 – 15
Prof. Alvin Liberman	Hakins Laboratories, New Haven, USA (guest shared with Department of Electrical and Communications Engineering, Laboratory of Computational Engineering), Apr 17– May 16
Mr. Norbert Lütke-Entrup	Ecole Normale Supérieure, Paris, France, Jan 1 – 21 and Jul 31 – Aug 11
Prof. Bernd Lütkenhöner	Institute of Experimental Audiology, Münster, Germany, May 3 – 9
Dr. Ceferino Maestu	University of Alcala, Spain, Dec 6 – 21
Mr. Jonataan Marsden	MRC Human Movement and Balance Unit, London, UK, Jan 7 – 14 and May 21 – Jun 3
Dr. Michel Martin	MDS Laboratory, Belgium, May 15 – 30
Mr. Markus Mertens	Institute of Experimental Audiology, Münster, Germany, May 3 – 30
Prof. Leonid Mezhov-Deglin	Institute of Solid State Physics, Chernogolovka, Russia, Mar 29 – 31
Dr. Livio Narici	University of Rome (Tor Vergata), Rome Italy, Dec 2 – 11
Prof. Jens Nielsen	University of Copenhagen, Denmark, Oct 9 – 10
Dr. Guido Nolte	Benjamin Franklin Clinic, Berlin, Germany, Apr 12 – May 2
Dr. Arkadi Odintsov	Delft University of Technology, The Netherlands, Nov 28 – Dec 4
Ms. Carla Ogliastro	University Rome, (Tor Vergata), Roma, Italy, Dec 2 – 11
Dr. Roberto Pineiro	John Radcliffe Hospital, Oxford, UK, Dec 6 – 21
Dr. Bernard Plaçais	Ecole Normale Supérieure, Paris, France, Jul 31 – Aug 21
Prof. Finn Rasmussen	University of Copenhagen, Denmark, May 1 – 30 and Jul 22 – Aug 19
Dr. Alfons Schnitzler	Heinrich-Heine University, Düsseldorf, Germany, Mar 15 – 18 and May 25 – Jun 4
Dr. Konrad Siemensmeyer	Hahn-Meitner Institut, Berlin, Germany, Mar 30 – 31
Prof. Michael Steiner	Hahn-Meitner Institut, Berlin, Germany, Apr 8 – 9
Dr. John Stins	The Open University, Milton Keynes, UK, Nov 25 – 29
Prof. Stephen Swithenby	The Open University, Milton Keynes, UK, Feb 19 – 21 and Nov 27 – 29

Dr. Peter Sörös	University of Münster, Germany, Jan 2 – 22
Prof. Noriaki Takahashi	Osaka University, Japan, May 11 – 12 and Nov 5 – Dec 1
Prof. Paula Tallal	Rutgers University, USA, Jun 10
Mr. Simon Wallace	Institute of Psychiatry, London, UK, Jul 3 – 7
Prof. Andrei Zabrodskii	Ioffe Physical-Technical Institute, Russian Academy of Sciences, St. Petersburg, Jan 31 – Feb 2
Dr. Boris Zacharzenia	Ioffe Physical-Technical Institute, Russian Academy of Sciences, St. Petersburg, Russia, Apr 29 – 30
Dr. Andrei Zaikin	University of Karlsruhe, Germany, Sep 20 – Oct 3

GROUP VISITS

Delegation from Lake Shore, Mar 17

Steve Horners, Vice President

Anders Johansson

Visitors from Media and Journalists Data for Press, Apr 12

French-Finnish Association for Scientific and Technical Research, Apr 30

Director Denis Randet, LETT

Director Jean-Michel Dion ELESA

Director Bernard Hebral CRTBT/CNRS

Group learder Thierry Vernet Laboratoire d'Ingenierie des Macromolécules

Monsieur Jacques Chavallier AEPI

Delegation from ELTE Hungary, May 20

Professor Dr. Andras Benczur, Dean

Professor Dr. Ferenc Lang, Deputy Dean

Dr. Andras Lorincz, Senior Advisory

Counsellor Sandor Darányi, Hungarian Embassy

Professor Eino Tunkelo and two members of Foundation of Polish Science (FNP), Jun 15

Members of TUTKAS, Jun 17

member of parliament Kalevi Olin

member of parliament Osmo Soininvaara

professor Erkki Pihkala (HKKK)

professor Ahti Salo (HUT)

researcher Kalle Laaksonen (PTT)

secretary Ulrica Gabrielsson

During the 22nd International Conference on Low Temperature Physics about 150 participants took a guided tour to the LTL, Aug 4 – 11

Delegation from the Japanese Medical Association with representatives from the Finnish Medical Association, Aug 17

International group of physics students, Aug 18

Japanese delegation SYMTEC, Sep 16

2nd and 3rd -year Physics students, Sep 29 and Oct 12

Parents of first year Physics students, Oct 2

A 4-men film group from Daegu Bank and Taegu University, South Korea, Oct 12

Electricians lecture days, Oct 22

Henry Färm, Turku's Energy, Turku
Jouni Lehtonen, Water Plant of Turku
Seppo Mäntynen, Water Plant of Turku
Kaarlo Nieminen, Finnish Air Forces, Flight Squadron of Satakunta, Tampere
Jorma Rantala, Forssa's Energy Ltd, Forssa
Jouko Ruokolainen, The Armed Forces Construction Plant, Joensuu Office, Kontioranta
Veikko Rönkkönen, Air Forces, Flight Squadron of Karjala, Toivala
Pekka Taavitsainen, Kotka´s Energy Ltd, Kotka
Kari Vallivirta, Primatel Ltd, Helsinki
Arto Vuorinen, Printing House Helsingin Sanomat, Forssa

Members of the Department of Clinical Neurophysiology, Turku University Hospital, Nov 26

10 students from Olari´s upper secondary school participated in SOLIS-education, Dec 10

RESEARCH

RESEARCH PARTNERS

Nanophysics research (NANO)

Microelectronics Centre, Helsinki University of Technology
VTT/Chemical Engineering and VTT/Automation, Technical Research Center
University of Jyväskylä

CNRS/CRTBT, Grenoble, France

Hebrew University, Jerusalem, Israel

Nuclear magnetism of metals at ultralow temperatures (YKI)

Risø National Laboratory, Roskilde, Denmark

Topological objects in quantum fluids (ROTA)

Kapitza Institute for Physical Problems, Moscow, Russia

L.D. Landau Institute for Theoretical Physics, Russia

CNRS/CRTBT, Grenoble, France

Leiden University, The Netherlands

Interfaces in quantum systems (INTERFACE)

Kapitza Institute for Physical Problems, Moscow, Russia

Leiden University, The Netherlands

COMPASS collaboration - polarized target (CERN)

Universität Bielefeld, Germany

Universität Bochum, Germany

Institut fur Strahlen- und Kernphysik, and Physikalisches Institut

Universität Bonn, Germany

JINR, Dubna, Russia

Universität Erlangen, Germany

Universität Freiburg, Germany

Max-Planck-Institut fur Kernphysik, Heidelberg, Germany

Physikalisches Institut der Universität Heidelberg, Germany

Universität Mainz, Germany

Universite de Mons-Hainaut, Mons, Belgium

Institute for Nuclear Research, Moscow,Russia

P.N. Lebedev Physical Institute, Moscow, Russia

Moscow State University, Moscow, Russia

Ludwigs-Maximilian-Universität Munchen, Munich, Germany

Technische-Universität Munchen, Munich, Germany

Nagoya University, Nagoya, Japan,

University of Osaka, Osaka, Japan

IHEP, Protvino, Russia

CEN-Saclay, Gif sur Yvette, France

Tel Aviv University, Tel Aviv, Israel

University of Tbilisi, Tbilisi, Georgia

INFN, Sezione di Torino, e Universitàdi Torino, Turin, Italy

INFN, Sezione di Trieste, e Universitàdi Trieste, Trieste, Italy

Soltan Institute for Nuclear Studies and Warsaw University, Warsaw, Poland

Technical University Warsaw, Warsaw, Poland

KEK and Myazaki, Sendai, Tohoku and Yamagata Universities, Tsukuba, Japan

Universität Zürich, Switzerland

The CERN-RD39 collaboration

University of Glasgow, UK

Helsinki University of Technology, Espoo, Finland

IEKP, University of Karlsruhe, Germany

INFN, University of Florence, Italy

LHEP, University of Bern, Switzerland

INFN, University of Naples, Italy

LIP, Lisbon, Portugal

Department of Radiology, University of Geneva, Switzerland

JSI, University of Ljubljana, Slovevia

University of Brunel, UK

Brookhaven National Laboratory, USA

Ioffe PTI, St. Petersburg, Russia

Technical University of Munich, Germany

CERN, Geneva, Switzerland

Cerebral magnetic fields as indices of human brain function (AIVO)

Department of Neurology, Helsinki University Central Hospital

Department of Neurosurgery, Helsinki University Central Hospital

Department of Radiology, Helsinki University Central Hospital

Department of Psychiatry, Helsinki University Central Hospital

Children and Youth Hospital, Helsinki

Department of Zoology, University of Helsinki

Department of Physiology, University of Helsinki

Department of Psychology, University of Helsinki

Department of Neurology, University of Turku

Department of Neurology, Central Hospital of Central Finland

NTT Basic Research Laboratories, Atsugi City, Japan

Several European Universities in connection with EU Large-Scale Facility BIRCH

Disorders of speech production: cortical dynamics in stuttering and motor aphasia (STUTTER)

Neurologische Klinik, Heinrich-Heine Universität, Düsseldorf, Germany

European Computerised Human Brain Database (BrainAtlas)

Karolinska Institut, Sweden

Heinrich-Heine Universität, Germany

Universidad Automa de Madrid, Spain

Netherlands Instituut voor Hersenonderzoek, The Netherlands

Groupment D'Interet Public Cyceron, France

University of Oxford, UK

Medical School, University of Patras, Greece

Brain mechanism of action viewing (Action viewing)

Institute of Physiology, University of Parma, Italy

Center for Advanced Studies Research and Development in Sardinia, Italy

Kyoto University, Japan

Medical School of Crete, Greece

UCLA, USA

University of Southern California, USA

NANOPHYSICS RESEARCH

M. Ahlskog, **P. Hakonen**, R. Lindell, M. Paalanen, J. Penttilä, L. Roschier, P. Routama, M. Sillanpää, E. Sonin (Jerusalem), R. Tarkiainen

We investigate mesoscopic quantum phenomena at low temperatures. Our topics include small superconducting junctions, single electron transistors, and nanotubes, as well as their noise properties and high frequency behavior. Single Josephson junctions provide an interesting, zero-dimensional quantum mechanical object to test general predictions of macroscopic quantum tunneling involving dissipation. Nanotubes, on the other hand, provide good model systems for one-dimensional conductors displaying quantized, ballistic conductance. Single electron transistors (SET) made of AlO_x tunnel junctions form the most sensi-

tive electrometers known today. Correlations in SETs as well as in mesoscopic conductors can be probed with good resolution using high frequency experiments.

Single Josephson junctions

Single junctions, effectively decoupled from the environment, provide a good, well-controlled model system for metal-insulator type of transition which results from an intricate competition of Coulomb blockade and Josephson coupling. Our experiments reveal a transition between superconducting and insulating behavior as a function of E_J/E_C when the shunt resistance becomes smaller than about 6.5 kΩ. This is a dissipative phase transition where superconductivity, destroyed by quantum fluctuations, is restored by additional damping. Our results, however, differ from the universal theory of Schön and Zaikin; the actual position of the phase boundary is governed by the voltage resolution of the measuring equipment. The experimental data in a small magnetic field display an unexpected insulator-insulator transition, the nature of which is only in qualitative agreement with theoretical predictions.

Single normal junctions

The behavior of a single mesoscopic tunnel junction depends on fluctuations caused by the surrounding electromagnetic environment. We have investigated how a resistive environment influences the asymptotic IV-curve of a normal junction. At large voltages, all resistors begin to look like *RC* transmission lines, which leads to an asymptotic approach as $1/\sqrt{V}$ toward the linear IV-dependence. This specific square-root dependence has been observed in our experiments on AlO_x junctions, isolated using 10 μm long Cr-resistors of R = 50 kΩ.

Single electron transistors (SET)

Asymmetric SETs have been used to design and test a noise reduction scheme based on current reversal modulation. The asymmetry allows current reversal in such a way that the gain for external charge variations remains unchanged. In this case, variations in the tunnel barrier resistance are eliminated and only the background charge noise remains. This allowed us to conclude that the charge noise in our standard SETs is due to background charge fluctuations.

We have also investigated SETs with a normal metal section on the island (either Cr or Cu) in otherwise superconducting structure. It appears that the density of states at the tunnel junctions is enhanced by the presence of normal metal on the island. Experiments to measure the density of states directly have been initiated. In conjunction with these experiments, we have also investigated the proximity effect at an Al/Cr interface.

Single junction SETs

We have utilized the analogy between SQUIDs and SETs to estimate the noise performance of an rf-SET, the component analogous to the rf-SQUID. The rf-SET is basically a single electron box connected to a high-Q tank circuit, the changes of which have to be measured with good precision. To test these issues, niobium resonators with $f_{res} \approx 1$ GHz have been manufactured at the State Research Center (Espoo).

For high frequency experiments, we have built a balanced HEMT amplifier operating at $f = 800 - 900$ MHz. The gain of the amplifier at 4 K is 21 dB, while the reflection coefficient S_{11} stays well below 10 dB over the working bandwidth. The amplifier is intended for transmission type of experiments, e.g., with rf-SETs. The amplifier is mounted directly on a 1 K refrigerator with a large cooling power.

Nanotubes

Single-walled nanotubes, as well as the multiwalled ones, provide good models for one dimensional electron systems. We have employed AFM manipulation techniques to move multiwalled nanotubes (MWNT) on top of gold electrodes. The contact resistance has been found to be between 30 kΩ to 1 MΩ so that these samples behave like single electron transistors. Mechanical properties using LFM microscopy have also been investigated.

Nanotube SETs

We have made several single electron transistors utilizing AFM-manipulation on MWNT of 10 - 20 nm in diameter. Since the self-capacitance of such nanotube is about 10 - 20 aF/μm, rather long sections can be used to make islands for SETs and the island capacitance remains still quite small. The Coulomb energies of our nanotube SETs are around 20 K for a device length of one micrometer. One of our MWNT samples turned out to be rather exceptional in the sense that it gave an unusually regular gate modulation curve.

New equipment

During the previous year we increased our capabilities in scanning probe microscopy by acquiring a multipurpose head that allows for lateral force and scanning tunneling microscopy. For high frequency work, we purchased a network analyzer Hewlett Packard 8753E and a high frequency spectrum analyzer E4407B.

NUCLEAR MAGNETISM IN RHODIUM (YKI PROJECT)

K. Juntunen, T. Knuuttila, K. Lefmann (Risø), J. Martikainen, E. Pentti, A. Sebedash (Moscow), **J. Tuoriniemi**.

Low-frequency-NMR spectroscopy on highly polarized nuclear-spin system of rhodium was used to study the mutual interactions between the nuclear magnetic moments in this metal. The dipolar coupling between the spins allows one single photon to flip two or more spins, giving rise to weak resonances at integer multiples of the Larmor frequency. For the first time, these effects were investigated at both positive and negative spin temperatures. Sensitive measurements utilizing a SQUID made it possible to analyze the double-spin-flip resonance quantitatively, and also to demonstrate the existense of single and double-spin resonances excited *parallel* to the external magnetic field. The dipolarlike contribution and the isotropic exchange term of the interactions could be deduced separately from the frequency shifts of these resonances.

Accurate knowledge of the strength of the spin-spin interactions is essential in order to understand theoretically the missing evidence for nuclear magnetic ordering in rhodium in spite of the relatively high nuclear polarization achieved ($p = 0.86$) in these experiments. Quantum mechanical calculations by exact diagonalization of the Hamiltonian for a cluster of 1/2-spins in an FCC lattice are being performed in collaboration with Risø National Laboratory.

Later in 1999, we were able to reach the superconducting state of rhodium, whose transition temperature and the critical magnetic field are the lowest known. The values we measured, $T_c = 210$ μK and $B_c = 3.4$ μT, are somewhat below those reported earlier for pure rhodium. The main experimental difficulty was the strong supercooling of the normal state: the ambient field had to be reduced below 0.2 μT in order to trigger the superconducting transition even at the lowest electronic temperatures achieved, about $T_e = 70$ μK. Nevertheless, we were able to polarize the nuclear spin system in a magnetic field of 2 T and enter the superconducting state after demagnetization maintaining a finite nuclear polarization ($p \sim 0.4$). Subsequently, we measured the spin-lattice relaxation in the normal and in the superconducting state. At the limit $p \to 0$, the ratio of the relaxation rates was an exponential function of the electronic temperature, in accordance with the BCS theory, rising up to about 5 at the lowest temperatures. More interestingly, though, the ratio of the relaxation rates was clearly suppressed by finite nuclear polarization, down to about 2 at $p \sim 0.4$. The effect of nuclear polarization on the relaxation rate in the superconducting state was far stronger than anticipated and its explanation remains to be found.

At the end of the year the cryostat was warmed up in order to install the new experiment on isotopic mixtures of ^{3}He and ^{4}He. The first version of the experimental cell has

three separate miniature sample cavities, each with somewhat different design. The first cooldown of this setup will take place at the beginning of the year 2000.

To supplement this experiment we started a new collaboration with Kapitza Institute in Moscow. A novel method of cooling ^{3}He-^{4}He mixtures by adiabatic melting of solid ^{4}He was proposed. Upon melting of the ^{4}He crystal, the ^{3}He component will dissolve and absorb the heat of mixing. The cooling takes place in the liquid itself thereby avoiding completely the serious problem of the enormous Kapitza resistance to any external coolant at very low temperatures. Preparations for constructing an experimental cell utilizing this principle have been started. The existing nuclear stage of our refrigerator will be employed for precooling the ^{3}He component below its superfluid transition temperature prior to the adiabatic melting of ^{4}He.

TOPOLOGICAL OBJECTS IN QUANTUM FLUIDS (ROTA PROJECT)

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Quantum systems in their superfluid or superconducting state are described by an order parameter which is analogous to a macroscopic Schrödinger-like wave function. The order-parameter field displays coherence over length scales which are a characteristic property of the system, but it may include spatially dependent structure due to textures and the presence of topologically stable defects. Often the different defect structures are characterized by a quantized quantity, which makes the order parameter distribution in the bulk fluid analogous to a quantum field.

Experimentally the most well-behaved quantum system for the study of defect structures is liquid ^{3}He. It is here where the largest number of possibilities exists for different types of defect structures in two anisotropic superfluid phases, which have the cleanest bulk-matter properties in all of condensed matter. Over the years we have identified with NMR spectroscopy a multitude of topological objects with different structures. During 1999 two efforts have been in the forefront of our studies:

Doubly quantized vortex line in ^{3}He-A

When ^{3}He-A is gently accelerated to rotation, doubly quantized vortex lines are formed since they generally have the lowest critical velocity. Their NMR signal was observed in the very first rotating experiments in this laboratory in 1981 and the origin of this signal, a satellite peak in the ^{3}He NMR spectrum, was analytically explained by Grigory Volovik. With the improved sensitivity of our new NMR measurement methods and digital signal-to-noise enhancement techniques it became possible to observe a signal from one single vortex of this kind.

The interpretation of the measured single-vortex signal is based on the fact that the superflow circulating around the core of the vortex has a velocity dependence $v_s = n\kappa/(2\pi r)$ as a function of distance r from the core. Here n is the quantum number and $\kappa = h/(2m_3)$ the quantum of superfluid circulation in a Fermion system like superfluid ^{3}He, where the current is carried by a Cooper pair with the mass of two ^{3}He atoms. In the experiment superfluid ^{3}He-A is contained in a cylinder with a radius R = 2 mm. When the container is rotated, energetically the most favourable state is one with rectilinear vortex lines, which allows the superfluid to mimic solid-body rotation with a flow velocity $\langle v_s \rangle = v_n = \Omega r$ (averaged over a length scale larger than the inter-vortex distance). This state is reached when each new vortex is formed after an increment $\Delta\Omega = n\kappa/(2\pi R^2)$ in rotation velocity. The measured signal from this process is periodic as a function of the externally applied rotation velocity Ω and is shown in Fig. 1. The periodicity $\Delta\Omega_m$ directly fixes n = 2.

In ^{3}He-A the existence of the double-quantum vortex structure is conditioned by the properties of the anisotropic order-parameter field and thus by the structure of the defect itself. The doubly quantized vortex is in many situations also energetically the most favourable vortex structure in ^{3}He-A, since the magnitude of the order parameter remains constant throughout the vortex core while only its orientation changes.

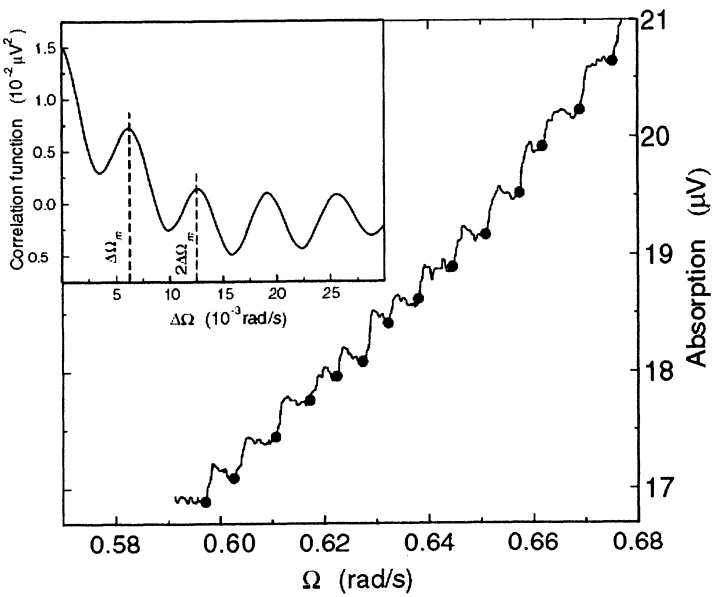

Fig. 1. NMR absorption amplitude $A(\Omega)$ of the satellite peak from doubly quantized vortex lines, as a function of the applied rotation velocity Ω. The height of the satellite peak increases in increments of $\Delta\Omega_m$ on increasing the drive Ω. The signal displays long-range periodicity in $\Delta\Omega_m$ which is shown in the inset by the correlation function $F(\Delta\Omega)$ as a func-

tion of $\Delta\Omega$. It consists of a series of equally spaced peaks, where the correlation of the signal amplitude, $\langle A(\Omega-\Delta\Omega)\cdot A(\Omega)\rangle$, is maximized and whose heights are not getting smaller at increasing harmonics of $\Delta\Omega_m$. [From R. Blaauwgeers et al., Nature vol. 403 (2000)]

Dynamic response: the fastest state in rotating ^{3}He -A

The dynamic response of ^{3}He-A is also strongly affected by the order-parameter structure. When the rotation velocity is rapidly changed, vortex lines are eventually replaced by a vortex sheet. The equilibrium state of the vortex sheet is one where a single continuous sheet parallel to the rotation axis is folded in equidistant meanders. At both ends the sheet is connected along two lines to the cylinder wall. It is through these connection lines that superfluid circulation in single-quantum units is able to enter and leave the sheet. Once a piece of sheet has been formed, it will remain in the container as long as the rotation velocity remains finite. This is because of the connection lines which reduce the critical velocity much below that of isolated vortex lines.

For several years it has been a major puzzle why in rapid changes of Ω the vortex sheet seems to be formed. New measurements combined with numerical calculations now prove that by increasing the number of the connection lines of the sheet with the cylinder wall, dynamic response is dramatically enhanced and the kinetic energy of the hydrodynamic flow reduced. Such configurations of the vortex sheet displace both vortex lines and the equilibrium vortex sheet during rapid changes of Ω. An example of the sheet structure with multiple wall connections is shown in Fig. 2.

The maximum possible number of wall connections corresponds to a configuration where the separation between wall connections is the same as that between the sheets. The distance between layers, in turn, is fixed by the rotation velocity and is proportional to $\Omega^{-2/3}$. Thus by increasing the number of wall connections and by splitting the sheet into more pieces, the interchange of circulation with the container wall is much enhanced and a state with the fastest dynamic response in all of the ^{3}He superfluids is obtained. Compared to the number of wall connections, the exact folding configuration of the different pieces appears to be a less crucial property.

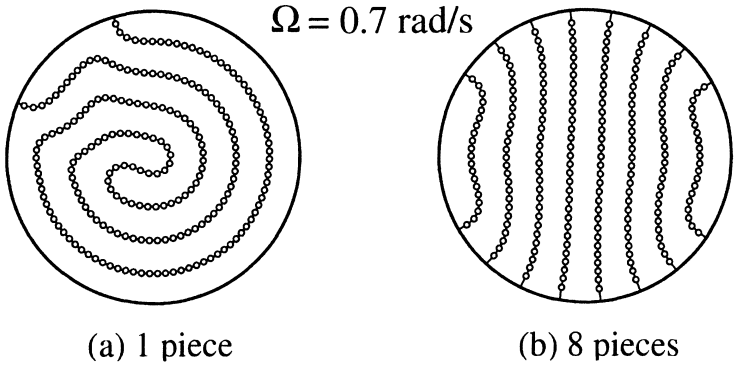

Fig. 2. The vortex sheet in the rotating cylindrical container: (a) equilibrium state and (b) with multiple wall connections. The sheet itself is a planar structure consisting of a domain-wall-like defect, which separates two degenerate order-parameter textures on either side of the sheet, and of linear quantized vorticity which is incorporated inside the sheet parallel to the rotation axis and distributed in a continuous fashion along the sheet. Each of the little circles marks the location of the centre for a 2π circulation quantum.

INTERFACES IN QUANTUM SYSTEMS

H. Alles, A. Babkin, J. Heiskala, J. Härme, R. Jochemsen (Leiden), J. Lönnroth, A. Parshin (Kapitza), V. Tsepelin

The superfluid/solid interface of helium existing at low temperatures is a model system which allows observations which are difficult to accomplish in ordinary crystals. For instance, while ordinary crystals are usually found to be in a metastable state, the relaxation of ^{4}He crystals into the true thermodynamical equilibrium shape takes place within milliseconds below 0.5 K. This ultra fast relaxation is due to the good thermal conductivity of superfluid ^{4}He and the small latent heat of fusion of crystalline ^{4}He. Moreover, periodic, dissipationless melting-freezing waves (crystallization waves), a phenomenon non-existing in ordinary crystals, have been discovered in ^{4}He. During recent years the Interface group has carried out extensive, mainly optical studies on ^{4}He crystals concentrating on the equilibrium shape and growth mechanisms of the crystals.

The lighter isotope of helium, ^{3}He, has much higher latent heat of crystallization and its superfluid has a much lower thermal conductivity when compared with ^{4}He at relatively high temperatures. However, at ultra low temperatures, well below 1 mK one can expect that the behaviour of the superfluid/solid interface of ^{3}He is becoming similar to that of ^{4}He. In addi-

tion, due to the nuclear spin and fermonic nature of ^{3}He external magnetic field is expexted to affect the dynamics of the superfluid/solid interface of ^{3}He.

The interferometric investigations of *bcc*-^{3}He crystals require path interferometry. For optical studies of the superfluid/solid interface of ^{3}He we have built a Fabry-Pérot multiple-beam interferometer into our nuclear demagnetization cryostat. A He-Ne laser is used for imaging and the interferograms are recorded by a remote cooled CCD sensor inside the cryostat yielding a horizontal and vertical resolution of 15 μm and 5 μm, respectively. In our novel setup also phase shift techniques can be applied. As a result, the real shape of the crystal can be determined on the basis of measured 3D phase information. The precision achieved by our optical setup is therefore by far superior compared with other optical observations on ^{3}He crystals at ultra low temperatures.

In our first experiments with ^{3}He crystals we were able to reach temperatures down to about 0.5 mK. Nucleation of the solid phase initiated by high voltage was explored. The growth kinetics of the superfluid/solid interface of ^{3}He was studied by combining optical and high precision pressure measurements. The effective growth coefficient obtained in our preliminary measurements is consistent with data of other research groups.

As a next step we are planning to study the morphology and the anisotropy of the growth kinetics of ^{3}He crystals. We also aim for even lower temperatures in our future experiments. As the measurements with the present optical cell are going on, the construction of a new optical cell, enabling to apply a magnetic field on the sample, is well on the way.

THEORY OF SUPERFLUID ^{3}He

R. Hänninen, N. Kopnin (Landau), N. Kovalainen, J. Kopu, E. Sonin (Jerusalem), **E. Thuneberg**, J. Viljas, **G. Volovik**

The majority of theoretical work in the LTL is closely connected to the experimental effort in the laboratory. Only a few of the ongoing theoretical projects are listed below.

The most efficient observation method in superfluid ^{3}He is NMR. The theoretical analysis of the NMR spectrum in the B phase consists of two steps. The first is to calculate the texture of the order parameter. The second is to add additional line broadening effects. Previous studies have neglected the second step. We have now completed calculations where we add the broadening due to Leggett-Takagi relaxation and the inhomogeneity of the magnetic field. This seems to account for the observations in the case of large counterflow velocity.

The superfluidity of ^{3}He in very porous aerogel is now studied experimentally at several laboratories. We have studied theoretically how the aerogel affects the superfluid properties of ^{3}He using quasiclassical scattering theory. We have developed the isotropic inhomogeneous scattering model (IISM). Previous calculation of the pairing amplitude shows

that this model is superior to the earlier used model of homogeneous scattering. We have now applied the IISM to calculate the superfluid density in the B phase and the pairing amplitude in the A phase. The calculated suppression of the superfluid density is similar as for the pairing amplitude. The IISM is the simplest model of inhomogeneous scattering. It can account well for the large suppression seen in aerogel, but it fails in details where the different length scales of aerogel become important.

The Josephson coupling between two reservoirs of superfluid ^{3}He was recently studied in the University of California at Berkeley and a new type of current-phase relation at low temperatures, so-called "π-state", was found. Besides our previous Ginzburg-Landau model, we have studied this new state with a tunnel-junction model. The tunneling model allows simple analytic demonstration of the origin of the π-state, and gives current-phase relations that are very similar to the measured ones. Moreover, we have studied the π-state using a pinhole model.

The quasi-stationary state of superfluids was suggested to simulate the black hole physics in superfluids. Event horizon and Hawking radiation can be realized in a thin ^{3}He-A film moving with the supercritical velocity on the top of a ^{4}He film. The superflow of the ^{3}He-A film produces an effective "gravitational" field for ^{3}He-A quasiparticles. The effective metric of the curved space in which quasiparticles move is the so called Painlevé-Gulstrand metric describing the black hole in general relativity. The Hawking radiation related with the existence of the event horizon is responsible for the quantum friction, experienced by the supercritically moving liquid. The Hawking flux from the black hole can be verified by measuring the dissipation of the superflow.

Similar quantum friction will be experienced by a solid body rotating in a superfluid at $T = 0$. This effect is analogous to the amplification of electromagnetic radiation and spontaneous emission by the body or black hole rotating in quantum vacuum, first discussed by Zel'dovich and Starobinsky. The rotational quantum friction is caused by the interaction of the part of the liquid, which is rigidly connected with the rotating body. It represents the comoving detector, with the "Minkowski" vacuum outside the body. The emission process is the quantum tunneling of quasiparticles from the detector to the ergoregion, where the energy of quasiparticles is negative in the rotating frame. The quantum rotational friction caused by the emission of quasiparticles is estimated for phonons and rotons in superfluid ^{4}He and for Bogoliubov fermions in superfluid ^{3}He. Superfluids and Bose-condensates in laser manipulated Bose gases appear to be useful systems for experimental and theoretical simulations of quantum effects related to event horizons and ergoregions.

There is a growing evidence that the layered superconductor Sr_2RuO_4 has a chiral p-wave order parameter similar to that in ^{3}He-A. Several phenomena have been discussed for such superconductors with broken time reversal symmetry:

The energy levels of the electrons bound to the vortex core in chiral superconductors were considered. It was found that in general there are two classes of chiral superconductivity. In the superconducting state of class I the axisymmetric singly quantized vortex has the same energy spectrum of bound states as the de Gennes levels in s-wave superconductor: $E = (n+1/2)\omega_0$ with integral n. In the class II the corresponding spectrum is $E = n\omega_0$ and the vortex contains a bound state with exactly zero energy. Vortices with exactly zero-energy state must have unusual properties, since the electron on this level behaves as Majorana fermion. In particular since the zero-energy level can be either filled or empty, there is a fractional entropy $(^1/_2)\, k_B \ln 2$ per layer related to the vortex. The effect of a single impurity on the spectrum of bound state was also considered. For the class I the spectrum acquires the double period $\Delta E = 2\omega_0$ and consists of two equidistant sets of levels. In contrast the Majorana fermions on vortices in the class II superconducting states are not influenced by a single impurity.

It has been shown that a twisted wire loop made out of a chiral superconductor can trap fractional flux. For example, the chiral p-wave superconductor in a tetragonal crystal will trap about 1/4 of flux quantum $\Phi_0 = hc/2e$, while the flux of $\Phi_0/6$ will be trapped if the underlying crystal lattice has hexagonal symmetry.

CERN – COLLABORATIONS

SMC

P. Berglund

LTL's participation in SMC (Spin-Muon Collaboration) was initiated in 1989. Our resposibility was to build a dilution refrigerator for cooling the polarized target. The target, largest in the world, was in operation from spring 1993 to autumn 1996. The performance of the dilution refrigerator was excellent (the lowest temperature obtained in the mixing chamber containing the target has been around 22 mK) and it made very successful series of runs possible until the end of the experiment in October 1996. The measurements provided an abundance of data; analysis and publications of results continued to the end of 1998. SMC produced about 20 scientific papers, many with remarkably high citation indexes.

COMPASS

P. Berglund and J. Koivuniemi

The SMC dilution refrigerator is now modified for a new experiment, COMPASS (Common Muon and Proton Apparatus for Structure and Spectroscopy), on the spin of a po-

larized nucleon. LTL is involved in the modification of the refrigerator and the microwave cavity. The main goal of the muon programme is to measure the gluon contribution $\Delta G/G$ to the spin. This experiment requires a large acceptance of 180 mrad for the polarized target and a minimum amount of extra material around the target. The target material is ^{6}LiD.

RD-39

P. Berglund

The superconducting microstrip detector project changed its programme considerably during 1998 and its main activities continued at CERN with new collaborators. Some evidence of efficiency recovery had been found for charge collection in heavily irradiated silicon detectors operated at cryogenic temperatures. This feature could prove extremely useful for the LHC in radiation intensive particle collision experiments. Some of the cryogenic instruments and refrigerating equipment built in the first phase of the RD-39 project have been modified for experiments with the silicon detector.

NEUROMAGNETIC RESEARCH

BRAIN RESEARCH UNIT

Senior members: N. Forss, **R. Hari,** P. Helenius, M. Hämäläinen, V. Jousmäki, S. Levänen, O.V. Lounasmaa, J.P. Mäkelä, S. Salenius, R. Salmelin, C. Tesche, and S. Vanni

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Neuro-BIRCH visitors: F. Alary (Toulouse), J. Aspell (Newcastle upon Tyne), A. Bailey (MRC-P), S. Baker (London), S. Braeutigam (Milton Keynes), D. Bramwell (Newcastle upon Tyne), P. Brown (London), L. Christensen (Copenhagen), P. Cornelissen (Newcastle upon Tyne), L. Craighero (Parma), G. Curio (Berlin), L. Fadiga (Parma), E. Gomez-Utero (Madrid), G. Green (Newcastle upon Tyne), J. Gross (Düsseldorf), A. Jackson (London), J. Kilner (London), R. Lavis (Newcastle upon Tyne), R. Lemon (London), N. Loveless (Dundee), B. Lutkenhoner (Münster), J. Marsden (London), M. Mertens (Münster), L. Narici (Rome), J. Nielsen (Copenhagen), G. Nolte (Berlin), G. Ogliastro (Genoa), R. Pineiro (Oxford), M. Schürmann (Lübeck), U, Shahani (Glasgow), J. Stins (Milton Keynes), S. Swithenby (Milton Keynes), and S. Wallace (London)

Functions of the human cerebral cortex have been studied by measuring magnetic fields outside the head. The magnetoencephalographic (MEG) method allows totally non-invasive studies of healthy and diseased human brains during different tasks and conditions.

Our new 306-channel neuromagnetometer (Vectorview™, Neuromag Ltd), houses 204 gradiometers and 102 magnetometers with a whole-scalp coverage. To combine functional and structural information, we typically integrate MEG data with the subject's magnetic resonance images (MRIs). Since 1994, an important part of the research has been done in collaboration with European scientists visiting the laboratory under the auspices of the Neuro-BIRCH (Biomagnetic Research Center in Helsinki) Large-Scale Facility, financed by the European Union. In April 2000, the third funding period of the Large-Scale Facility (Neuro-BIRCH III) started and will continue another three years.

Cortex-muscle interaction

S. Avikainen, S. Baker (Sobell, London), P. Brown (MRC-N, London), N. Forss, **R. Hari**, P. Kettunen, J. Kilner (Sobell, London), M. Lehecka, R. Lemon (Sobell, London), J. Marsden (MRC-N, London), N. Murayama (Kumamoto), M. Pohja, **S. Salenius** and T. Silén.

We have previously found that rhythmic ~ 20-Hz activity, generated in the primary motor cortex, is coherent with motor unit firing of isometrically contracting muscle. These results have been extended to the 'Piper rhythm', at about 40 Hz in frequency and observed in several muscles during strong contraction. The delays between cortex and different muscles agree with the corresponding cortex-muscle conduction times. Both 20- and 40-Hz cortical rhythms thus seem to drive motor unit firing in contracting muscles.

We have also demonstrated that 10-Hz MEG-EMG coherence may occasionally be observed during isometric contraction, but that the cortex-muscle delays corresponding to this frequency range are more variable, probably reflecting an interaction between efferent and afferent activity. In a hold-ramp-hold precision grip task we showed that the strength of 15–30 Hz cortex-muscle coherence depends on the preceding movement.

We have extended our cortex-muscle interaction studies to Parkinsonian patients. The cardinal symptoms of Parkinson's disease (rigidity, slowness of movement and tremor) are believed to be caused by progressive degeneration of dopaminergic neurons, resulting in overactivity in basal ganglia output and in secondary underactivity of thalamic projections to motor cortices. We found in untreated Parkinsonian patients less coherence in both the 15–30 Hz and the 35–60 Hz band than in healthy subjects. The coherence increased significantly after treatment with levodopa. We thus propose that the basal ganglia support the synchronisation of cortical activity and the corresponding rhythmic muscle discharges.

In a recent comparison between EEG and MEG recordings we found rather similar cortex-muscle coherence at about 15-30 Hz. Phase-spectra and measures of synchronisation revealed a systematic delay between the cortical and muscular signals in both recordings; the delay was 15 ms longer for foot than hand muscle contractions. The MEG-EMG coherence and synchronisation were of similar strength as the bipolar EEG-EMG coherence but clearly

stronger than the unipolar EEG-EMG coherence. Partial coherence analysis revealed that the MEG-EMG coherence could not be completely explained by the EEG-EMG coherence and vice versa. Thus both EEG and MEG recordings reveal a functional coupling between cortical and muscular rhythmic activity during isometric muscle contraction; however, they reflect partly independent sources of coherent cortical activity.

We have demonstrated in healthy subjects that tactile stimulation influences motor cortical rhythmic activity and significantly modulates the rhythmicity of corticospinal motor commands. Coherence of MEG with EMG activity from hand muscle (interosseus) is reduced by stimulation of the palm of the same hand. Stimulation of smaller skin areas in the same hand also often reduces coherence. Stimulation of the palm of the other hand induced significant, and sometimes even dramatic changes in most subjects; however, the changes were inconsistent and not significant at the group level. The effect of tactile input on the MEG-EMG coherence thus seems to depend both on the stimulated area and the side of stimulation.

We have also examined cortex-muscle coherence in a previously healthy male who suffered a lacunar infarct in the right superior cerebellar artery territory. Clinical symptoms included clumsiness and ataxia of the right hand, objectively notable only during the first measurement, 9 days after the stroke. Muscle forces of the hands were symmetric on clinical examination. In the first measurement no MEG-EMG coherence was found for the right (affected) hand whereas left hand muscles displayed MEG-EMG coherence in the normal frequency range. During the second and third measurements, 1 and 4 months after the stroke the MEG-EMG coherence was found for both hands. However, coherence was 20 to 60% weaker for the right than left hand, and the left hand coherence was about 50% stronger than during the first measurement. MEG measured over the left sensorimotor area showed a weaker 15–30 Hz but stronger 10-Hz activity in the acute phase than during the recovery. These results suggest that disruption of cerebellar function affects rhythmic activity of the sensorimotor cortex and decreases the normal rhythmicity of corticospinal motor commands, especially for muscles ipsilateral to the cerebellar lesion.

In patients with progressive myoclonus epilepsy (ULD-type PME), the cortex-muscle coherence was more than double compared with the controls. Whereas the coherence was strictly contralateral in controls, 5 out of 8 patients showed coherent activity also in the ipsilateral motor cortex. The results suggest decreased inhibition in the motor cortex of PME patients. This hypothesis is also supported by the different reactivity of the patients' 20-Hz mu rhythm to median nerve stimuli: in healthy controls the stimuli are followed within 500 ms with increased levels, "rebounds" of the 20-Hz activity, whereas the PME patients lack the rebounds.

Action viewing

S. Avikainen, **R. Hari, S. Levänen, N. Nishitani** (Kyoto), S. Salenius, and K. Uutela

As social creatures, we humans spend a considerable part of our waking time in predicting the intentions and feelings of our cocitizens. This largely unconscious cerebral computing is based on sensory cues derived from other persons' behavior, gestures, and vocalizations. The reading of other persons' intentions, often called 'theory of mind', seems to be a continuum, with autism as the most dramatic example of a total lack of the mindreading skill.

The monkey brain has been shown to contain an observation/execution matching system which may play an important role in action understanding and imitation: 'mirror neurons' of the premotor cortex discharge both when the monkey performs hand actions and when it observes another individual to make similar actions. We have earlier demonstrated that rhythmic 20-Hz activity is significantly suppressed both when the subject moved her fingers and also when she just viewed another subject to perform finger movements; these results demonstrated the involvement of the action observation/execution system in humans and involvement of the primary motor cortex in it.

To further clarify the existence and properties of the action observation/execution matching system in humans, we recorded MEG signals when the subject made hand movements herself, and when she observed or imitated similar actions made by the experimenter. In addition to occipital and central areas, the left inferior frontal (posterior Broca) area was also activated during action execution, imitation and observation. The important aspect of the data, obtainable only by MEG records, was the consistent temporal activation sequence of the brain areas: The Broca's region was always activated first, followed by activation of the left motor cortex. Furthermore, online imitation strongly increased activity in the Broca's region and in the left motor cortex, with no clear change in the right motor cortex. The results show that common structures and functional mechanisms in the fronto-central areas are involved in action observation/execution matching and that Broca's region acts as an orchestrator of this system.

In an ongoing study, subjects are viewing pictures of face expressions and are asked to imitate them. We have also started to run the same experiments on subjects with Asberger syndrome, a mild autistic disorder. As autistic subjects are deficient in their imitation skills, we hypothetized that they might have abnormalities in their action observation/execution system.

Basic functions of the sensory systems

F. Alary (Toulouse), S. Avikainen, G. Curio (Berlin), **N. Forss**, N. Fujiki (Kyoto), L. Gootjes (Amsterdam), D. Hamdorf, **R. Hari**, **P. Helenius**, V. Hero, M. Hämäläinen, M. Illman, **V. Jousmäki**, H. Koivikko, R. Laiho, S. Lamminmäki, **S. Levänen**, L. Narici (Rome), J. Numminen, T. Raij, K. Saarelma, **S. Salenius**, **R. Salmelin**, M. Schürmann (Lübeck), T. Silen, C. Simões, L. Stenbacka, T. Tanskanen, and **S. Vanni**

Auditory system

Developmental dyslexia is often associated with problems in phonological processing based on or accompanied by deficits in perception of rapid auditory changes. We have previously shown that dyslexics perceive a directional hearing illusion in an abnormal manner and they are also impaired in perceiving pitch streaming. However, we have not found any evidence for impaired phase-locking of neuronal firing in dyslexics. We are running MEG experiments on adult dyslexics who listen to tone pairs, noise-square-wave combinations, and monotonous sequences of tones with infrequent frequency changes. The preliminary analysis suggests that whereas responses to the first parts of tone pairs and other sound combinations are similar in dyslexics and normal-reading subjects, the transients to the latter parts are diminished in dyslexics. Our present hypothesis is that this decrease reflects weakened triggering of automatic attention. This hypothesis is at present tested by e.g. quantifying in dyslexic adults the strength of automatic orienting reaction at spinal level after loud sounds.

Knowledge about language lateralization is of special value in evaluation of patients who are candidates for brain surgery (e.g. removal of an epileptic focus or a brain tumor from the temporal lobe). Since resection of brain regions that contribute to basic language skills is likely to result in language impairments, it is essential to determine preoperatively which hemisphere is dominant for language. We have thus aimed to develop a straightforward clinical test for language dominance and evidently been succesful in that task: We recorded auditory evoked fields from 11 healthy right-handed subjects to binaurally presented Finnish vowels, pure tones and piano sounds groups of 2 or 4 stimuli. The subjects were required to detect whether the first and the last item in a group were the same. In the left hemisphere of all subjects, vowels evoked significantly (37% to 79%) stronger responses than piano sounds and pure tones, whereas in the right hemisphere the responses to different stimuli did not differ significantly. Thus clear evidence was found for hemisphenic specificity for vowels.

In one recent study we found neuronal correlates in the transient auditory responses and in the sustained fields for the peculiar "octave illusion". This illusion is produced when the subject is presented with binaural stimuli (400 Hz to one ear and 800 Hz to the other, or vice

versa, with the lateralization changing a few times per second); the subject only perceives single tones alternating between the ears.

We have started to study binaural interaction at the auditory cortex by presenting continuous tones simultaneously to both ears but modulating their amplitudes at different frequencies to follow this frequency-tagged processing from each ear to each hemisphere.

Sensorimotor system

We have earlier reported that isometric contraction of the thenar muscles of the hand significantly enhances activation of contra- and ipsilateral SII cortices, possibly reflecting specificity of SII neurons towards relevant tactile input arising from the region of the body where the muscle activation occurs. To further investigate sensorimotor integration at SII, we explored the effect of submaximal isometric contraction from different body parts on somatosensory responses to left median nerve stimulation. Short-latency responses from the primary somatosensory cortex did not change during contraction. Responses from the right and left SII cortices were significantly enhanced during contraction of the left thenar muscles. Responses from the left SII were significantly enhanced also during contraction of the left deltoid muscles but suppressed during contraction of the masseter and left tibialis anterior muscles. The results confirmed that SII activation is modulated by motor activity and they further showed that the effect depends on the topographical proximity of the stimulated and contracted body parts.

We continued our studies of somatosensory cortical network by recording median nerve somatosensory evoked fields in stroke patients suffering from an ischemic cortical lesion in the right parietal lobe. Strength of the 20-ms response that originates in the SI cortex reflected roughly the severity of the tactile impairment. In addition, activation pattern of the healthy hemisphere was also altered, suggesting dimished interhemispheric inhibition via callosal connections after unilateral stroke. Responses of the affected hemisphere showed large interindividual variability due to different extents of the lesions. Right SII responses were absent in patients with abnormal right SI responses, whereas the left SII was active in all patients, regardless of responsiveness of the right SI and/or SII. Thus the human SI and SII cortices may be sequentially activated within one hemisphere, whereas SII ipsilateral to the stimulation may receive direct input from periphery, at least when normal input from SI is interrupted.

We have also started to investigate how activation of the sensorimotor cortex is modified in patients suffering from cortical myoclonus. We recorded SEFs and muscle-cortex coherence from 8 genetically verified Unverricht-Lundborg type (ULD) progressive myoclonus epilepsy patients (PME). The preliminary results show that activation of the somatosensory cortical network beyond the SI is clearly altered in cortical myoclonus; in five patients activation of the ipsilateral SI cortex was observed, whereas SII responses, normally observed in

all healthy subjects, were absent. The results suggest decreased inhibition in the somatosensory cortex of PME patients.

One ongoing study compares transient vs. sustained fields at the SI and SII cortices to stimulus trains of different repetition rates to learn about neuronal processing differences at these two cortical areas. We have also started to study effects of passive movements on the cortical somatosensoy network.

Vision-related brain activation and neural basis of visual perception

We have studied activation of the right-hemisphere frontal eye field and posterior parietal cortex when the subject's attention is systematically varied towards a peripheral luminance stimulus. Some individuals showed selectively strongest responses during attention in the inferior parietal lobule after 180 ms while others had frontal eye field activation before 160 ms. This apparently confusing result agrees with earlier patient data suggesting that different individuals may use different areas for coding both eye movements and attention shifting. We also observed that it is the visual attention *per se*, and not the focus of attention which is important for activation of the right frontal eye field.

Visual stimuli are known to activate primary visual cortex, V1, before other cortical areas. Earlier studies with monkeys have suggested rapid activation of the dorsal visual stream areas after V1. By using L1 minimum-current estimates, we found activation of precuneus region almost immeduiately after the V1 activation. This activation showed no clear retinotopic organization, suggesting that it may reflect combination of information across the whole visual field.

In a simulation several partly overlapping sources were placed into various visual cortices. We found that the L1 minimum-current estimate can reliably differentiate simultaneous activity when the sources are about 3 cm apart or when they do not fully overlap in time. We have also used the L1 estimate to form group averages of MEG data.

In collaboration with Department of Physiology, University of Helsinki and Brain Work Laboratory, Institute of Occupational Health, we are following patients who are rehabilitated after cortical blindness causing hemianopia. The results show individual differences in line with earlier suggestions: One patient used the remaining V1 cortex with delayed response, whereas another showed no cortical responses in the blind hemifield despite conscious detection.

In a neuropsychological study, visual working memory was found to be significantly impaired after unilateral cataract operation in otherwise healthy adults; the tests were made before, 1 week and 1 month after the operation. One possible causal reason is the increased load for the visual memory when the longtime underused vision is again bringing strong input to the brain.

In a recent study, designed to test temporal processing deficits in dyslexic adults, we observed that a visual target stimulus captures attention for 30% longer time in dyslexics than in control subjects. Thus it takes longer for dyslexics than normal readers to disengage their attention from the previous target to redirect it towards a new one. Such slowness could contribute to the observed sluggish temporal processing of sensory stimuli in dyslexics. Because similar but much stronger prolongation of the attentional dwell time is seen in patients who have left-sided neglect (ignorance of the left visual field) as the result of a damage to the right posterior parietal lobe, we as the next step asked whether the dyslexic subjects might suffer from a similar but milder "minineglect".

To test this hypothesis we studied dyslexic adults and control subjects in two visual attention tasks (judgement of temporal order between stimuli presented to the left and right visual hemifields and a line motion illusion task). The results showed that dyslexics process more slowly information from the left than the right visual hemifield and that their stimulus-triggered attentional shifts are sluggish in both visual hemifields. These results agree with the proposed left-sided minineglect, which is considerably milder but otherwise similar to that seen after right-hemisphere lesions.

Our data suggest that dyslexic adults suffer from several small deficits of attention: weakened attentional capture, prolonged attentional dwell time, and sluggish attentional shifting. These deficits, now quantified for the first time, could provide the missing pathophysiological link between two disorders observed in dyslexic subjects in several previous studies: the magnocellular deficit and the decreased processing speed of stimulus sequences. The resulting temporal processing deficits, themselves, may play an important role in the genesis of the reading disorder, although this connection is still inconclusive.

Multisensory interactions

To characterize the cortical mechanisms of audiovisual integration of letters of the alphabet, subjects have been presented with a series of auditory, visual, and audiovisual letters and control stimuli, and required to react to a target letter regardless of the stimulus modality. The results is that the left posterior superior temporal sulcus is involved in audiovisual integration of letters, and may be important for the learned connection between the visual and auditory patterns.

In an ongoing study were are identifying cortical areas and their activation sequences when musically trained subjects are presented with visual note scripts and are asked to immediately form the corresponding musical pitch in their minds. We expect automatic activation of specifically auditory areas by presentation of visual stimuli only because of the learned strong connection between the notes and the pitches.

Development of clinical applications of MEG

N. Forss, R. Hari, M. Hämäläinen, M. Illman, E. Kirveskari, **S. Salenius, R. Salmelin,** and M. Seppä

A 'CliniMEG' team was assembled in 1997 to develop clinical applications of MEG for routine use in collaboration with the Department of Clinical Neurosciences at the Helsinki University Central Hospital. The focus has been on preoperative evaluation of patients with brain tumors and epilepsy. We have developed routine methods to provide the neurosurgeon with 3-dimensional visualization of the functional anatomy of the rolandic cortex, to facilitate tumor resection without damaging functionally irretrievable areas in the somatomotor strip. The central sulcus has been identified by functional and morphological criteria; the functional landmarks were based on somatosensory responses to hand, foot, and occasionally also to lip stimulation, and motor cortex identification on cortex-muscle coherence. The functional locations are displayed on 3-D reconstructions of the individual brains, with the blood vessels, derived from MR angiography, shown on the exposed brain surface; this was achieved with software developed at the LTL specifically for this purpose.

In 1999 CliniMEG continued to study patients with brain tumors and epilepsy for presurgical purposes; the hospital and the patients have not been charged for the examinations. During surgery, the preoperative localizations have been confirmed with cortical stimulations and recordings, and at least one member of the CliniMEG team has been present in the operation room. The preoperative visualization of the functional anatomy has greatly facilitated navigation during the neurosurgical operation.

Methodological development

P. Berglund, S. Hakala, **R. Hari, M. Hämäläinen**, J. Heiskala, **V. Jousmäki**, M. Kajola, J. Kujala, L. Parkkonen, **R. Salmelin**, M. Seppä, A. Tarkiainen, S. Taulu, K. Uutela, and R. Vigario (HUT)

Our activities consist of improving the hardware for neuromagnetic measurements and development of new acquisition and analysis software. In collaboration with VTT Automation we have studied the noise performace of the new magnetically shielded room and adjusted the active noise compensation system to reject the external disturbances more effectively. The Vectorview MEG system has been maintained in close collaboration with Neuromag Ltd.

The accuracy of source localization has been improved by implementing calibration software which can measure both the cross-talk between the channels and the individual calibration coefficients. It was found that taking into account the cross-talk matrix in the

analysis improves the signal-to-noise ratio on the planar gradiometer channels considerably. However, the effect of cross talk was only minor factor in the localization of current sources.

The acquisition system has been made more robust and sampling rates up to 3 kHz can be now employed. A new head-position indicator system with phase-locked detection of marker-coil signals was implemented and the associated fitting procedure was improved. The new detection scheme potentially allows for quick acquisition of the current head position information during the measurement. Data compression algorithms suitable for MEG studies were also studied and a new compression program was implemented.

In source analysis, the software for calculating minimum-norm estimates was improved and it has been used as an alternative for the traditional dipole modelling methods in several studies. The standard source modelling program was enchanced for EEG modelling and smooth analysis of Vectorview data. A collaborative project with the Heinrich-Heine University in Düsseldorf was started to analyze signal coherence estimates between virtual channels represented in the source space instead of among the actually measured data directly.

The software for the Brain Atlas project was completed and first MEG data were entered into the database. As an indirect result of the project we have now software to apply deformations to individual MR images to match them with a standard anatomical brain. These programs can be employed to bring source modelling data from different subjects into a common frame of reference.

The visualization capabilities are being extended using object-oriented approaches combined with voxel-based renderings. For this purpose, we are using OpenGL-based graphics hardware with texture mapping capabilities. With stereoscopic displays, a very realistic views of the anatomy combined with the MEG data can be redered. A special versatile interpreter program was written for prototyping. This tool can be also employed in the development of user applications and is thus essential in our future visualization research.

A collaborative project with the Neural Networks Research Institute, Helsinki University of Technology, was continued. Independent Component Analysis (ICA), a novel statistical method whose major application is in signal separation, was tested further to extract independent components from MEG signals. In the future, ICA tool can be used to separate various signals, such as artifacts and various brain activations, in MEG recordings.

Language perception and production – function and dysfunction

J. Connolly (Halifax), P. Cornelissen (Newcastle upon Tyne), **P. Helenius,** K. Kiviniemi, M. Laine (Turku), **O.V. Lounasmaa**, H. Lyytinen (Jyväskylä), **R. Salmelin**, A. Schnitzler (Düsseldorf), E. Service (Helsinki), A. Tarkiainen, and **M. Vihla**

We have extended our studies of reading comprehension in fluent and dyslexic readers to speech comprehension. Auditory perception is a highly relevant aspect of research on dyslexia, as a deficit in phonological processing is commonly viewed as the main cause underlying the manifest difficulties in reading. We used the same 400 Finnish sentences which had been previously employed in the reading experiments. The sentence-ending word was either the expected one, unexpected but semantically correct, totally anomalous, or semantically inappropriate but misleadingly sharing its initial phonemes with the expected word. The condition-dependent variation of the MEG response revealed cortical areas and time windows involved in comprehension. The superior temporal cortex, in the immediate vicinity of the auditory cortex, was most consistently involved in both reading and speech comprehension from 200 to 600 ms after word onset. Whereas this process was left-hemisphere lateralized for reading, speech comprehension showed a more bilateral pattern of activation. Remarkably, the timing of the N100m response did not differ between the subject groups but the onset of speech comprehension was slightly delayed in the dyslexic subjects as compared with normal controls. This dissociation points to a deficit at 100-200 ms after word onset in dyslexic subjects, possibly reflecting impaired phonological analysis.

We have examined cortical correlates of training in three anomic subjects, as a model of brain processes in language rehabilitation. The subjects had extensive left-hemisphere lesions. They were trained to name 50 pictured objects which they were initially unable to name, but of which they had semantic knowledge. The subjects were also tested on hard-to-name untrained items and easy-to-name items. Behavioural and MEG experiments were performed twice before and twice after the 3-week training interval. Behaviourally, all subjects showed long-term item-specific learning which did not generalize to the hard untrained items. At the cortical level, training effects, starting 400-500 ms after picture presentation, concentrated in the region of the supramarginal gyrus, adjacent to the lesioned brain structures. Earlier brain imaging studies have suggested a role in phonological encoding for this region.

Some brain-damaged individuals have a specific disorder in naming objects but not actions, or vice versa, which suggests existence of partly distinct networks for accessing nouns and verbs. To investigate processing of different classes of words, we chose a novel approach where we created a single set of figures from which one can name either an object or an action. These pictures were tested on 10 normal subjects and on one aphasic subject

with a deficit in object naming, using both MEG and behavioural measures. Intriguingly, the subjects were on average 30 ms faster in naming actions than objects, when the instructions to name one or the other were randomized across trials. This effect may reflect the way linguistic expressions are accessed in normal contextual language production. In the MEG recording, the 20-Hz activity of the left motor cortex showed a stronger or earlier post-stimulus rebound for action than object naming. Task-dependent differences in evoked responses were also found predominantly in the left hemisphere, in the perisylvian language areas.

A collaborative project with the Neural Networks Research Institute, Helsinki University of Technology, was continued. Independent Component Analysis (ICA), a novel statistical method whose major application is in signal separation, was tested further to extract independent components from MEG signals. In the future, ICA tool can be used to separate various signals, such as artifacts and various brain activations, in MEG recordings.

MEG investigation of working memory

C. Tesche and J. Karhu

Working memory (WM) is the ability to maintain information "on-line" for the performance of a cognitive task. WM requires both maintenance of information in short-term memory and optimal allocation of attentional resources. We utilized the whole-scalp MEG array to study the dynamics of neuronal population activity in several brain areas known to be active during WM tasks: prefrontal and cingulate cortex and hippocampal formation.

The anterior cingulate cortex, located on the medial surface of the frontal lobes, is believed to participate in executive functions, especially those involving the generation of movement. Hippocampus and the associated entorhinal and parahippocampal cortecies are also located deep within the brain, and are considered essential for normal memory function. We have shown previously that whole-scalp arrays are particularly useful for the investigation of activity in deep brain structures.

Our normal adult subjects were asked to memorize for a brief time a set of 1, 3, 5 or 7 integers. The retention of these items was tested by asking the subjects to respond to a "probe" integer with a lift of the finger. We derived waveforms from the data for left and right prefrontal cortex (BA 44), anterior cingulate (BA 24/32) and hippocampus. Waveforms were also determined simultaneously for areas in occipito-parietal cortex that were involved in the initial processing of the visual stimuli, and neuronal populations in motor cortex that were synchronized with the finger movements. We utilized the dynamics of these neuronal population responses to infer the function of the various brain areas.

We found a remarkably early 80-ms response in anterior cingulate following both the memory-set and probe stimuli. This activation suggests early involvement of cingulate in the top-down allocation of attentional resources for the processing of salient stimuli. Interest-

ingly, the cingulate was also active when the subject became aware that the task demand had changed from storing information in memory, to evaluation of a probe stimulus. This response is consistent with recent suggestions that cingulate may participate to the monitoring of conflicts in information processing. The first activation of hippocampal structures also occurred quite early, at 125-130 ms after presentation of probe stimuli. Activation of prefrontal cortex followed hippocampal responses by ~10 ms. The prefrontal responses were strongly enhanced following the probe stimuli, supporting the concept that prefrontal cortex is involved in the processing of the congruence between the memory set and probe stimuli, rather than in the processing of sensory input *per se*.

Ongoing theta activity in a VM task

O. Jensen and **C. Tesche**

Ongoing theta oscillations (5-8 Hz) have been found to be associated with memory in animals. These findings have inspired physiological models for human WM in which theta oscillations are involved in active maintenance and recall of STM representations. We investigated the role of ongoing theta activity in humans performing the WM task described above (the Sternberg task). We found that the activity in the theta band over the frontal midline increased parametrically with the number of items retained in WM during the 3 s retention interval. A time-frequency analysis revealed that the theta activity was present during the full 3 s retention interval. Our findings support the case that ongoing theta activity is involved in the maintenance of WM.

Visually evoked gamma activity during voluntar hyperventilation

O. Jensen, R. Hari and K. Kaila

Hyperventilation is known to have powerful effects on gross neuronal excitability. Interestingly, recent in vitro experiments on the rat hippocampus have shown that "respiratory alkalosis" leads to a GABAA receptor-dependent increase in the temporal stability of carbachol-induced gamma oscillations. To study whether hypocapnia alters gamma activity in a similar manner in the human brain, we recorded visually evoked gamma activity before, during, and after voluntary hyperventilation. Checkerboard patterns were continuously presented in the lower left and right visual field. Brain activity was recorded in response to the changing patterns before, during and after voluntary hyperventilation During the control period, the visual stimuli evoked phase-locked gamma activity (constrained to the 35-40 Hz band) over the occipital areas. A time-frequency analysis revealed that the onset of the gamma activity took place about 90 ms after the stimulus. During the subsequent period of hyperventilation, followed by normal breathing, the magnitude of the phase-locked gamma

activity increased. A large number of theoretical and experimental studies have demonstrated that the activity of GABAergic interneuronal networks is crucial for creating the synchrony underlying at least certain kinds of gamma oscillations. However, there is little information on the physiological mechanisms responsible for generating gamma activity in the visual system. A recent in vitro study on the rat hippocampus has demonstrated that hypocapnia, beyond increasing neuronal excitability, also enhances GABAA receptor-mediated inhibition. One possibility could be that the increase in gamma activity during hyperventilation is a consequence of increased neuronal synchrony resulting from enhanced GABAA inhibition rather than elevated neuronal excitability.

H. Yoshida and **C. Tesche**

Processing of auditory information in the human brain encompasses both extraction of features of individually presented stimuli and a cognitive analysis of information contained in the pattern of stimulus presentation. These processes may be occuring almost simultaneously in overlapping brain areas. In order to disentangle sensory perception from higher-order cognitive processing, we studied neuronal population responses generated during a silent period. We found localized slow activity in the right supratemporal plane (STP; a key region of acoustic discrimination) following the cessation of an established temporal pattern of acoustic stimulation. We hypothesize that the neural circuitry of cognitive function associated with auditory cortex is activated not only by information processing of auditory stimuli but also by internal time-keeping processes involved with the perception of periods of silence. The circuitry which processes the temporal pattern of sensory input supports the global activation in STP, where analytic processes for the acoustic stimuli are converted to cognitive processing with no loss of information conveyance.

TEACHING

COURSES AND OTHER TEACHING ACTIVITIES

Courses

Matti Krusius, *Graduate school in technical physics, Relativistic Astrophysics: Black Holes, White Dwarfs, and Neutron Stars*, (Tfy-44.174)

Juha Tuoriniemi, *Matalien lämpötilojen fysiikan menetelmät (Matter and Methods at Low Temperatures)* (Kyl 0.102)

Minna Vihla, *Anatomian ja fysiologian kurssi*, Logopedian laitos, Helsingin yliopisto

Pertti Hakonen, Mikko Paalanen, *Mittaustekniikan lisenssiaattiseminaari* (Kyl-0.106)

Teaching assistants

Samuli Hakala and Jan Kujala served as teaching assistants for *Bioelectric measurements* (Biosähköisiä mittauksia), a laboratory course in the Department of Engineering Physics and Mathematics (Tfy-99.219)

Leif Roschier served as a teaching assitant for *Matalien lämpötilojen fysiikan menetelmät* (Kyl 0.102)

Supervision of special projects

Matti Hämäläinen supervised Juha Heiskala's special project *Pallosymmetrisen johdemallin parametrien optimointi samanaikaisten MEG- ja EEG-mittausten perusteella.*

Docent Erkki Thuneberg supervised Risto Hänninen's special project *Kaikkien osa-aaltojen vaikutus epäpuhtaan ^{3}He:n supranesteen tiheyteen käyttäen homogeenisen sironnan mallia.*

Harry Alles supervised Juha Heiskala's special project *A vibrating wire thermometer for liquid ^{3}He.*

Harry Alles supervised Johnny-Stefan Lönnroth's special project *A new optical cell for studies on ^{3}He crystals.*

Simo Vanni supervised Linda Stenbacka's advanced studies for medical faculty *Analysis of simulated activity on visual cortex with dipole model and minimum current estimate.*

ACADEMIC DEGREES

Diploma theses

Reeta Tarkiainen graduated as M.Sc. Tech. from the Department of Engineering Physics and Mathematics on April 13. Her diploma thesis *Wetting phenomena and pinned vorticity in superfluid ^{4}He* was done in the LTL. Supervisor: Pertti Hakonen.

Risto Hänninen graduated as M.Sc. Tech. from the Department of Engineering Physics and Mathematics on June 8. His diploma thesis *Superfluid density of ^{3}He-B in aerogel using an inhomogeneous scattering model* was done in the LTL. Supervisor: Erkki Thuneberg.

Leif Roschier graduated as M.Sc. Tech. from the the Department of Engineering Physics and Mathematics on May 11. His diploma thesis *Fabrication of single electron transistor using scanning probe manipulation* was done in the LTL. Supervisor: Pertti Hakonen.

Juho Härme graduated as M.Sc. Tech. from the Department of Engineering Physics and Mathematics on Oct 5. His diploma thesis *Multiple-beam interferometry and phase measurement of helium crystals* was done in the LTL. Supervisor: Alexei Babkin.

Mika Sillanpää graduated as M.Sc. Tech. from Department of Engineering Physics and Mathematics on Nov 2. His diploma thesis *Superconducting single electron transistor with a section of normal metal in the island* was done in the LTL. Supervisor: Pertti Hakonen.

Ph.D. theses

Päivi Helenius defended her Ph.D. thesis *Neuromagnetic and psychoacoustical correlates of impaired reading and abnormal sound sequence processing in developmental dyslexia* on June 12th. The opponent was Prof. Uta Frith, Institute of Cognitive Neuroscience, University College London, UK. The work, carried out in the Brain Research Unit, LTL, was supervised by Prof. Riitta Hari and Doc. Riitta Salmelin.

Jussi Numminen defended his Ph.D. thesis *Studies of human cortical auditory processing: Neuromagnetic approach and methodological development* on Oct 1st. The opponent was Dr. Bernd Lütkenhöner, Institute of Experimental Audiology, University of Münster, Germany. The work carried out in the Brain Research Unit, LTL, was supervised by Prof. Riitta Hari.

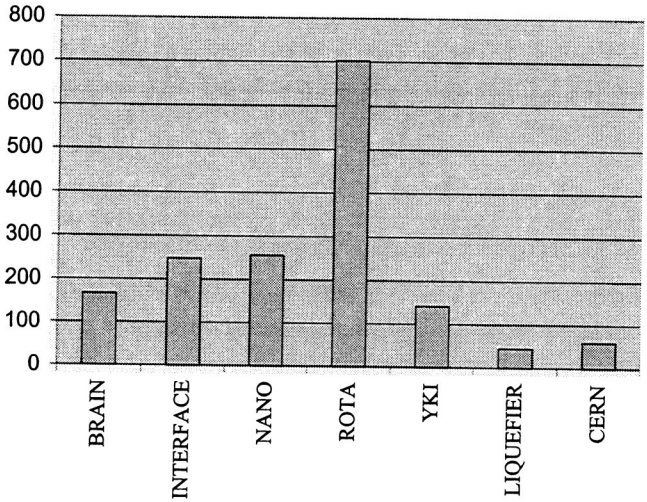
TECHNICAL SERVICES

MACHINE SHOP

A. Huvila, J. Kaasinen, M. Korhonen, M. Lehtovuori, and K. Rauhanen.

The workshop is a joint venture where, in addition to the Low Temperature Laboratory, the Material Physics Laboratory (MAFY), the Nuclear Physics Laboratory (YDI) as well as the Institute for Medical Technology (LTT) have their shares. The distribution of manufacturing man hours spent by the workshop on various groups is shown in the graph below. The LTL groups are shown explicitly as well as the workshop itself and the producer of cryogenic liquids (LIQUEFIER).

Below is the diagram of the workload of various groups in manhours.

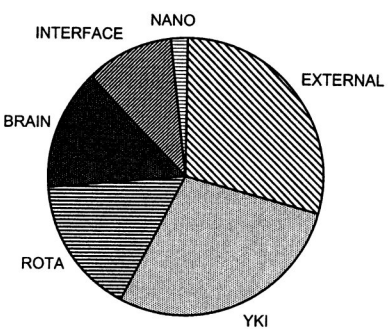


CRYOGENIC LIQUIDS

A. Isomäki, and A. Salminen

Helium

The total amount of liquid helium distributed to the users was 50 000 liters. About 30 %, was sold to external users. The distribution of the Helium consumption is shown below.

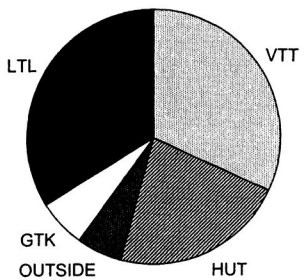


The helium liquefaction equipment (Linde TCF-20) has been in use for over 10 years and a renewal will become necessary within the next 5 years.

Our helium gas storage capacity is 12.5 cubic meters at high pressure (150 bars) which corresponds to about 2500 liquid liters. The liquid storage capacity is at present about 3500 liters of liquid helium in various cryogenic containers.

Nitrogen

Our nitrogen liquefier (Linde - LINIT 25) was installed in 1996 and more than half of its production goes outside the LTL. The total amount produced was 33 200 liters. The distribution of the users is shown below.



PUBLIC RELATIONS AND GENERAL INFORMATION

LT22

The 22nd International Conference on Low Temperature Physics was organized by the LTL in Otaniemi on August 4 – 11, 1999. Altogether 1381 participants and 172 accompanying persons attended this succesful conference. The Final Report of LT22 is attached in Appendix 1 and the Preface of the Proceedings in Appendix 2.

LTL ON THE INTERNET

The LTL WWW home page, http://boojum.hut.fi/ has been accessible since the end of 1994.

The WWW-pages give up-to-date information on the research and other activities in the LTL. Peter Berglund and Mark Mehtonen have modernized the pages to conform with the new look of HUT. Mika Seppä and Ole Jensen have constructed pages for the BRU.

ACTIVITIES OF PERSONNEL

PERSONNEL WORKING ABROAD

Sillanpää	CERN, Jun 2 - Aug 31

EXPERTISE AND REFEREE ASSIGNMENTS

Alles	Member, Local Organizing Committee of LT22
	Organizer of Sjökulla seminar (Apr 16 – 17) for graduate students
Berglund	Advisory editor, Cryogenics, Butterworth Heinemann, UK
	Member, Finnish Academy of Technical Sciences
	Member, Local Organizing Committee of LT22
	Member, International Cryogenics Engineering Committee, ICEC
	Member, SMC Executive Committee (CERN NA47), CERN, Switzerland
	Member, Svenska tekniska vetenskapsakademien i Finland
	Referee, US National Science Foundation
Forss	Referee, Human Brain Mapping
	Referee, Neurosci. Letters
Hakonen	Fellow, American Physical Society
	Guest editor, Physica B (LT22)
	Member, Local Organizing Committee of LT22
	Member, Programme Committee of the 27th annual meeting of the Finnish Physical Society
	Pre-examiner of dissertation, Mikko Leivo, Jyväskylä
	Referee, Europhysics Letters
	Referee, Journal of Low Temperature Physics
	Referee, Physical Review Letters
	Referee, The Israel Science Foundation
	Referee, US National Science Foundation

Hari

Chief, Section of Neuromagnetism, Department of Clinical Neurosciences, Helsinki University Central Hospital (part-time)

Coordinator, EU Large-Scale Installation BIRCH (Biomagnetic Research Centre in Helsinki), Finland

Coordinator, Functional Brain Mapping, Finland-Taiwan Scientific Cooperation

International reviewer, Neuroscience Research

Member, Academia Europaea, UK

Member, Advisory Panel (Human Cognition) of the James S. McDonnel Foundation Centennial Fellow Awards Program, USA

Member, Editorial Board inScight (web journal)

Member, Editorial Board of Brain Topography

Member, Editorial Board of Electroencephalography and Clinical Neurophysiology

Member, Editorial Board of Human Brain Mapping

Member, Editorial Board of Neuroimage

Member, European Dana Alliance for the Brain

Member, Finnish Academy of Sciences and Letters

Member, Organizing Committee and Chair of the Program Committee, 12th International Conference on Biomagnetism Biomag2000, Espoo, Finland, 2000

Member, Scientific Advisory Board of the National PET Center, Turku

Member, Selection Panel for the Wiley Young Investigator's Award

Member, Society for Neuroscience, USA

Member, Steering Committee of the Helsinki Graduate School of Neurobiology

Member, The American Physiological Society

Opponent for doctoral dissertation of Heidi at Department of Clinical Neurosciences, University of Helsinki, Finland

Partner, EU Biotech Programme on European Computerized Human Brain Database

Partner, Human Frontier Science RG 39-98 Action viewing

Referee for grants, European Science Foundation

	Referee for grants, Fonds für Förderrungder Wissenschaftlichen Referee Fund, Austria
	Referee for grants, Ministerie de l'Education Nationale de la Reserche & la Technologie, France
	Referee for grants, Wellcome Trust, UK
	Referee, Annals of Neurology
	Referee, Brain
	Referee, Brain Research
	Referee, Brain Topography
	Referee, Duodecim
	Referee, Electroencephalography and Clinical Neurophysiology
	Referee, Hearing Research
	Referee, Human Brain Mapping
	Referee, Journal of Neurophysiology
	Referee, Nature
	Referee, Neuroreport
	Referee, Neuroscience Letters
	Referee, Neurosience
	Referee, Proceedings of the National Academy of Sciences, USA
	Referee, Trends in Cognitive Sciences
Hämäläinen	Associate editor, IEEE Transactions on Biomedical Engineering
	Referee, Fons zur Förderung der wissenschaftlichen Forschung, Austria
	Referee, Human Brain Mapping
	Referee, IEEE Transactions on Biomedical Engineering
	Referee, Medical and Biological Engineering and Computing
	Referee, NeuroImage
	Referee, Physics in Medicine and Biology
Jousmäki	Referee, Neuroscience Letters
	Referee, Human Brain Mapping
Krusius	Advisory Editor, Physica B: Condensed Matter
	Chairman, Commission C5 Low Temperature Physics, International Union of

Pure and Applied Physics (IUPAP) (until Aug 31)

Chairman, Programme Committee of LT22

Co-ordinator, INTAS network of research groups, project 96-0610, Dec 97 – Dec 99

Fellow of the American Physical Society

Member of Board, Low Temperature Section, Condensed Matter Division, European Physical Society

Member, Academia Europaea, UK

Member, European Physical Society

Member, Finnish Academy of Sciences and Letters

Member, Finnish Physical Society

Member, Local Organizing Committee of LT22

Member, Programme Committee, 18th General Conference of the Condensed Matter Division of the European Physical Society, 13 – 17 March, 2000

Member, Programme Committee, Symposium on Ultra Low Temperature Physics, St. Petersburg, Russia, August 12 – 14, 1999

Member, Steering Group, European Science Foundation Network on Topological Defects – Non-equilibrium field theory in particle physics, condensed matter, and cosmology

Referee of science funding agencies: European Science Foundation, Academy of Finland

Lounasmaa

Advisory Editor, Europhysics Letters

Chairman, Advisory Committee of the BIOMAG2000 Conference

Fellow, American Physical Society

Foreign member, National Academy of Sciences of the USA

Honory degree of Doctor of Philosophy, Helsinki University (1990)

Honorary degree of Doctor of Technology, Tampere University of Technology (1992) and Helsinki University of Technology (1998)

Honorary fellow, Indian Cryogenics Council

Honorary member, Finnish Physical Society

Member, Academia Europaea, UK

Member, Board of the Center for Ultra-Low Temperature Research, University of Florida

Member, Comité International des Poids et Mesures, France

Member, Commission A1/2, International Institute of Refrigeration

Member, Editorial Board of Europhysics Letters

Member, European Physical Society

Member, Finnish Academy of Sciences and Letters

Member, Finnish Academy of Technical Sciences

Member, LUMA-panel set up by the Ministry of Education

Member, Organizing Committee of LT22

Member, Research Council of HUT 1 Sep 1999 – 31 Jul 2000

Member, Royal Swedish Academy of Sciences

Member, Societas Scientiarum Fennica

Mäkelä

Member of scientific committee, XXXIII International congress of military medicine, Helsinki, Jun 25–30

Referee for appointment of docent in neurology, University of Helsinki

Secretary, working group for defining a research program for the military health care in the near future (2000–2005)

Thesis examiner for Heidi Wikström, University of Helsinki

Paalanen

Chairman, Board of SOLIS (Educational Campaign of Finnish Physical Society for the improvement of physics education in highschools)

Chairman, LT 22

Coordinator of Low Temperature Physics Research, Finland-Taiwan Scientific Cooperation

Coordinator of ULTI II (Ultra Low Temperature Installation) Large Scale Installation in EU-funded TMR program Apr 1, 1998 - Mar 31, 2000

Fellow, American Physical Society

Member, Academia Europaea, UK

Member, Board of Arkhimedes (Finnish Physical Journal)

Member, Board of VTT Automation (until Dec 31, 1999)

Member, Board of High Speed Electronics Photonics, Nanoscience, and

Quantum Devices, Consortium in Chalmers University of Technology, Gothenburg

Member, Board of Uudenmaan Rahasto of Finnish Cultural Foundation

Member, Editorial Board of Journal of Low Temperature Physics

Member, Finnish Academy of Sciences and Letters

Member, Finnish Academy of Technical Sciences

Member, Comission C5 Low Temperature Physics, International Union of Pure and Applied Physics (IUPAP) (Sep 1, 1999 -)

Member, Programme Committee, Localization 1999, Jul 30 - Aug 3, Hamburg, Germany

Referee for appointment of Associate Prof. in Penn State University, USA

Referee, EU Science Programs

Referee for appointment of Assistant Professor in Chalmers University of Technology

Referee for appointment of Professor in Tampere University of Technology

Referee, Journal of Low Temperature Physics

Referee, National Science Foundation, USA

Referee, Physical Review B

Referee, Physical Review Letters

Referee, Swedish Research Council for Engineering Sciences

Thesis examiner for Sven-Bertil Carlsson, University of Lund, Lund, Sweden

Salmelin

Member, Editorial Board, Journal of Neuroimaging

Member, Scientific Committee, ISBET 2000

Referee, Brain

Referee, Electroencephalography and Clinical Neurophysiology

Referee, Human Brain Mapping

Referee, Journal of Neuroimaging

Referee, Proceedings of the National Academy of Sciences USA

Referee, Human Frontier Science Program

Pre-examiner for PhD thesis, Ricardo Nuno Vigario: "Independent Com-

	ponents Approach to the Analysis of EEG and MEG Signals"
Tesche	Principal investigator, NIH NS34533 hippocampus
	Referee, Human Brain Mapping
	Thesis examiner of Heidi Wikström, Department of Clinical Neurosciences, University of Helsinki
Thuneberg	Guest editor, Physica B (LT22)
	Member, Local Organizing Committee of LT22
	Referee, Journal of Low Temperature Physics
	Referee, Physical Review B
	Referee, Physical Review Letters
Tuoriniemi	Member, Local Organizing Committee of LT22
	Referee, Physica B
Vanni	Referee, Neuroscience
Volovik	Associate editor, JETP Letters, Russia
	Member, Discussion Panel at Editorioal Board Meeting of JETP Letters, Moscow, Russia
	Member, Local Organizing Committee of LT22
	Member, Evaluation Panel of The Physics Programmes in Engineering and Physical Sciences Research Council, UK
	Opponent, Second doctor dissertation by A. Babkin in Kapitza Institute, Kapitza Institute, Moscow, Russia, Mar 3
	Opponent, PhD by D. Efremov at Kapitza Institute, Moscow, Russia
	Referee, appointment for Professorship in Theoretical Physics, Germany
	Referee, book proposals for Oxford University, and Gordon and Breach

CONFERENCE PARTICIPATION AND LABORATORY VISITS

Ahlskog	poster presentation *Conductivity measurements of catalytically synthesized carbon* at Nanotube -99, Michigan State University, Michigan East Lansing, USA, Jul 24

Alles poster presentation *Looking at the shape of ^{3}He crystals using a multiple beam interferometer* at International Conference on Ultra Low Temperature Physics, St Peterburg, Russia, Aug 12-15

Avikainen oral presentation *Normal movement reading in Asperger subjects* at HFS grant Annual Meeting, Iraklion, Crete, Greece, Oct 10-11

Berglund TV interview on LT22 with Jesper Brandt at TV1 news at 18:15, LTL, Finland, Aug 4

Blaauwgeers poster presentation *Vortex dynamic in UPt_3 probed with rf-measurements* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

oral presentation *Singularity-free quantized vortex lines in ^{3}He -A* at Workshop on Topological Defects in Cosmology, Particle Physics and Condensed Matter, Dresden, Germany, Jun 7-12

Boldarev participation, co author of *Local Bose condansate: Observations on two-dimensional atomic hydrogen* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4 -11

Participation, co author of *Efficiency of cooling of ^{3}He -^{4}He mixtures during adiabatic melting at ultralow temperatures* at International Conference on Ultralow Temperature Physics, St-Petersburg, Russia, Aug 12-15

Eltsov oral presentation and panel hearing *Dynamic response of superfluid ^{3}He-A* at 2nd Symposium Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

oral presentation *Vortex sheet and its dynamics in superfluid ^{3}He-A* at ESF Workshop in Topological Defects in Cosmology, Particle Physics and Condensed Matter, Dresden, Germany, Jun 7-12

poster presentation *Dynamics of the vortex sheet in superfluid ^{3}He-A* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *Topological transition of the vortex sheet in rotating ^{3}He-A* at

International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 12-15

Forss — invited talk *Recent advances in basic brain research* at IV Meeting of the Network of WHO Collaborating Centers in Occupational Health, Hanasaari Congress Center, Helsinki. Finland, Jun 9

session chairman at XI ICEMGCN International congress of EMG and Clinical Neurophysiology, Prague, Czech Republic, Nov 7

Hakonen — poster *Superconductor-insulator transition in a single Josephson junction,* Conference on Quantum Physics at Mesoscopic Scale at Les Arcs, France, Jan 23-30

invited talk *Superconductor-insulator transition in mesoscopic Josephson junctions* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

poster *Manipulation of aerosol particles using atomic force microscopy* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

invited talk *Dissipative phase transition in a single superconducting junction* at Copenhagen Mesoscopic Days, Copenhagen, Denmark, May 7-9

poster *Manipulation of aerosol particles using atomic force microscopy* at Copenhagen Mesoscopic Days, Copenhagen, Denmark, May 7-9

invited talk *Dissipative phase transition in a single Josephson junction* at 22nd International Conference on Low Temperature Physics, Otaniemi an Helsinki, Finland, Aug 4-11

poster *Reduction of noise in single electron transistors at audio frequencies* at Conference on Electron Transport in Mesoscopic Systems, Chalmers, Sweden, Aug 12-15

Hari — invited comment *Large scale facility tutkijankoulutuksen vahvistajana* at Tutkijankoulutuksen kansainvälistäminen – seminaari, Helsinki, Finland, Feb 4

invited talk *Miten aivot käsittelevät tietoa?*, "Aivot työssä"-Symposium at the

25-year celebration of Neurology Foundation, University of Helsinki, Helsinki, Finland, Feb 11

invited talk *Human brain imaging,* Exploratory Workshop on Neurosciences at Hanasaari Cultural Center, Espoo, Finland, Feb 22-23

participation at Annual Meeting of Finnish Graduate School of Neuroscience, Oulu, Finland, Mar 18

honorary lecture *The Rodin von Euler Honorary Lecture in cognitive and neurobiological aspects of reading and language development deficits of auditory processing in dyslexic adults: psychoacoustical results* at RIKEN Brain Science Institute, Japan, Apr 6-8

invited talk *Aivotutkimuksen näkymiä* at Studia Naturalia, Joensuu, Finland, Apr 20

radio interview at Pohjois-Karjalan yle-radio, Joensuu, Finland, Apr 20

invited talk *Miksi lukihäiriöinen käsittelee aistiärsykkeitä hitaammin* at HERO (Helsingin seudun erilaiset oppijat), Helsinki, Finland, May 26

invited talk *Neuromagnetic and psychoacoustical results on human auditory processing* at The Active Ear Symposium, Oulun pääkirjasto, Finland, Jun 11

participation at 5th International Conference on Functional Mapping of the Human Brain (HBM99), Düsseldorf, Germany, Jun 22-26

participation at 2 meetings of the OHBM Council, Düsseldorf, Germany, Jun 22-26

invited talk *Miksi lukihäiriöinen käsittelee aistinärsykkeitä normaalia hitaammin? Why do dyslexics process sensory stimuli slower than normal readers do?* at Erilaisesta oppijasta erinomaiseksi oppijaksi, Helsinki, Finland, Sep 7

workshop presentation *MEG data available for the European Computerized Human Brain Database*, EU grant workshop (ECHBD), Patras, Greece, Sep 23-26

invited talk *Peilisolujärjestelmä (The mirror neuron system)* at Haagan Neu-

rologinen Tutkimuskeskus NEUROn kuukausiseminaari, Helsinki, Finland, Sep 29

oral presentation *Dynamics of cortical representation for action* at HFS grant; annual workshop, Crete, Greece, Oct 9-12

invited talk *Brain mechanisms of action viewing: A neuromagnetic approach* at Dynamical Neuroscience VII: Integration across multiple imaging modalities, Delray Beach, Florida, USA, Oct 21-22

poster *Left-sided minineglect and attentional sluggishness in dyslexic adults* at Society for Neuroscience Annual Meeting, Miami Beach, Florida, USA, Oct 23-28

invited talk *Why are dyslexics slow in processing sensory stimuli?* at Time and Timing in Biological Systems, Kloster Seeon , Germany, Nov 5-8

Helenius invited talk *Aivojen toiminnan muutokset lukihäiriön patogeneesissa* at SLY's Annual Meeting, Helsinki, Finland, Feb 4

oral presentation *Äänisarjojen havainto ja lukemisen toiminnallinen organisaatio kehityksellisessä dysleksiassa* at Oppimisvaikeuksien Tutkimus Suomessa - 2. Valtakunnallinen Tutkijatapaaminen, Turku, Finland, Feb 5-6

oral presentation *Neuromagnetic correlates of impaired reading in developmental dyslexia* at Basic Mechanisms of Language & Language Disorders, Leipzig, Germany, Sep 26-30

invited talk *Lukemisen aikainen aivoaktivaatio lukihäiriöisillä* at Lastenneurologian yksikön jatko- ja täydennyskoulutusohjelma, HYKS/Lastenlinna, Finland, Oct 26

Hämäläinen invited talk *Neuromagnetic imaging with multichannel SQUID arrays* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *New magnetoencephalography: Neuromag Vectorview* at Shinshu Neurosurgical Seminar, Department of Neurosurgery Shinshu University School of Medicine, Matsumoto, Japan, Aug 20

invited talk *MEG measurements and data analysis with a hybrid whole-head magnetometer in noisy environments* at Regular Meeting of the Branch Committee of High-Performance SQUID Systems, the JSPS 146 Committee of Superconducting Electronics, Tokyo University, Tokyo, Aug 31

invited talk *Principles of neuromagnetic imaging,* Meeting on Methodological Issues in Functional Brain Imaging at Turku, Finland, Sep 10-11

Hänninen poster *Superfluid density for ^{3}He in aerogel assuming inhomogeneous scattering* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *NMR frequencies of single splay soliton in ^{3}He-A* at International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 12-15

Jensen invited talk *Bayesian reconstruction of location from the firing of hippocampal place cells reveals a phase code or Why you should care about brain oscillations* at Laboratory of Computer and Information Science, Helsinki University of Technology, Finland, Mar 19

invited talk *Reconstruction of location using hippocampal place cells reveals a phase code* at Department of Biosciences, University of Helsinki, Finland, Apr 9 and Department of Neuroscience and Neurology, University of Kuopio, Finland, Apr 23

oral presentation *10-12 Hz oscillations increase with memory load in a short-term memory task* at Human Brain Mapping 1999, Dusseldorf, Germany, Jun 22-26

poster *Theta activity in right inferior temporal cortex increases with memory load in a short-term memory task: A Parametric MEG Study* at Dynamical Neuroscience VII: Integration across multiple imaging modalities, Delray Beach, Florida, USA, Oct 21-22

participation at Society for Neuroscience Annual Meeting, Miami Beach, Florida, USA, Oct 23-28

Jousmäki invited talk *Somatosensory processing, basic and clinical application of human*

brain mapping: Effective use of EEG/ERP neuroinformatics at Ålborg, Denmark, Jan 30-31

participation at Cognitive Science of Natural Language Processing (CSNLP-8) LANGUAGE, VISION & MUSIC, National University of Ireland, Galway, Ireland, Aug 9-11

participation at Short Course on Statistical Parameter Mapping, University of Kuopio, Finland, Dec 16-17

Kirveskari participatio at XI ICEMGCN International congress of EMG and Clinical Neurophysiology, Prague, Czech Republic, Nov 7

Kiviniemi lecture *Anomian kuntoutus, mieli ja aivot: Aivotrauman jälkeinen kognitiivinen kuntoutus ja sen hermostolliset mekanismit* at Turku, Finland, Apr 29

oral presentation *Modelling the mechanisms of language rehabilitation in aphasia - An MEG approach* at Basic Mechanisms of Language and Language Disorders, Leipzig, Germany, Sep 26-30

Knuuttila poster presentation *SQUID NMR measurements on a Rh single crystal at ultralow temperatures* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

poster presentation *SQUID NMR measurements on a Rh single crystal at ultralow temperatures* at Annual Meeting of Finnish Physical Society, Turku, Finland, Mar 4-6

poster presentation *Double spin flip mode of rhodium nuclei* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *Double spin flip resonance of rhodium nuclei* at International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 12-15 and

Koivikko poster *Diminished change-related auditory cortical responses in dyslexic adults* at Dynamical Neuroscience VII: Integration across multiple imaging modalities, Delray Beach, Florida, USA, Oct 21-22

Koivuniemi oral presentation *Common muon and proton apparatus for structure and spectroscopy - the polarized target at CERN* at Ultralow Temperature Facility, Physikalisches Institut, Universität Bayreuth, D-95440 Bayreuth, Germany, Jul 29

poster *Dilution refrigerator for COMPASS polarized target* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *Low temperature GaAs MESFET amplifier with high-Q LC resonator* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *Parametric amplification with cooled varactor in high-Q LC resonator* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

Kopu poster *NMR line shapes in rotating superfluid ^{3}He-B* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

poster *Calculation of NMR line shape in rotating superfluid ^{3}He-B* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *NMR line shapes in rotating superfluid ^{3}He-B* at International Conference on Ultra Low Temperature Physics, St Petersburg, Russia, Aug 12-15

Krusius lecture *Topological defects of ^{3}He superfluids,* Workshop of ESF Network on Topological Defects and The Non-equilibrium Dynamics of Symmetry-breaking Phase Transitions at Les Houches, France, Feb 16-26

poster *Single-vortex resolution in NMR spectroscopy of rotating superfluid ^{3}He-A* at Annual Meeting of the Finnish Physical Society, Turku, Finland, Mar 25-27

participation at IUPAP Council Meeting, Atlanta, Georgia, USA, Mar 16-17

participation at IUPAP General Assembly, Atlanta, Georgia, USA, Mar 18-20

contributed *talk Topology and dynamics of the vortex sheet in rotating superfluid ^3He* at American Physical Society Centennial Meeting, Atlanta, Georgia, USA, Mar 20-26

Levänen invited talk *Näkyykö kuntoutuskin aivoissa?* at Harvinaiset Haasteet -seminaari, Pienet kuulovammaryhmät haasteena asiantuntijuudelle, Helsinki, Finland, Jan 14-15

invited talk *Cross-modal plasticity in the human auditory cortex* at The 4th European Conference of Audiology (EFAS 1999), Oulu, Finland, Jun 6-10

member of discussion panel at The 4th European Conference of Audiology (EFAS 1999), Oulu, Finland, Jun 6-10

poster presentation *Viewing sign language: Cortical activation in deaf and hearing subjects* at 5th International Conference on Functional Mapping of the Human Brain (HBM99), Düsseldorf, Germany, Jun 22-26

Lin invited talk *Functional characterization of somatosensory cortex* at International Symposium on Brain Mechanisms of Tactile Perception, Stockholm, Sweden, Oct 11-13

Lounasmaa participation at 136th Annual Meeting of the National Academy of Sciences, Washington, D.C., USA, Apr 24-27

chairman of the Kurti Memorial Session at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

invited talk *Nicholas Kurti in Memoriam* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

member of Organizing Committee at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

invited plenary talk *From single-SQUID to 306-channel MEG detection during the past 15 years* at A Conference to Honor Professor Samuel J. Williamson on The Occasion of His 60th Birthday, New York, USA, Sep 24-25

participation at Comité International des Poids et Mesures

21st Conférence Générale des Poids et Mesures, Paris, France, Oct 7-15

Mäkelä invited talk *Auditory evoked fields to amplitude and frequency modulations* at Third Meeting of the European Study Group for Psychoacoustics, Strasbourg, France, Jun 11-13

invited lecture *MEG functional imaging and intracranial recordings* at Fifth IBRO World Congress in Neuroscience, Jerusalem, Israel, Jul 11-15

lecture *Voidaanko ajatuksia lukea?* at Tieteen Päivät, Helsinki, Jan 13

lecture *Armeija ja epilepsia* at Epilepsialiiton Nuorten Tapahtuma, Helsinki, Sep 4

lecture *Magnetoenkefalografia (MEG)* at Psykonet/Neuropsykologian Erikoispsykologikoulutus, Neurotiede II: Kuvantamismenetelmät, Helsinki Nov 19

Paalanen participation at Board Meeting of High Speed Electronics Consortium in Chalmers University of Technology, Gothenburg, Sweden, Mar 2-3

participation at Annual Meeting of Finnish Physical Society, Turku, Finland, Mar 4-6

lecture *Nanotechnology: Past, resent and future* at Graduate School in Material Physics, University of Helsinki, Finland, Mar 16

participation at March Meeting of American Physical Society, Atlanta, USA, Mar 20-26

lecture *How to reach the top in research* at Graduate School Seminar in the Laboratory of Telecommunication Technology, Sjökulla, Finland, May 26

participation at Evaluation Meeting of the Finnish Nanotechnology Program, Turku, Finland, Sep 7-8

Parkkonen poster *Experiments on interference suppression in MEG measurements* at 5th International Conference on Functional Mapping of the Human Brain, Düsseldorf, Germany, Jun 23-26

consultation at National Centre of Neurology and Psychiatry, Tokyo, Kohnan

Hospital, Sendai. Hokkaido University, Sapporo. Tokyo University, Tokyo, Japan, Aug 4-21

Penttilä oral presentation *Dissipative phase transition in a single Jospehson function* at Annual Meeting of Finnish Physical Society, Turku, Finland, Mar 4-6

poster presentation *Dissipative phase transition in a single Jospehson junction* at Annual Meeting of Finnish Physical Society, Turku, Finland, Mar 4-6

oral presentation *Coulomb blockade in a normal tunnel junction at large voltages* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *Dissipative phase transition in a mesoscopic Josephson junction in a weak magnetic field* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *Band picture and ohmic dissipation in a single Josephson junction* at Electron Transport in Mesoscopic Systems Conference, Gothenburg, Sweden, Aug 12-15

Roschier oral presentation *Scanning probe manipulation of aerosol particles and carbon nanotubes* at Jyväskylä, Symposium on Micro- and Nanocryogenics, Finland, Aug 1-3

poster presentation *Scanning probe manipulation of aerosol particles and carbon nanotubes* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *Fabrication of single-electron transistor using multimulti-walled carbon nanotube and scanning probe manipulation* at Electron Transport in Mesoscopic Systems Conference, Gothenburg, Sweden, Aug 12-15

Ruohio poster presentation *Single vortex resolution in NMR spectroscopy of rotating superfluid ^{3}He-A* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-7

poster presentation *Single vortex resolution in NMR spectroscopy of rotating superfluid ^{3}He-A? at* Annual Meeting of Finnish Physical Society, Turku, Fin-

land, Mar 4-6

poster *Surface-activated A —> B transition in superfluid ^{3}He: Texture dependence*, 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

Salenius interview, radio extreme, May 26

lecture *Tourette syndrome* at Psychiatry Clinic, Helsinki University Central Hospital, Sep 7

EEG and MEG techniques at Copenhagen Summer School in Central Motor Control, Jul 6

Salmelin consultation at HFSP collaboration, Heinrich-Heine-Universität, Düsseldorf, Germany, Jan 22-24

invited talk *Lukivaikeus viimeaikaisten aivotutkimusten valossa: magnetoenkefalografiset (MEG) tulokset* at Lukiopetus Sosiaali- ja Terveysalalla, Opetushallitus, Helsinki, Finland, Mar 8-9

invited talk *Cortical dynamics of fluent and dyslexic reading* at Haskins Laboratories Staff Meeting, New Haven, USA, Apr 8

poster presentation *Native language affects functional organization of the male auditory cortex* at Annual Meeting of the Cognitive Neuroscience Society, Washington DC, USA, Apr 11-13

poster presentation *Nature language affects functional organization of the male auditory cortex* at 5th International Conference on Functional Mapping of the Human Brain (HBM99), Düsseldorf, Germany, Jun 22-26

invited talk *Practical approaches to the analysis of complex MEG data sets* at The Art of EEG/MEG Source Analysis Satellite Symposium of HBM99, Düsseldorf, Germany, Jun 27-28

invited talk *MEG in language disorders* at XI International Congress of EMG and Clinical Neurophysiology, Prague, Czech Republic, Sep 7-11

invited talk *Cortical dynamics of speech production in fluent speakers and*

stutterers at Fourth International Hans Berger Congress, Jena, Germany, Sep 26-29

invited talk *Neurophysiology of word processing - implications for dyslexia* at International Symposium on Dyslexia, Würzburg, Germany, Oct 8-10

invited talk *Real-time neuromagnetic imaging of human brain function,* at EUPRO 2nd Workshop "Physics and Biology", Helsinki, Finland, Oct 28

Schakel — lecture *Defects induced phase transitions,* Friday's Colloquium at Department of Physics,Norwegian University of Science and Technology,Trondheim, Norway, Nov 24-28

Schanen — poster *Measurement of quantized vortex lines in rotating ^{3}He-B* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

Silén — participation at 4th Congress of the European Federation of Neurological Societies, Lisbon, Portugal, Sep 7-11

participation at 23rd International Epilepsy Congress, Prague, Czech Republic, Sep 13-17

Simões — poster presentation *Relationship between responses to contra- and ipsilateral stimuli in the human second somatosensory cortex-SII* at 5th International Conference on Functional Mapping of the Human Brain (HBM99), Düsseldorf, Germany, Jun 22-29

Tarkiainen Antti — poster presentation *Words in noise: Graded visual responses in the left occipital cortex at* Neuroscience Finland 1999, Oulu, Finland, Mar 18-19

oral presentation *Early activation of the occipitotemporal cortex in reading: Dissociation between dyslexic and fluent readers* at Basic Mechanisms of Language & Language Disorders, Leipzig, Germany, Sep 26-30

Tarkiainen Reeta — poster presentation *Why is the superfluid spreading incomplete?* at Annual Meeting of Finnish Physical Society, Turku, Finland, Mar 4-6

poster presentation *Single-electron transistor made of a multiwalled carbon nanotube using AFM Manipulation* at Copenhagen Mesoscopic Days, Copen-

hagen, Denmark, May 7-9

poster *Pseudo-contact angles and pinned vorticity in superfluid ^4He* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

poster *Single-electron transistor made of a multiwalled carbon nanotube using AFM manipulation* at NanoteC 99, University of Sussex at Brighton, UK, Sep 8-10

Tesche

poster *Characterization of theta oscillations in normal human hippocampus during a working memory task* at Fifth International Conference on Functional Mapping of the Human Brain, Düsseldorf, Germany, Jun 22-26

poster *Hippocampal MEG responses during a Sternberg memory task* at 5th International Conference on Functional Mapping of the Human Brain, Düsseldorf, Germany, Jun 23-26

invited talk *Detection of activity from subcortical and cerebellar structures with MEG* at The Art of EEG/MEG Source Analysis, Düsseldorf, Germany, Jun 27-29

invited talk *MEG study of hippocampal theta during a working memory task* at 2nd International Symposium on Noninvasive Functional Source Imaging NSFI'99, Zagreb, Croatia, Sep 3-7

participation at Methodological Issues in Functional Brain Imaging, Turku, Finland, Sep 10-11

poster *Reset of the phase of hippocampal theta observed in normal human subjects during a working memory task* at The Parahippocampal Region: Basic Science and Clinical Implications, Baltimore, Maryland, USA, Sep 23-26

invited talk *MEG imaging of magnetic fields from current flow in deep brain structures* at Department of Physics, University of New Mexico, Albuquerque, New Mexico, USA, Sep 28

consultation at Department of Psychology, VA Medical Center, Albuquerque, New Mexico, USA, Sep 29

poster *Phase reset of theta in normal human hippocampus during a working memory task* at Dynamical Neuroscience VII: Integration Across Multiple Imaging Modalities, Delray Beach, Florida, USA, Oct 21-22

poster *Cerebellar-hippocampal interaction in man during processing of temporally discontiguous sensory input* at Society for Neuroscience Annual Meeting, Miami Beach, Florida, USA, Oct 23-28

oral presentation *Timing of neuronal activation in human prefrontal, cingulate and limbic areas during a working memory task* at Society for Neuroscience Annual Meeting, Miami Beach, Florida, USA, Oct 23-28

participation at The Cerebellum and Alcohol: Roles in Cognitive and Motor Function Satellite Symposium to the 1999 Society for Neuroscience Annual Meeting, Miami Beach, Florida, USA, Oct 23

consultation at National Foundation for Functional Brain Imaging, Director: Dr. Ed Flynn, Albuquerque, New Mexico, USA, Oct 27

invited talk *Using magnetoencephalography to image activity in human hippocampus and cerebellum* at 1999 International Conference on Bioelectromagnetism: Science, Medicine and Progress, Alcala de Henares, Spain, Nov 11-12

consultation at Executive Summary, National Foundation for Functional Brain Imaging: Applications of fMRI and MEG Methods in Mental Illness Research, Albuquerque, New Mexico, USA, Dec 10-11

Thuneberg oral presentation *Nucleation of defects in normal - superfluid transition* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-8

oral presentation *Theory of pi-state in ^{3}He Josephson junctions* at 2nd Symposium of Physics and Technology at Low temperatures, Bayreuth, Germany, Feb 4-8

invited talk *Theory of pi-state in ^{3}He Josephson junctions* at Macroscopic Quantum Coherence Phenomena, Trieste, Italy, Jul 5-9

invited talk *Theory of pi-state Josephson junctions* at 22nd International Con-

ference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *Nucleation of defects in normal - superfluid transition* at International Conference on Ultra Low Temperature Physics, St Petersburg, Russia, Aug 12-15

talk *Pinhole model for the pi-state in ^{3}He Josephson junc*tions at International Conference on Ultra Low Temperature Physics, St Petersburg, Russia, Aug 12-15

session chairman at International Conference on Ultra Low Temperature Physics, St Petersburg, Russia, Aug 12-15

Tsepelin oral presentation *Nucleation and morphology of ^{3}He crystals below 1 mK* at 2nd Symposium of Physics and Technology at Low Temperatures, Bayreuth, Germany, Feb 4-8

poster *Nucleation and growth of ^{3}He crystals below 1mK* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

oral presentation *Nucleation and growth of ^{3}He crystals at submillikelvin temperatures* at International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 12-15

Tuoriniemi invited talk *Nuclear cooling and spin properties of rhodium down to picokelvin temperatures* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

Participation at International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 12-15

Uutela poster *Activation sequence of the visual projection areas* at 5th International Conference on Functional Mapping of the Human Brain (HBM99), Düsseldorf, Germany, Jun 22-26

invited talk *Minimum l1-norm estimates in the analysis of MEG data* at 2nd International Symposium on the Noninvasive Functional Source Imaging with the Human Brain and Heart (NFSI99), Zagreb, Croatia, Jul 3-7

Vanni

invited talk *Katsaus visuaalisen informaation prosessointiin ihmisen aivokuorella. (Review of visual information processing in the human cerebral cortex, in Finnish)* at Lecture Serie: Studia Psychologica, Kognitiivisen aivotutkimuksen rajat ja mahdollisuudet (The Limits and Possibilities of Cognitive Brain Research), University of Helsinki, Finland, Feb 23

poster presentation *Attentive fixation enhances right frontal eye field response to a peripheral unattended stimulus* at 3rd Annual Vision Research Conference, Fort Lauderdale, Florida, USA, May 7-8

poster *Activation sequence of the visual projection areas* at Human Brain Mapping, Düsseldorf, Germany, Jun 22-26

Viljas

poster *Metastable pi-state in the Josephson effect of superfluid ^{3}He-B* at XXXIII Annual Conference of The Finnish Physical Society, Turku, Finland, Mar 4-6

poster *Theory of the pi-state in ^{3}He-B Josephson junctions* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

Volovik

chairman at Editorial Board Meeting of JETP Letters, Moscow, Russia, Feb 5

member of discussion panel at UK Physics Programme 1999 Evaluation Panel EPSRC, Warwick University, Coventry, UK, Feb 14-15

lecture *^{3}He and Universe parallelism* at NATO advanced school Topological Defects and the Nonequilibrium Dynamics of Symmetry Breaking Phase Transition, Les Houches, France, Feb 16-26

invited talk *Vacuum instability in superfluids: Hawking radiation and Unruh effect* at Meeting in honour of Gabriel Bartan 65th Birthday, Brighton, Sussex University, UK, Feb 26-27

member of discussion panel at Editorioal Board Meeting of JETP Letters, Moscow, Russia, Mar 4

invited talk *Vortices vs spinning strings: Iordanski force and gravitational Aharonov-Bohm effect* at Institute of Physics Conference Topological Defects

in Quantum Hall Systems and Quantum Liquids, Lancaster University, UK, Mar 19-20

lecture *Effective gravity and effective gauge fields in condensed matter systems* at Seminar at Uppsala University, Uppsala, Sweden, Mar 26

session chairman at Editorial Board Meeting of JETP Letters, Moscow, Russia, Apr 22

member of discussion panel at Evaluation Panel Meeting of Engineering and Physical Sciences Research Council of UK, Coventry, UK, May 9-10

lecture *Chiral fermions, effective gauge fields and effective gravity* at Seminar in Imperial College, London, UK, May 11

session chairman at ESF Workshop on Topological Defects in Cosmology, Particle Physics and Condensed Matter, Dresden, Germany, Jun 7-12

invited talk *Fermion zero modes on strings in condensed matter* at ESF Workshop on Topological Defects in Cosmology, Particle Physics and Condensed Matter, Dresden, Germany, Jun 7-12

invited talk *Forces acting on condensed matter vortices and their analogues in relativistic theory* at ESF Workshop on Topological Defects in Cosmology, Particle Physics and Condensed Matter, Dresden, Germany, Jun 7-12

invited talk *Fermion zero modes on vortices* at Landau Institute Conference, Chernogolovka, Russia, Jun 25-28

invited talk *Universe as condensed matter* at CWS-99, Chernogolovka, Russia, Jul 28 -Aug 3

invited talk *Defect formation in inhomogeneous 2nd order phase transition* at 22nd International Conference on Low Temperature Physics, Espoo and Helsinki, Finland, Aug 4-11

invited talk *Quantum friction in superfluids* at International Conference on Ultralow Temperature Physics, St Petersburg, Russia, Aug 11-15

session chairman at International Conference on Ultra Low Temperature

Physics, St Petersburg, Russia, Aug 11-15

invited plenary talk *Analogies between condensed matter and cosmology* at 11-th General Conference of European Physical Society, EPS-11, Trends in Physics, London, UK, Sep 6-10

invited plenary talk *Links between gravity and dynamics of quantum liquids* at IV International Conference Cosmology, Relativistic Astrophysics, Cosmoparticle Physics (COSMION-99), Moscow, Russia, Oct 17-24

AWARDS

One of the most esteemed prizes in Low Temperature Physics, **the Fritz London Prize** was awarded to **Academy Professor Matti Krusius** on Aug 4 during 22nd International Conference on Low Temperature Physics for his imaginative and pionering use of rotation combined with nuclear magnetic resonance to study various properties of superfluid ^{3}He, including textures of the order parameter and, the structure, pinning and collective behavior of several different types of vortices, the critical velocity under rotation, the effects of motion of the A-B interface and the systematics of nucleation and vorticity by neutron irradiation.

The Board of Directors of Academy of Technical Sciences has awarded Academician Olli V. Lounasmaa a medal for the valuable work he has done in the Low Temperature Laboratory which he has founded and for his contribution to the development of brain research instruments. The medal was given to Lounasmaa in the House of Estates "Säätytalo" on Nov 10 during the seminar "Polymers as Engineering Materials".

LTL SEMINAR SERIES

RESEARCH SEMINARS ON LOW TEMPERATURE PHYSICS

Organized by Matti Krusius and Pertti Hakonen

Reijo Voutilainen, Picowatt Ltd: *Resistance thermometry at low temperatures* (Jan 8)

Andrei Zabrodskii, Ioffe Institute, St. Petersburg: *Insulator to metal transition in doped semiconductors as the coulomb gap collapse phenomenon* (Feb 1)

Reyer Jochemsen, Kamerlingh-Onnes Laboratory, Leiden University, The Netherlands: *Interface instability during rapid melting of spin-polarized solid ^{3}He* (Mar 18)

Leonid Mezhov-Deglin, Institute of Solid State Physics, Chernogolovka, Russia: *Waves of rarefaction and compression of 1st sound in superfluid HeII* (Mar 30)

Konrad Siemensmeyer, Hahn-Meitner-Institute, Berlin: *Feasibility of neutron diffraction experiments on magnetism in solid ^3He* (Mar 31)

Risto Nieminen, Laboratory of Physics, Helsinki University of Technology: *Electronic structure and properties of metallic nanowires* (Apr 8)

Takahashi Nori, Osaka University, Japan: *Radioactive impurities in superfluid helium* (May 11)

Michel Martin, Department of Chemistry, KULeuven University, Belgium: *Fluorescence quenching of BP6p porphyrin rings: Preliminary experiments* (May 24)

Sevolod Gantmakher, Institute of Solid State Physics Chernogolovka, Moscow Region, Russia: *Magnetic-field-tuned superconductor-insulator transition in amorphous InO_x films* (May 28)

Yuriy Bunkov, CRTBT-CNRS, Grenoble: *New NMR results for liquid ^3He* (Jun 3)

Konstantin Arutnyunov, Department of Physics, Jyväskylä University: *Unconventional behavior of mesoscopic-size superconducting structures* (Jun 4)

Frank Hekking, CNRS-CRTBT, Grenoble: *Re-entrant spin susceptibility of small superconducting grains* (Jun 14)

Frank Hekking, CNRS-CRTBT, Grenoble: *Anomalous thermal transport in quantum wires* (Jun 16)

Alexander Sebedash, Kapitza Institute, Moscow: *Self-cooling of dilute solutions of ^3He in ^4He during adiabatic melting* (Jun 17)

Kim Lefman, Risø National Laboratory, Denmark: *Evidence against standard d-wave superconductivity in the high-T_c compound $La_{2-x}Sr_xCuO_4$* (Jun 21)

Qaisar Shafi, Bartol Research Institute, University of Delaware, USA: *Hot Dark Matter in the light of neutrino oscillations* (Jul 13)

Gert Ingold, University of Augsburg, Germany: *Josephson effects and fluctuations* (Sep 14)

Adriaan Schakel, Freie Universität Berlin, Germany: *Defects induced phase transitions – an introduction* (Dec 2)

Adriaan Schakel, Freie Universität Berlin, Germany: *Quantum numbers of ^3He-B vortex core states* (Dec 7)

RESEARCH SEMINARS OF THE BRAIN RESEARCH UNIT

Organized by Simo Vanni

Peter Brown, Human Movement and Balance Unit, Institute of Neurology, University College London: *What can cortical myoclonus tell us about motor control* (Jan 5)

Riitta Hari, LTL: *Chairperson: Status of PhD students* (Jan 11)

Riitta Salmelin, LTL: *Work in progress* (Jan 18)

Sari Levänen, LTL: *Viewing sign language* (Jan 25)

Jan Kujala, LTL: *RapMusic*, (Feb 1)

Stephan Salenius, LTL: *Mirror neurons review* (Feb 8)

Pertti Saariluoma, University of Helsinki*: Brain-based explanations of mental contents: Scope and limitations* (Feb 15)

Sven Brautigam, The Open University, Milton Keynes, UK*: Oscillatory neural dynamics following semantic incongruity* (Mar 1)

Tom Reuter, University of Helsinki: *Principles of sensory analysis* (Mar 8)

Nobuyaki Nishitani, LTL: *Summary of the work in LTL* (Mar 15)

Juha Voipio, University of Helsinki: *Dendritic currents* (Mar 22)

Dorothea Hamdorf, LTL: *Behavioral and perceptual differencies in processing vibrotactile stimuli between hearing, deafned and deaf subjects: A psychophysical comparison study.* (Mar 29)

Erika Kirveskari, LTL: *Travel report from Salt Lake City* (Mar 29)

Veikko Jousmäki, LTL: *Greetings from a Danish Graduate School meeting* (Mar 29)

Yuki Kamitani, Caltech, USA: *Seeing magnetic brain suppression* (Mar 31)

Simo Vanni, LTL: *Extrastriate visual processing* (Apr 12)

Ole Jensen, LTL*: An oscillatory short-term memory model can account for data on the Sternberg task* (Apr 19)

Riitta Hari, LTL: *Temporal processing deficits in dyslexic subjects: A new interpretation* (Apr 26)

Katri Kiviniemi, LTL: *Perceptual Neuroscience, Chapter 2* (May 3)

Tommi Raij, LTL: *Perceptual Neuroscience, Chapter 3* (May 10)

Päivi Helenius' oral examination before dissertation (May 17)

Yung-Yang Lin, LTL: *Perceptual Neuroscience, Chapter 4* (May 24)

Teija Silen, LTL: *Perceptual Neuroscience, Chapter* 5 (May 31)

Mika Seppä, LTL: *Greetings from Australia* (Jun 7)

Simo Vanni, LTL: *Greetings from ARVO and 3rd Vision Research Conference* (Jun 7)

Peter Sörös, Department of Neurology, University of Münster, Germany*: Perceptual Neuroscience, Chapter* 7 (Jun 14)

Liselotte Gootjes, Free University Amsterdam, The Netherlands: *Hemispheric asymmetry for processing of vowels: A whole-scalp neuromagnetic study. Work in progress* (Jun 14)

Sari Avikainen, LTL: *Perceptual Neuroscience, Chapter 8* (Aug 30)

Human Brain Mapping-meeting participants: *Meeting reports* (Sep 6)

Pentti Haikonen, principal scientist, Cognitive Technology, Nokia Research Center: *An artificial cognitive neural system* (Sep 13)

Jussi Numminen's oral examination before dissertation (Sep 20)

Ole Jensen, LTL: *Perceptual Neuroscience, Chapter 6*

Kimmo Uutela & Cristina Simoes: *Meeting reports* (Sep 27)

Jaana Sirkiä, TKK:n lakimies: *Laki lääketieteellisestä tutkimuksesta* (Oct 4)

Martin Schürmann, Lübeck: *Motivation of his study*

Nina Forss, Erika Kirveskari & Topi Tanskanen, LTL: *Meeting reports* (Oct 11)

Jaakko Järvinen, LTL: *Signal transduction in neurons*

Päivi Helenius, Katri Kiviniemi & Antti Tarkiainen, LTL: *Meeting reports* (Oct 18)

Erika Kirveskari, LTL: *Perceptual Neuroscience, Chapter 9* (Nov 1)

Marjatta Pohja, LTL: *Perceptual Neuroscience, Chapter 10* (Nov 8)

Eye movement symposium in Työterveyslaitos (Nov 15)

Neuroscience participants: *Meeting reports* (Nov 22)

Topi Tanskanen, LTL: *Perceptual Neuroscience, Chapter 11* (Nov 29)

Minna Vihla, LTL: *Medical writing - modality in focus*

Cristina Simões, LTL: *Perceptual Neuroscience, Chapter 12*

Hanna Koivikko, LTL: *Recent dyslexia data* (Dec 13)

Information about conferences in year 2000 (Dec 20)

PUBLICATIONS

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Hari, R. and. Forss, N., *Magnetoencephalography in the study of human somatosensory cortical processing*, The Royal Society (Phil. Trans. R. Soc. Lond.) **354** (1999) 1145-1154

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Helenius, P., Salmelin, R., Service, E., and Connolly, J. F., *Semantic cortical activation in dyslexic readers*, Journal of Cognitive Neuroscience **11** (1999) 535-550

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APPENDIX 1

LT22 FINAL REPORT

Venue and program

The 22nd International Conference on Low Temperature Physics was organized in the metropolitan area of Helsinki, Finland on August 4-11, 1999. All sessions, except the opening ceremony, took place in Espoo on the campus of the Helsinki University of Technology at the same site were LT14 was organized in 1975. The opening ceremony was conducted in the Cultural Hall in downtown Helsinki.

The conference program consisted of five parallel program lines:

Quantum Gases, Fluids, and Solids
Superconductivity
Magnetism and Properties of Solids
Quantum Electron Transport and Mesoscopic Physics
Applications, Materials, and Techniques

Compared to the previous LTs, the scientific program of LT22 had several new features. Quantum Electron Transport and Applications, Materials and Techniques were promoted for the first time to truly independent program lines. Due to lack of large lecture halls on the University campus, half plenary lectures were introduced in the program. In order to promote low temperature physic within the larger physics community, all oral contributions were called invited lectures.

The scientific program included 238 oral and 1250 poster presentations. Only five of the oral presentations were full plenary lectures. The daily program started with four half plenary lectures, followed by five parallel oral sessions both in the morning and in the afternoon. The program continued on the traditional way with twelve parallel poster sessions followed by poster discussions.

The Program Committee held only one meeting in Otaniemi. Most of the committee work was conducted through email.

Attendance

During the 50-year history of LT conferences, the attendance to LT has steadily increased and the trend seems to continue. At LT22, the numbers of registered participants and accompanying persons were 1381 and 172, respectively.

LT17	1984	Karlsruhe	1150
LT18	1987	Kyoto	1563*
LT19	1990	Brighton	1212
LT20	1993	Eugene	1229
LT21	1996	Prague	1421
LT22	1999	Helsinki	1381

* High attendance at LT18 was related to the discovery of high T_c superconductors and the large number of domestic participants (60%).

The LT22 attendance by countries is shown in Annex 1. The 387 Japanese participants constitute by far the largest delegation. In the 1990s, the participation of FSU (Former Soviet Union) scientists has grown significantly. Especially LT21 and LT22 have enjoyed from this increase which, due to hard economic conditions in the FSU countries, might not continue. Over 80% of the FSU participants to LT22 received financial aid.

Abstracts, manuscripts, and proceedings

This was the first LT conference which tried to live up to the era of electronic communication, including submission, editorial processing, and dissemination of abstracts and manuscripts. Altogether 1550 abstracts were submitted to LT22 and published in the Abstract Book. They were followed by 1362 manuscripts, out of which 1353 were in proper electronic form and could be included in uncorrected and unrefereed form on a CD-ROM. This preconference CD-ROM was distributed to the participants in the registration package upon arrival at the conference site. Since then, all manuscripts have been carefully refereed, 10% rejected, and the remaining 1232 will appear in Physica B in April, 2000.

The printed version of the full Proceedings was ordered by 271 participants (Annex 2). The printed Proceedings is also available in libraries subscribing to regular issues of Physica

B or by accessing the Physica B web site at the address http://www.elsevier.nl/locate/physb. Access to this web site is free to all those within a domain attached to a paid subscription.

Support

The Organizing Committee of LT22 received about 500 support applications for nearly 600 000 CHF. Over 70% of the applications came from FSU countries. 263 participants, 116 of them from FSU, were supported from the LT22 budget with a total sum of 177 867 CHF. This sum includes the 6 000 CHF and 33 218 CHF donations from IUPAP and INTAS, respectively.

The support applications were evaluated by the Financial Support Committee. Most of the support was distributed in the form of partially or fully reduced registration fees (100 000 CHF). This was especially convenient for participants from FSU countries who, due to unreliable banking connections, could not transfer their registration fees. 65% of the support was given to 181 ordinary participants and the rest to 82 invited speakers.

Budget

The budget of LT22, shown in detail in Annex 3, was 1 003 527 CHF ($650 000). When compared to the budgets of LT20 ($575 000) and LT21 (560 000 CHF), one has to take into account that the LT22 figures include the waived registration fees (100 000 CHF) both as an income and as participant support in the expenditures. With this addition, the LT22 budget is very similar to the budget of LT20 but somewhat larger than the budget of LT21. LT21, organized in Prague, benefited greatly from the lower price level in Eastern Europe.

Most of the conference income resulted from the registration fees of 1800 mk/participant (484 CHF or $320) and 360 mk/accompanying person (97 CHF or $64). The total registration fee paid by any registrant could also include an optional fee for the final Proceedings in Physica B (900 mk), Conference Dinner (330 mk), Suomenlinna Barbecue (90 mk) and a Church Concert (50 mk).

The organizing committee applied successfully for grants and donations from international and domestic foundations and private companies. The grants from IUPAP, INTAS, Oxford Instruments (10 000 CHF) and 12 domestic donators (87 000 CHF) added up to 151 000 CHF (15% of the total budget).

On the expenditure side, Proceedings, Social Program and refreshments, and Participant support count over 57% of the budget. By request of Physica B, the manuscripts of the Proceedings were carefully refereed with about 10% rejection rate. The refereeing of the manuscripts as well as the abstracts, conducted by five editors (Vsevolod Gantmakher, Pertti

Hakonen, Jukka Pekola, Finn Rasmussen and Erkki Thuneberg), required altogether about 15 months of editorial work.

Helsinki University of Technology supported the conference with free use of its lecture rooms. This resulted in rather low expenditures on facilities (6% of the total budget).

TSG-Congress Ltd., an outside service company, was hired to handle the registration, hotel reservations and travel arrangements of the participants. Other conference related tasks required additional help and 296 896 CHF in total was spent in salaries and fringe benefits of the people working in various parts of the LT22 organization.

The LT22 budget ended with a surplus of about 4.5% of the total budget. Most of this, $25 000 (41 700 CHF), will be donated to the F. London Award endowment at Duke University. The rest of the surplus, 5 368 CHF, will be used to purchase the Proceedings for various libraries in developing countries, to be selected by the Financial Support Committee.

Exhibition

The exhibition stands were placed in the same hall adjacent to the poster area. Altogether 15 companies participated in the exhibition by renting 1-3 stands for a 2000 CHF fee per stand. The exhibition was financially successful yielding a 21 084 CHF additional income to LT22.

EXHIBITION PARTICIPANTS

Air Liquide - DTA, Sassenage, France
Cryophysics SA, Geneva
Cryogenic LTD, London
Elsevier-Science Publisher, Amsterdam
GVL Cryoengineering, Stolberg, Germany
Goodfellow Cambridge LTD, Cambridge, England
Institute of Physics Publishing LTD, Bristol
Lake Shore Cryotronics INC, Westerville, Ohio
Leiden Cryogenics, Leiden, The Netherlands
Linear Research INC, San Diego, California
Nanoway OY, Jyväskylä, Finland
Neuromag LTD, Helsinki, Finland
Oxford Research Instruments, Abingdon, UK
Picowatt OY, Vantaa, Finland
Quantum Design, San Diego, California

Espoo, February 1, 2000

Mikko Paalanen
Chairman, LT22

Matti Krusius
Chairman, Programme Committee

APPENDIX 2

PREFACE OF LT22 PROCEEDINGS

22nd INTERNATIONAL CONFERENCE ON LOW TEMPERATURE PHYSICS - LT22
Helsinki University of Technology
August 4 - 11, 1999

The 22nd in the series of the triennial International Low Temperature Conferences was organized on the campus of the Helsinki University of Technology in August, 1999. This was the first time that the LT Conference was revisiting one of the venues where it had already been once before, namely when LT14 took place in 1975. From the 814 participants in 1975 the Conference had now grown to 1381.

For 5 1/2 days LT22 cultivated five complete parallel programme lines in

1) Quantum gases, fluids, and solids, in
2) Superconductivity, in
3) Magnetism and other properties of solids, in
4) Quantum electron transport and mesoscopic physics, and in
5) Applications and techniques.

The 240 talks were classified as plenary lectures (45 min), half-plenary lectures (45 min), invited talks (30 min), and invited brief reports (15 min). The programme of the five parallel sections was worked out in each case by a four member team of experts, who together formed the LT22 Programme Committee. The oral programme was complemented by 1250 poster presentations. Unlike at most previous LT Conferences, at LT22 the section on "Applications, devices, materials, and techniques" had been elevated to an independent and complete parallel programme line. The oral sessions in this section covered a wide spectrum of new developments and drew large audiences. It is to be hoped that the increased emphasis on new technology will also collect a larger share among the contributed papers at future LT Conferences.

Of all this concentrated activity these proceedings contain 1232 reports which, interestingly enough, fall into the following groups: 19 % Quantum fluids and solids, 32 % Superconductivity, 27 % Magnetism, 14 % Mesoscopics, and 9 % Techniques. Actually a large fraction of the section which we call "Magnetism and other properties of solids " discusses the interface between

magnetism and superconductivity. In mesoscopics more often than not, quantum electronics in superconducting structures is discussed. It is thus instantly appreciated, by leafing through these Proceedings, that in today's LT Conferences the majority of the programme deals with the physics of a quantum condensate state and the superflow of particles of one kind or another.

This was the first of the LT Conferences which tried to live up to the era of electronic communication, including submission, editorial processing, and dissemination of the contributions to these LT22 Proceedings. Surprisingly 99 % of the 1362 manuscripts, which had been received by July 15, were submitted in electronic form. Even more surprising was that 96 % arrived as LaTeX files in the recommended format of Physica B. All electronic manuscripts were included in their unrefereed and uncorrected version in the preconference CD-ROM disk which was distributed to the conference participants upon arrival at the conference site. Since then, all contributions have been carefully refereed, 10 % rejected, and the rest after corrections and revising passed on for processing to Physica B. The final LT22 Proceedings you can now read in printed form as part of the regular edition of Physica B volumes or by accessing the Physica B web site at the address http://www.elsevier.nl/locate/physb. Access to this web site is free for all those within a domain attached to a paid subscription.

The LT Conferences constitute one of the few global forums for all those who view themselves as low temperature physicists. The maintenance of this life line is supervised by the IUPAP Commission C5 on Low Temperature Physics. A second important tradition at the LT Conferences is the award of the Fritz London Prize in Low Temperature Physics. The recipient(s) is(are) selected by the London Prize Committee. This time the London Prize was presented to Douglas Brewer (University of Sussex) for his numerous experimental discoveries in helium physics, to Wolfgang Ketterle (Massachusetts Institute of Technology) for his work on Bose-Einstein condensation in dilute alkali gases, and to one of the undersigned (MK, Helsinki University of Technology) for his studies of rotating superfluid ^{3}He.

A conference like LT22 only becomes possible through the dedicated effort of a large number of energetic achievers. We owe all of them our thanks. LT22 was also generous with financial help, which made it possible for 82 invited speakers and 181 participants, mostly from eastern countries, to have part of their participation and travel expenses covered. Most of this financial aid was donated by outside funding agencies and commercial sponsors. For a conference which is dealing with basic new research, this appreciation from our sponsors is a important event. We also use this chance to thank the five Editors of the Proceedings who each put several months of

full-time work in supervising the refereeing and revision of both the conference abstracts and manuscripts: Vsevolod Gantmakher, Pertti Hakonen, Jukka Pekola, Finnberg Rasmussen, and Erkki Thuneberg. They were assisted by the Editorial Advisors Reyer Jochemsen and Grigory Volovik, and the Editorial Secretaries Peter Berglund, Mark Mehtonen and Tomi Ruokola. A most important link in the editing process was our large international circle of referees who performed a remarkable job in improving individual manuscripts.

In hindsight, the greatest value of a Proceedings like this one is to provide an expansive overview of progress within low temperature physics during the last three years, a reference book on "Who is doing What?" With electronic access and new search tools, we hope that these volumes will serve even better this purpose. The increased concern of refereed journals to eliminate duplication, also from conference proceedings, runs somewhat against the goal of wide representativeness. However, inspite of the increased rejection ratio of the LT22 Proceedings, it appears that all of our community insists on having their conference contributions published in a refereed journal of high reputation. In fact, there were authors who demanded that their manuscripts should not be included in the preconference CD disk, which is an unofficial platform of "unpublished" reports, but none who asked to be removed from the refereed and published proceedings in Physica B.

Mikko Paalanen — Chairman, LT22

Matti Krusius — Chairman, Programme Committee

The following organizations and individuals created the LT22 Conference:

COMMISSION C5 ON LOW TEMPERATURE PHYSICS: Conference supervision
INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS

Matti Krusius, Chairman, Helsinki
Hans Ott, Vice-chairman, Zürich
Henri Godfrin, Secretary, Grenoble
Marcel Ausloos, Liege
Vladimir Dmitriev, Moscow
Alexander Feher, Kosice
Laura Greene, Urbana
John Harrison, Kingston

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Vsevolod Gantmakher: Superconductivity

Pertti Hakonen: Applications, devices, materials & techniques

Jukka Pekola: Quantum electron transport & mesoscopic physics

Finnberg Rasmussen: Magnetism & other properties of solids

Erkki Thuneberg: Quantum gases, fluids & solids

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Harry Alles, satellite conferences and travel grants

Peter Berglund, information, correspondence and exhibition

Vsevolod Gantmakher, proceedings and programme

Pertti Hakonen, proceedings and programme

Marja Holmström, finances and administration

Matti Krusius, programme

Olli Lounasmaa, advisory member

Jukka Pekola, proceedings and programme

Erkki Thuneberg, proceedings and programme

Juha Tuoriniemi, technical support and transportation

Grigori Volovik, advisory member

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Cryophysics SA, Geneva
Cryogenic LTD, London

Elsevier-Science Publisher, Amsterdam
GVL Cryoengineering, Stolberg, Germany
Goodfellow Cambridge LTD, Cambridge, England
Institute of Physics Publishing LTD, Bristol
Lake Shore Cryotronics INC, Westerville, Ohio
Leiden Cryogenics, Leiden, The Netherlands
Linear Research INC, San Diego, California
Nanoway OY, Jyväskylä, Finland
Neuromag LTD, Helsinki, Finland
Oxford Research Instruments, Abingdon, UK
Picowatt OY, Vantaa, Finland
Quantum Design, San Diego, California

AWARD OF THE 1999 FRITZ LONDON PRIZE
Announcement by the Fritz London Prize Committee

The Fritz London Prize in Low Temperature Physics will be awarded at the 22nd Intemational Conference on Low Temperature Physics in Helsinki Finland this summer to:

Douglas F. Brewer (University of Sussex, UK), for his seminal experimental discoveries in adsorbed helium films, including the reduced transition temperatures and T2 specific heat; and for his finding of the linear temperature dependence of the specific heat of ^{3}He; the surface-enhanced nuclear susceptibility of liquid ^{3}He and his verification of the minimum in the ^{3}He melting curve;

Wolfgang Ketterle (Massachusetts Institute of Technology, USA), for his development of techniques needed to study Bose-Einstein condensation in dilute alkali gases, including the cloverleaf Ioffe-Pritchard trap, rf evaporation, optical trapping and non-destructive interrogation using phase contrast and dark-field imaging; and for his pioneering investigations of these systems, including experiments on sound propagation, the time development of Bose condensation, phenomena in a spinor condensate and quantum interference between two previously disconnected condensates, the last being a crucial step towards the realization of an atom laser;

Matti Krusius (Helsinki University of Technology, Finland), for his imaginative and pioneering use of rotation combined with nuclear magnetic resonance to study various properties of superfluid ^{3}He, including textures of the order parameter, the structure, pinning and collective behavior of several different types of vortex, the critical velocity under rotation, the effects of motion of the A-B interface and the systematics of nucleation of vorticity by neutron irradiation.

The Fritz London Memorial Award is an international prize to recognize outstanding contributions to low temperature physics, awarded every three years at the International Confer-ence on Low Temperature Physics. It is supported by endowments administered by Duke Uni-versity, due to the generosity of John Bardeen, of the organizers of LT20 and of Horst Meyer, and by a generous gift from Oxford Instruments.

Fritz London Prize Committee

Moses Chan Patrick Lee Anthony Leggett Daniel Prober
Richard Webb (Chair)