ECT*

Annual Report 2000

European Centre for Theoretical Studies in Nuclear Physics and Related Areas,
Trento
Institutional member of the European Science Foundation Associated Committee NuPECC

Contents

Preface

In the year 2000, ECT* made further steps in developing and improving both its infrastructure and scientific activities. During the year, however, we had a tremendous loss, with the death of Dominique Vautherin. Dominique had been serving at ECT* as Chairman of the Board of Directors and it was during the February meeting of the Board that his illness began to manifest itself. In spite of this, during the months he endured his illness, Dominique followed the development of ECT* through friends and colleagues. We at ECT* joined so many others in mourning Dominique's death; he was greatly respected and much liked by his friends and colleagues of the scientific community.

On a less sad note, the restoration of the ECT*'s new headquarters, Villa Tambosi, was finally completed after three years of hard work and we were able to begin to furnish it. A Danish firm was chosen to provide the furnishing, which is particularly fitting, since this "Danish" touch will remind people of the important role that the Niels Bohr Institute had in the early stages of proposing that a Theory Centre be set up. Ben Mottelson was the first, as past Director and Acting Director, to try out the new Director's office.

The year 2000 was again an active one, with a full schedule of projects and meetings and other activities of the research staff, as can be seen in the following chapters.

In June 2000 the Board of Directors joined ECT* staff, friends and colleagues in celebrating the 60th birthday of the Scientific Secretary.

During 2000, Rudi Malfliet, Director of ECT* from October 1998 until December 2000, came to the decision to retire. He served actively and with his help we prepared the "laborious" application that from February 2000 allowed ECT* to be ranked as "Major Research Infrastructure". Furthermore, under his leadership, the basis for the international financing of ECT* by the various national funding agencies was effectively enlarged.

The start of 2001 sees Ben Mottelson serving as Acting Director as we look forward to the official nomination of the new Director of the ECT*, Wolfram Weise (TU Munich), later in the year.

Renzo Leonardi
Scientific Secretary

1 ECT* Board of Directors, Staff and Researchers

1.1 ECT* Board of Directors (BoD)

Professor Juha Aysto, PPE-ISOLDE, CERN, Geneva, Switzerland
Professor Gordon Baym (from October 2000), Univ. of Illinois, USA
Professor Claudio Ciofi degli Atti, Dept. of Physics, Universitá di Perugia, Perugia, Italy
Professor Sidney Gales, IPN Orsay, Univ. de Paris Sud, Orsay Cedex, France
Professor Wolfgang Hillebrandt, MPI für Astrophysik, Garching, Germany
Professor Larry McLerran, Physics, Department, Brookhaven National Lab., Upton, USA
Professor Ben Mottelson, NORDITA, Copenhagen, Denmark
Professor Alfredo Poves, Dept. de Fisica Teorica, Univ. Autonoma de Madrid, Madrid, Spain
Professor Dominique G. Vautherin, Physique Theorique des Particules Elementaires, Université Pierre et Marie Curie, Paris Cedex 05, France
Professor Jochen Wambach, Insitute of Nuclear Physics, Technical University Darmstadt, Darmstadt, Germany

ECT* Director
Professor Rudi Malfliet

ECT* Scientific Secretary
Professor Renzo Leonardi

1.2 ECT* Staff

- *Ines Campo*
  Technical Programme Co-ordinator
- *Corrado Carlin*
  Maintenance Support Manager
- *Cristina Costa*
  Technical Programme Co-ordinator
- *Barbara Currò Dossi*
  System Manager
- *Tiziana Ingrassia*
  Accounts Assistant
- *Alessandro Lapiana*
  Web Manager
- *Mauro Meneghini*
  Driver
- *Mauro Mion*
  Technical Programme Support
- *Rachel Weatherhead*
  Technical Programme Manager/
  Personal Assistant to the Directors

1.3 ECT* Board Meetings in 2000

The Board met three times in 2000, on the following days:
12 February
23-24 June
21 October

1.4 Resident Postdoctoral Researchers in 2000

Tommaso Calarco (Italy)

Marina Gibilisco (Italy)

Evgueni Kolomeitsev (Russia)

Norbert Ligterink (Netherlands)

Barbara Pasquini (Italy)

Sergio Scopetta (Italy)

Timothy Walhout (USA)

Norbert Ligterink and Evgueni Kolomeitsev

1.5 Junior Visiting Scientists in 2000 (6 weeks)

Steven Bass

Steven Bass (UK), coming from Technische Universität München

Francois Gelis (France), coming from GANIL

Theodore E. Liolios (Greece) coming from the University of Thessaloniki

Dmitri Monakhov (Russia) coming from JINR Dubna

Gevorg S. Poghosyan (Armenia) coming from Yerevan State University

Armen Sedrakian (Armenia) coming from Kernfysisch Versneller Instituut, Groningen

Nadya Smirnova (Russia) coming from University of Leuven

Yasuo Umino (Japan) coming from IFIC - C. S. I. C. Valencia

1.6 Senior Visiting Scientists in 2000 (6 weeks)

A. Baha Balantekin (USA) coming from the University of Wisconsin-Madison

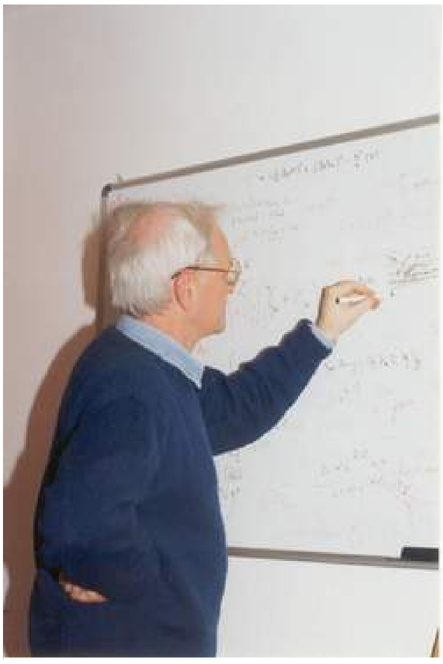
Vladmir B. Belyaev (Russia) coming from JINR Dubna

David Blaschke (Germany) coming from Rostock

Lex Dieperink (Holland) coming from Kernfysisch Versneller Instituut, Groningen

1.7 Visitors to ECT* in 2000

Oreste Nicotra (Italy) coming from Catania	31 Dec. 1999 - 31 March 2000
Marcello Baldo (Italy), coming from Catania	May - July
David Brink (UK) coming from Oxford	29 January - 19 February
Fiorella Burgio (Italy), coming from Catania	May - July
W. Klink (USA) coming from Graz	4 - 6 April
J. Knoll (Germany) coming from GSI Darmstadt	13 March - 9 April
Georges Ripka (France) coming from Paris	1 Nov. 1999 - 15 February 2000 15 October - 15 February 2001
Floarea Stancu (Belgium) coming from the University of Lìege	October - May 2001
Isaac Vidana (Spain) coming from the University of Barcelona	1 June - 15 July



Georges Ripka

2 Projects in 2000

31 Jan. - 11 Feb.	**New perspectives in pairing phenomena in nuclear systems** *Organizers: U. Lombardo, University of Catania (Co-ordinator), J. Cugnon, University of Liege, N. Sandulescu, Institute of Nuclear Physics and Engineering, Bucharest, P. Schuck, Institut des Sciences Nucleaires, Grenoble, J. W. Clark, Washington University, St. Louis*
2 – 6 May	**Nuclear correlations and final state interactions in inclusive and semi-inclusive high energy processes off nuclear targets (Collaboration Meeting)** *Organisers: C. Ciofi degli Atti, University of Perugia, D. Treleani, University of Trieste*
8 – 19 May	**Transport in finite many-body systems** *Organizers: H. Hofmann, Physik Dep., Garching (Co-ordinator), D. Kusnezov, Sloane Physics Lab., Yale.*
24 - 26 May	**Applications of the continuum shell model to atomic nuclei (Collaboration Meeting)** *Organisers: J. Dobaczewski, Warsaw, W. Nazarewicz, Knoxville/Warsaw, M. Ploszajczak, Caen*
5 – 17 Jun.	**Parity violation in atomic, nuclear and hadronic systems** *Organizers: C. J. Horowitz, Indiana University (Co-ordinator), W. T. H. van Oers, University of Manitoba, Canada (Co-ordinator), G. A. Miller, University of Washington, M. Ramsey-Musolf, University of Connecticut*
19 Jun. – 7 Jul.	**Extended Workshop (2 parts)** **Part I (3 weeks) Physics of Neutron Star Interiors** *Organizers: Glendenning (Co-ordinator), D. Blashcke, Rostock, A. Sedrakian, Groningen*
10 Jul. – 4 Aug.	**Part II (4 weeks) Thermonuclear supernovae** *Organisers: W. Hillebrandt, Garching (Co-ordinator), F-K. Thielemann, Basel, S. E. Woosley, Santa Cruz*
16 - 19 Jul.	**EUROBALL Collaboration Meeting** *Organisers: H. Hübel, ISKP, University of Bonn (Co-ordinator)*
11 – 22 Sep.	**Phase transitions in finite systems** *Organisers: Ph. Chomaz, GANIL, Caen (Co-ordinator), M. D'Agostino, University of Bologna, D. Gross, HMI Berlin, F. Gulminelli, LPC Caen, H. Haberland, Freiburg University*
25 Sep. - 6 Oct.	**Artificial atoms and related finite fermion and boson systems** *Organisers: S. Reimann, University of Jyväskylä (Co-ordinator),B. Mottelson, NORDITA, P. E. Lindelof, Niels Bohr Institute,H. Weidenmüller, Max-Planck Institute*

30 Oct - 10 Nov. **Photon production by a Quark Gluon Plasma (Collaboration Meeting)**
Organisers: F. Gelis, Brookhaven National Laboratory

6 – 17 Nov. **Relativistic dynamics and few-hadron systems**
Organizers: G. Salmé, INFN Rome (Co-ordinator), B. L. G. Bakker, Vrije University, Amsterdam, B. Desplanques, Institut de Sciences Nucléaires, Grenoble, V. Karmanov, Lebedev Physics Institute, Moscow

20 – 24 Nov. **Exotic aspects of nuclear decay by light-particle emission (Collaboration Meeting)**
Organizers: E. Maglione, University of Padova (Co-ordinator), N. Carjan, University of Bordeaux, Lidia S. Ferreira, Technical University of Lisbon, D. Strottman, Los Alamos National Laboratory

27 –Nov. – 1 Dec. **Physics with radioactive beams: key experiments and requirements**
Organizers: P. V. Duppen, University of Leuven (Co-ordinator), K. Heyde, University of Gent, K-H. Schmidt, Darmstadt

3 Report on Scientific Activities

3.1 Summary

The ECT* projects in 2000 covered a wide range of research at the frontiers of nuclear physics and its related fields. Out of 14 projects accepted, ten were organised in the form of extended programmes of up to 4 weeks; the remaining four were held as more specialised meetings on research topics of current interest, both theoretical and experimental. All projects were performed by selected international groups of experts from Europe and around the world.

The subjects were all at the frontline of modern nuclear and hadron physics research, exploring present developments and future perspectives in the following active fields:

- **Nuclear structure and reactions**

  This topic was highlighted by projects on **Pairing phenomena in nuclear systems and Physics with radioactive beams** focusing on key experiments. It was supplemented by collaboration meetings on the **continuum shell model**, on **nuclear decay by light particle emission** and on the physics with the **EUROBALL** detector. The projects combined new developments in nuclear structure theory with detailed outlooks on the experimental programmes and possibilities at the upcoming radioactive beam facilities.

- **Physics of many-body systems**

  Highlights of this field were the projects on **Artificial atoms and related fermion and boson systems**, on **Phase transitions in finite systems** and **Transport in finite many-body systems**. A short workshop on **Rotating Bose-Einstein condensates** highlighted recent developments in this exciting topic and brought together international experts in the field with the nuclear physics community with members of the Physics Department of the University of Trento.

- **Fundamental symmetries**

  An extended project on **Parity violation in atomic, nuclear and hadronic systems** underlined the interdisciplinary character of this important subject.

- **Physics of neutron stars and supernovae**

  This extensive two-part project covered altogether seven weeks and focused on the state-of-the-art in the **Physics of neutron star interiors** and **Thermonuclear supernovae**. The second part, in particular, brought together a world-wide panel of experts exchanging and updating their views, in active co-operation, on supernova explosion scenarios. This project profited strongly from the scientific environment and the computing facilities at ECT*. A European network programme was proposed to intensify collaborations between the participants.

- **High-energy nuclear physics and relativistic dynamics**

  These projects included a programme **on Relativistic dynamics and few-body systems** and a collaboration meeting on **Nuclear correlations in inclusive and semi-inclusive high-energy processes**, a topic that is of considerable importance in the context of experiments performed at modern electron facilities, and for future perspectives at such facilities.

- **Physics of the quark-gluon plasma**

  One of the outstanding challenges of nuclear physics in coming years is the investigation, both in experiment and theory, of the conditions under which a quark-gluon plasma can be produced, and the detection of its signatures. The formation of such an extreme state of matter has been the primary goal of research with ultra-relativistic heavy ions at CERN, and it is just started at the still higher energies provided by RHIC at the Brookhaven National Laboratory. At ECT*, the project on **Photon production by a quark-gluon plasma** focused on a particularly important source of information from this deconfinement phase of QCD.

3.2 Projects and Collaboration Meetings

1. **NEW PERSPECTIVES IN PAIRING PHENOMENA IN NUCLEAR SYSTEMS,** 31 January - 11 February

   ORGANISERS:

   U. Lombardo, University of Catania (Co-ordinator), J. Cugnon, University of Liege, N. Sandulescu, Institute of Nuclear Physics and Engineering, Bucharest, P. Schuck, Institut des Sciences Nucléaires, Grenoble, J. W. Clark, Washington University, St. Louis

   NUMBER OF PARTICIPANTS: 58

   MAIN TOPICS:

   - Pairing interactions in nuclear matter and in neutron matter
   - Pairing phenomena in neutron stars.
   - Description of pairing interactions in nuclei, especially in neutron rich nuclei
   - Neutron-proton pairing

   SPEAKERS:

   F. Azaiez (*IPN - Orsay*), M. Baldo (*INFN, Catania*), F. Barranco (*Universidad de Sevilla*), P. Bonche (*CEA Saclay SPTh*), P. *Bozek (Michigan State University*), R. Chasman (*Argonne National University*), J. W. Clark (*Washington University*), J. Cugnon (*Université de Liege*), G. De Angelis (*INFN, Legnaro*), F. De Blasio (*University of Oslos*), J. Dukelsky (*Instituto de Estructura de la Materia*), J. Farine (*Ecole Navale*), S. A. Fayans (*Russian Research Centre - Kurchatov Institute*), H. Flocard (*Institut de Physique Theorique - Orsay*), A. Goodman (*Tulane University*), M. Grasso (*Institut de Physique Nucleare - Orsay*), P-H. Heenen (*Université Libre Bruxelles*), S. Kamerdzhi (*State Scientific Center of Russia*). V. *Khodel (Kurchatov Institute Russian Research Centre*), H. Lenske (*Universität Giessen*), U. Lombardo (*University of Catania*), D. Page (*Universidad Nacional Autonoma de Mexico*), P. Pieri (*University of Camerino*), M. Ploszajczak (*GANIL*), P. Ring (*Technischen Universität München*), G. Roepke (*Universität Rostock*), H. Sagawa (*University of Aizu*), N. Sandulescu (*Royal Institute of Technology*), P. Schuck (*Institut des Sciences nucleaires*), H-J. *Schulze (Universidad de Barcelona*), A. Sedrakian (*Kernfysisch Versneller Instituut*), M. Serra (*Technische Universität München*), T. Takatsuka (*Iwate University*), R. Tamagaki (*University of Kyoto*), J. Terasaki (*INFN Sezione di Milano*), M. Veneroni (*Institut de Physique Theorique - Orsay*), E. Vigezzi (*INFN, Sezione di Milano*), R. Wyss (*Royal Institute of Technology, Stockholm*), M. Zverev (*Kurchatov Institute Russian Research Centre*)

   SCIENTIFIC REPORT:

   The project concentrated on superfluidity problems related to or inspired by the future possibilities of studying experimentally exotic nuclei and from the expected improvement of the experimental information concerning neutron stars. In particular the following issues were extensively covered.

The theoretical ab initio derivation of the superfluid properties of extended systems as well as of finite nuclei has retained a lot of attention. Although satisfactory theoretical frameworks exist for infinite matter, embodying the quasi-particle picture, they cannot be used without relying on some approximations. Many discussions pointed to the necessity to go beyond the simplest BCS approximation but have shown the lack of guidelines for the determination of further accurate and conserving approximations. This issue as well as the possibility to go beyond the quasi-particle approximation, in particular for $^3S_1$ pairing in neutron matter, have been identified as important problems to be tackled in the future. The various approximations used in finite nuclei, restricting attention however in this case to effective pairing forces, have also been discussed. On the other hand, in this case, approximations can be tested in some academic models for which exact solutions are known. However, another problem, particularly relevant for nuclei close to the drip line and for halo nuclei, is the proper treatment of the continuum states. Although this raised interesting discussions, it should be considered as an open question deserving future investigations.

Some aspects of the superfluidity of the neutron star interior were reviewed in relation with observable quantities, like the surface temperature and the post-glitch relaxation rate. Discussion of data on surface temperature pointed to the evidence of the influence of the interior superfluidity on the cooling process. However, it seemed premature to assess the importance of superfluidity and a fortiori to conclude about the existence of exotic pairings, like hyperon pairing or delta-nucleon pairing. Similarly, improved calculations of the Magnus force do not seem to account quantitatively for post-glitch phenomena. Clearly, the appropriate scenario cannot be pinned down in view of the existing, rather scarce, neutron star data.

Another issue which was given attention is the surface enhancement of pairing. Semi-infinite matter calculations point into this direction. On the other hand, it was discussed in the project whether the particle surface vibration coupling could account for the observed enhancement in actual nuclei. Clearly, this problem is far from being settled. Along the same lines, several participants discussed the phenomenological evidence of the surface-enhanced effective pairing force in nuclei and arrived at converging conclusions.

The longstanding problem of the $T = 0$ neutron-proton pairing was also discussed at length. First, the experimental evidence for this phenomena was debated at several moments, in relation with odd-even staggering in various static quantities (mass, spectra, separation energies, r.m.s. radius,...) and with the possible Wigner term in mass formulae. Second, convincing arguments were presented and discussed which attest to a rapid disappearance of this pairing effect with the asymmetry of the nuclei. But one of the highlights was the study of the possible effects of this pairing on the rotational bands of $N = Z$ medium weight nuclei. Experimentalists indicated that, in some of these nuclei, there is a delayed Coriolis alignment with breaking of pairs in low energy rotational bands and presented these data as a puzzling contrast with neighboring nuclei. Direct explanations were provided by theoretical calculations presented in the discussions. The lowest rotational band itself, dominated by $T = 0$ *np* pairing, undergoes in fact a Coriolis alignment, but crosses before a $T = 1$ dominated rotational band which can support a Coriolis alignment without breaking of a pair. As a result, there is no observable effect of pair breaking along the yrast line. The astonishing agreement between these independent investigations support the likelihood of a phenomenon which, if confirmed, appears both novel and appealing. The project will certainly speed up the future activity on this topic.

In conclusion, the project cast light on many topics which should retain the attention of the nuclear physics community in the near future. A tentative list for the next three years would include, at least, the theoretical discussion of the appropriate approximations beyond BCS, the link between bulk superfluidity and finite nuclei features, the role of the surface degrees of freedom, the n - p $T = 0$ $^3S_1$ pairing features in $N = Z$ nuclei and the pairing properties of halo nuclei and of nuclei close the neutron drip line.

2. NUCLEAR CORRELATIONS AND FINAL STATE INTERACTIONS IN INCLUSIVE AND SEMI-INCLUSIVE HIGH ENERGY PROCESSES OFF NUCLEAR TARGETS (COLLABORATION MEETING), 1 - 12 March

ORGANISERS:

C. Ciofi degli Atti, University of Perugia (Co-ordinator), D. Treleani, University of Trieste

NUMBER OF PARTICIPANTS: 7

MAIN TOPICS:

- Inclusive and semi-inclusive quasi-elastic lepton scattering
- The total high energy neutron-nucleus cross section
- The shadowing corrections in hight energy photon-nucleus interactions
- FSI effects in deep inelastic semi inclusive processes off nucleons and nuclear targets
- The nuclear structure functions at Feynman x larger than one.

SPEAKERS:

M. Alvioli (*INFN/University of Perugia*), M. Braun (*University of St. Petersburg*), C. Ciofi degli Atti (*University of Perugia*), L. Kaptari (*Dubna*), H. Morita (*Sendai*), S. Scopetta (*ECT**), D. Treleani (*University of Trieste*)

3. TRANSPORT IN FINITE MANY-BODY SYSTEMS, 15 - 26 March

ORGANISERS:

H. Hofmann, Physik Dep., Garching (Co-ordinator), D. Kusnezov, Sloane Physics Lab., Yale

NUMBER OF PARTICIPANTS: 32

MAIN TOPICS:

Microscopic derivations of transport equations include, influence functional approaches to effective actions, diabatic, pictures, application of linear response theory, as well as techniques based on chaos, statistical mechanics and kinetic, theory. In addition to trying to put these methods into perspective in terms of their scope we studied how they deal with:

- Transition from reversible to irreversible motion
- Relevance of non-Markovian features and the relation to various stochastic assumptions
- Temperature, self-consistency and dissipation in finite, many-body systems
- Inclusion of quantum effects for the nucleonic degrees of freedom
- Quantum effects for collective motion, such as dissipative tunneling
- Application to realistic situations encountered both in nuclear physics as well as mesoscopic systems, from fission and fusion reactions at low and moderately high energies to transport in quantum dots, wires etc

SPEAKERS:

S. Aaberg (*Lund Institute of Technology*), G. Adamian (*Justus-Liebig-Universitaet*), N. Antonenko (*Joint Institute for Nuclear Research*), K. Aoki (*Keio University*), S. Ayik (*Tennessee Techn. Univ*.), A. Baha Balantekin (*Univ.Wisconsin-Madison*), A. Bulgac (*University of Washington*), G. Do Dang (*Université de Paris-Sud-Orsay*), H. Grabert (*Albert-Ludwigs-Universität*), H. Hofmann (*Technische Universität München),* G-L. Ingold (*Universität Augsburg*), F. Ivanyuk (*Technische Universität München),* J. Sudhir (*Bhabha Atomic Research Centre*), A. Kelic (*IReS*), D. Lacroix (*LPC/ISMRA*), W. Nsrenberg (*GSI*), D. Rastovic (*Polytechnic of Zagreb*), R. Rossignoli (*Universidad Nacional de La Plata*), C. Rummel (*Technische Universität München*), M. Thoennessen (*Michigan State University*), M. Veneroni (*Marcel Institut de Physique Theorique*), M. Wilkinson (*Strathclyde University*), V. Zelevinsky (*Michigan State Univ*.)

SCIENTIFIC REPORT:

In the first week, the morning sessions were dedicated to pedagogical lectures from researchers various backgrounds. These talks were complemented in the afternoons by pre-sentations of models addressing transport in small systems like nuclei, mesoscopic systems and so forth. The second week was devoted first to a survey on experimental results, followed by the more practical aspects of applying such models to experimental situations. The main speakers had been asked to prepare some objective remarks concerning the limitations of the topics they discussed, such as what physics these models can and cannot describe, and almost all had followed these suggestions.

In both weeks, there was ample time for critically reviewing the models and theories presented.
Some time was spent critically analyzing the issues and the scopes of various theoretical approaches. Likewise, experimental limitations were discussed, such as the model dependencies that appear in the experimental measurement of transport coefficients.

In our opinion the level of the talks as well as that of the discussions was very high and met the objectives we had posed for ourselves. Most of the lectures were pedagogically excellent and the overall atmosphere was very friendly. This helped the audience to gain insight into new fields and to clarify many issues of controversial nature.

4 APPLICATIONS OF THE CONTINUUM SHELL MODEL TO ATOMIC NUCLEI (COLLABORATION MEETING), 24 - 26 May

ORGANISERS:

J. Dobaczewski, Warsaw (Co-ordinator), W. Nazarewicz, Knoxville/Warsaw, M. Ploszajczak, Caen

NUMBER OF PARTICIPANTS: 12

SPEAKERS:

M. Baldo (*INFN, Catania*), K.Bennaceur (*CEA/DAM/DIF/DPTA/SPN*), J. Dobaczewski (*University of Warsaw*), S. Drozdz (*Institute of Nuclear Physics, Krakow*), G. A. Lalazissis (*Technische Universität München*), K. Langanke (Aarhus C, Denmark), N. Michel (*GANIL*), W. Nazarewicz (*Oak Ridge Nat. Lab.*), F. Nowacki (*CRN, Strasbourg*), J. Okolowicz (*University of Krakow*), M. Ploszajczak (*GANIL*), I. Rotter (*FZR - Rossendorf*), W.Satula (*University of Warsaw*)

SCIENTIFIC REPORT:

The description of coupling between discrete and continuum states is an urgent and important problem in nuclear physics, mainly in the connection with the description of both the structure of exotic nuclei and the "simple" reactions which could exhibit their structure, with strong implications in many fields of physics such as nuclear astrophysics, molecular physics and condensed matter physics. Our collaboration, which includes physicists from various institutions in Europe and in the USA, met at ECT* to discuss most recent results, new possible developments and cross-disciplinary problems. For that reason, the meeting was organized as series of "panel discussions" each one with the specified subject, and more informal "collaborations meetings", where participants discussed and worked together in small subgroups. The panel discussions were devoted to the following subjects: continuum in mean-field theories, quantum open systems, continuum aspects of shell model, pairing interactions in weakly bound systems, shell model description of capture processes of astrophysical interest. The informal character of the meeting was strongly emphasized, which helped discussions and exchange ideas. In this atmosphere, also the students partcipated very actively. We agreed that meetings of this kind should be continued in the future and that the ECT* provides a good framework for them.

5. PARITY VIOLATION IN ATOMIC, NUCLEAR AND HADRONIC SYSTEMS, 5 - 17 June

ORGANISERS:

C. J. Horowitz, Indiana University (Co-ordinator), W. T. H. van Oers, University of Manitoba, Canada, G. A. Miller, University of Washington, M. Ramsey-Musolf, University of Connecticut

NUMBER OF PARTICIPANTS: 62

MAIN TOPICS:

- Low energy tests of the Standard Model.
- Parity violating electron scattering and strange quarks.
- Atomic parity nonconservation and its dependence on nuclear structure.
- Parity violating measurements of neutron densities.
- Mean field and effective field theories of neutron densities.
- Anapole moments and radiative corrections.
- Parity violation in proton-proton scattering from low to high energies.
- Parity violation with neutrons.
- Parity violation in few nucleon systems.
- Nuclear structure for parity violation.
- Weak meson-nucleon couplings.
- Effective field theory for weak interactions.
- Weak hyperon production.

SPEAKERS:

S. Bass (*Technische Universität München),* D. Beck (*University of Illinois*). P. Bedaque (*University of Washington*), J. D. Bowman (*Los Alamos National Laboratory*), A. Brown (*Michigan State University*), R. Carlini (*Jefferson Lab*.), B. Desplanques (*Institut Sciences Nucléaires, Grenobles*), P.-D. Eversheim (*Bohn*), R. *Furnstahl (Ohio State University*), E. Henley (*University of Washington*), B. Holstein (*University of Massachusetts*), T. Kishimoto (*Osaka*), S. *Kowalski (Massachusetts Institute of Technology*), K. Kumar (*Massachusetts Institute of Technology*), J. M. Lattimer (*Stony Brook*), D. Leinweber (*Adelaide*), D. M. Markoff (*Tunl*), R. McKeown (*Carltech*), R. Michaels (*Jefferson Lab*.), J. A. Niskanen (*University of Helsinki*), S. A. Page (*University of Manitoba*), S. Pollock (*University of Colorado*), P. *Sandars (University of Oxford*), I. Sick (*Universität Basel*), P. Souder (*University of Syracuse*), M. Simonius (*ETH-Zurich*), J. Soffer (*Marseille*), L. Smotritsky *(Academy of Sciences of Petersburg*), W. M. Snow (*Indiana University*), R. Springer (*Duke University*), D. Vretenar (*University of Zagreb*), W. S. Wilburn (*Los Alamos National Laboratory*), B. Wojtsekhowski (*Jefferson Lab*.).

SCIENTIFIC REPORT:

Sixty-one physicists attended the program specializing in a very wide range of atomic, nuclear and high-energy physics. There was an excellent interplay between theory and experiment with approximately half of the talks from experimentalists.

I) Parity Violating Electron Scattering.

a) Axial radiative corrections to electron-proton and electron-deuteron scattering appear, in preliminary SAMPLE measurements, to differ from theoretical expectations. If true, this surprising result needs to be understood for the interpretation of many parity-violating measurements.
b) Nucleon electromagnetic form factors are a significant uncertainty in extracting strange quark contributions.
c) Strange quark contributions in the nucleon are consistent with zero. However there are significant error bars and existing measurements are only at a very limited set of kinematics.

II) Atomic Parity Nonconservation.

The atomic theory error for extracting the weak charge in Cs was reported by two groups to be 0.7 to 1%. There has been a slight improvement in theory from recent parity conserving measurements but it is probably not as accurate as recently claimed by the Colorado group. Therefore, the significance of the discrepancy between the Boulder Cs measurement and theory may be less than two sigma and its meaning is unclear. There is a pressing need for better atomic theory for Cs.

III) Parity Violating Neutron radius measurements.

a) The nuclear structure motivation for a parity violating electron scattering measurement of neutron densities in a heavy nucleus is very strong. This measurement will constrain the density dependence of the symmetry energy and provide important information on the energy of neutron rich matter that is important in astrophysics.
b) Existing hadronic probes of neutron densities suffer from important systematic errors because of strong interaction uncertainties that are hard to quantify. If these errors are small, present data suggests the difference between the neutron and proton rms radii in 208Pb is small, consistent with zero. Based on theoretical expectations, this results as very unlikely and would imply large deviations of the energy of neutron rich matter from present calculations.
c) Neutron radius measurements can constrain the nuclear structure needed for the interpretation of precision atomic parity measurements. Future work should address how well theory can extrapolate the radius from one nucleus to another and how well nuclear theory and measurements can constrain isotopic neutron radius differences.

IV) Hadronic parity violation.

a) The preliminary SAMPLE radiative correction results should be studied in terms of possible large hadronic couplings and what these couplings might imply for parity violation in other hadronic processes.
b) Proposed measurements of parity violation in radiative capture as well as the inverse photodissociation reation are very important to finally determine the weak pion nucleon coupling constant $f\pi$ in the two nucleon system.
c) Parity violation in p + p scattering at 221 MeV allows one to focus on only the ${}^3P_2$ - ${}^1D_2$ transition which is sensitive to the weak rho-nucleon coupling of the effective NN interaction. The errors in the existing 221 MeV TRIUMF measurement should be improved.
d) Chiral perturbation theory and effective field theories may allow one to determine connections between parity violating measurements and QCD. The role of chiral extrapolations to include light pion contributions should be studied further.
e) The DDH formalism of meson-nucleon couplings should be recast in terms of parity violating effective nucleon-nucleon interactions. This is necessary because of ambiguities in the exchanged quanta of one boson exchange potentials that are fit to NN scattering.
f) It is important to confirm or deny the ZGS 6 GeV/c proton parity experiment by Lockyer et al. The confirmation of their very large value of A_L would signify a major PV effect that is not understood.

Conclusions.

Atomic parity nonconservation, parity violating electron-proton and electron-electron scattering, neutron and nuclear beta-decay and high-energy experiments provide important complimentary probes of possible physics beyond the standard model. Likewise forward and backward angle parity violating electron-proton, backward angle electron-deuteron and forward angle electron-4He scattering as well as neutrino-nucleon scattering provide complimentary probes of strange quarks in the nucleon. We recommend a full compliment of experiments as several quantities must be constrained and no single measurement can accomplish this.

Hadronic parity violation will have a larger physics impact as experimentalists work to speed up the difficult measurements. Furthermore, there can be important cross-fertilization between hadronic parity violation that studies the weak interaction in hadrons and nuclei and nuclear astrophysics that also studies the weak interaction in dense matter.

Finally, parity violating measurements of neutron densities provides information on the equation of state of dense neutron rich matter that is important for astrophysics. Therefore, there may be important connections between measurements of neutron star radii and the neutron radius of a finite nucleus.

6. EXTENDED PROJECT (2 PARTS), PART I (3 WEEKS) PHYSICS OF NEUTRON STAR INTERIORS, 19 June - 7 July

ORGANISERS:

N. Glendenning, Lawrence Berkeley National Laborator, (Co-ordinator), D. Blashcke, Rostock, A. Sedrakian, Groningen

NUMBER OF PARTICIPANTS: 64

MAIN TOPICS:

- Nuclear Matter Phases
- Pairing, Glitches, Internal Structure
- Quark Matter, Color Superconductivity
- K. Rajagopal (MIT)
- Evolution, Cooling
- Mergers, Gamma-Ray Bursts
- X-ray Binaries, ms-Pulsars
- Consequences of Phase Transitions
- Meson Condensates
- Recent Observational Trends

SPEAKERS:

M. Baldo (*University of Catania*), D. Blaschke (*University of Rostock*), I. Bombaci (*University of Pisa*), F. Burgio (*INFN, Sezione d Catania*), B. Carter (*Observatoire de Paris*), M. Colpi (*University of Milano*), L. Dieperink (*Kernfysisch Versneller Instituut*), A. Drago (*INFN*). R. Epstein (*Los Alamos National Laboratory*), C. Gocke (*University of Rostock*), H. Grigorian (*Yerevan State University*), P. Haensel *(Polish Academy of Sciences*), H-T. Janka (*Max-Planck-Institut München*), V. Kalogera *(Harvard-Smithsonian Center for Astrophysics*), E. Kolomeitsev (*GSI*), D. *Lai (Cornell University*), D. Langlois (*Observatoire de Paris-Meudon*), J. Lattimer (*State Univ. of New York*), T. Liolios (*University of Thessaloniki*), U. Lombardo (*Dipartimento di Fisica*), R. Manka (*Silesian University*), E. Moreno-Mendez (*Universidad Nacional Autonoma de Mexico*), S. A. Moszkowski (*UCLA*), F.Pizzolato (*University of Milano*), G. S. Poghosyan (*Yerevan State University*), J. A. (*Pons State University of New York*), S. B. Popov (*Moscow State University*), A. Possenti (*University of Milano*), K. Rajagopal (*Massachusetts Institute of Technology*), A. Ramos (*Facultat de fisica*), F. Rasio (*MIT*), S. Reddy (*University of Washington*), C. *Roberts (Argonne National Laboratory*), T. Schaefer (*SUNY at Stony Brook*), J. Schaffner-*Bielich (Brookhaven Nat. Lab*.), H-J. Schulze (*Universidad de Barcelona*), A. W. Steiner *(State University of New York at Stony Brook*), A. Taurines (*Universidade Federal do Rio Grande do Sul*), E. N.E. van Dalen (*Kernfysisch Versneller Instituut Zernikelaan*), I. Vidana (*Universidad de Barcelona*), D. Voskresensky (*Moscow Inst. Physics and Engineering*), J. Wambach (*Technical University Darmstadt*), I. Wasserman (*Cornell University*), F. Weber (*Lawrence Berkeley Natl. Laboratory*), J. Zdunik (*Polish Academy of Sciences*)

SCIENTIFIC REPORT:

The International Project on *Physics of Neutron Star Interiors* was part of a seven-weeks summer activity on *Astrophysics of Neutron Stars and Thermonuclear Supernovae* and its results will be summarized in a book of the series *Lecture Notes in Physics*, to be published by the Springer Verlag beginning next year (2001).

Aim and Purpose:

The focus of this workshop was the physics of the superdense matter in compact objects - neutron stars and quark stars.
Since the understanding of the complex physical phenomena in compact objects requires expertise from virtually all branches of physics, ranging from the Theory of General Relativity, to the Low Temperature Physics of fermion and boson condensation, to the QCD at finite densities, it was essential to build up bridges between workers in different sub-fields in order to gain an overall physical picture of compact stars and confront the theory with the observations.

Recent progress on the observational front was reported at the workshop.

Apart from the substantial growth of the number of known pulsars, now of the order of 1000, measurements have been made of neutron star masses in a number of binaries; observational constraints have been set on the mass-radius relationship of neutron stars using X-ray binaries.
Measurements of the surface temperature of a half a dozen of isolated neutron stars have been made.
There are a number of upcoming large scale observational projects that will shed light on the physics of neutron stars; examples are the Chandra X-ray satellite (former XAF) which will provide information of the extreme soft X-ray and UV spectra of isolated neutron stars and the gravitational wave detectors LIGO/VIRGO which will open a window for the detection of gravitational waves from compact objects.

In view of these developments the workshop was devoted to improve the general understanding of the compact objects by continuous feedback from the theory. Issues dicussed at the meeting include the equation of state of superdense matter, pairing correlations in nuclear matter, meson condesation, solid state aspects of the highly compressed matter, weak reaction rates in nuclear and quark matter, implications of color superconductivity as a possible new phase of QCD at high densities, deconfinement signals in the pulsar timing, etc.

7. EXTENDED PROJECT (2 parts), Part II (4 weeks) THERMONUCLEAR SUPERNOVAE, 10 July - 4 August

ORGANISERS:

Organisers: W. Hillebrandt, Garching (Co-ordinator), F-K. Thielemann, Basel, S. E. Woosley, Santa Cruz

NUMBER OF PARTICIPANTS: 25

MAIN TOPICS:

- Observed light-curves and spectra (near and far)
- Interaction with the companion star, observational
- Implications
- Progenitor evolution to ignition
- The ignition process
- Physics of thermonuclear burning and explosion models
- Radiation transport
- Nuclear physics and nucleosynthesis aspects
- Cosmological implications

SPEAKERS:

E. Baron (*Ohio State U.*),S. Blinnikov *(ITEP)*, F. Brachwitz (*U.Basel*), A. Burrows (*U.Arizona*), R. Canal (*U.Barcelona*), W. Hillebrandt (*MPA, Garching*), K. Iwamoto *(Nihon University),* B. Leibundgut (*ESO, Garching*), E. Lentz *(University of Oklahoma),* E. Livne (*Hebrew University, Jerusalem*), P. Lundqvist *(Stockholm Observatory),* P. Mazzali (*OAT,Trieste*), J. Niemeyer (*MPA, Garching*), K. Nomoto *(University of Tokyo),* M. Reinecke *(Max-Planck-Institut fuer Astrophysik),* P. Ruiz-Lapuente (*U.Barcelona*), E. Sorokina (*ITEP, Moscow*), F.-K. Thielemann (*U.Basel*), J. Truran (*U.Chicago*), H. Umeda *(University of Tokyo),* S. Woosley (*UC Santa Cruz*)

SCIENTIFIC REPORT:

Systematic studies of type Ia supernovae at high red-shifts between z $\simeq$ 0.3 and 1 give increasing evidence that we are living in an expanding universe which began to *accelerate* its expansion when it was somewhat older than half its present age. This finding is commonly interpreted as being due to a finite positive cosmological constant Λ (interpreted as the energy density of the vacuum) or, alternatively, attributed to a new form of yet unidentified energy density with negative pressure.

The main aim of the programme was to address the question: Can we salvage $\Lambda = 0$ cosmologies in the light of the recent supervova observations?

The format was to have typically one extended lecture in the morning, which should also serve as a tutorial for students and recent postdocs, followed by short presentations of new results, and topical round-table discussions. The afternoons were devoted to work in small sub-groups, individual research, iterations of questions that were raised earlier and active collaborations between individual participants.

There was active collaboration work from the beginning, leading to presentations of results that were obtained by computer simulations performed during the workshop at ECT*. Here, in particular, the groups working on radiative transfer in type Ia supernovae need to be mentioned.

The Russian group showed their results in which the UV-flux was very high. This was questioned by the Oklahoma-group and by others. Computations performed on the basis of the same explosion models by both groups at ECT* (and in parallel by colleagues in Livermore) confirmed the earlier results of Blinnikov and Sorokina, provided a comparable set of atomic data was used to compute the opacities, in particular for atoms such as Ni, Co, Cr, and Fe, and the correct population of ionization states. It also became clear, however, that a better treatment of the atomic lines will likely suppress most of the UV-flux, an effect which is important for the interpretation of supernovae at high redshifts. We were also lucky that at the time of the workshop a type Ia supernova was observed to explode in the well-studied galaxy NGC 524. Participants of the programme (B. Leibundgut, P. Lundqvist, K. Nomoto) had been granted target-of-opportunity time on the new 8m ESO-VLT in Chile to take pre-maximum spectra of such a rather near supernovae in order to search for emission of Hα from hydrogen.

The group had good observation conditions, the first spectrum was obtained several days before maximum, a first reduction was done at ECT* and showed a feature in the spectrum at exactly the position where Hα should be at the redshift of the galaxy NGC 524. The group then decided to go for a second spectrum 5 days later, and again the data could be analyzed already the next day. The result was that the feature was still present in the spectrum, but did not weaken, as was expected from the theoretical models. Therefore the interpretation of the data is not straight forward, but it may well be that for the first time hydrogen has been discovered in thermonuclear supernovae which would, if confirmed, rule out progenitor models based on the merging of two white dwarfs.

Other results were not so spectacular but nonetheless very important. The Basel and Tokyo groups presented first calculations that made use of newly computed electron-capture rates in high-density nuclear burning. Additional metallicity effects, which could lead to dimmer supernovae at high redshifts, were discussed by several groups, thus challenging the cosmological interpretation.

On the other side, it also became clear that metallicity alone cannot be the parameter which determines the observed correlations between peak brightness and light-curve shape. A better sampling of nearby supernovae with full spectral coverage for at least one year might help to answer this questions, and proposals for observational programmes to close this gap were discussed.

On the question of explosion models there was general agreement that, in principle, only models which assume that an accreting white dwarf reaches the (critical) Chandrasekhar-mass seem to be compatible with all the observational data available to date. This does not exclude that explosions both at the very luminous and the faint end of the luminosity distribution may not have another origin. The key question still is that, although simplified versions of this explosion model can fit all observations extremely well, the physics of thermonuclear combustion seems to be in contradiction with those fits. Numerical experiments and tests were suggested which hopefully will resolve the discrepancy.

All participants agreed that it would be very good if they could meet again as a group in about a year from now (and possibly again at ECT*) for a couple of days to give progress reports on many of the ‘‘home-work problems” they took away with them from Trento.

8. **PHASE TRANSITIONS IN FINITE SYSTEMS,** 11 - 22 September

ORGANISERS:

M. D’Agostino, Bologna, Ph. Chomaz, GANIL (Co-ordinator), D. Gross, Berlin, F. Gulminelli, Caen, H. Haberland, Freiburg

NUMBER OF PARTICIPANTS: 41

MAIN TOPICS:

- Thermodynamics without the thermodynamical limit
- Definition of thermostatistical phase transition
- Signals of phase transitions and critical points
- Theoretical signals from mass partitions
- Experimental status for low-energy nuclear systems
- Results on clusters
- Phase transition of self-gravitating systems
- Equilibrium, thermometers and other observables
- Applications to other phase transitions
- Open problems and new propositions

SPEAKERS:

M. Antoni (*Université d'Aix Marseille*), A. Bonasera (*INFN Catania*), B. Borderie (*Orsay*), P. Borrmann (*University of Oldenburg*), R. Bougault (*GANIL*),C. Brechignac (*Orsay*), M. Bruno (*University of Bologna*), A. Chbihi (*GANIL*), Ph. Chomaz (*GANIL*), M. D’Agostino (*University of Bologna*), C. Dorso (*Universidad Nacional de La Plata*), J. Doye (*University Chemical Laboratory, Cambridge*), J.B. Elliott *(Lawrence Berkeley Laboratory*), M. Farizon (*IPN Lyon*), H. Feldmeier (*Darmstadt*), D. Gross (*Hahn-Meitner-Institut für Kernforschung*), C. Guet (*Grenoble*), F. Gulminelli (*Caen*), H. Haberland (*Universität Freiburg*), J. Jellinek (*Argonne Nat. Lab*.), H. Krivine (*Orsay*), P. Labastie (*Université Paul Sabatier*), J. Leygnier (*Orsay*), T. Maruyama (*INFN Catania*), I.N. Mishustin (*NBI*), L.G. Moretto (*Lawrence Berkeley Laboratory*), M. Pettini (*Conservatorio Astrofisico di Arcetri, Firenze*), H. Posch (*Universitaet Wien*), A.H. Raduta (*Bucharest*), A.R. Raduta (*Bucharest*), J. Richert (*University of Strasbourg*), F. Rivet (*Orsay*), M. Schmidt (*Universität Freiburg*), F. Spiegelmann (*Université Paul Sabatier*)

SCIENTIFIC REPORT:

Phase transitions are universal properties of interacting matter which have been widely studied in the thermodynamical limit of infinite systems. However, in many physical situations this limit cannot be accessed and phase transitions should be reconsidered from a more general point of view.

For all these systems the experimental issue is how to find a signal of a possible phase transition in a finite system.
Recently, many different groups have made considerable progresses on these issues on experimental as well as on the theoretical side.
In order to share the progresses and to join the efforts of the various groups we felt it was important that such "hot" issues and new ideas should be discussed and criticized by a pluridisciplinary community. This is why in this Trento meeting about half of the participants come from the nuclear physics and half from the cluster physics community and some astrophysicists. The cross-fertilization between these different fields was remarkable and we were able to develop a common language and make real progress in the understanding of the general thermodynamics of systems far away from the thermodynamical limit. The main conclusions of our work can be schematically summarized as follows:

Phase transitions can be discussed in finite systems, even in a non ergodic and not even mixing system

A number of examples were given and discussed in detail.

In all the cases, equilibrium has to be conceived as a collection of events filling a portion of the available phase space and the appropriate statistical ensemble can be constructed without analyzing the dynamical process leading to the equilibrium and without speaking of time altogether.

Definitions of phase transitions in finite systems

A number of different definitions of first and second order phase transitions were proposed which can be applied also for a finite number of constituents. Some examples were pointed out where these definitions do not agree.

Definition of phases

A general agreement on the definition of phases in a finite system was found for a first order phase transition as a convexity intruder in the generalized (thermodynamical) potential. This leads to an anomaly (a minimum) in the relevant probability distribution along the transformation from one state to another. The relevant coordinate can then be considered as an order parameter characterizing a symmetry or any other observable. Phases are then defined by the maximal values of the order parameter probability distribution.

Thermostatistical variables

Different natural variables for the statistical problem were proposed.

Ensembles

All thermodynamical observables obviously depend on the ensemble; some examples were given where the existence itself of a phase transition may depend on the ensemble chosen to describe the physical system under study.

Thermometers

Thermometers measure the temperature of the ensemble they are coupled to. In particular, temperature is everywhere uniquely defined in the microcanonical ensemble and a small thermometer weakly coupled to such a system measures the slope of the entropy even in the region of negative heat capacity.

Thermodynamical limit

The available definitions of phase transitions in finite systems do not necessarily imply the survival of the anomaly in the thermodynamical limit. It was proposed that phase transitions have their direct meaning in finite systems independently of whether they survive in the thermodynamical limit or not (D.Gross).
A certain number of participants however feel that the link with the bulk remains a non academical question and that in order to keep a link to classical thermodynamics the expression "phase transition" should be reserved to phenomena that converge to a thermodynamical phase transition in the bulk limit.

Open systems

In the experimental study of phase transitions in nuclear and cluster physics we are dealing with open time dependent systems. The definition of a thermodynamical ensemble for such systems is still an open question.

Relevant observables

Both for first order and second order phase transitions, the relevant observables are not settled yet.

Many signals are proposed but their generality and compatibility has to be checked. General tools to control the relevant order parameter have to be discussed.

Other open problems

A number of very important questions were not been properly addressed or sufficiently discussed during the meeting due to a lack of time. In particular:
the experimental feasibility of equilibria and tools to control the realization of equilibrium in data have to be discussed.
Transport properties of systems in connection with a phase transition have to be assessed.
The origins of criticality in finite (open) systems have to be further explored.
The quantum aspect of the question should be discussed.

The clear success of the meeting was due to the high quality presentations and enthusiastic and lively discussions of all the participants, but it was also favoured by the excellent working and discussing conditions at the ECT*. In particular the practical organization and the constant and kind disponibility of the whole ECT* staff allowed us, among other things, to profit for the whole period of the presence of a colleague with reduced mobility. All the participants also appreciated the abundance of working and discussing places, the informatic resources and the pleasant environment.

9. ARTIFICIAL ATOMS AND RELATED FINITE FERMION AND BOSON SYSTEMS, 24 September - 6 October

ORGANISERS:

S. Reimann, Lund University, Co-ordinator, B. Mottelson, NORDITA, P. E. Lindelof, Niels Bohr Institute.

NUMBER OF PARTICIPANTS: 45

MAIN TOPICS:

- Finite boson systems
- Properties of rotating bose condensates
- Transport properties of artificial atoms
- Quantum dots and quantum wires
- Mean field methods and their limitations
- Quantum computing
- Experiments on quantum dots, artificial atoms and carbon nanotubes

SPEAKERS:

S. Aaberg (*Lund University*), C. Amann (*Regensburg University*), D. G. *Austing (NTT Research Labs*), M. Barranco (*University of Barcelona*), M. *Brack (Regensburg University*), C. Canali (*Lund University*), V. Gudmundsson (*University of Iceland*), K. Hansen (*University of Jyväskylä*), H. Hansson (*KTH Stockholm*), R. *Haug (University of Hannover*), D. Heitmann (*University of Hamburg*), G. Kavoulakis (*NORDITA*), K. Yong-Hoon, J. Kinaret (*Chalmers University of Technology*), P-E. *Lindelof (Niels Bohr Institute*), E. Lipparini (*University of Trento*), M. Macucci (*University of Pisa*), M. Manninen (*University of Jyväskylä*), M. Mehta (*University of Regensburg*), T. Miyakawa (*University of Tokyo*), B. R. Mottelson (*NORDITA*), T. Papenbrock (*University of Washington*), F. Pederiva (*ECT**), M. Pepper (*University of Cambridge*), D. Pfannkuche (*University of Hamburg*), M. Rontani (*University of Modena*), A. Sachrajda (*University of Ottowa*), L. Serra (*University les Illes Baleares*), M. Stopa (*NTT Research Labs.*), S. Stringari (*University of Trento*), K. *Tanaka (University of Saskatchewan*), S. Tarucha (*University of Tokyo*), S. *Tomsovic (Washington State University*), M. Tran (*McMaster University*), P. van Isacker (*GANIL*), S. Viefers (*NORDITA*), A. Wacker (*Technical University Berlin*), H. *Yabu (Tokyo Metropolitan University*)

SCIENTIFIC REPORT:

The project was dedicated to research on confined systems of fermions and bosons. As in a previous workshop on "Artificial Atoms" held at ECT* in April 1999, it was the primary intention of the organizers to invite scientists from several different fields of physics and to create a cross--disciplinary exchange of ideas. Areas for future theoretical and experimental work in the fields of nanostructures (quantum dots and quantum wires, carbon nanotubes) and related finite fermion and boson systems (clusters, atomic nuclei, trapped atomic gases) were to be disussed in this framework.

The project lived up to these expectations. There was a lively exchange of results and ideas between researchers, both theorists and experimentalists, from different commmunities. We believe that the meeting, together with the previous one on "Artificial Atoms", contributed to a cross-fertilization of hitherto rather unrelated fields of physics.

The meeting was opened by an overview on the theory of Bose-Einstein condensation and recent experimental results for dilute trapped Bose gases at ultralow temperatures. The session was continued with the effect of angular momentum on the spectrum and structure of a Bose condensate for the case of weak and attractive interactions between the atoms, the analogies between a trapped Bose gas under rotation and the physics of quasiparticles in the fractional quantum Hall regime, and an introduction to low-dimensional nanometer-sized electronic systems, the so-called "artificial atoms" or quantum dots, and their transport properties. Aside from the many possible technological applications, what makes the study of these "artificial atoms"" exciting are the numerous far--reaching analogies to the physics of atoms, nuclei, metallic clusters and trapped atomic gases. Applications of spin density--functional theory to quantum dots, effects of finite thickness of quantum dots and different exchange-correlation approximations were considered. Recently, much attention has been given to quantum computers. These devices are able, in principle, to perform tasks which are far beyond the capabilities of a classical computer. An introduction to this very timely topic with special emphasis on the physics of superconducting Josephson junctions was given. Recent attempts to physically realize the "qubit", i.e., the quantum--mechanical unit of information, and on how to construct and possibly operate logical elements were discussed.

The second half of the meeting concentrated mainly on fermionic systems like quantum dots, quantum wires, and carbon nanotubes, with emphasis on novel experimental results. Lateral quantum dots typically contain a few hundred particles, and it is very difficult to decrease the number of confined electrons to less than about 20: the tunnel barriers formed by the depletion potential would become too large to observe a current. It is possible to vary the number of confined electrons between about 50 and zero, so that one can empty the dot completely, avoiding the pinch-off problem. Coulomb and Spin Blockade measurements make it possible to construct the addition spectrum of a lateral device in large magnetic fields. Spin phenomena such as singlet-triplet transitions, spin flips etc. were observed directly through current readout. The experimental results were furthermore compared to exact diagonalization calculations. Spin effects in semiconductors or metals are frequently referred to in connection with quantum computing or spintronics concepts and were discussed. Experimental results for vertical quantum-dot artificial "molecules" constructed by vertically stacked electron layers in triple barrier heterostructures were given. The experimental data in high magnetic fields reveal that the phase diagrams for double dots can be quite different from the phase diagram for a single dot. In particular, the maximum density droplet in the lowest Landau level seems much less stable, and extra features that can be related to the depopulation of anti-bonding states (isospin flips) are seen. Recent calculations in the few--electron limit utilizing Hartree-Fock, exact diagonalization, and spin density functional theory suggest differing scenarios. A very broad introduction to the physics of carbon nanotubes and studies of their electrical transport, also focusing on spin-related odd-even oscillations and the Kondo effect was given.

Towards the end of the meeting, the discussions focused on semiclassical aspects of the electronic structure in mesoscopic quantum dots and related systems. "Hot Topic" discussion sessions were chaired by Carlo Canali who focused on disorder and interaction-induced pairing in the addition energy spectra of quantum by M. Stopa on the Kondo effect, and by Guy Austing who presented further experimental results on the electronic and magnetic structure and addition energy spectra of vertical quantum dot artificial atoms and molecules. The open exchange of experimental data was very inspiring and certainly provoked many further thoughts on the theoretical side. As a result of lively discussions after this session, particularly interesting aspects of vertical quantum dot molecules were seen for electron-hole double-layer systems. Here future work, both in theory and experiment, will address excitonic states and the possibility of Bose condensation in quantum dots.

On Saturday afternoon a separate meeting was held by the members of a NORDITA Nordic Project meeting on "Confined electronic systems" in order to summarize past activities and to coordinate future projects within several research teams in the Nordic countries. The response of the participants after the workshop has shown that the need for smaller collaboration meetings and informal workshops is particularly important in this field of reserach where most meetings are held in the style of large conferences. Especially researchers from a field like nanostructure science where the frontiers between condensed matter physics, atomic physics and nuclear physics are not clearly defined, benefit much from cross-disciplinary and informal discussions.

As was the case for the previous meeting in 1999, we were told by many of the participants that it is in particular the small size of our workshop, the opportunity for much collaboration work in between the sessions and the atmosphere of an open forum for discussions created by the ECT* which makes such meetings attractive.

10. **RELATIVISTIC DYNAMICS AND FEW-HADRON SYSTEMS,** 6 - 17 November

ORGANIZERS:

G. Salmé, INFN Rome, (Co-ordinator), B. L. G. Bakker, Vrije University, Amsterdam, B. Desplanques, Institut de Sciences Nucléaires, Grenoble (Project Leader), V. Karmanov, Lebedev Physics Institute, Moscow

NUMBER OF PARTICIPANTS: 62

MAIN TOPICS:

- Relativistic approaches to few-hadron systems
- Light-front dynamics
- Field theory versus fixed number of particle approaches
- Electromagnetic properties of few-hadron systems: theory and experiments
- Relativity in nuclear systems
- Electroweak properties of few-nucleon systems: theory and experiments

SPEAKERS:

J. Adam (*Inst. of Nuclear Physics*), I. R. Afnan (*Flinders University*), H. Arenhovel (*Johannes Gutenberg-Universitaet*), B.L.G. Bakker (*Vrije Universiteit de Boelelaan*), M. Beyer (*Universitaet Rostock*), P. Blunden (*University of Manitoba*), J. Carbonell (*Institut Sciences Nucléaires*), T. Cousin (*Laboratoire de Physique Corpusculaire*), B. Desplanques (*Institut Sciences Nucléaires*), L. *Dieperink (Kernfysisch Versneller Instituut*), S. Dorkin (*Vladivostock*), A. Faessler (*Universitaet Tuebingen*), E. Ferreira Suisso (*Instituto Tecnologico da Aeronautica*), R. Furnstahl (*Ohio State University*), M. Garcon (*CEA- Saclay*), C-R. Ji (*North Carolina State University*), H. *Kamada (Ruhr Universitaet*), W. Klink (*University of Iowa*), M. Mangin-*Brinet (Institut des Sciences Nucléaires*), J-F. Mathiot (*Univ. Blaise Pascal*), E. Pace (*I.N.F.N. Roma*), D. R. Phillips *University of Washington*) P. Ring (*Technischen Universitaet Muenchen*), O. Scholten (*Kernfysisch Versneller Instituut*), A. V. Smirnov (*P. N. Lebedev Physical Institute*), A. Stadler (*Universidade de Lisboa*), M Traini (*University of Trento*), E. Truhlik (*University of Prague*), M. van Iersel (*Vrije Universiteit*), J. Wallace (*Van Orden Old Dominion University*), R. Ferdinand (*Wagenbrunn University of Graz*)

SCIENTIFIC REPORT:

Motivation and Aim

The accurate measurements of hadronic properties already available (e.g. from TJlab) in the kinematical region of a few GeV, and the forthcoming ones in the near future, represent a great incentive for performing relativistic calculations; but this task is very difficult, if one would fully solve the relevant relativistic field theory, due to the presence of an infinite number of degrees of freedom. Therefore, it becomes of great interest to investigate approaches that belong to the domain between nonrelativistic quantum mechanics and fully relativistic field theory, since they represent a source of phenomenological knowledge that, in turn can yield useful hints for improving these approaches. The aim of the meeting was the comparison and assessment of viable approaches used in both particle and nuclear physics, through a detailed discussion of theoretical frameworks adopted and numerical approximations used. In particular the workshop focused at identifying common problems crossing the border between the two disciplines, medium energy nuclear physics and QCD.

Main achievements

In the first week, a wide spectrum of approaches, e.g. i) the manifestly covariant Bethe-Salpeter and Schwinger-Dyson equations, ii) Hamiltonian dynamics in different forms: instant form, point form and both explicitly and non-explicitly covariant light-front dynamics, iii) constraint dynamics, were presented. Extensive talks and discussion sessions allowed, through close comparison, essential progress in understanding the relations between the different dynamical models and the different methods to be achieved. In particular, the need for a benchmark model to enable the evaluation of the advantages and disavantages of the different approaches has been pointed out.

In the second week, applications to hadronic phenomenology, ranging from the nucleon properties to finite nuclei, including few-nucleon systems and nuclear matter, even to neutron stars, were discussed. The valuable methodological simplification that can be achieved by describing the phenomenology within relativistic approaches was pointed out. In particular, relativistic dynamics yields a very effective way of understanding the spectra of heavy nuclei in a unified and relatively simple manner. Moreover, it turned out that in some important cases, e.g. the deuteron current operator in i) 1/M expansion, ii) the spectator model and iii) light-front dynamics proved to be very similar if they incorporate the same relativistic dynamics. Indeed, in view of the recent, very accurate experimental results on the deuteron form factors obtained at TJlab and presented in detail at the meeting, the deuteron could represent an actual testing ground for the different relativistic approaches.

11. EXOTIC ASPECTS OF NUCLEAR DECAY BY LIGHT-PARTICLE EMISSION, 6 -7 November

ORGANIZERS:

E. Maglione, University of Padova (Co-ordinator), N. Carjan,University of Bordeaux, L. S. Ferreira, Technical University of Lisbon, D. Strottman, Los Alamos National Laboratory

NUMBER OF PARTICIPANTS: 25

MAIN TOPICS:

- Experimental status of proton emission
- Theoretical description of proton emission from deformed nuclei
- Fine structure in proton and alpha emission
- Decay out of superdeformed states through proton, alpha and gamma emission
- Alpha emission during fission and from oriented nuclei
- Beta-delayed proton emission
- Two proton emission

SPEAKERS:

A. Andreyev (*University of Liverpool*), J. Aysto (*CERN*), J. Batchelder (*JIHIR/ORNL*), B. Blank (*CENBG*), M. J. G. Borge (*Instituto de Estructura de la*

Materia, CSIC), C. N. Davids (*Argonne National Laboratory*), L. Grigorenko (*University of Surrey*), A. Insolia (*University of Catania*), S. Kadmenski (*Voronez State University*), T. L. Khoo (*Argonne National Laboratory*), G. Lalazissis (*Aristotle University of Thessaloniki*), E. Maglione (*University of Padova*), C. Petrache (*University of Camerino*), G. Pollarolo (*University of Turin*), D. Rudolph (*University of Lund*), P. Schuurmans (*University of Leuven*), F. Soramel (*University of Padova*), N. J. Stone (*University of Oxford*), J. R. Stone (*University of Oxford*), P. Talou (*Los Alamos National Laboratory*), T. Vertse (*Hungarian Academy of Sciences*), P. J. Woods (*University of Edinburgh*).

SCIENTIFIC REPORT:

The project brought together theoreticians and experimentalists from different European and American groups, to discuss various aspects of exotic nuclear decays when a light particle is emitted.

The meeting started with a presentation of the latest experimental results in proton decay done at Argonne, Oak Ridge and Legnaro. New data was shown on the decay of ^{117}La, and ^{146}Tm show for the first time show a fine structure spectrum in a vibrational nucleus.

This was followed by the presentation of the different theoretical approaches. The theory to describe the decay from a vibrational nucleus and from an odd-odd deformed emitter was shown for the first time.

Afterwards the different decays (α, ρ, γ) where a change of deformation is observed were considered both from an experimental and theoretical point of view. From the discussion, the possibility was suggested that the same mechanism governs these completely different processes.

New experimental data on the coexistence at low energy of different nuclear shapes, as seen in α decay, was presented. A proposal for an experiment to observe the angular distribution of the proton emission from oriented nuclei was presented.

12. PHYSICS WITH RADIOACTIVE BEAMS: KEY EXPERIMENTS AND REQUIREMENTS, 27 November - 1 DeceMBER

ORGANIZERS:

P. V. Duppen, University of Leuven (Co-ordinator), B. L. G. Bakker, Vrije University, Amsterdam, B. Desplanques, Institut de Sciences Nucléaires, Grenoble (Project Leader), V. Karmanov, Lebedev Physics Institute, Moscow

NUMBER OF PARTICIPANTS: 32

MAIN TOPICS:

- Nuclear Reaction Aspects for the Production of Secondary Beams
- Production of Secondary Beams: Technical Developments
- Physics Cases and Instrumentation
- Nuclear Theory
  - The Mean Field and the Shell Model
  - Nuclear Reactions using Secondary Beams
  - New Symmetries Out of Stability

SPEAKERS:

J. S. Al-Khalili (*University of Surrey*), F. Azaiez (*IPN - Orsay*), D. Baye (*Université Libre de Bruxelles*), J. Benlliure (*Dept. Fisica de Particulas Elem.*), J-E. Garcia-Ramos (*Institute for Theoretical Physics*), H. Geissel (*GSI*), W. *Gelletly (Science and Engineering Research Council*), M. Hjorth-Jensen (*University of Oslo*), M. Huyse (*Instituut voor Kern Stralingsfysika*), F. Ibrahim (*Institut de Physique Nucléaire*), A. Junghans (*University of Washington*), U. Koester (*CERN Theory Division*), K. Markenroth (*Chalmers Univ. of Technology*), D. Morrissey (*Michigan State Univ.*), M. Ploszajczak (*GANIL*), R. Raabe (*Instituut voor Kern Stralingsfysika*), T. Radon (*GSI*), L. Ravn (*CERN Theory Division*), P. Ring (*Technischen Universitaet Muenchen*), H. Scheit (*Universitaet Heidelberg*), N. Smirnova (*ECT**), P. V. Isacker (*GANIL*), D.V. Neck (*University of Gent*), D. Vretenar (*Univ. of Zagreb*), H. Weick (*GSI*)

SCIENTIFIC REPORT:

The workshop brought together theorists as well as experimentalists to discuss some selected aspects of nuclear physics, more in particular in the field of radioactive nuclear beams. This field is a topic of great current interest. Therefore, worldwide efforts to produce more intense and pure beams of exotic nuclei are undertaken. The two complementary ways to produce such beams - fragmentation followed by in-flight separation and the isotope separator on-line concept followed by post-acceleration - are pursued. The main physics goal thereby is to study nuclei up to the drip-lines by varying the isospin degree of freedom, in order to obtain crucial nuclear-structure information. One indeed expects new quantum phenomena to arise in systems with unusually small binding energies. One of the key issues in that respect is to learn how global nuclear properties like mass, radius, shape change when studying such nuclei. Exploring and understanding the way in which the mean field changes over a large span of nuclei and how new symmetries, underlying the nucleon-nucleon interactions, might appear in these nuclear species with exotic proton-to-neutron ratios is a challenging task. From an astrophysics point of view, important new nuclear-physics input data will be obtained for use in explaining explosive nucleosynthesis processes. Here, radioactive nuclei play a key role in building paths and actually study such processes in laboratory conditions.

Instead of covering the whole field of exotic nuclei research, a few selected aspects were chosen. In this way it was possible to get an in-depth discussion on a specific subject.

Below we give a short summary.

I. Nuclear Reaction Aspects for the Production of Secondary Beams

The different ways to produce exotic nuclei were discussed. The focus was on reactions induced with intermediate and relativistic energy heavy-ion beams. A wealth of accurate experimental data is now available over a wide range of masses. Important to note is that thanks to elaborate detection systems, the different reaction mechanisms can be disentangled. These data allow improving the present models used to predict production cross sections. These new and/or adapted models predict the cross section in a satisfactory way and are extremely important to predict the beam intensities that will become available at the second-generation facilities.
Special emphasis was put on the so-called two-step production process. It was considered important to investigate this process more carefully in view of its potential to produce nuclei in unknown regions.

II. Production of Secondary Beams: Technical Developments

This session was focussed on the production of ISOL type beams using two complementary methods: the more “classical” one using high-temperature target-ion source techniques and the gas stopping approach. It became clear that developments along both lines should be vigorously pursued. Laser ionisation whereby the atom is resonantly ionised using laser light has shown its potential and its importance will grow further. This technique does not only produce elemental purified beams, it can also be used as a diagnostics tool to investigate the different processes taken place in a gas cell. From the discussion it became clear that laser ion sources will play an important role in any future ISOL based radioactive beam facility. In case of the high-temperature approach, it was concluded that a dedicated effort to produce a beam of short-lived isotopes for almost every element separately was needed. Global solutions are difficult to optimise and the field has reached the phase where specific efforts should be undertaken. An illustrative example for the production of ^{11}Li was presented. Although the gas cell concept offers in principle a “global” solution it should be investigated in greater detail. Only its full understanding will show its capabilities and limitations.

III. Physics Cases and Instrumentation

A critical overview of the physics one can investigate using low-, intermediate and high-energy beams was presented. As the properties of the beams are very different depending on the production and selection technique used, it was shown that the approaches give complementary information. Some possible key experiments were presented and examples on how the instrumentation should be adapted because of the use of radioactive beams were given. Results from pioneering experiment performed at the existing first generation facilities were presented. These included halo physics, mass measurements, coulomb excitation and in-beam studies and determination of moments. In certain cases it is clear that "old" experimental techniques that were exploited using stable beams and that were “out of use” because no new essential information could be obtained, should be revived and adapted to the new situation where radioactive beams will be used (e.g. transfer and pick-up reactions, determination of moments using hyperfine interactions).

IV. Nuclear Theory

A detailed confrontation deriving from the study of atomic nuclei using mean-field (both non-relativistic and, more recently, relativistic studies) techniques, on one side, and detailed nuclear structure results derived from the nuclear shell model problem, using large-scale shell-model diagonalizations, on the other side, proved very fruitful. Issues like the spin-orbit splitting, shell quenching, changes in the nuclear effective interaction, appearance of new regions of deformation and related new symmetries were treated in depth. Exact many-body studies, exploring the thermal properties of atomic nuclei (QMC method) as well as new algorithms for sampling such many-body systems were discussed. The complementary with more detailed SMMC calculations was emphasized during the meeting.

New results on how the region of bound nuclear states can be extended and joined, in a natural way, with the region of unbound states (scattering states, nuclear reactions) were presented and discussed. New emphasis was put on reaction theory. The latter is definitely needed in order to interpret the experimental results from nuclear reactions at different energies.

3.3 Sixtieth birthday celebration of the Scientific Secretary

(24 June 2000)

R. Leonardi and S. Galés

Lake Tovel, September ’67

Orsay (Paris), November ’66

The Mottelsons and R. Leonardi, ’97

State Museum, Bruges (Belgium), '97

3.4 Projects of ECT* Researchers

Tommaso Calarco

- ACQUIRE project description

The last few years have seen tremendous advances in the theory of quantum information processing, and already some of the basic ideas have been explored and demonstrated in the laboratory using techniques such as cavity QED, ion traps, quantum dots, and NMR. While progress in this new field has been rapid and impressive, still none of the experimental methods seems to be ideal and there remains a pressing need to develop new technologies capable of fully implementing the quantum operations envisioned in a scalable way.
The key objective of the ACQUIRE project is to combine the expertise and experience of the partners in the fields of experimental and theoretical quantum optics, nanofabrication technology and integrated optics in order to develop and assess a new extremely promising experimental approach to quantum information processing: neutral-atom manipulation using integrated micro-devices. Thereby combining the best of two worlds: The ability to use cold atoms - a well controllable quantum system - as the qubit, and the immense technological capabilities of nanofabrication and microelectronics to manipulate the qubits.

Francois Gelis

- Out-of-equilibrium field theories

This is the continuation of an on-going collaboration with D. Schiff and J. Serreau (Laboratoire de Physique Théorique, Orsay, France), on the problem of generalizing the tools of thermal field theory to systems which are not in statistical equilibrium. The simplest formalism one can imagine to study an out-of-equilibrium system consists just in replacing the equilibrium statistical weights (Bose-Einstein or Fermi-Dirac distributions) by arbitrary functions characterizing the new statistical state. In the simplest version of this extension, the time dependence (relaxation) of those functions is neglected. Therefore, one would expect that this simple formalism is correct for the study of fast processes taking place in a system that returns slowly to equilibrium. However, this had never been justi_ed so far because it happens that this formalism is plagued by singularities known as "pinch singularities" (those singularities cancel if the statistical weights are the equilibrium ones), which consist of ill-defined products of propagators. It has been known for a long time that they can be regularized by taking into account the collisional width of the particles, but the order of magnitude of their contribution was unclear. By studying several examples, we were able to show that those terms are suppressed (compared to the regular ones) by a factor $\lambda_{coh} / \tau_{relax}$, where λ_{coh} is a time-scale characterizing the process under study, while τ_{relax} is the relaxation time of the non-equilibrium background. This ratio is small if the process we are studying is fast compared to the relaxation phenomena. This finally justifies the intuitive assumption that this formalism should work for such a fast process.

- Collaboration project on "Photon production by a quark- gluon plasma"

This project was undertakend in collaboration with two colleagues from the Laboratoire d'Annecy de Physique Thérorique (Annecy, France): Patrick Aurenche and Stéphane Peigne. The aim of the meeting was to work on the problem of photon production by a quark-gluon plasma. Indeed, it is commonly believed that photons (or lepton pairs) are a very clean signature for the formation of a quark-gluon plasma in heavy ion collisions. This is due to their long mean free path, which enables them to escape without re-interactions. The main problem however is that their production rate is poorly known.

Two problem were focused upon:
1. Calculation of the effects of multiple scatterings on photon production by bremsstrahlung. It is indeed expected that multiple scatterings of the quark emitting the photon will affect the shape of the photon spectrum in the region of low energy photons. We managed to reduce the calculation of this effect to the resolution of an ordinary differential equation. At this point, straightforward numerical methods can be used to finish the calculation.

2. Another problem worked on is the calculation of a new contribution to the rate of hard lepton pairs. This process is the one obtained from bremsstrahlung by crossing one fermion: it can therefore be seen as the process $\bar{q}q^* \rightarrow \gamma^* \rightarrow I^+ I^-$ calculated for lepton pairs.

Significant progress was made during our stay in Trento concerning this calculation.

Marina Gibilisco

- Cosmic rays for propogation in the geomagnetic field

In 2000, I started a research work, by also participating in an international Collaboration project involving ECT*, INFN, the University of Perugia and (only at the beginning) the "Cosmion" Group of Moscow University. This long term project aims to develop a theoretical study of cosmic rays, looking at the new perspectives opened by the AMS (Alpha Magnetic Spectrometer) Experiment.

In particular, this theoretical research would give a possible interpretation of the present and future AMS data, concerning both the propagation and the composition of the cosmic rays. The study I performed at ECT* describes the cosmic rays propagation in the proximity of the Earth, where the effect of the geomagnetic field is presumably important;a good knowledge of the cosmic rays motion in the field of the Earth is really important, because it offers the possibility to distinguish particles having different charges and it gives many information about the possible presence of non-secondary antinuclei.
In this way, one might clarify the baryogenesis mechanism in the Early Universe, the formation of matter/antimatter domains and the problem of the possible presence of antideuterium as a trace of supersymmetric dark matter in the present Universe.

- Ultrahigh energy cosmic rays produced by the decays of topological defects

In 2000 I carried out some research also concerning cosmic rays physics, but focused on problems connected to their ultimate origin. Thus, I studied, as possible sources, topological defects decays, with particular attention to the case represented by magnetic monopoles: such objects have probably been formed in a relevant quantity during the various phases transitions which characterized the Early Universe. Monopoles having an opposite magnetic charge may form, through a radiativecapture process, a metastable bound state, called "monopolonium": such a state is generally described by using nuclear Bohr model and assuming that it may exist in discrete configurations, characterized by a principal quantum number *n*. Through many transitions, similar to the nuclear ones, the monopolonium loses its energy, releasing it in the form of particles as photons, gluons, quarks, *Z* bosons and finally the heavy gauge bosons *X* of the GUT theories, having a mass $m_x \sim 10^{16} \sim GeV$: such huge energies and masses guarantee the possibility to produce very energetic secondary particles, may be identifiable with the observed ultrahigh energy cosmic rays.

Thus, in this work, I determined the time evolution of the *X* boson density and the flux of the secondary cosmic rays produced in their decay, with the aim to establish a comparison with the experimentally observed fluxes; in this calculation, an important parameter is represented by the initial free monopole density $n_M(t)$. Such a quantity can be determined in the frame of different inflationary models for the Early Universe, both on the basis of geometrical considerations and of on-lattice simulations. In future, some techniques of parallel computation will be possibly adopted in order to develop such simulations.

Evgeni Kolomeitsev

- Meson-baryon scattering within chiral SU(3) theory *in collaboration with M.F.M. Lutz (GSI, Darmstadt, Germany)*

We successfully used the relativistic chiral SU(3) Lagrangian to describe meson-baryon scattering. Within our χ-BS(3) approach we established a unified description of pion-nucleon, kaon-nucleon and antikaon-nucleon scattering describing a large amount of empirical scattering data including the axial vector coupling constants for the baryon octet ground states. We derived the Bethe-Salpeter interaction kernel to chiral order $Q^3$and then computed the scattering amplitudes by solving the Bethe-Salpeter equation. This leads to results consistentwith covariance and unitarity. Moreover we consider the number of colors N_c in QCD as a large parameter performing a systematic $1/N_c$ expansion of the interaction kernel. This establishes a significant reduction of the number of parameters. In the course ofdeveloping our scheme we constructed a projector formalism, which decouples in the Bethe-Salpeterequation covariant partial wave amplitudes and also suggested a minimal chiral subtraction scheme within dimensional regularization which complies manifestly with the chiral counting rules.

Our results for the $\bar{K}N$ amplitudes have interesting consequences for kaon propagation indense nuclear matter as probed in heavy ion collisions. According to the low-density theorem an attractive in-medium kaon spectral function probes the kaon-nucleon scattering amplitudes at subthreshold energies. The required amplitudes are well established in our work. In particular we find sizeable contributions from p-waves not considered systematically so far.

We expect our scattering amplitudes to lead to an improved description of the spectral functions of antikaons in nuclear matter and pave the way for a microscopic description of kaonic atom data. The latter are known to be a rather sensitive test of the antikaon-nucleon dynamics.

- Phi mesons from a hadronic fireball *in collaboration with P. Filip (MPI, Muenchen, Germany)*

We have studied distributions of phi mesons in heavy-ion collisions at SPS energies reconstructed via hadronic K^+K^- and dilepton $l^+ + l^-$ decay channels. The analysis of phi meson mean free path allows to suppose that phi mesons decouple from the hadronic system at somewhat earlier stage before the common breakup of the hadronic fireball. Therefore, kaon pairs originated from the phi decays inside a fireball can be rescattered or absorbed. Such kaon pairs will not contribute to phi meson reconstruction, whereas the leptonic probes can leave a fireball freely. We derive the expressions for the apparent momentum distribution of phi mesons in kaonic and muonic channels respectively. Within a simple model of spherically expanding fireball we investigate dependence of a relative suppression factor of the hadronic channel with respect to the dileptonic one on parameters of the system and on the phi meson in-medium properties.
The increase of the phi meson width in medium provides a mechanism for strong suppression of the kaonic detection channel due to the enhancement of phi decay probability inside a fireball increasing thus rescattering of daughter kaons. The final net relative suppression factor of kaon channel to muon channel ~ 0.3. This value is close to experimental observations at CERN SPS.
We have found that reconstructed rapidity distributions of phi mesons become effectively wider, if in-medium properties of mesons and rescattering of kaons are taken into account.

Norbert Ligterink

In the year 2000 I worked on several projects. I continued the work ith Niels Walet in Manchester on the Hamiltonian lattice gauge theory, and I visited Manchester early in the year to finish the large paper we now published in Annals of Physics. Still ongoing is the extension of this work to include multiplaquette basis states, and, separately, the write-up of the developments in numerical calculations for the non-linear sigma model. I also continued to work with George Ripka on the self-consistent treatment of quark fields in the presence of a confining potential, which turned out to be a difficult, but educational project. I picked up the work on bound states again, with my former supervisor Ben Bakker from Amsterdam, where we look at the Coulomb problem, with self-energy effects included. We submitted a paper on the subject, however, the paper is not published. Finally, as the result of visit to the Confinement conference in Vienna, in July,

I started to collaborate with Axel Weber, from Morelia, Mexico, on the Bloch-Wilson, perturbatively improved Hamiltonian. I ended the year with a two-week visit to Mexico, where we worked out the finer details of a paper we submitted early in 2001. I also started looking for a new position as my contract ends September 2001. I have accepted a two-year contract at the University of Pittsburgh from this date.

Barbara Pasquini

During the first year of activity at ECT*, my research work was aimed at the theoretical investigation of the hadron structure in electromagnetically induced reactions. The electromagnetic properties of hadrons provide important information in the understanding of the dynamics responsible for their internal structure. A most valuable source of information is given by Compton scattering, which corresponds to elastic scattering of photons by hadronic system.Because of its fundamental character, Compton scattering in different kinematical regimes has recently received a great deal of attention, both experimentally and theoretically.In this context, my working plan was focusedon these topics:

B.Pasquini

- a dispersion theoretical analysis of real and virtual Compton scattering off the nucleon at low energy;
- a study of virtual Compton scattering polarizabilities within different hadronic models.

The first topic concerns an extension of the research work started in collaboration with the theory group of the University of Mainz. The dispersion-relation approach gives a powerful predictive tool to analyze the Compton scattering and the investigation was addressed on those kinematical regimes where a fruitful interpretation in terms of nucleon structure observables is possible. In the case of real Compton scattering, I studied the possibility to extract information on the spin polarizabilities of the proton from double polarization observables. To show the results of this work I was invited to the "Symposium on the Gerasimov-Drell-Hearn sum rule and spinstructure of the nucleon", Mainz (Germany), 14-17 June 2000.
The dispersion-relation approach has been also extended to a theoretical analysis of the generalized polarizabilities (GPs)which can be accessed in virtual Compton scattering (VCS). In this case, one can measure the dependence of the VCS process on the photon momentum transfer Q^2 to map out the spatial distribution of the nucleon polarizabilities. I reported the results of this work at the "Gordon Research Conference on Photonuclear Reactions", Tilton School, NH (USA), 30 July - 4 August 2000, where fruitful collaborations began with experimental groups to analyze recent VCS data within the dispersion-relation formalism. The experimental activity in this field is in fact very rich. A first experiment at low energy has been successfully completed last year at MAMI, and further experiments at JLab and MIT-Bates are under analysis. In addition, we studied the possibility to obtain more information on the GPs in double polarization VCS and a proposal for a first experiment at MAMI has been recently approved.

Concerning the second topic of my research activity, I first investigated the proton GPs polarizabilities within a constituent quark model. Second, in the case of VCS off meson, I concentrated the work on a theoretical calculation of the pion and kaon polarizabilities in VCS within the framework of chiral perturbation theory (ChPT). Predictions for the dipole electric and magnetic polarizabilities of pions and kaons were already known from one-loop calculation in ChPT, and only recently ChPT in the SU(2) sector has been applied to obtain predictions about the Q^2 dependence of the VCS generalized polarizabilities of the pion. The purpose of my work was to extend the calculation of the VCS amplitude to the SU(3) sector of ChPT. On one side, this calculation allowed the kaon-loop contribution to the GPs of the pion to be included and on the other side, it provided first theoretical predictions for the GPs of the kaon.

Georges Ripka

The work concerning the evaluation of the quantum fluctuations of the quark condensate has been completed and it is published in Nuclear Physics A683 (2001) 463. The calculation shows that there are indeed surprisingly large quantum fluctuations of the quark condensate, but that they do not lead to the restoration of chiral symmetry, as speculated by Kleinert. The calculation also revealed a hitherto unsuspected instability of the Nambu Jona-Lasimio model, visible already in the semi-classical approximation, and which is due to poles induced by the regularization.

Another research project was initiated in collaboration with Norbert Ligterink at ECT*. The aim of this project is to perform a calculation of the confined states of a quark and a antiquark using a confining interaction which is defined in 4-dimensional x-space and which respects Lorenz invariance. The aim is less to simulate QCD (the confining mechanism of which is not understood) than to find a way of performing the analytic continuation required to calculate on-shell mesons in the presence of confining potentials.

Sergio Scopetta

During the year I spent at ECT*, I was mainly involved in calculations of inclusive and semi-inclusive scattering of leptons off nuclei and nucleons. Among the other topics, I performed a theoretical analysis of polarized electron scattering off polarized light nuclei, in order to properly extract the neutron polarized structure functions from nuclear data, in the resonance region. For this proposal I collaborated with researchers from the TJNAF Lab (Virginia, USA) and I was invited to discuss my results to the Conference "Hix2000", held in Philadelphia in March.

Such a program requires proper treatment of final state interaction effects and, to develop it, I started a collaboration with the group of Prof. C. Ciofi degli Atti at the University of Perugia.

At the same time, I have been collaborating to write a proposal for an experiment to be performed at the TJNAF Lab, aimed to extract the unpolarized neutron deep inelastic structure, at large values of Bjorken χ, using ^3He and ^3H nuclear targets. Together with researchers from Rome (Prof. E. Pace and G. Salmé and Pisa (Prof. A. Kievsky) I was also involved in studies of the nucleon structure, collaborating with Prof. V. Vento (Valencia), where I was invited in March, and with Profs. M. Traini and F. Cano (Trento). In particular, we faced the problem of obtaining parton distributions from relativistic quark models of the nucleon, i.e., high energy properties from low energy ones. We completed the calculation of Orbital Angular Momentum (OAM) parton distributions in Light-Front Dynamics. It turned out that OAM is very sensitive to the relativistic treatment of the spin in a light-front dynamical approach and further studies in this direction seem very promising.

At the end of October 2000 I obtained a tenure position at the University of Perugia, and I had to leave the ECT*.

Timothy Walhout

Research programme consists of:

(1) develop Dyson's intermediate picture within framework of similarity renormalization group and apply to light-front QCD and other model systems;
(2) develop Feynman variational path integral (FVPI) approach, previously shown to reproduce Fermi hypernetted chain for spin-independent systems;
(3) develop quark model for application to dense nuclear matter and the phase transition to quark-gluon plasma

Collaborators on (2): Stefano Fantoni (SISSA, Trieste), Rinaldo Cenni (Genova) and Adelchi Fabrocini (Pisa); on (3) Nir Barnea (ECT*).

Status is:

(1) General framework was set up in a long paper with encouraging results. Dyson's scheme allows use of less restrictive regulators not available in other LF approaches. A confining potential appears in similarity transformed LFQCD Hamiltonian. Now applying Similarity Framework to rotating Bose-Einstein condensates (at suggestion of Ben Mottleson), to delta-function dimensional transmutation model of Jackiw, to linear sigma model, and running LFQCD coupling.
(2) General application of FVPI to spin-dependent systems is set up in a long preprint where it is shown how to go beyond single-operator chain (SOC) approximation (FHNC has been restricted to SOC for 20 years), and formalism is applied to neutron matter, where it is found that corrections to SOC are indeed small (as always hoped). A snag that slowed progress for some time was the discovery that the choices of boundary conditions and unperturbed Hamiltonian necessary to reproduce FHNC puts the Feynman variational principle at risk. This has been understood and controlled, as explained in another preprint where a "correlated" perturbative expansion about the variational minimum is worked out.
(3) Nontopological quark model with dynamical confinement mechanism and explicit quark-meson coupling was developed in (4) where a detailed modeling of dense solitonic systems was introduced for application to nuclear matter, with qualitatively accurate results already for a rather stripped down version of the model.

Current work in (1): calculation of running LFQCD coupling, evaluation of Bethe-Salpeter-like equation for ladder summation of confining potentials; in (2): calculation of perturbative corrections for model interactions, extending formalism to spin-orbit and tensor interactions.

3.5 Publications from 2000

"Quantum computing with neutral atoms"
H.-J. Briegel, T. Calarco, D. Jaksch, J. I. Cirac, and P. Zoller
Journal of Modern Optics 47 (2000) 415.

"Quantum gates with neutral atoms: Controlling collisional interactions in time dependent traps"
T. Calarco, E. A. Hinds, D. Jaksch, J. Schmiedmayer, J. I. Cirac and P. Zoller
Physical Review A 61 (2000) 022304.

"Entangling neutral atoms for quantum information processing"
T. Calarco, H.-J. Briegel, D. Jaksch, J. I. Cirac, and P. Zoller
in press on *Journal of Modern Optics 47 (2000) 2137.*

"Quantum computing with trapped particles in microscopic potentials"
T. Calarco, H.-J. Briegel, D. Jaksch, J.I. Cirac and P. Zoller
Fortschritte der Physik 48 (2000) 945.

"Nanofabricated atom optics: Atom chips"
K. Brugger, T. Calarco, D. Cassettari, R. Folman, A. Haase, B. Hessmo, P. Krüger, T. Maier and J. Schmiedmayer
Journal of Modern Optics 47 (2000) 2789.

"Quantenoptik und Nanotechnologie - auf dem Weg zum universellen Quantencomputer"
D. Jaksch, T. Calarco and P. Zoller
Physik in unserer Zeit 31 (2000) 260.

"Atom Chips"
M. Bartenstein, D. Cassettari, T. Calarco, A. Chenet, R. Folman, K. Brugger, A. Haase, E. Hartungen, B. Hessmo, A. Kasper, P. Krüger, T. Maier, F. Payr and S. Schneider, J. Schmiedmayer
Journal of Quantum Electronics 36 (2000) 1364.

"Micromanipulation of neutral atoms with nanofabricated structures"
D. Cassettari, A. Chenet, R. Folman, A. Haase, B. Hessmo, P. Krueger, T. Maier, S. Schneider, T. Calarco and J. Schmiedmayer
Applied Physics B 70 (2000) 721.

"Entangling ions in arrays of microscopic traps"
T. Calarco, J.I. Cirac and P. Zoller
Physical Review A, Vol 63 (2001) 062304.

"An analytical solution of the cosmic rays transport equation in the presence of the geomagnetic field"
M. Gibilisco
Int. Journ. of Mod. Phys A16 (2001) 2293.

"Quasiparticle model of the quark gluon plasma in a strong magnetic field"
M. Gibilisco
Int. Journ. of Mod. Phys. A16 (2001) 2473.

"Monopolonium decay as a source of ultrahigh energy cosmic rays"
M. Gibilisco
Submitted to Astrophysics and Space Science (April 2001).

"Solving multiloop feynman diagrams using light-front coordinates"
N.E. Ligterink
Phys. Rev. D 61 (2000) 105010.

"A hamiltonian many-body approach to su(n) lattice gauge theory"
N.E. Ligterink, N.R Walet and R.F. Bishop
Nucl. Phys. (Proc. Suppl.) B 83-84 (2000) 956.

"A many-body treatment of hamiltonian lattice gauge theory"
N.E. Ligterink, N.R Walet and R.F. Bishop
Nucl. Phys. A663&664 (2000) 983c.

"Towards a many-body treatment of hamiltonian lattice su(n) gauge theory"
N.E. Ligterink, N.R Walet and R.F. Bishop
Ann. Phys. (N.Y.) 284 (2000) 215-262.

"Phase transition in the transverse ising model using the extended coupled cluster method"
J. Rosenfeld and N.E. Ligterink
Phys. Rev. B 62 (2000) 308.

"The field-theoretical coulomb problem"
N.E. Ligterink and B.L.G. Bakker
hep-ph/0010167.

"Hamiltonian lattice gauge theory"
N.E. Ligterink,
Proceedings of the Fourth International Conference on Confinement and the Hadron Spectrum,Vienna, 3-8 July 2000.

"Coupled cluster studies of chiral meson field theories: the nonlinear sigma model on the lattice"
R.F. Bishop, N.E. Ligterink and N.R. Walet
Condensed Matter Theories, Vol. 14 (2000) (Ed. Ernst).

"Screened coulomb potentials for astrophysical nuclear fusion reactions"
Theodore E. Liolios
Eur.Phys. J. A9 (2000) 287-292.

"Atomic effects in astrophysical nuclear reactions"
T. E. Liolios
Journal-ref: Phys.Rev. C63 (2001) 045801.

"Multi-electron SEFs for nuclear reactions involved in advanced stages of stellar evolution"
T. E. Liolios
Journal-ref: Nucl.Phys. A693 (2001) 847-860.

"Dispersion relation formalism for virtual Compton scattering and the generalized polarizabilities of the nucleon"
B. Pasquini, D. Drechsel, M. Gorchtein, A. Metz and M. Vanderhaeghen,
Phys. Rev. C62 (2000) 052201 (R)

"Virtual Compton scattering off the pseudoscalar meson octet"
T. Fuchs, B. Pasquini, C. Unkmeir and S. Scherer,
Czech. J. Phys., Proc. of the 13th Indian Summer School: "Understanding the structure of Hadrons", Prague, Czech. Republic, 28 August - 01 September, 2000.

"Dispersion analysis of the spin polarizabilities"
B. Pasquini, D. Drechsel, M. Gorchtein and M. Vanderhaeghen,
Proc. of the Symposium on the Gerasimov-Drell-Hearn sum rule and the nucleon spin structure in the resonance region, (World Scientific), 2001

"Dispersion analysis for generalized spin polarizabilities"
M. Vanderhaeghen, D. Drechsel, M. Gorchtein, A. Metz and B. Pasquini
Proc. of the Symposium on the Gerasimov-Drell-Hearn sum rule and the nucleon spin structure in the resonance region, (World Scientific), 2001.

"Double polarization Virtual Compton scattering in the threshold regime"
A1 Collaboration, Spokesperson: R. Neuhausen
Exp.-Nr. A1/1-00.

"Generalized polarizabilities of the proton in a constituent quark model revisited"
B. Pasquini, S. Scherer and D. Drechsel
Phys. Rev. C63 (2001) 025205.

"Solitons in non-local chiral quark models"
W. Broniowski, B. Golli and G.Ripka
hep-ph/0107139 (July 12, 2001) submitted to Nuclear Physics A.

"Orbital angular momentum parton distributions in light front dynamics"
F. Cano, P. Faccioli, S. Scopetta and M. Traini
Phys. Rev. D 62 (2000) 054023.

"Neutron unpolarized structure function F_2x from deep inelastic scattering off ^{3}He and ^{3}H"
E. Pace, G. Salmé, S. Scopetta
Nucl. Phys. A689 (2001) 453-456.

"Properties of ordinary and exotic hadrons"
Fl. Stancu
Few-Body System Suppl. 13 (2001) pp. 225-234.

"Nuclear matter in nontopological soliton models with quark-meson coupling"
Nir Barnea and T.S. Walhout
Nucl. Phys. A677 (2000) 367-395.

3.6 Conference Contributions and Talks in 2000

Steven Bass

"Proton spin structure and the low-energy $pp \to pp\,\eta'$ reaction"
S.D. Bass
hep-ph/0006348, invited talk at DIS 2000 (Liverpool, U.K.),
Proc. 8th International Workshop on Deep Inelastic Scattering, eds. J. Gracey and
T. Greenshaw (World Scientific 2001) 206-207.

Norbert Ligterink

"Control on Hamiltonian lattice gauge theory"
Conference on quark confinement and hadron spectra, Vienna, 3-8 July 2000.

"The field-theoretical Coulomb problem"
Poster (and talk) *Few-Body XV, Evora, Portugal, 11-16 September 2000.*

"Bound-state equations for massless exchange particles"
Workshop on relativistic dynamics and few-hadron systems, 6-17 November 2000, ECT, Trento, Italy.*

"Relativistic bound-state problems"
8 December 2000, IFM, University of Michoacan, Morelia, Mexico

"The quantum phase transition in the non-linear sigma model: a study of spontaneous symmetry breaking"
14 Dec 2000, KVI, Groningen, The Netherlands

Barbara Pasquini

"Dispersion analysis of the spin polarizabilities}, contribution at the "Symposium on the Gerasimov-Drell-Hearn Sum Rule and the Nucleon Spin Structure in the resonance region"
Mainz, Germany (14-17 June 2000)
"Dispersion analysis of real and virtual Compton scattering"
Invited talk at "2000 Gordon Research Conference on Photonuclear Reactions", Tilton School,
NH (USA), (30 July - 4 August 2000)

"The formalism of dispersion relations to extract the generalized polarizabilities in virtual Compton scattering"
Collaboration Meeting at the J. Gutenberg University in Mainz, Germany (8-10 November 2000)

Sergio Scopetta

"Nucleon Structure Functions in a Constituent Quark Scenario"
Valencia University, Spain, 23.03.2000

"Neutron Spin Structure from Inclusive Electron Scattering off 3-Body Systems"
Temple University, Philadelphia, USA, Conference "HiX2000", 31.03.2000

"The $F_2^n(x,Q^2)/F_2^p(x,Q^2)$ ratio in DIS at high *Bj-x*"

ECT, Trento, 03.05.2000, during the Collaboration Meeting "Nuclear correlations and final state interactions in inclusive and semi-inclusive high energy processes off nuclear targets"*

"Neutron unpolarized structure function $F_2^n(x)$ from DIS off ^3H and ^3H"

Evora, Portugal, 12.09.2000, XVII European Few-Body Conference

3.7 Lectures

Fl. Stancu gave a 24 hours course on Group Theory to PhD Students at the Faculty of Sciences in Povo, during the period November 2000 - February 2001

S. Scopetta, R. Malfliet, J. Wambach, T. Walhout, A. Sedrakian

3.8 Seminars at ECT* in 2000

As in past years, a weekly seminar series was maintained at the ECT*, drawing speakers from the research staff here and at the University of Trento, as well as short and long-term visitors to the ECT*. In addition, the post-docs initiated an intermittent set of informal talks/dicussions on subjects of mutual interest. This led also to idea of organizing somewhat more formal mini-workshops on specific overlapping areas of research to be held peridiocally during weeks when no workshops or collaboration meetings are planned. The first such mini-workshop was held on 28 November, entitled "QCD AND CONFINEMENT: methods, models, and the bridges between them". The speakers and subjects were:

Maria-Paola Lombardo, INFN-Padova:	"Euclidean Lattice QCD"
Norbert Ligterink, ECT*:	"Hamiltonian Lattice Gauge Theory"
Floarea Stancu, Liege:	"Constituent Quark Models"
Marco Traini, Trento:	"Parton Distributions & Quark Models"
Tim Walhout, ECT*:	"Light-Front QCD"

The next mini-workshop was scheduled for February 2001, on topics in Chiral Symmetry.

List of seminars

January 13th - Sergio Scopetta

"Parton Distributions and Constituent Quark Models"

January 27th - Marina Gibilisco

"Cosmic Rays Astrophysics: an analytical study of their propagation within the magnetic field of the Earth, perspectives in the discovery of antinuclei and antimatter in the Universe"

April 6th - William Klink

"Applications of Point Form Relativistic Quantum Mechanics to Quarks and Nucleons"

April 13th - Rudi Malfliet

"Non-classical Behaviour in Non-equilibrium Quantum Systems"

April 19th - Barbara Pasquini

"Compton Scattering off the Nucleon and Polarizabilities"

May 13th - Thomas Steele

"Asymptotic Pade Approximation Methods in QCD"

June 1st - Steven Bass

"The Spin Structure of the Proton"

June 21st - Alessandro La Piana
"Calculation of Exclusive Cross Sections with the Lorentz Integral Transform Method"

September 20th - Marvin Girardeau
"Fermi-Bose Mapping for 1D many particle systems"

September 27th - Yasuo Umino
"Diagonalization of the strongly coupled lattice QCD Hamiltonian"

October 5th - Lex Dieperink
"Soft Electro-Weak Bremsstrahlung and the Thermal Evolution of Neutron Stars"

October 11th - Vladmir Belyaev
"The Low-energy Interaction of eta-mesons with light Nuclei"

October 17th - Nadya A. Smirnova
"Algebraic Approach to Multiphonon Exitations in near-spherical Nuclei"

October 25th - Nadya A. Smirnova
"Auger decay Rates of Antiprotonic Helium"

November 2nd - Francois Gelis
" Photon Production by a Quark-Gluon Plasma"

4 Report on other activities

4.1 STATE: 5th EU Programme

Since the beginning of 2000, ECT* has been ranked, within the 5th EU Programme, Human Potential and Mobility, as a "Major Research Infrastructure": the EU partially finances the access to ECT* of user groups of EU Member and Associated States.

This contract provides transnational access for researchers to the ECT* as a Major Research Infrastructure under the programme “Improving the Human Research Potential and Socio-Economic Base”. For more information please consult http://www.ect.it under STATE.

ACCESS BEING OFFERED FOR USERS

Any ECT* Activity is open to all qualifying people (users also called participants), but is however limited by capacity control and a selection procedure. People wishing to participate can either contact the project co-ordinators or the Project Manager, the Director of the ECT* directly.
Each activity and its closing dates will be announced separately on our web-site (http://www.ect.it).

4.2 ECT* Joint Finance Review Committee (EJFRC)

The members of the EJFRC met on 17 June 2000 to discuss the financial status of the Centre in 2000 and prospects for the future.

Members of the EJFRC:

CEA (France)
IN2P3 (France)
GSI/BMBF (Germany)
INFN (Italy)
ITC (Italy: Istituto Trentino di Cultura)

Support from other countries:

Many other countries contribute or will contribute financially towards the scientific activities of ECT*; so far these countries include:

Austria, Belgium, Czech Republic, Denmark, Finland, Japan, The Netherlands, Poland, Portugal, Spain, Sweden, UK.

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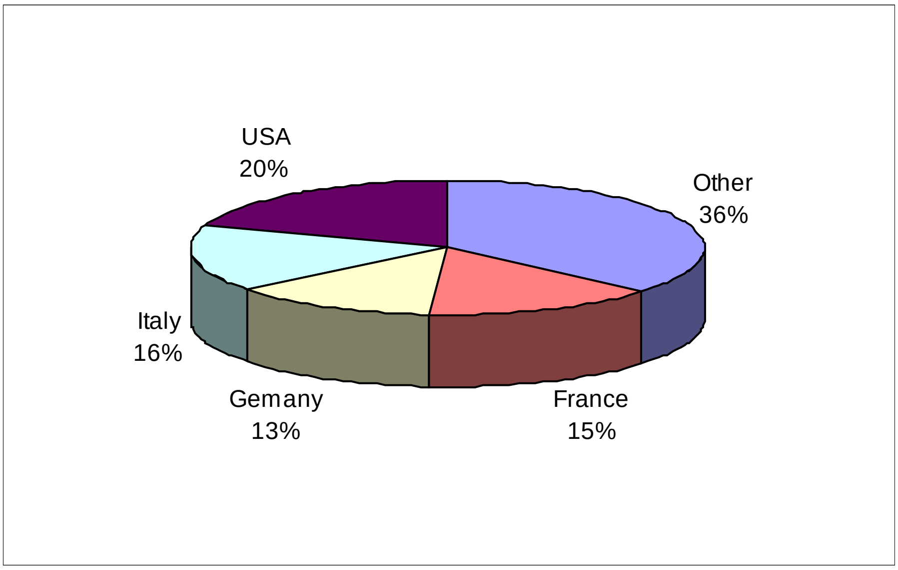
6 Visitors to ECT* - Statistics

During 2000 ECT* welcomed nearly 700 visitors coming from almost 40 different countries:

- 622 visitors participated in projects and collaboration meetings (see next page)
- 65% of visitors came from the countries which directly supported ECT* in 2000 (France, Germany, Italy, Austria, Belgium, Czech Republic, Denmark, Finland, Japan, The Netherlands, Poland, Portugal, Sweden and the UK)
- 30% of guests came from overseas countries.

The country with the greatest number of visitors was USA, while 84% of visitors came from non-Italian institutions.



Participants in ECT* projects and collaboration meetings in 2000
(Summary)

Participants in ECT* projects and collaboration meetings in 2000, specified according to home institution at the time of the visit (Total 622)