Beyond the Desert 2002

Accelerator, Non–Accelerator and Space Approaches in the NEW MILLENIUM

Proceedings of the Third International Conference on Particle Physics Beyond the Standard Model: Accelerator, Non-Accelerator and Space Approaches, Oulu, Finland, June 2 – 7, 2002

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The third conference on particle physics beyond the Standard Model (BEYOND THE DESERT’02 - Accelerator, Non-accelerator and Space Approaches) was held during 2–7 June, 2002 at the Finish town of Oulu, almost at the northern Arctic Circle. It was the first of the BEYOND conference series held outside Germany (CERN Courier March 2003, pp. 29-30). This decision arose at the time when the University of Oulu invited us to consider the Pyhäsalmi mine as a site for our GENIUS project, and to help to push the development of a Finish Underground Laboratory. Nowadays Oulu is a modern rapidly growing university town at the Gulf of Bothnia in northern Finland. The conference was held at the POHTO center at Nallikari in a couple of minute-walk distance to the Gulf of Bothnia with a sunny beach and 3 km bike route from Oulu centre. It provided an intensive and pleasant atmosphere for a restricted number of about 120 participants.

Traditionally the Scientific Programme of BEYOND conferences, brought into life in 1997 (see CERN Courier, November 1997, pp.16-18), covers almost all topics of modern particle physics. At this conference major emphasis was on new theoretical developments in the fields of Extension of the Standard Model by means of Grand Unified and SUSY theories and Extra dimensions. These subjects were discussed in talks of N. Mavromatos (Oxford and CERN), P. Nath (Boston), E. Ma (Riverside), A. Pilaftsis (Manchester), B. Bajc (Lubljana), H. Bech-Nielsen (DESY), I. Antoniadis (CERN) and others. M-theory and Fundamental symmetries were considered in the talks of A.E. Faraggi (Minnesota), M. Cvetic (Pennsylvania), M. Kirchbach (Zacatecas, Mexico), T. Kuo (Stony Brook), Yu. Kamyshkov (Knoxville), T. Söldner (Grenoble), M. Kreuz (Grenoble), and M. Morita (Tokyo). New results of the Search for Higgses, SUSY particles, R-parity violation, Leptoquarks and Excited Fermions at LEP and HERA colliders were presented in the talks of R. Nicolaidou (Saclay), S. Costantini (Roma), U. Katz (DESY), A. Lipniacka (Stockholm) and O. Yushchenko (Protvino).

The long-standing and intriguing problem of dark matter in the Universe is a permanent topic at any conference aiming at new physics and new phenomena. From theoretical point of view the dark matter problem was extensively discussed by D. Nanopoulos (Texas), R.L. Arnowitt (Texas), A. Green (Stockholm), V.A. Bednyakov (Dubna), R. Viollier (Cape Town). Results and perspectives for Direct Dark Matter Experiments with Scintillators (DAMA project) and Germanium detectors with big target mass (GENIUS and GENIUS-TF projects (see also CERN-Courier, December 1997, pp.19)) were presented by R. Bernabei (Roma) and I.V. Krivosheina (Heidelberg and Nizhniy Novgorod). Today only these two experiments are in principle able to see (DAMA already may have seen) a positive signal from dark matter particle interaction with target nuclei by means of seasonal modulation. Other experiments (for example with sophisticated cryogenic detectors and ionisation-to-heat discriminations) due to the very small detecting mass are at present unable to notice such modulation signature of WIMP interactions. From the talk of N. Sugiyama (Tokio) — ”Cosmic Microwave Background: A New Tool for Cosmology and Fundamental Physics” it was evident that an unexpectedly huge amount of fundamental information can be extracted from current research into cosmic microwave background. This is just one example showing that astrophysical data are inevitable nowadays for modern particle physics.

Astrophysical investigations are tightly connected with the exciting question of neutrino
properties. Cosmic high energy neutrinos can interact with relic neutrinos producing Z-Bursts which could explain the mysterious origin of extremely High Energy Cosmic Rays (S. Katz, Eotvos Hungary). Excitingly this mechanism requires the neutrino mass to be in the range 0.02–2.2 eV, which intriguingly fits with recent results obtained from neutrinoless double beta decay of Germanium in the Heidelberg-Moscow experiment. Neutrinos from Supernova are also in the field of current theoretical interest and investigations (A. Yu. Smirnov, Trieste and Moscow).

Undoubtedly central topic of this conference was neutrino physics. Modern understanding of and a general view on Neutrino Masses and Mixings was described by R.N. Mohapatra (Maryland). Consequences of the SNO Neutral Current Rate for resolving the Solar Neutrino Puzzle, were discussed by S. Choubey (UK). The Standard Solar Model and modern experimental hints for an elemental composition of the Sun, radically different from the present usual assumptions were discussed by O.K. Manuel (Missouri).

Extended discussion of the experimental achievements in solar and atmospheric neutrino oscillation experiments included first of all the Sudbury Neutrino Observatory (M. Dragowsky) and its results from recent analysis with pure heavy water target. SNO performed first measurements of the total active neutrino flux and claims evidence for neutrino flavour transformation at a 5.3 sigma level. Global MSW analysis favours the Large Mixing Angle (LMA) region.

The status and prospects for neutrino oscillation experiments KamLAND, K2K, Super-Kamiokande and new facilities like neutrino factories and JHF-SK project were presented and discussed. For example, KamLAND (presented by F. Suekane from Tohoku Univ, Japan) is a very long baseline reactor neutrino oscillation experiment (with 1000 t liquid scintillator detector), which is able to directly test the MSW-LMA solution only with half-year of data and to determine the oscillation parameters with very high accuracy if the LMA case is true. The experiment started data taking in 2002 and first neutrino events are successfully recorded. Rebuilding of the Super-Kamiokande detector was started in 2002 and full reconstruction is expected before 2007 (T. Kajita, Tokyo). The physics Potential and Status of the second generation proton decay and Neutrino experiment ICARUS (Imaging Cosmic And Rare Underground Signals) in the Gran Sasso Laboratory (Italy) were discussed by F. Mauri (Pavia) and I. Gil-Botella (Zurich).

An exciting problem is the nature of neutrinos. Are these most mysterious objects Dirac or Majorana particles and which are their masses. One of the best tool to find the answer is neutrinoless double beta decay. The evidence for observation of neutrinoless double beta decay (CERN-Courier Vol. 42 (number 2) 2002) of the isotope Ge-76 claimed by the team of H.V. Klapdor-Kleingrothaus (MPI-Kernphysik, Heidelberg) on the basis of the unique data of the Heidelberg-Moscow collaboration has huge resonance among scientists. This result inevitably took a central part in the discussions at this conference. The for this analysis crucial very accurate data on the Q-Value of the $^{76}$Ge Double Beta-Decay Determined from Accurate Mass Measurements in a Penning Trap were given in the talk by I. Bergstrom (Stockholm). The spokesperson of the HEIDELBERG-MOSCOW collaboration H.V. Klapdor-Kleingrothaus then outlined the present evidence for neutrinoless beta decay as well as the general Future for Double Beta Experiments. The collaboration fixes the effective neutrino mass in the region of 0.05–0.84 eV (95 % C.L.), which is meanwhile supported by independent information from CMB (WMAP) and others, and by theory. A highly interesting new theoretical conception concerning massive Majorana Particles was presented by D.V. Ahluwalia (Zacatecas, Mexico) who possible its consequences for the structure of space-time.

The important question of nuclear matrix elements for double beta decay was described thoroughly by F. Simkovic (Bratislava). It was shown that transitions to different excited daughter states could help to distinguish between different mechanisms triggering the
neutrinoless beta decay process. Important new Constraints on Neutrino Mixing Parameters following from the Observation of Neutrinoless Double Beta Decay of the HEIDELBERG-MOSCOW collaboration were also discussed by H. Sugiyama (Tokyo).

Doubtlessly the Conference has made a remarkable contribution to fruitful exchange of ideas between the physicists working in particle physics, nuclear physics and cosmology. More people now believe that neutrinos at extremely low energies as well as at extremely high energies are the particles which can supply us with new exciting discoveries in the future.

We thank all colleagues who have contributed to the success of this meeting by their excellent talks and lively discussions. We thank our colleague Y. Peltoniemi and his team from the University of Oulu for the splendid local organization of the conference. We are grateful in particular also to the Local Conference Secretary, Ms. Birgitta Brusila, for her professional and always very friendly management during all the time.

I also would like to thank at this point, as Chairman of this conference, those people, who made our visit of the Pyhäsalmi mine in February 2001 an exciting experience: Jorma Kangas, at that time director of the CUPP project at the University Oulu, and Y. Peltoniemi, present director of the CUPP project, Dr. Partti Kokkonen, Vice-Governor from the provincial Goverment at Oulu, but in particular Mr. Pasi Vallivaara (Mayor of Pyhäsalmi), Jukka Tikanmaki and their coworkers, and the highly accomodating representants of the Outokumpu mining company: Timo Mäki, chief geologist and other members of the highly efficient staff.

We are, in particular, indebted to the Scientific Secretary of the conference, Dr. I.V. Krivosheina (Nishnij Novgorod/Heidelberg) for her enthusiastic and highly efficient help in scientifically organizing this conference and in preparing these Proceedings.

Hans Volker Klapdor-Kleingrothaus
Conference Chairman
Heidelberg, May 2003
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