1991 HEPP Conference

LEP Precision is Main Feature

The Divisional Conference of the High Energy and Particle Physics Division takes place every two years. As the IUPAP Lepton-Photon Symposium was due to be held in Europe, it was felt that one should accommodate the large overlap in physics topics with the EPS High Energy Physics Conference by organizing only one meeting in Geneva. The 1991 Conference was thus organized jointly by EPS, IUPAP and CERN, and took place in the Geneva Conference Centre with over 1000 participants from around the world. The excellent organization was in the hands of Luigi di Lella (CERN) as Chairman of the international organizing committee, and Keith Potter (CERN), the head of the local organizers.

The HEPP Division awards the EPS High Energy Physics Prize on the occasion of its biennial conference. In Geneva, Nicola Cabbibo (Rome University) was honoured for his fundamental contributions to the theory of weak interactions leading to quark mixing (see appreciation on page 181).

The conference itself was divided into two parts. The first three days (25-27 July) comprised parallel sessions on 17 topics, where contributions from individual groups were presented, or the most recent developments in a particular field were summarized by *rapporteurs*. The second half (29 July to 1 August) was devoted to plenary talks, essentially summarizing the discussions in the parallel sessions.

LEP Precision

Physics at the Conference was dominated by the excellent data presented by CERN's four LEP experiments (ALEPH, DELPHI, L3 and OPAL). Together they have collected more than one million Z^0 decays, which have been analyzed with respect to various physics aspects, including precision tests of the standard model, QCD studies, heavy flavour physics, and the search for new particles.

J. Carter summarized precision tests of the standard model and the following set of measurements serves as an example of the high level of accuracy with which the fundamental parameters for electroweak interactions have been determined:

$M_Z = 91.175 \pm 0.021$ GeV; $\Gamma_Z = 2.487 \pm 0.71$ GeV

$\sin^2\theta_W = 0.233 \pm 0.01$; $\sigma_{peak} = 31.36 \pm 0.3$ nb

The electroweak Z parameters have been used to evaluate the number of light neutrino generations, which is found to be 2.99 ± 0.05. Furthermore, lepton universality has been established to a level well below 1%. The precision of the experimental data is also sufficient to detect effects of electroweak radiative corrections, which depend on the mass of the top quark. J. Ellis gave a limit for the top mass M_t of 125 ± 30 GeV, and a more conservative estimate with input from other electroweak processes of 80 GeV $< M_t <$ 200 GeV. He also described how a first attempt in 1990 to use high-precision LEP data to constrain hadronic uncertainties in placing bounds on the mass of the Higgs gave 1.8 Gev $< M_H <$ 6 TeV with an optimal value of $\approx$ 40 GeV. The latest LEP data give rise to speculations that the Higgs is "light" (< 200 GeV).

T. Hebbeker concentrated on the QCD studies in hadronic decays of the Z boson. The data are well described by the standard nonabelian QCD gauge theory with a strong coupling constant $\alpha_S = 0.120 \pm 0.007$ at the Z^0 mass. The impact of the new data on the status of QCD was summarized by G. Martinelli. Some observables suggest that the domain of computability, made less easily accessible by the relatively large value of α_S, can be studied experimentally.

Heavy flavour physics at LEP was covered in a talk by P. Roudau, while M. Danilov summarized the investigation of heavy quark decays from experiments at lower centre of mass energies. Lifetime measurements of heavy quarks and τ leptons [$\tau_b = (1.33 \pm 0.05 \pm 0.06).10^{-12}$ s, $\tau_\tau = (302.5 \pm 5.9).10^{-12}$ s] from various experiments now agree. Furthermore, the new data have improved the knowledge of the Cabbibo-Kobayashi-Maskawa matrix elements. The way CP violation is achieved in nature still remains an open question. Two experiments at CERN and at Fermilab, employing neutral kaon beams, do not yet allow a conclusive answer to the size of the CP violating parameter Re (ε'/ε), but new experiments with a higher accuracy are planned (J.M Gerard).

The four LEP experiments have also searched for new phenomena beyond the standard model and, in particular, have looked for the appearance of new particles. M. Davier demonstrated that as compared to previous experiments, all limits have been considerably improved owing to the large statistics and the increase in energy. Much low energy territory is excluded as the Higgs must be heavier than 57 GeV, as opposed to an unambiguous limit of 52 MeV for only one pre-LEP experiment. The 57 GeV limit will probably be pushed out to 60-65 GeV in the next two years at LEP. Physics beyond the standard model such as compositeness, SUSY and GUT's which we may meet at higher energies were discussed by G.G. Ross. With regard to the 17 keV neutrino problem, it can be accommodated consistent with most conservative cosmological bounds, but accounting for decay of this heavy neutrino requires new physics.

At high energies, hard hadronic processes are well described in the framework of perturbative QCD. However, the fact that hadronic interactions are, in principle, very complicated and difficult to interpret becomes apparent from the study of soft hadronic interactions (P. Landshoff) and hadron spectroscopy (R. Landua). There is still hope, nevertheless, that thermodynamic methods may give some insight into long range quark-gluon interactions by studying very high energy, heavy ion collisions. As pointed out by H. Satz in his review talk, the next generation of accelerators could have the potential to create a quark-gluon plasma.

S.L. Glashow speaking at the final plenary session of the Joint International Lepton-Photon Symposium and Europhysics Conference on High Energy Physics.

New Facilities

Progress in high energy physics is based on the development of new accelerators and the steady improvement in detector techniques. The HERA ep collider at DESY in Hamburg is the next large facility which is at present being commissioned and will come into operation next year (B.H. Wiik). C. Rubbia thought other accelerator projects such as SSC, LHC and B factories were still several years ahead of us. Definitive studies of solar phenomena requiring the simultaneous observation in real time of neutrino scattering and β decays are now being implemented in the passive detectors ICARUS and Super-Kamiokande (the Japanese Government approved in May an upgrade of Kamiokande from 3 to 50 k tonnes). As QCD is probably the correct description for nuclear interactions, he looked forward to its being thoroughly tested at HERA, to

From the left, W. Schmidt-Parzefall, P. Schlein and B.H. Wiik in front of the EPS stand at the 1991 LP-HEP Conference.

some extent at LEP and in heavy ion collisions at CERN-SPS and later at RICH. He underlined the importance of supercomputer calculations at APE in Rome and information on the spectroscopy of bound hadronic states from LEAR and planed e^+e^- colliders. Finally, while the K meson system is too complicated to distinguish between competing models for CP violation, mixing in the B quark system has opened up a new field to search for CP violation. Powerful new sources of B quarks are thus planned at LEP, a future e^+e^- collider, SSC, and at LHC.

New accelerator techniques for high energy facilities, notably linear and circular ep machines, for the next century were discussed by Y. Kimura. The progress that has been made in detector design, mainly in the field of calorimetry, particle identification and high resolution tracking devices, was covered by P. Jenni, who quoted test beam measurements with a spatial resolution down to 20 μm: detectors with such a resolution would be used for lifetime measurements at colliders.

Passive Experiments

New results from non-accelerator experiments gave rise to animated discussions. The observed flux of energetic solar neutrinos seems to be significantly lower than model calculations would predict. If this is verified, the observations could be the first hint of a new physics beyond the standard model. It therefore remains important to measure the neutrino flux from the sun with low threshold detectors (first generation detectors using a chloride solution only measured ^{8}Be and ^{7}B fluxes in the solar neutrino spectrum). Two experiments with Ga as the detector medium (GALLEX and SAGE) are on the verge of obtaining data within the next few years. SAGE in the USSR involving 60 t of metal rather than a solution of the chloride is more compact, but extraction of the ^{71}Ge produced is more complicated. However, a background radiation problem has held up calibration of GALLEX with a ^{51}Cr source. It arose owing to the generation during storage of ^{68}Ge by cosmic radiation. Heating the solution was evaluated in "hot runs" that started in late-1990 and the cool down last April resulted in a satisfactory background level.

First results from the SAGE experiment for five months in 1990 show interesting results, which need further cross-checking. Assuming a 100% extraction efficiency for ^{71}Ge, which is presently being verified with

Professor Y. Yamaguchi, IUPAP President-Designate, with Dr. B. Richter, Director of SLAC, seated in the background.

a ^{51}Cr source, the measured flux was low (< 79 Solar Neutrino Units — SNU — at 90% confidence limits) as compared to the theoretically predicted rate of 132 SNU. Finally, two new experiments are in preparation (BOREX and SNOW) for measuring the solar neutrino spectrum.

The existence of a 17 KeV neutrino (page 182) gave rise to controversial discussions which only further experiments will be able to resolve (talks by B. Barish and R. Mössbauer). In an audience dominated by experimental physicists, C. Itzykson succeeded in explaining to a largely non-expert community the most recent trends and developments in abstract field theory. The impact of particle physics on cosmology was reviewed by M. Turner, one of the top experts in the field.

W. Bartel, *DESY, Hamburg*

1991 EPS High Energy Physics Prize
Nicola Cabibbo

The 1991 EPS High Energy Physics Prize, which is awarded every second year on the occasion of the Divisional conference, was given to Professor Nicola Cabibbo at the joint International Lepton-Photon and Europhysics Conference on High Energy Physics held in Geneva on 25 July–1 August.

Nicola Cabibbo, who has been Professor of Theoretical Physics at the University of Rome since 1982 and is at present President of the INFN, received the prize for his "fundamental contribution to the theory of weak interactions leading to the concept of quark mixing". He is credited with a long list of honourable memberships in various committees and other bodies, amongst them the Academia Nazionale dei Lincei in Rome.

He started his scientific career in 1958 with a degree in physics from the University of Rome. After positions in Rome, Frascati, CERN and LBL, Berkeley, he became a lecturer at Harvard University. In 1965, he obtained his first position as a professor in theoretical physics at the University of L'Aquila, where he stayed for

M. Jacob, President of EPS, presenting the 1991 EPS High Energy Physics Prize to N. Cabibbo (facing camera).

only one year before moving to the University of Rome. He left Rome for short stays at the Institute for Advanced Studies, CERN, Paris, New York, Syracuse, and he held the Enrico Fermi professorship at the University of Chicago.

The work of N. Cabibbo has covered a wide range of physics and everywhere he made important contributions. We find him amongst the early advocates of e^+e^- colliding beam experiments (1961). He, together with others, proposed the use of crystals for producing multi-GeV polarized bremsstrahlung photon beams. In collaboration with Doniach he proved the existence of trapped flux units in Type I superconductors and recently he has been interested in the construction of parallel processors for QCD lattice calculations — the APE Project, one of the most ambitious and advanced projects in the field.

His contributions to the theory of weak interactions, which is the basis for the EPS award, is published in a paper "Unitary Symmetry and Leptonic Decays" in *Phys. Rev. Lett.* **10** (1963) 531. In those days in 1963 there were three phenomena in weak interactions which were awaiting a physics interpretation: there was the observation of strongly suppressed strangeness-changing weak decays and an apparent violation of the universality of weak interactions, or the CVC theorem. The vector coupling constants derived from O^{14} nuclear β decay and μ decay were different. Furthermore, the observed rate of hyperon β decays did not fit into any theory.