«ETTORE MAJORANA» FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE

TO PAY A PERMANENT TRIBUTE TO GALILEO GALILEI, FOUNDER OF MODERN SCIENCE AND TO ENRICO FERMI, THE "ITALIAN NAVIGATOR", FATHER OF THE WEAK FORCES

INTERNATIONAL SCHOOL OF SUBNUCLEAR PHYSICS

REFLECTIONS ON THE NEXT STEP FOR LHC

51st Course – ERICE-SICILY: 24 JUNE – 3 JULY 2013

Sponsored by the: · Italian Ministry of Education, University and Scientific Research · Sicilian Regional Government · Academies of Sciences of Estonia, Georgia, Lithuania, Russia and Ukraine · Chinese Academy of Sciences · Commission of the European Communities · European Physical Society · Italian National Institute for Nuclear Physics · Weizmann Institute of Science · World Federation of Scientists · World Laboratory

PROGRAMME AND LECTURERS

SSB CELEBRATION

My Life as Boson
• P.W. HIGGS, University of Edinburgh, UK

INSTANTON CELEBRATION

Origin and Status of Instantons
• G. 't HOOFT, Utrecht University, NL

OPENING REMARKS AND REFLECTIONS

• A. ZICHICHI, CERN, Geneva, CH; INFN & University of Bologna, IT

HOT THEORETICAL TOPICS

Mass Hierarchy and Physics Beyond the Standard Model
• I. ANTONIADIS, Ecole Polytechnique, Palaiseau, FR

Magic Supergravity from Squaring Yang Mills
• M.J. DUFF, Imperial College London, London, UK

Gauge Forces: From QCD to Quantum Gravity
• L.N. LIPATOV, Saint-Petersburg State University, RU

The Internal Structure of the Weak Bosons
• H. FRITZSCH, Ludwig-Maximilians-Universitaet, Muenchen, DE

Embedding Oscillatory Modes of Quarks for Baryons in QCD
• P. MINKOWSKI, University of Bern, CH

No-scale Supergravity in the Light of LHC and Planck
• D.V. NANOPOULOS, Texas A&M University, College Station, TX, US

Inflation and Quantum Origin of Structure in the Universe
• V. MUKHANOV, Ludwig Maximilian University of Munich, DE

The Pedagogic Higgs – or Somebody's – Boson
• F. CLOSE, University of Oxford, UK

New Symmetries of N=4 Supersymmetric Gauge Theories
• E. SOKATCHEV, LAPTH, Annecy-le-Vieux Cedex, FR

Dualities in Supergravity
• S. FERRARA, CERN, Geneva, CH; LNF - INFN, Frascati, IT

Status of the Perturbative Approach to Supergravity
• Z. BERN, UCLA, Los Angeles, CA, US

Discreteness and Determinism in Superstring Theory
• G. 't HOOFT, Utrecht University, NL

HOT EXPERIMENTAL TOPICS

Highlights from ATLAS – ALICE – CMS
• S. BERTOLUCCI, CERN, CH

Status of the Gran Sasso Lab
• F. FERRONI, INFN, Rome, IT

Latest Results from BNL and RHIC
• M.J. TANNENBAUM, Brookhaven National Laboratory, Upton, NY, US

Highlights from ALICE
• P. GIUBELLINO, CERN, CH

Highlights from the Planck Satellite
• A. RIAZUELO, Institute d'Astrophysique de Paris, FR

SEMINARS ON SPECILIZED TOPICS

Roadmap at the LHC to the Higgs Boson and Beyond
• P. JENNI, CERN, Geneva, CH

Status of the Three Neutrinos
• A. BETTINI, INFN & Padoa University, IT; Canfranc Underground Lab, ES

Present status of the EMC effect
• K. RITH, DESY, Hamburg, DE; FAU Erlangen-Nuremberg, DE

Technology and Computing in relation to "Reflections on the Next Step for LHC"
• H. WENNINGER, CERN, Geneva, CH

What is the Ontological Status of the Higgs Particle?
• T.Y. CAO, Boston University, MA, US

New Spectroscopy with Charm and Beauty Multiquark States
• L. MAIANI, Sapienza University of Rome, IT

The Time of Flight (TOF) World Record
• A. ZICHICHI, CERN, Geneva, CH; INFN & University of Bologna, IT

CLOSING REMARKS

• G. 't HOOFT, Utrecht University, NL

TEN PROBLEMS OPEN FOR COMPETITION

THE FIRST GROUP: MIXINGS

- *Is there an explanation for the flavour mixing mechanisms?*
- *Why do these mechanisms produce results that differ substantially in the quark and in the lepton sectors?*
- *Why does the mixing of states not exist in any other fundamental interaction?*

THE SECOND GROUP: ELEMENTARY AND COMPOSITE STATES

- *What is the role of instantons in the spectrum of hadrons in QCD? Where are the scalar hadronic states in QCD? Are there scalar states in the leptonic system?*
- *Why are there only fundamental particles with the minimum quark or lepton quantum numbers? Do elementary particles with higher, composite quantum numbers exist?*
- *Is there a fundamental reason why elementary fermions exist (quarks and leptons) but not elementary scalars in the same mass range?*
- *Do we really need sterile neutrinos? If yes, why? If not, why?*

THE THIRD GROUP: SYMMETRY BREAKINGS

- *Why are the global discrete symmetries (C, P, CP, T) explicitly and not spontaneously broken, as it seems to be the case today?*
- *To what extent can we be confident that the Supersymmetry breaking threshold is not at the Planck Scale?*
  (If this were the case it would be impossible to find at LHC any evidence for Supersymmetry).

• L. CIFARELLI, INFN & University of Bologna, IT
• D. HAIDT, DESY, Hamburg, DE
• C. KORTHALS-ALTES, CNRS-Luminy, Marseille, FR
• A.N. TAWFIK, ECPT, MTI University, Cairo, EG
• T. TAYLOR, CERN, Geneva, CH
• A. WALKER, University of Edinburgh, UK
• C. WILLIAMS, CERN, Geneva, CH

ONE OF THE AIMS OF THE SCHOOL is to encourage and promote young physicists to achieve recognition at an international level. A worldwide competition is open to select **New Talents**. Young fellows who think they have the ability to compete are invited to apply. At the end of the School twenty-three Diplomas will be awarded to the **Best New Talents** by a Committee composed by the Lecturers and the Invited Scientists. The same Committee will decide on the **Best Student** and on the winners of the competition open for the ten problems. The solutions will be presented at the Special Sessions of the School.

VICTOR WEISSKOPF COMMEMORATIVE FUND. The *WORLD FEDERATION OF SCIENTISTS* (WFS) has established this **fund** to support needy students. At the time of the application to the School, students who need financial support should apply for this **fund**, specifying their needs (i.e. fee only, or full board and lodging, or low-cost travel expenses).

BOARD OF LECTURERS AND INVITED SCIENTISTS. In addition to the Lecturers, a group of distinguished physicists is invited to contribute to the lively intellectual atmosphere of the School by participating in the discussions following the Lectures. Lecturers and Invited Scientists will take part in the selection of the **New Talents** and in the award of the various scholarships and grants open for competition.

SPECIAL SESSIONS FOR NEW TALENTS. Each student may propose a contribution for open presentation. The Board of Lecturers and Invited Scientists will select the best proposals. The selection will be based solely on "scientific excellence", without favour to geographical distribution, the Laboratory or the University of origin. Priority will be given to the new material of either experimental or theoretical nature, especially if the candidate has made an important contribution to the results to be presented. A review paper has lower priority and, as before, will only be selected if the candidate can point out some new features in the field reviewed. There will be poster sessions whereby each student will have the privilege of presenting the results of current studies and interacting with other participants to their mutual benefit.

DIPLOMAS FOR THE BEST NEW TALENTS

The following Diplomas have been established in honour of, and named after, the late physicists:

JOHN S. BELL
PATRICK M.S. BLACKETT
NICOLA CABIBBO
JAMES CHADWICK
SIDNEY COLEMAN
RICHARD H. DALITZ
PAUL A.M. DIRAC
RICHARD P. FEYNMAN
BRUNO FERRETTI
VLADIMIR N. GRIBOV
ROBERT HOFSTADTER
GUNNAR KÄLLEN
SEYMOUR J. LINDENBAUM
YUVAL NEEMAN
GIUSEPPE P.S. OCCHIALINI
ORESTE PICCIONI
BRUNO PONTECORVO
GIAMPIETRO PUPPI
ISIDOR I. RABI
GIULIO RACAH
BRUNO ROSSI
JULIAN S. SCHWINGER
VICTOR F. WEISSKOPF
EUGENE P. WIGNER
BJORN H. WIIK
CHIEN SHIUNG WU

These Diplomas will be awarded at the end of the Course by the Board composed of the Lecturers and the Invited Scientists.

PURPOSE OF THE SCHOOL

This year we focus on reflections about the next step for LHC, not forgetting that, since complexity exists at the fundamental level, a totally unexpected discovery should be given to us by LHC.

The lectures will be, as usual, fully devoted to the latest and most significant achievements in theoretical and in experimental physics. In fact during the last half century the School has been involved in all crucial steps of our Physics. Few examples: SU(3) flavour and SU(6) [with SU(2)-spin coupled with SU(3) flavour] dismantled by the "No-Go-Theorem", the battle between S-Matrix and Field Theory, the Universality of the weak forces [started with the ε-parameter and the non existence of the "flavour changing-neutral currents" solved by the existence of "charm"], the experimental search for the 3rd lepton in the early sixties before the discovery of CP breaking, the birth of the Electroweak Unification and the SSB (Spontaneous Symmetry Breaking) mechanism, the discovery of the negative sign of the β-function and of asymptotic freedom, the triumph of non Abelian field theories (QCD and QFD) with all consequences (including Instantons), the discovery of Supersymmetry (many years – and not few days – after the "No-Go-Theorem"). Now we would like LHC to give us the first sign for the existence of the Superworld.

THE FIFTIETH ANNIVERSARY

The Ettore Majorana Foundation and Centre for Scientific Culture (EMFCSC) is celebrating its 50th Anniversary over the three years 2011-2013. Why three years? The EMFCSC started in 1961 when one of us first discussed with John Bell the problem of creating a bridge between university courses and activities in advanced physics laboratories such as CERN. A year later on May 8th at CERN Bell, Patrick Blackett, Victor Weisskopf, Isidor Rabi and Zichichi formally established the EMFCSC. The Centre's first activity was the School of Subnuclear Physics at Erice in 1963. This is why the celebrations are over three years. This year School will be the third of the three devoted to the celebrations of the 50th Anniversary. This year we will celebrate with two special Sessions of the School the Spontaneous Symmetry Breaking (SSB) and Instantons. In 2012 we have celebrated QCD. In 2011 we have celebrated the discovery of the negative sign of the β-function and of asymptotic freedom.

PLEASE NOTE

Participants must arrive in Erice on June 24, not later than 5 p.m.

POETIC TOUCH

According to legend, Erice, son of Venus and Neptune, founded a small town on top of a mountain (750 metres above sea level) more than three thousand years ago. The founder of modern history — i.e. the recording of events in a methodic and chronological sequence as they really happened without reference to mythical causes — the great Thucydides (~500 B.C.), writing about events connected with the conquest of Troy (1183 B.C.) said: «*After the fall of Troy some Trojans on their escape from the Achaei arrived in Sicily by boat and as they settled near the border with the Sicanians all together they were named Elymi: their towns were Segesta and Erice.*» This inspired Virgil to describe the arrival of the Trojan royal family in Erice and the burial of Anchise, by his son Enea, on the coast below Erice. Homer (~1000 B.C.), Theocritus (~300 B.C.), Polybius (~200 B.C.), Virgil (~50 B.C.), Horace (~20 B.C.), and others have celebrated this magnificent spot in Sicily in their poems. During seven centuries (XIII-XIX) the town of Erice was under the leadership of a local oligarchy, whose wisdom assured a long period of cultural development and economic prosperity which in turn gave rise to the many churches, monasteries and private palaces which you see today. In Erice you can admire the Castle of Venus, the Cyclopean Walls (~800 B.C.) and the Gothic Cathedral (~1300 A.D.). Erice is at present a mixture of ancient and medieval architecture. Other masterpieces of ancient civilization are to be found in the neighbourhood: at Motya (Phoenician), Segesta (Elymian), and Selinunte (Greek). On the Aegadian Islands — theatre of the decisive naval battle of the first Punic War (264-241 B.C.) — suggestive neolithic and paleolithic vestiges are still visible: the grottoes of Favignana, the carvings and murals of Levanzo.

Splendid beaches are to be found at San Vito Lo Capo, Scopello, and Cornino, and a wild and rocky coast around Monte Cofano: all at less than one hour's drive from Erice.

APPLICATIONS

Interested candidates should send a letter to the Director of the School:
Professor Antonino ZICHICHI
CERN, CH-1211 GENEVA 23, Switzerland

Needed: *i) date of birth and present activity; ii) nationality; iii) letter of recommendation from a senior physicist.*

More information about the other activities of the "ETTORE MAJORANA" FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE can be found on the WWW at the following address: http://www.ccsem.infn.it

G. 't HOOFT – A. ZICHICHI
CO-DIRECTORS OF THE COURSE

A. ZICHICHI
DIRECTOR OF THE SCHOOL