«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

STATUS OF THEORETICAL UNDERSTANDING AND OF EXPERIMENTAL POWER FOR LHC PHYSICS AND BEYOND

52nd Course – ERICE-SICILY: 24 JUNE – 3 JULY 2014

50TH ANNIVERSARY CELEBRATION OF THE QUARK WITH MURRAY GELL-MANN AND GEORGE ZWEIG

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

CELEBRATION LECTURE

ACES (QUARKS) AT ERICE: THE SECOND LECTURE 50 YEARS LATER
• G. ZWEIG, MIT, Cambridge, MA, US

OPENING SESSION

A lesson for the Future of our Science. My Testimony on Lord Patrick M.S. Blackett
• A. ZICHICHI, CERN, Geneva, CH; INFN & University of Bologna, IT

STATUS OF THEORETICAL UNDERSTANDING

Canonical Methods in deterministic Quantum Mechanics
• G. 't HOOFT, Utrecht University, NL

Gauge Theories on the Coulomb Branch
• J.H. SCHWARZ, CALTECH, Pasadena, CA, US

Generalised Geometry and Supergravity
• H. NICOLAI, Max Planck Institute, Potsdam, DE

A No-Scale Framework for Sub-Planckian Physics
• D.V. NANOPOULOS, Texas A&M University, College Station, TX, US

The Mass Hierarchy and Physics Beyond the Standard Theory
• I. ANTONIADIS, Ecole Polytechnique, Palaiseau, FR; CERN, Geneva, CH

Complexity and Nonextensive Statistical Mechanics in High Energy Physics
• C. TSALLIS, CBPF & INCT-SC, Rio de Janeiro, BR

Recent Developments in Scattering Amplitudes
• Z. BERN, UCLA, Los Angeles, CA, US

Higher derivative Supergravity, Supersymmetry Breaking and Inflation
• S. FERRARA, UCLA, Los Angeles, CA, US; CERN, Geneva, CH; LNF–INFN, Frascati, IT

Cosmological perturbation theory and inflation
• A. RIAZUELO, Institute d'Astrophysique de Paris, FR

Gravity as the Square of a Gauge Theory
• M.J. DUFF, Imperial College London, UK

Problems with Ultrahigh-energy Neutrino Interactions
• D. SCHILDKNECHT, Werner-Heisenberg-Institut, München; Universität Bielefeld, DE

STATUS OF EXPERIMENTAL POWER

HL-LHC and beyond: Experimental challenges and physics opportunities
• S. BERTOLUCCI, CERN, Geneva, CH

The INFN vision for Neutrino Physics
• F. FERRONI, INFN, Rome, IT

Highlights from BNL and RHIC 2014
• M.J. TANNENBAUM, Brookhaven National Laboratory, Upton, NY, US

Status of ALICE
• P. GIUBELLINO, CERN, Geneva, CH

Results from the Planck Mission
• A. RIAZUELO, Institute d'Astrophysique de Paris, FR

The QGCW Project
• H. WENNINGER, CERN, Geneva, CH

The Direct Search for Dark Matter (including WIMPs and axions)
• A. BETTINI, INFN & Padoa University, IT; Canfranc Underground Lab, ES

Probing Subnuclear Structure with Neutrinos
• J. KNOBLOCH, CERN, Geneva, CH

Complexity and New Physics
• A. ZICHICHI, CERN, Geneva, CH; INFN & University of Bologna, IT

CLOSING REMARKS

• G. 't HOOFT, Utrecht University, NL

BRUNO ZUMINO
SPECIAL SCHOLARSHIP FOR THE BEST STUDENT

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).

INVITED SCIENTISTS

• A. AHMADOV, Baku State University, AZ
• L. CIFARELLI, INFN & University of Bologna, IT
• H. FRITZSCH, Ludwig-Maximilians-Universitaet, Muenchen, DE; Nayang Technological University, Singapore, SG
• M. GELL-MANN, Santa Fe Institute, New Mexico, US
• D. HAIDT, DESY, Hamburg, DE
• C. KORTHALS-ALTES, CNRS-Luminy, Marseille, FR
• H. LEUTWYLER, University of Bern, CH
• P. MINKOWSKI, University of Bern, CH
• S. RAGAZZI, Gran Sasso National Laboratory, L'Aquila, IT
• A.N. TAWFIK, ECPT, MTI University, Cairo, EG

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 the Diplomas to the **Best New Talents** will be awarded by a Committee composed by the Lecturers and the Invited Scientists.

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.

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.

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
BRUNO FERRETTI
RICHARD P. FEYNMAN
VLADIMIR N. GRIBOV
ROBERT HOFSTADTER
GUNNAR KÄLLEN
SEYMOUR J. LINDENBAUM
YUVAL NE'EMAN
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
BRUNO ZUMINO

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

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).

PURPOSE OF THE SCHOOL

This year we focus our attention on the status of the theoretical understanding and of the power of our experimental set-ups in the physics we are working with. 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. Finally we should not forget that, since complexity exists at the fundamental level, a totally unexpected discovery should be given to us by LHC or by some other Lab engaged at the frontier of our knowledge.

THE BRIDGE BETWEEN UNIVERSITY TEACHING AND ADVANCED PHYSICS LABS SUCH AS CERN

The Ettore Majorana Foundation and Centre for Scientific Culture (EMFCSC) has celebrated its 50th Anniversary over the three past 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 in Geneva, at CERN, the existence of EMFCSC. The Centre's first activity was the School of Subnuclear Physics at Erice in 1963. This is why the celebrations have been over three years. In 2011 we have celebrated the discovery of the negative sign of the β-function and of asymptotic freedom. In 2012 we have celebrated QCD. In 2013 the Spontaneous Symmetry Breaking (SSB) and Instantons.

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