



«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

## THE MOST UNEXPECTED AT LHC

## AND THE STATUS OF HIGH ENERGY FRONTIER

**47th Course – ERICE-SICILY: 29 AUGUST – 7 SEPTEMBER 2009**

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

#### OPENING SESSION

*Can the LHC lead us to a New Age of Discovery?*

- Reports from ALICE – ATLAS – CMS Projects

#### HOT THEORETICAL TOPICS

*The Landscape and Cosmological Vacuum Selection*  
• R. BOUSSO, University of California, Berkeley, CA, US

*Ultraviolet Behavior of  $N=8$  Supergravity*  
• L. DIXON, SLAC, Menlo Park, CA, US

*Microscopic Black Holes, Entropy and Particle Species*  
• G. DVALI, CERN, Geneva, CH

*Flux Vacua and Supersymmetry Breaking in String Theory*  
• D. LUEST, Max-Planck-Institute für Physics, München, DE

*Is the Best Superstring Model NP Complete?*  
• M.R. DOUGLAS, Rutgers University, Piscataway, NJ, US

*Supergravity: Foundations and Applications*  
• S. FERRARA, CERN, Geneva, CH; UCLA, Los Angeles, CA, US

#### SEMINARS ON SPECIALIZED TOPICS

*Extra-Dimensions in Superstring Theories: Experimental Results*  
• Th.W. HÄNSCH, Max-Planck-Institute für Physics & University, München, DE

*Diffraction with Real and Virtual photons at High Energies: What did we learn from HERA*  
• G. WOLF, DESY, Hamburg, DE

*Status of Dark Matter and Neutrino Physics*  
• A. BETTINI, University of Padua, IT; Canfranc Underground Laboratory, ES

*Results from RHIC with Implications for LHC*  
• M.J. TANNENBAUM, BNL, Upton, NY, US

*Status of Black Holes Physics*  
• G. 't HOOFT, Utrecht University, NL

*Complexity and Prediction in Frontier Physics*  
• A. ZICHICHI, CERN, Geneva, CH; INFN & University of Bologna, IT

#### HOW COSMOLOGY AFFECTS SUBNUCLEAR PHYSICS

*Present Status of Inflationary Cosmology*  
• A. LINDE, Stanford University, CA, US

*String Cosmology and CMB*  
• R. KALLOSH, Stanford University, CA, US

#### HIGHLIGHTS FROM LABORATORIES

##### BNL–RHIC:

- T.D. LEE, Columbia University, NY, US

##### CERN:

- R.-D. HEUER, CERN, Geneva, CH

##### FERMILAB:

- P.J. ODDONE, Fermi Lab, Chicago, IL, US

##### E. FERMI CENTRE:

- A. ZICHICHI, E. Fermi Centre, Rome, IT

##### GRAN SASSO:

- E. COCCIA, LNGS, L'Aquila, and University of Rome Tor Vergata, IT

##### ISS–AMS:

- S.C.C. TING, MIT, Cambridge, MA, US

#### 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).*
- *Are we really sure that the electro-weak symmetry breaking occurs at the Fermi scale due to a local maximum of the potential for some scalar field in the Lagrangian, also known as the "Higgs mechanism"? (If this were not the case, it would not be possible to find at LHC any evidence for Higgs particles).*

#### INVITED SCIENTISTS

- R. ARNOWITT, Texas A&M University, College Station, TX, US
- R. BALBINOT, INFN and University of Bologna, IT
- L. BAUDIS, University of Zürich, CH
- L. CIFARELLI, INFN and University of Bologna, IT
- D. HAIDT, DESY, Hamburg, DE

- P.W. HIGGS, University of Edinburgh, Scotland, UK
- C. KORTHALS-ALTES, CNRS-Luminy, Marseille, FR
- L. McLERRAN, BNL, Upton, NY, US
- L. SUSSKIND, Stanford University, CA, US
- H. WENNINGER, 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-one 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 also 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  
JAMES CHADWICK  
SIDNEY COLEMAN  
RICHARD H. DALITZ  
PAUL A.M. DIRAC  
VLADIMIR N. GRIBOV

ROBERT HOFSTADTER  
GUNNAR KÄLLEN  
YUVAL NEEMAN  
GIUSEPPE P.S. OCCHIALINI  
ORESTE PICCIONI  
BRUNO PONTECORVO  
GIAMPIETRO PUPPI

ISIDOR I. RABI  
GIULIO RACAH  
BRUNO ROSSI  
VICTOR F. WEISSKOPF  
EUGENE P. WIGNER  
BJORN H. WIJK  
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**

If Complexity exists at the fundamental level, a totally unexpected discovery should show up at the LHC. Waiting for the LHC first results, the present status of Subnuclear Physics will be reviewed, together with the highlights from all Labs and the theoretical work on fascinating topics, such as extra-dimensions in superstring theory which, unfortunately, are not easily amenable to experimental verification. All this will be discussed with invited scientists, lecturers and students, in the most exciting sessions of the School entirely devoted to debate hot topics.

#### **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.

- **PLEASE NOTE**

Participants must arrive in Erice on August 29, not later than 5 p.m.

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.csem.infn.it>

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

**A. ZICHICHI**  
**DIRECTOR OF THE SCHOOL**

#### **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 Sicilians 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.