OPENING SESSION
Erice, 20 August 2012

WHY SCIENCE IS NEEDED FOR THE CULTURE OF THE THIRD MILLENNIUM

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Paul A.M. Dirac Lecture Hall – Patrick M.S. Blackett Institute
Erice, 20 August 2012
WHY SCIENCE IS NEEDED FOR THE CULTURE OF THE THIRD MILLENNIUM

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INTRODUCTION

TEN SLIDES
THE STANDARD MODEL AND BEYOND

2nd Slide

The five basic steps in our understanding of nature. ① The renormalization group equations (RGEs) imply that the gauge couplings ($\alpha_i$) and the masses ($m_i$) all run with $k^2$. It is this running which allows GUT, suggests SUSY and produces the need for a non point-like description (RGST) of physics processes, thus opening the way to quantize gravity. ② All forces originate in the same way: the gauge principle. ③ Imaginary masses play a central role in describing nature. ④ The mass-eigenstates are mixed when the Fermi forces come in. ⑤ The Abelian force QED has lost its role of being the guide for all fundamental forces. The non-Abelian gauge forces dominate and have features which are not present in QED.

3rd Slide

Galilean Science during the last 4 Centuries
FROM PLANCK TO COMPLEXITY

30 years ago & Now

$E_{Planck}$

Complexity at the fundamental level
It turns out that Complexity in the real world exists, no matter the mass-energy and space-time scales considered, as illustrated in the Figure.
The latest news coming from the culture of our time, called Modern Culture, is that all Fields of Science need **HOLISM** no **REDUCTIONISM**. Modern Culture claims that from proteins up to History **everything interacts with the environment**. In fact History needs us, the living form of matter, L, *i.e.* human being, whose roots are in the most elementary form of life, the so called “minimal life cell”, C, for which genes and proteins are needed: **everything interacts with the environment**. But proteins and all other pieces needed for L are made with molecules and from molecules down to the Basic Constituents, the interaction with the environment is zero: the greatest achievements of Science are coming from the study of our Constituents which do not interact with the environment.

The Culture of our Time neglects two points. First that Holism has been dominant for 10,000 years, without ever being able to discover any Fundamental Law of Nature. Second, that all achievements of our knowledge come from **Reductionism**, started four centuries ago, not from Holism.
SCIENCE, TECHNOLOGY AND CULTURE IN THE THIRD MILLENNIUM: A PROJECT FOR MANKIND

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WHY SCIENCE IS NEEDED FOR THE CULTURE OF THE THIRD MILLENNIUM

Antonino Zichichi

I

THE CULTURE OF OUR TIME AND THE ONE NEEDED
The Culture of our time is based on the first great achievement of our intellect: Language. Language means Poetry, Literature, Music, Arts, Theatre, Economy, Politics and other manifestations of the human intellect such as Philosophy; all intellectual activities that could exist even if neither rigorous Logic nor Science had ever been discovered.

Rigorous Logic and Science must be brought into the cultural patrimony of the third millennium, since the number one enemy of humanity is Ignorance.
The first monumental construction of rigorous Logic is Euclidean geometry – more than 2,000 years ago. Rigorous Logic includes arithmetic (theory of numbers), algebra (theory of variables), analysis (theory of functions), and topology (theory of domains where the functions exist).

None of these activities could be discovered if our intellectual activities were limited in the domain of Language.

The next point to realize is that all activities in the domain of rigorous Logic would exist even if Science had never been discovered.

In fact, Science is the only rigorous Logic which has been used in order to create the world as it is.
There are many logical theoretical structures which are not found in Nature, e.g. a space with infinite dimensions does not lead to any self-contradiction. The space with infinite number of dimensions exists from a rigorous theoretical logic point of view, but the space where we live has a finite number of dimensions apparently four (three of space and one of time), but probably 43, if the Superworld exists.

If we physicists, using the most powerful Subnuclear Physics collider – LHC (Large Hadron Collider) – with its high precision technological instruments will be able to have the experimental evidence for the existence of the Superworld, new horizons will be opened to our vision of the world where we leave.
I hope this remark allows to make clear the distinction between rigorous Theoretical Logic (mathematics) and rigorous Experimental Logic (Science).

Out of all possible Rigorous Theoretical Logic structures only one has been chosen to build the world as it is. This Logic is Science.

The reason why Science can be an instrument for peace is the fact that Science is the most rigorous way which allows one to distinguish a great “pure” achievement of the human intellect from the use we can make of it.
Science is neither good nor evil. People currently use the word “science” to mean the “use of science” (i.e. technology) which is no longer “science”, just as the “use of language” is no longer “language” and the “use of logic” is no longer “logic”.

Let me elaborate further on this point since the Culture of our time, called Modern Culture, has never devoted the necessary attention to distinguish Science from Technology.

An example of great achievement in “pure” Science is the discovery of the “Standard Model”, i.e. the superb synthesis that can explain all phenomena of our world in terms of three Fundamental Structures (called the three families of elementary particles) and three Fundamental Forces of Nature (the electroweak, the strong subnuclear and the gravitational). See Addenda I.a–II.b.

An example of great achievement in “pure” Logic is the invention of the rigorous and formidable logical structure called the Infinite.
Examples of great achievement in “pure” Language are the *Pietà* by Michelangelo, the *Primavera* by Botticelli, the *Ninth Symphony* by Beethoven, the *Fifth Symphony* by Mahler, the *Divina Commedia* by Dante. All these achievements in “pure” Science, Logic and Language are for mankind.

Applied Science, Logic and Language do exist. These “applications” can be for and against mankind. For example the use of Science against mankind, corresponds to war technology.

The use of Logic against mankind corresponds to the invention of computer technology for the control of billions of people, thus destroying individual freedom.

The use of Language against mankind corresponds to the invention of ideologies like Stalinism and Nazism.

Examples that are for mankind do indeed exist in the domain of Applied Science, Language and Logic.
Peace technology, instruments to help mankind in Medicine, Agriculture and Meteorology, all correspond to Applied Science for mankind.

Applied Logic for mankind corresponds to the invention of new robots to avoid dangerous and unpleasant work for man, of specialised computer-based applications for medicine, for weather forecasting, etc.

Applied Language for mankind corresponds to the performance of pieces of poetry, of music and of art, plus all other activities designed to help increase the quality of everyday life in all sectors that would exist even if Logic and/or Science had never been discovered.

The components of Applied Logic for mankind and Applied Science for mankind contribute enormously to improve the quality of life.
The three pillars [Language, Logic, Science] in their applied part for man, have a common task and reach the same goal, i.e. to improve the quality of everyday life.

Science, in the Immanent (therefore without appealing to any existential topic connected with the Sphere of the Transcendent), is the source of a new hope, well rooted in the Logic of Nature with its Fundamental Laws, which all aim at good and never at evil.

But for this to happen also in Applied Science, it is necessary that the technological applications of the great scientific discoveries be entrusted not to political bodies, but to the scientific community itself.

This has never been the case because Applied Science implies decision-making actions and this means political activity, which belongs to Applied Language.
This can be for mankind (Democracy) and against mankind (Dictatorship). It is Dictatorship that produces weapons and war technology, nevertheless everybody considers us scientists responsible for Applied Science against mankind.

Worse still, people think that Science was born of Technology. Some would even say that we scientists would not be here, if it were not for military technological development research work.

The claim, by the fellows responsible for the Culture of our time, that Technology precedes Basic Science is due to the fact that the “fire” and the “wheel” were invented before Galilei discovered Science: i.e. the Logic of Nature.

They never say that the “fire” and the “wheel” were understood after Basic Science had been discovered by Galilei. To “invent” a new instrument does not necessarily mean understanding “why” it works.
The spectacular successes in the construction of Pyramids and other masterpieces of Architecture, all over the world, did not give rise to the discovery of the first pieces of the Logic of Nature, such as the Principle of Inertia and the other two laws of Mechanics. A discovery in Basic Science corresponds to “understanding” all possible instruments that can be invented.

For example, the discovery of a Fundamental Force of Nature, the electromagnetic force, has enabled us to understand that all our senses (sight, hearing, smell, taste and touch) are manifestations of the same fundamental force.
This force originates from a unique entity, called “the electric charge”. If we could switch off this “charge” our five senses would cease to exist. Thus all present and future “inventions” connected with sight, hearing, smell, taste and touch are understood even before they are really implemented.

Before Basic Science was discovered, thanks to Galileo Galilei, it was the other way around; i.e.: since the Fundamental Laws of Nature had not been discovered, the technological inventions were always rotating around the same two original ones, the “fire” and the “wheel”.

Since neither the “fire” nor the “wheel” were “understood”, the technological development could not produce anything really new.
And this went on until Galilei in the 17th Century started to discover the first Fundamental Laws of Nature.

This is how, in just four centuries, we have implemented the enormous number of technological inventions that are a part of our daily life: telephone, TV, computers, internet, and all such instruments that would take pages and pages to list. This list is the proof that the motor of progress is scientific discovery.

If the quality of life in the industrialized world has reached the level never realized before, this is due to the enormous number of scientific discoveries in four centuries of Science. If fundamental Science stopped discovering new phenomena, the quality of life would stop improving.

Language, Logic and Science, all contribute to improve the quality of our life, but the decisive role is due to Science, since Applied Science for mankind is the real motor for progress.
An example: when Galilei started to discover the Logic of Nature, mankind was measuring the Time using the sundial, with errors of at least a few seconds per day. Galilei having discovered the laws governing the oscillation of the pendulum made great advancements in the precision of time measurement and this enabled us in just four centuries to reach the present day precision of one second per Universe lifetime, i.e. 20 billion years.

During the many millennia preceding the discovery of Science, all civilizations were measuring time with the same error of one second per day. If Science had never been discovered we could never have reached the vision of the Universe as it looks through our instruments, from the structure of the proton to the farthest Galaxy.

This is synthetically represented in Figures 1 and 2 shown here.
Figure 1: The convergence of the Fundamental Forces of Nature are reported by the three lines of the Figure. For this convergence it is necessary the hypothesis that the Superworld exists. We see that the “Universe” illustrated in this Figure consists of many important details. The “Universe outside” is the one which comes after the decoupling of protons, electrons and photons, when atoms started their formation, 380 thousands years after Big Bang-1. The mathematical basis, which includes the hypothesis of the Superworld, is reported in Figure 3.

Figure 3: The lines are the result of calculations executed with a supercomputer using the following system of three weakly coupled differential non-linear equations:

\[
\mu \frac{d\alpha_i}{d\mu} = \frac{b_i}{2\pi} \alpha_i^2 + \sum_j \frac{b_{ij}}{8\pi^2} \alpha_j \alpha_i^2
\]

This system describes the evolution of all phenomena including the Superworld, from the maximum level of energy, EGUT, to our world which is at the minimum energy level.
To achieve this superb synthesis of human knowledge Reductionism has been the Basic Logic: to solve one problem and only one at the time.

The latest news coming from the culture of our time, called Modern Culture, is that all Fields of Science need HOLISM no REDUCTIONISM.

Modern Culture claims that from proteins up to History everything interacts with the environment.

In fact History needs us, the living form of matter, L, i.e. human being, whose roots are in the most elementary form of life, the so called “minimal life cell”, C, for which genes and proteins are needed: everything interacts with the environment.

But proteins and all other pieces needed for L are made with molecules and from molecules down to the Basic Constituents, the interaction with the environment is zero: the greatest achievements of Science are coming from the study of our Constituents which do not interact with the environment.
The Modern Culture neglects what is shown in Figure 4: i.e. from molecules, down to the Basic Quantities there is no interaction with the environment and all achievements of our knowledge come from Reductionism, started four centuries ago.
The Culture of our Time neglects that Holism has been dominant for 10,000 years, without ever being able to discover any Fundamental Law of Nature, as reported in Figure 5.
It turns out that Complexity in the real world exists, no matter the mass-energy and space-time scales considered, as illustrated in the Figure 6. This result is coming thanks to REDUCTIONISM.
To the great achievements of Reductionism have contributed many distinguished scientists, some of them are here: T.D. Lee the Co-chair of our Seminars; Dick Garwin, Dick Wilson and many other scientists who have been during many decades here in Erice at the Subnuclear Physics Courses.

To these great achievements of Science correspond the 71 Planetary Emergencies to which we will return later. Let me explain how these achievements of Science are related to our Project. This is in fact the logic of our Project.
The Logic of our Project is that Basic Science and Technology should be dedicated to the fight against Planetary Emergencies by promoting knowledge transfer and education, which in turn will allow to increase the standards of living of a Nation. Let me quote a statement by Abdus Salam a co-founder of WFS\(^{(1)}\): "On science and technology depend the standards of living of a nation." This Statement explains how are the achievements of Science, as it the Standard Model and Beyond, related to our Project.

Planetary Emergencies cannot be solved without having with us the best fellows from developing Countries.
1) New projects within the Basic Science and Technology program of the PROJECT for MANKIND.

The ICSC-World Laboratory works on the principle that one of the better ways of helping Developing Countries is to support the participation of their scientific elite in projects aimed at the solution of their particular problems, working in collaboration with their peers in Developed Countries and contributing to the advancement of science and human knowledge as a whole.

This program is closely related with CERN, the LAA project and R&D works for advanced experiments and technology.

Hundreds of bright young scientists from developing countries were given training in CERN, to help in the development of highly sophisticated detectors for the LAA, the ALICE and the R&D for Advanced Technologies experiments.
Specific new pilot projects should now be considered and implemented to promote research and innovation using technology as a tool for international development. For this I refer to the great success of the LAA project at CERN, where the recruitment of technicians, engineers, and physicists, dedicated to basic research, innovation and development, allowed to invent new detectors and initiate technologies, such as advanced electronics. Even today, some 25 years later, technological spin-offs triggered by the LAA project find spectacular new applications (2).

2) Use the advances in communications technology, the informatics and computing frontiers.

People's training and the use of advanced computing and informatics technologies will help the economy and the development of a country.
A similar training effort was part of the very successful programs of the ICSC-World Laboratory in the past when supporting hundreds of students and fellows from Developing Countries to participate in top research experiments at CERN.

Today - in the times of distributed computing with GRIDS and CLOUDS – training can be organised remotely but requires highly developed informatics infrastructures and competent areal or local teams in each participating institution and country.

This has been demonstrated by the outstanding success of the LHC experimental teams of students when considering the speed with which the groups identified the Higgs signal within the Tsunami of data received via the computer grids.

Effective monitoring of Planetary Emergencies is helped by real-time collection and distribution of information. This in turn is the basis for prevention, response and recovery from emergencies.
3) The QGCW experiment proposal will allow the study of new accelerator techniques, imaging and prototype new detector concepts and find solutions for ultra fast time synchronization.

*Examples of the classifical applications: fast timing synchronization of TOF detectors for medical treatments with PET detectors.* The development of CRAB cavities for future colliders and energy recovery linear accelerators are only examples of planned global efforts to improve accelerator performance.

New ideas – such as plasma acceleration for example – need more efforts and bright students to get involved.

All these techniques are part of the accelerator R&D plans, which will undoubtedly lead to applications outside basic research experiments.

An important part of these global collaborations is also the work on improved fabrication methods and investment in superconducting magnets and cryogenic systems.

Another excellent project would be training of technicians and engineers in magnetic field measurements and in cold testing of magnets, as well demonstrated by a recent successful project of this type, launched for LHC between CERN and India.
4) Use the ongoing general progress in the domain of microelectronics, new sensors, and radiation detector development for use in health care, for the protection of environment and/or for energy saving measures.

Dedicated projects on focused training and education of students will help Developing Countries to master and improve techniques, which are essential for improved domestic health care efforts to avoid future emergencies.

5) A Permanent Monitoring Panel (PMP) on Technology and Innovation has been established in the basic field of new research developments in technological instruments and informatics. The PMP will be chaired by Professor Horst Wenninger.
His activities will start with the EPS-TIG workshop, scheduled at Erice in October 2012 aiming to highlight - review - evaluate technologies and devices, developed for use in basic research and identified as candidates for potential applications in health care and in production of innovative products. The invited keynote speakers are themselves involved in the development of innovative technologies or experts with good knowledge and overview of ongoing activities and speakers with experience in best practices of technology transfer.

* * * * * * *

• All these projects are ideal training fields for new talents helping them to acquire competences in most advanced technologies.

Working on basic sciences motivated by curiosity results in competences required for applied sciences, designed to answer specific questions.

* * * * * * *
This is the reason why we have launched last year a competition to encourage our fellows, the world over, to think about Totally Unexpected Discoveries (TUD).

6) A competition the world over for young fellows to think about Totally Unexpected Discoveries (TUD).

Proposal: a competition worldwide for young fellows to start thinking about new problems.

Why? Because the Culture of our Time, called modern, is in fact pre-Aristotelian: neither rigorous theoretical logic (Math) nor rigorous experimental logic (Science) have the role they should have.

* * * * * * *
Let me remind you that the funds needed to study the Planetary Emergencies compete with other projects like man going to Mars. But, while billions of Dollars are spent for going to Mars practically nothing has been devoted to the study of the Planetary Emergencies.
In order to allow decision-making leaders to focus their attention on Planetary Emergencies, we need to convince them that the new Science, the so-called “Science of Complexity” (see Addenda) is in our hands.

This is the reason why the World Federation of Scientists, through the National Scholarship Programme, has established a competition for all young fellows to think about TUD.
The Planetary Emergencies have been practically ignored by World Leaders, as can easily be deduced by the following telegraphic synthesis of worldwide affairs:

• Disarmament – 22 years ago, we went from a bipolar world to a monopolar world and nothing seems to have changed. The arms race continues, local and regional wars are spreading out and the armament industry has not been regulated;

• Terrorism has thrived and terrorist cells have multiplied worldwide. Wars undertaken to contain and eliminate Terrorism were long and costly in terms of human casualties and economy, costing trillions of dollars, and have largely failed in achieving their aims. It seems to have instead exacerbated the problem and created well-trained and armed roving brigades of Jihadists, ready to lend support to every extremist party worldwide;
• Our Western economic systems are floundering, unable to restrain unbridled consumerism which, coupled to widely open markets, led to jobs being lost by the thousands and unemployment increasing in all levels of our societies. Banks have heavily contributed to the worsening of the economic situation by playing with markets in an uncontrolled fashion, generating losses by the trillions;

• Security at every level has become a real concern. Our civil societies have become more violent and their ethics have degraded. Unemployment plays a big role in some countries but, more generally, it is mostly due to moral degradation and lack of civic values. A new security concern has arisen in the last few years, which endangers what was shaping up as the most promising tool for our common future: the security of information. Hooliganism has thus entered the Golden informatics era;
• After a century of heavy industrialisation, pollution is now threatening our very existence. Our soils, our lakes, our rivers and oceans and the very air we breathe are polluted. Some of the chemicals used for agriculture and industry are causing mortal diseases and malformation in foetuses;

• Our earth is already now heavily overpopulated and the increase in population will accelerate. Natural non-renewable resources have become scarce and agriculture needs urgent action in order to be able to feed our population. There is a crying need for worldwide control to ensure a sustainable future;
• Despite the progress achieved in diagnosis and cure, new factors such as pollution, transport globalisation and overcrowding are creating new emergencies for health. For commercial reasons, some of the new diseases and drug-resistant bacteria are not being investigated as they should be;

• Climate has become a worldwide concern. Projections show a trend towards a global warming of the planet which needs two inputs: firstly to be confirmed and precisely evaluated and, secondly, to determine the percentage of the impact of human activities which is far from being quantitatively established. What is needed is an urgent worldwide preparation to mitigate consequences and adapt to possible changes.
The Planetary Emergencies have been at the centre of our attention since 1981 and here we are again, one hundred and eleven scientists from 40 countries, 

Armenia  Israel  Republic of  
Australia  Italy  Moldova  
Austria  Japan  Romania  
Azerbaijan  Jordan  Russia  
Belgium  Kenya  Senegal  
Canada  Korea  Slovenia  
Colombia  Kosovo  South Africa  
Czech Republic  Kuwait  Spain  
Denmark  Kyrgyzstan  Switzerland  
Egypt  Malaysia  Tajikistan  
France  Mexico  UK  
Germany  P.R. China  Ukraine  
Greece  Philippines  USA  
India  

gathered in Erice to analyse a series of crucial multidisciplinary scientific issues. They are all part of the 71 Planetary Emergencies identified by the World Federation of Scientists 25 years ago.

The main topics of this 45th Session are:

WHY SCIENCE IS NEEDED FOR THE CULTURE OF THE THIRD MILLENNIUM (XIII)
MITIGATION OF TERRORIST ACTS (IX.3)
CLIMATE & CLIMATE ECONOMICS (VII.3)
GLOBAL NUCLEAR ENERGY ISSUES (IV.2)
ENERGY & SUSTAINABILITY IN CITIES (V.5)
GLOBAL FOOD PRODUCTION (VI.6)
FOREST DYNAMICS (VII.3)
WATER, POLLUTION (V.5) & TERRORISM (IX.3)
BRAIN AGING & BEHAVIOUR (XII.6)
FRONTIERS IN FAST COMPUTING & INFORMATICS (X.1)
INFORMATION SECURITY (XIII.5)
All I have said is a partial contribution to the reasons why WFS has taken the actions needed for the implementation of our Project. (Details in the Addenda).
Why this Project? Because we care about the consequences of the Planetary Emergencies on the future of the human race.

We want to overcome the danger of an Environmental Holocaust. Environmental Holocaust means spending enormous resources – billions of Dollars / Euros – for the solution of problems whose origin is believed to be known but it is not.
We are confronted with a very difficult task since, at the origin of the Planetary Emergencies, there is a lack of Knowledge, which in our days means a lack of Scientific Culture.

This is why we have to convince the great public that Science is needed in the Culture of the third millennium.

We scientists cannot remain silent when the great public shows a vivid interest for topics such as those in focus at this 45th Session:

- Why Science is needed for the Culture of the Third Millennium (XIII)
- Mitigation of Terrorist Acts (IX.3)
- Climate & Climate Economics (VII.3)
- Global Nuclear Energy Issues (IV.2)
- Energy & Sustainability in Cities (V.5)
- Global Food Production (VI.6)
- Forest Dynamics (VII.3)
- Water, Pollution (V.5) & Terrorism (IX.3)
- Brain Aging & Behaviour (XII.6)
- Frontiers in Fast Computing & Informatics (X.1)
- Information Security (XIII.5).
We have to convince the great public that the solution to all these problems require clarity and rigour. We have to convince people that the best way to study a problem, with clarity and rigour, is through Science.

V

OUR CREDENTIALS
EMFCSC & WFS

Our community of Interdisciplinary Scientists has been able to contribute to overcome the danger of the Nuclear Holocaust, whose worldwide known symbol is the fall of the Berlin Wall.

Here comes a sequence of scientific leaders to whom we have dedicated our buildings.

Patrick M.S. Blackett which is the starting point (my youth).

Isidor I. Rabi a decisive step towards the creation of the Interdisciplinarity Scientific Community.

Eugene P. Wigner a witness of the crucial steps towards the fall of the Berlin Wall.

Victor F. Weisskopf whose support was decisive when this Institution was created at CERN-Geneva.

What have we been able to do in the past decades are our credentials.

ETTORE MAJORANA FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE

DATA ON ACTIVITIES SINCE 1963

124 INTERNATIONAL SCHOOLS, 1,594 COURSES, 113,684 PARTICIPANTS

(125 OF WHICH NOBEL LAUREATES)

COMING FROM 932 UNIVERSITIES AND LABORATORIES OF 140 NATIONS.
9 October 1982 – The President of the Italian Republic, Sandro Pertini, a strong supporter of the Ettore Majorana Foundation and Centre for Scientific Culture, receiving the Erice Statement.
ERICE PRIZE

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THE WORLD FEDERATION OF SCIENTISTS (WFS)
1966-2012

20 Agreements signed with Governments.
65 Scientific Collaboration Agreements signed with Governmental Institutions and Research Institutes worldwide.
43 Research Centres established in Developing Countries.
References

(1) Abdus Salam, the Nobel prize-winning physicist from Pakistan referred to by Robert Aymar, former Director General of CERN first published in Symmetry magazine, August 2006.

(2) Announcement CERN: On 31 July 2012 a Russian spacecraft was launched from the desert steppe of Kazakhstan. Its destination: the International Space Station (ISS). On board: five Timepix detectors developed by the Medipix2 Collaboration at CERN.