

**Antonino Zichichi**

A **Lesson**

for the

**Future**

of

**Our**

**Science**

My Testimony on  
**Lord Patrick M S Blackett**



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*European Physical Society, Switzerland*



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A **Lesson** for the  
**Future** of **Our Science**  
My Testimony on  
**Lord Patrick M S Blackett**

**Antonino Zichichi**, Emeritus Professor of Advanced Physics at the University of Bologna, has authored over 1100 scientific papers which include: 7 discoveries, 5 inventions, 3 original ideas which opened new avenues in high energy subnuclear physics and 5 high-precision measurements of fundamental physics properties. Among the discoveries are the Effective Energy in QCD and of nuclear antimatter; among the inventions are the electronic circuit for time-of-flight measurements with a precision of seventy picoseconds (thousandths of nanosecond); among the original ideas is that which brought the discovery of the third column in the fundamental structure of the Universe.

The great projects of European Physics – LEP and LHC at CERN, GRAN SASSO at INFN, HERA at DESY – are all linked to his name for his seminal contributions in their conception consequent study and implementation phases.

He has been in charge at the European and National level (EPS and INFN). He founded the “Ettore Majorana Center for Scientific Culture” in Erice and the “Enrico Fermi Centre” in Rome. He is President of the “World Federation of Scientists”.

Nine books were written by eminent scientists about his discoveries and inventions. The asteroid discovered in 1986 has been dedicated to him, 3951 Zichichi. He has written 21 books; received 104 Prizes, 24 honorary citizenships, 10 Gold Medals, 9 honorary Ph.D. degrees and is member of 13 scientific Academies. He was awarded honours in 16 Countries: Argentina, China, Georgia, Germany, Italy, Kyrgyzstan, Lithuania, Malta, Moldova, Poland, Romania, Russia, Ukraine, UK, USA and Vatican City.

## WHY OUR SCIENCE

*There are many intellectual activities which people consider to be Science. But there is a general agreement about Physics being the mother and the queen of all Sciences.*

*We should not forget that Modern Science, thanks to Galileo Galilei, is based on the following fundamental point: no matter what we are thinking (including the very rigorous theoretical form of thinking, which means expressing all our ideas using mathematical language, i.e. formulae), we have to find out what experiment has to be realized in order to prove the validity of our intellectual activity. If this is not the case, our intellectual activity has nothing to do with Science.*

*Richard Feynman (Erice, 1964): "It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."*



WE ALL SHOULD PAY TRIBUTE TO A PHYSICIST WHO HAS PLAYED A VITAL ROLE IN THE DISCOVERY OF THE SUBNUCLEAR UNIVERSE AND IN THE PROMOTION OF SCIENTIFIC CULTURE.

THE REAL MOTOR FOR THE PROGRESS IN TECHNOLOGICAL INVENTIONS THAT ALLOW THE QUALITY OF LIFE TO BE AT THE LEVEL IT IS TODAY IS THE SCIENTIFIC DISCOVERY AT THE 1<sup>st</sup> LEVEL OF GALILEAN SCIENCE.

## WHY MY TESTIMONY

*When, thanks to Paul Dirac, I had the privilege of meeting with Pyotr L. Kapitza, he told me that, when he had the courage of refusing the offer by Stalin to be the Director of the USSR nuclear fusion project, losing all material privileges including his salary, he realized that the only treasury nobody could take away from him was what all he knew and kept in his memory.*

*It happens that Blackett was firmly convinced that we physicists should not waste our time in writing notes in agendas but keeping all relevant steps in our brain, thanks to the privilege of having memory. The roots of all our activities are in our memory.*

*The present volume would have remained in my memory if it was not for the invitation I received from Mike Duff to give a lecture at Imperial College<sup>(\*)</sup>.*

*This is how I realized that sometimes we have to **stop** working on what we are still trying to understand better.*

*This **stop** has to be given top priority, at least once in our life, when we have to pay the due tribute to those who have played a crucial role in our scientific and cultural life.*

*The content of this book is based on what I can remember of the time when I started my activity in physics, including all consequences in terms of Physics, Logic and Ethics, in our Science. The published papers are the written testimony of what I tried to reconstruct.*

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<sup>(\*)</sup> "My Testimony on Lord Patrick M.S. Blackett" delivered at the Clore Lecture Theatre – Imperial College, **London**, **30<sup>th</sup> April 2014**.





Lord Patrick M.S. Blackett.

*(Picture courtesy of the Imperial College London).*

# A LESSON FOR THE FUTURE OF OUR SCIENCE MY TESTIMONY ON LORD PATRICK M.S. BLACKETT

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## CONTENTS

I	– <i>The reasons why this book has been written</i> .....	5
II	– <i>An incredible sequence of Unexpected Events: the Blackett, Bohr and Rabi “vital condition” for CERN</i> .....	13
II-1	– <i>Europe had only cosmic rays</i> .....	13
II-2	– <i>How it could happen that – few years after CERN was established – the discovery needed for the existence of the “strange” charge was obtained</i> .....	19
II-3	– <i>An example of ethics in our Science</i> .....	23
III	– <i>Blackett and the discovery of the Subnuclear Universe</i> .....	27
III-1	– <i>The <math>V^0</math>-particles: from strangeness to QCD and its “hidden” side plus the “end of a myth”</i> .....	27
III-2	– <i>The Nuclear Glue: from the <math>\pi</math>-meson to the third Family plus the gluon jets and the instantons</i> .....	41
III-3	– <i>Virtual Physics: from the “vacuum polarization” to the grand unification of all forces and the GAP</i> .....	47
III-3.1	– <i>The 1<sup>st</sup> discovery at CERN in the Physics of high precision. Consequences of Virtual Physics on the “Heavy Electron” called muon</i> .....	61
III-3.2	– <i>The 1<sup>st</sup> invention at CERN for the production of high precision magnetic fields that is <math>10^2</math> times faster for construction and <math>10^2</math> times cheaper than all existing technologies</i> .....	65
III-3.3	– <i>The 1<sup>st</sup> proof that CERN could compete with well established famous Labs and win</i> .....	69
III-3.4	– <i>The third lepton and the problem of Gödel in Physics</i> .....	73
IV	– <i>Blackett and Russell (Galilei, Einstein, Gödel)</i> .....	79
V	– <i>The “Blackett Effect” in the 2<sup>nd</sup> World War</i> .....	87
VI	– <i>Blackett, the Cambridge Circle and the whole of our knowledge including Virtual History and the three Big Bangs</i> .....	93
VII	– <i>New Institutions founded</i> .....	109
VIII	– <i>Memory is needed for the Future</i> .....	125
IX	– <i>The Future</i> .....	141
X	– <i>Conclusions – From Blackett to present day Physics</i> .....	149
XI	– <i>The “Piersanti Mattarella Tower of Thought” and the view which enchanted Professor Blackett</i> .....	159
XII	– <i>How things really happen</i> .....	171
	<i>Appendices</i> .....	187
	<i>References</i> .....	239
	<i>Acronyms</i> .....	251
	<i>Index of Names</i> .....	254
	<i>Analytic Index of the Main Topics</i> .....	261



The central door entrance of the Blackett Institute in Erice.



## I – THE REASONS WHY THIS BOOK HAS BEEN WRITTEN

The contributions of Professor Blackett to progress in Physics, in Scientific Culture and in the 2<sup>nd</sup> World War deserve to be highlighted.

In 1932, it was Blackett who provided the experimental proof for the existence of the so called “vacuum polarization” effect, the first example of “virtual physics”. Without the existence of “virtual phenomena” it would have been impossible to have the theoretical structure to develop the Unification of the Fundamental Forces of Nature, called Grand Unified Theory (GUT).

It is the discovery of the so-called “strange particles” in the Blackett group that opened a new horizon towards the existence of the subnuclear universe.

During the 2<sup>nd</sup> World War, thanks to the “Blackett effect”, the British Navy won the Mediterranean battle which gave Sicily two years of peace instead of the two terrible last years of war, from mid-1943 to mid-1945. The Blackett effect will be the subject of Chapter V.

On the problem of developing new institutions after the last attempt of Europe to destroy itself during the 2<sup>nd</sup> World War, there are two inspiring examples: CERN in Geneva, now the largest and most powerful laboratory investigating the subnuclear universe, and the EMFCSC (Ettore Majorana Foundation and Centre for Scientific Culture) in Erice, now the famous Centre where scientists from all countries work together for a science without secrets and without borders.

CERN is well known all over the world. I will later describe the first activities of CERN in more detail: two discoveries and one invention. **The first Physics discovery**, just a few years after CERN's foundation (in 1954), was the simultaneous production of heavy mesons with positive and negative strangeness (as we will see in Chapter II). **The second Physics discovery** was in the field of high precision experiments on the muon magnetic moment (Chapter III and Section III-3.1). **The first invention** was a new technology for the construction of high precision magnetic fields a hundred times cheaper and a hundred times faster to construct than all existing technologies (Chapter III-3.2). There is also proof that this new laboratory was able to do what other labs tried to do and failed. This was in the measurement of the universal weak charge (Chapter III-3.3), now known as the Fermi coupling. These achievements allowed CERN to be known in the Physics community the world over.

These results could be achieved at CERN because Blackett gave to CERN his cosmic ray group, which was the most powerful experimental Physics group in the world, as we will see in Chapter II.

Concerning the EMFCSC, I will only give some data. During the five past decades, more than 100,000 scientists from all over the world have participated in the 126 International Schools of the EMFCSC. The majority of these scientists were engaged in activities far away from Physics. The data are in the table below.

***DATA ON ACTIVITIES OF THE ETTORE MAJORANA FOUNDATION AND  
CENTRE FOR SCIENTIFIC CULTURE SINCE 1963***

**126 SCHOOLS,  
1,778 COURSES,  
123,716 PARTICIPANTS<sup>(\*)</sup>  
COMING FROM 932 UNIVERSITIES  
AND LABORATORIES OF 140 NATIONS.**

At the EMFCSC, the first institute was dedicated to Lord Patrick M.S. Blackett. Many fellows asked me why it was named after Blackett.

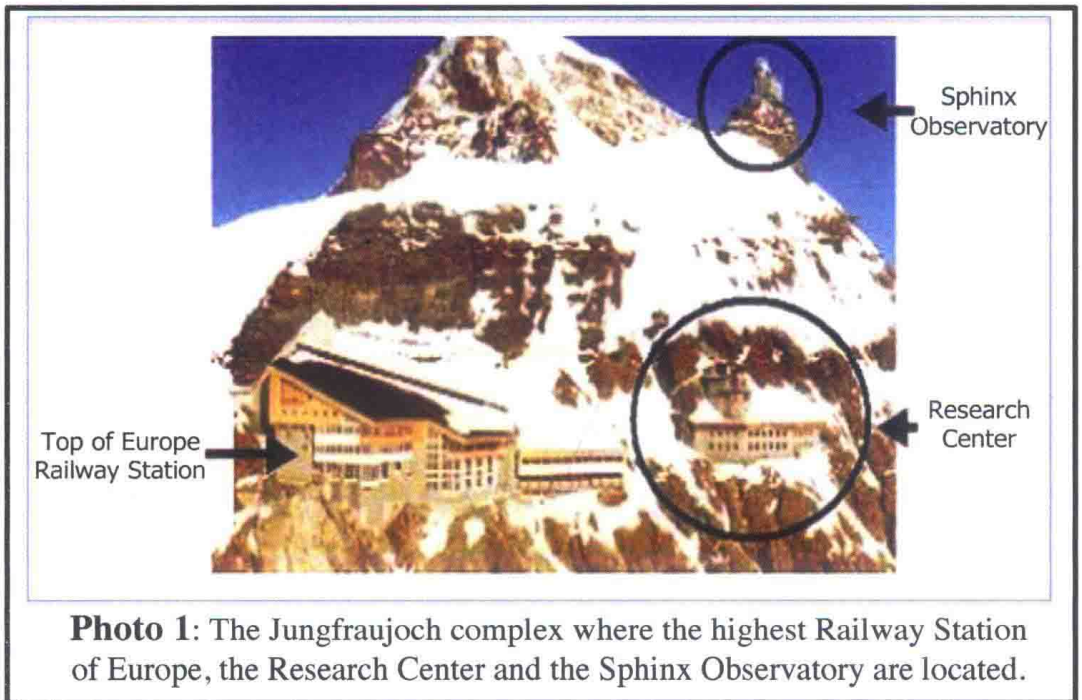
(\*) One hundred and thirty five Nobel Laureates (eighty-six of them were awarded the Nobel Prize after their participation to the EMFCSC Schools and forty-nine were already laureates when they started taking part in the EMFCSC's activities).

Having told them the reason, they encouraged me to write about these “extremely interesting” facts. I have not done it till now. What follows is my first attempt.

Professor Mike Duff organized at Imperial College on April 2014 a formidable set of events and invited me to recall what happened when I was 67 years younger than now (2014).

In fact, the first time I learned about the existence of the Blackett group was in 1947 when the new particles called  $V^0$ s were discovered by a group of physicists whose leader was the same fellow who gave Sicily the privilege previously mentioned during the 2<sup>nd</sup> World War of two extra years free from war. 1947 was the last year of my pre-university studies, in Trapani (Ximenes Liceum), Sicily.

I could not imagine that eight years after this totally unexpected discovery I would have become the youngest member of Professor Blackett’s Physics group, whose two discoveries – the production of  $(e^+e^-)$  pairs in 1932 in London and in 1947 of the  $V^0$ -particles in Manchester – attracted the attention of the physics community the world over. When I joined the Blackett group the detectors (Wilson-cloud-chamber and associated equipment) were installed in the Sphinx Observatory, Europe’s highest lab (3,580 meters a.s.l.), at Jungfraujoch (see **Photos 1 and 2**).



**Photo 1:** The Jungfraujoch complex where the highest Railway Station of Europe, the Research Center and the Sphinx Observatory are located.





**Photo 2:** The Jungfrauoch Lab (in the Sphinx Observatory) where the Blackett group had its powerful detectors.

From Sicily I went to the top-Lab of Europe, thanks to an incredible sequence of unexpected events which allowed me to become a pupil of Professor Blackett (see Chapter II). **Professor Blackett was the leader of the most powerful group of experimental Physics in the world.** This has been of vital importance not only for my career in Physics but also for my activities, including the scientific culture endeavours, to communicate to people the role of scientific discoveries in everyday life and the establishment of new institutions such as the ones already mentioned – **CERN** in Geneva and **EMFCSC** in Erice – and later the **WFS** (the World Federation of Scientists) in Geneva, New York, Beijing and Moscow and the **World Lab**, with its projects implemented in many developing countries (see Chapter VII).

Professor Blackett was convinced that it is us, the physicists, who must be engaged directly in letting the people outside our labs know what the role of science is in the progress of our civilisation.

I would like to thank Lord Blackett: it is because of him that I had the privilege of spending an evening with his friend **Bertrand Russell** and getting

to know his views on us physicists who were and are engaged at the frontiers of human knowledge in order to understand the Logic of Nature (see Chapter IV).

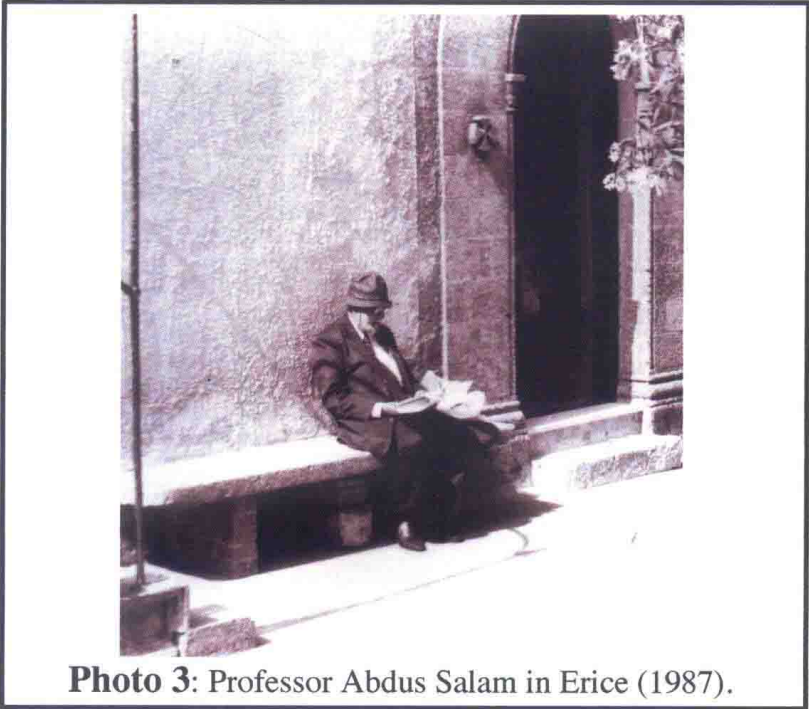
Professor Blackett and his friend Bertrand Russell were interested in identifying the real motor for progress in technological inventions that has allowed the quality of life to be at the level it is today. We will see in Chapter VI that this motor is the scientific discovery at the **1<sup>st</sup> level of Galilean Science**.

We should all **pay tribute** to a physicist who played a vital role in the discovery of the subnuclear universe and in the promotion of scientific culture.

Today, the centre of everyone's attention are the problems concerning the **role of science** as the source of high quality life instead of being just the source of high precision and high power weapons. In the years after the 2<sup>nd</sup> World War, these problems were far from being of interest to the public. When I had the privilege of being in Professor Blackett's Physics group I learned a lot about these problems, essentially as Professor Blackett was engaged not only in the frontiers of Physics but also with problems concerning the role of science in the culture of our time (Chapter VI). This is how I learnt about the great technological achievements obtained thanks to the existence of the Manhattan Project, which developed the so-called atomic bomb in the USA during 2<sup>nd</sup> World War. In a few years the discovery of the "nuclear fission" produced a nuclear fire, millions of times more powerful than all known fires. Why were the nuclear bombs that destroyed Hiroshima and Nagasaki called "Atomic"? The answer was given to me by Professor Wigner, father of Time-reversal invariance, as we will see later. The fellows responsible for the Manhattan Project were three great physicists (Fermi, Oppenheimer, Wigner) and a military exponent of the USA army. When the nuclear fission bomb was experimentally checked to be working as expected, the three physicists proposed to give the name nuclear to the bomb. But the military exponent of the Manhattan Project pointed out that before 1940 the word "**Nuclear**" **did not exist in our language**. The name given to this invention of enormous power had to be the most advanced scientific word, not an unknown word. People would have been confused. The most advanced word was "atomic" and that was the reason why the first nuclear bomb was called "Atomic" (see "*Mach died convinced that Atomic Physics was not Science*", Appendix 1).

Now few words on the Time-reversal invariance. For us the time goes from past to future, apparently because we are very complex systems. The simplest examples of particles, called elementary, have no memory and no clocks; their interactions are the results of fundamental forces (see “*Fundamental Forces*”, Appendix 2). For these particles, **whatever they do** must be invariant with respect to time going from the past to the future and from the future to the past. The validity of the Wigner theorem was proved for the electromagnetic forces by A.Z. in the middle of last century, as we will see in Chapter IV.

The Manhattan Project was the result of the collaboration of many brilliant physicists working together in one place. According to Blackett and Russell, this project was the example of how the new frontiers of science and technology would have to be implemented in the future. The Manhattan Project is the proof that a new bridge is not only possible but also needed in order to fill the gap between traditional university teaching and the big projects for the future of science and technology. CERN did not exist at that point, nor other institutions such as the EMFCSC in Erice and the International Centre for Theoretical Physics (ICTP) in Trieste [1]. Abdus Salam (**Photo 3**), the founder of ICTP, had yet to join the Blackett group.



**Photo 3:** Professor Abdus Salam in Erice (1987).