A subjective appreciation of my *curriculum vitae*

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1 Introduction

Next to the traditional *curriculum vitae*, more and more universities and academic institutions are asking senior researchers to present a selection of five to ten of their papers, and possibly to briefly comment them. In my case such a selection and subjective appreciation are particularly important since almost half of my more than hundred published papers, reports, and books deal with a non-traditional academic discipline: the technical aspects of nuclear weapons non-proliferation.

As my professional work started in 1970 (as a CERN summer-student), I will select 8 papers, i.e., about one for every five years until 2005. These 35 years of research can be divided in three periods:

- 1970 — 1980 : In these ten years I primarily worked as an elementary-particle-physics experimentalist at Geneva (CERN), Oxford (RHEL), and Chicago (FNAL). Since my ambition was to become a theoretician with a good background in experimentation and technology, I thought that this was the right thing to do.
- 1980 — 1990 : As I was preparing to leave experimental physics for theory I made an important accidental discovery — Iraqi engineers came to CERN and wanted to know everything about the magnet used in our experiment. This led me to get interested in non-proliferation issues, and what I expected to be a "small detour" ended up in a 15 to 20 years long journey which made out of me a recognized expert in high-energy-density and plasma physics.

- 1990 — 2005 : In the last fifteen years (after a break from 1987 to 1989 due to a cancer, from which I fully recovered thanks to a successful chemotherapy) I progressively returned to theoretical physics. My ambition became to realize the program I had during the 1980s, namely to develop Lanczos's versions of Maxwell's and Dirac's theories, i.e., of using biquaternions to introduce isospin at the fundamental level into theory, rather then in a *ad hoc* fashion as is currently done in the Standard Model.

2 1970 — 1980

- *Coherent K_S regeneration amplitude for C, Al, Cu, Sn and Pb nuclei from 20 to 140 GeV/c and their interpretation*, Phys. Rev. Lett. /42/ (1979) 9–13.

- *K_L-nucleus total cross-sections between 30 and 150 GeV/c: Quantitative evidence for inelastic screening*, Phys. Rev. Lett. /42/ (1979) 13–16.

These two papers in Phys. Rev. Lett. are the two main products of my PhD experiment. A third product is that this experiment was the first large one in which all the data was analyzed "on line" by a dedicated computer system doing a preliminary physics analysis, rather than just written onto tape and analyzed at a computer center. That part of my work was never published as a comprehensive paper, or presented at a conference, because I wanted to quit experimentation.

For me the most interesting part of this experiment was that I was fully in charge of both the data taking and the physical analysis, which demonstrated several of the fascinating properties of the neutral K particles: K_L regeneration, CP violation, and inelastic screening. The last effect, which was for the first time quantitatively demonstrated in my PhD experiment, is a purely quantum mechanical effect resulting from the ability of an incident K_L to fully dissociate at one point within a target nucleus and to "recombine" subsequently at another. This remarquable effect could in fact be presented in introductory lectures on quantum theory as an illustration of the basic principles of quantum mechanics.

The two Letters in Physical Review for a single PhD experiment, and the on line analysis of its data in real-time, made that I was awarded the Medal of the Swiss Federal Institute of Technology in 1979.

3 1980 — 1990

- *Iraq's Calutrons 1991 — 2001*. Report ISRI-02-08, 15 pp.
  Available at http://nuclearweaponarchive.org/Iraq/Calutron.html

It is only in 2002, 23 years after the facts, that was able to explain in details what I had discovered at CERN in relation to Iraq's nuclear weapons program. This was the occasion to publish my only internet "blog," which contains references to several technical documents which I had published on this program between 1980 and 2000, that is before and after it was claimed to be (supposedly) "discovered" at the end of the 1991 Gulf war.

- *Antimatter induced fusion and thermonuclear explosions*, Atomkernenergie-Kerntechnik /49/ (1987) 198–203.

In the course of the development of my research on the nuclear proliferation aspects of the less discussed nuclear technologies (the "calutrons" used by Iraq being one example) I made several "discoveries" such as, for example, the possibility of using extremely small amounts (i.e., micrograms) of antimatter to trigger large scale thermonuclear explosions. This led to several "seminal" papers (such the above one of 1987) which are now regularly cited as the first open publication on the question.

4 1990—2000

- *Lanczos's equation to replace Dirac's equation?*, Proc. Int. Cornelius Lanczos Conf., Raleigh, NC, USA (SIAM Publ., 1994) 509–512.
  Available at http://arXiv.org/abs/hep-ph/0112317

This paper presented at the 1993 Cornelius Lanczos Centenary Conference in Raleigh is my first publication by which I was returning to the subject I first wanted to study in a possible PhD in theoretical physics, and that I wanted to develop in the 1980s as a theoretician. I was particularly happy to have John Wheeler listening to my oral presentation of this paper, and to be invited by him for lunch to talk about Lanczos's ideas on classical electrodynamics and Dirac's equation. He was apparently one of the rare persons at the conference to appreciate that a fundamental mathematical explanation for isospin could be of considerable interest.

- *Comment on "Deuterium–tritium fusion reactors without external fusion breeding" by Eliezer et al.*, Phys. Lett. A /253/ (1999) 119-121.
  Available at http://arXiv.org/abs/physics/0201004

This is an example of the level of expertise achieved after over twenty years of work in plasma physics, a branch of physics in which proficiency is particularly difficult to achieve because of its proximity with classified areas of knowledge. This small paper demonstrates that the misunderstanding of some very basic processes (inverse-Compton scattering in that case) can lead to very erroneous conclusions, implying that researchers have to make sure that they fully understand the concepts they use, and that they only apply formulas and algorithms that they are able to demonstrate themselves.

5 2000 —

- *Comment on Formulating and Generalizing Dirac's, Proca's, and Maxwell's Equations with Biquaternions or Clifford Numbers*, Found. Phys. Lett. /14/ (2001) 77–85.
  Available at http://arXiv.org/abs/math-ph/0201049

This paper was an opportunity to show that the recent rediscovery of the power of Clifford algebras such as the biquaternion algebra to formulate Maxwell's, Dirac's, and Proca's equations is facing the same difficulties as those already encountered by Lanczos in 1929, and after him by Einstein and Mayer in 1932. However, if the progress made in the 1950s and 1960s by Gürsey and a few others are taken into account, one gets a remarkable similarity between the Lanczos-Einstein-Mayer model and the contemporary Standard Model.

In particular, and in contradistinction with the Standard Model (which is based on the usual formulation of Dirac's equation and a number of *ad hoc* restrictions), Lanczos's equation directly leads to the fact that the spin of truly elementary particles is strictly comprised between 0 and 1, and that spin 1/2 elementary particles come in isospin doublets, as is observed in Nature.

- *Cornelius Lanczos's derivation of the usual action integral of classical electrodynamics*, Found. Phys. /35/ (2005) 865–880.
  Available at Available at http://arXiv.org/abs/math-ph/0408027

This paper is successfully completing the proof sketched by Lanczos, in his dissertation of 1919, of his claim that the usual action integral of classical electrodynamics can be derived from a more fundamental action integral in which there is no mass term. Contrary to the usual theory based on the inhomogeneous Maxwell's equations, in which charged particles are identified with the sources, Lanczos's electrodynamics is a a pure field theory in which charged particles are identified with singularities of the homogeneous Maxwell's equations interpreted as a generalization of the Cauchy-Riemann regularity conditions from complex to biquaternion functions of four complex variables.