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Opening Talk
on the
Course of Theoretical Physics
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1 Where we are

Radioactive carbon studies of inorganic and organic remnants revealed that Earth is about 4.5 billions years old (*i.e.* 4.5×10^9 years), life appeared about $2-3$ billions years ago, Homo erectus is signaled about 1 million (*i.e.* 1×10^6) years ago, and writing was used in Sumeria *cca* 6 thousands (6×10^3) years ago. Mice and rats are more venerable than humans in this respect, as they are *cca* 60 millions years old.

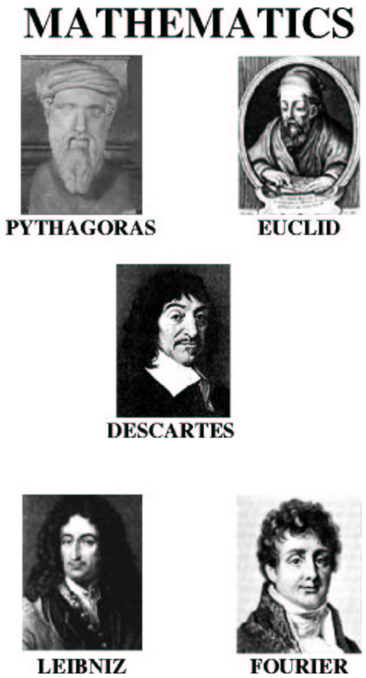
2 Cosmogony

People with phantasies believe that all the Universe was concentrated first in an extremely small space region, almost one point, where gravity was quantal. But the pressure was so high, that Universe started to blow up, get inflated, it was an inflationary Universe, and thus world began with a very Big Bang. Everything happened very fast, in about $10^{-43}s$, then fast enough appeared strong, weak and electromagnetic forces, then particles and radiation, and finally, in about one hundred thousands years, matter formed. Galaxies took about 1 billion years to build up, and finally our solar system needed about 5 billions years to appear.

All this is based on a very free play with the famous uncertainty quantal (in)equation $\Delta E\Delta t\geq\hbar$, where E is energy, t is time, and $\hbar$ is Planck's constant, with the symmetry breaking-which is an old and interesting technical trick (appeared for the first time probably in condensed matter theory in connection with superfluidity and superconductivity), and with Yang-Mills gauge fields, which again is an old technical trick.

3 The defeat of the Greeks

People idolatrized Nature at the beginning, then, for unknown reasons, they started to measure it, and to count. This made them happy a while, and believed that the essence of the world



rests in numbers (Pythagoras, ∼500 BC). However, Euclid (∼300 BC) discovered soon geometry, and, when people tried to measure the diagonal of the square by its side, they noticed that it does not make sense. Geometry is great, and many believe today that the essence of the world is geometrical, so geometry was not to be discarded, nor the numbers. Both together, the diagonal of the square and the numbers, raised therefore a problem. Similarly, people tried before to divide space and time in small bits, in order to understand motion, and ended in paradoxes (Zeno, ∼450 BC). Furthemore, they believed that matter is made of small, very small pieces, called atoms (Democritus, ∼400 BC), but did not know where to stop, it seems that there is no end in those fine divisions. All this happened in Greece, more than 2000 years ago, where irrational numbers, motion and atomism baffled the Greeks, and stopped them from further investigating the nature. They ended in philosophies, looking, like Plato (∼400 BC), for reliable knowledge, or just for analyzing the things, like Aristotle (∼350 BC). The latter wrote a book, entitled *Physics*, which is the Greek for Nature, where all the great subsequent ideas of the physical science, can be found. Among them, the atomism, space, time, motion, and, noteworthy, statistics. About one third of *Physics* is devoted to the *Theory of Luck and Chance*, where a probability and statistical picture of the world and motion is put forward.

However, the great difficulties in making sense of irrational numbers, motion and atoms experienced by Greeks, prevented people from further investigating Nature for about the next 2000 years. It was not the Dark Age, nor the great migrations, nor the wars, nor the predatory inclinations of the humans that stopped science after Greeks, but the difficulties in understanding the natural things. With the scientific defeat of the Greeks it has become apparent that science, Natural Philosophy, or Physics are more about us than about Nature. Most, if not all, of the problems in modern scientific research deal in fact with our mind, and less with Nature. Sort of an unknown similarity of our mind and Nature, a certain unclear resemblance, some imperfect adequacy of our mind to Nature, pointing out perhaps to a common origin, which can be but God, are in fact the scientific issues.

4 Mathematics

The way out to science was Mathematics, that started about 1600 AC with Decartes who put numbers in analyzing the geometrical curves. It followed Leibniz and Newton, who noticed that the variation of the curves is more relevant than the curves themselves, thus appeared calculus and functions. Differential equations and integrals are the fundamental tools in physics. Finally, Fourier showed that smooth curves are made by many distinct oscillatory curves, which deepened enormously our ways of analyzing.

We do not know what mathematics is. It is probably sort of conventions that enable universal reason and communication, whence its enormous usefulness. Reason is pure thinking, *i.e.* seeing, contemplation, identification with the object, common sense; as such, it is always universal and necessary, so it provides sure, positive knowledge. Thinking, or reasoning, is a mental process, this is why a theory of mind, or of thinking, is a non-sense, because mind and thinking become one in this process.

Science is positive knowledge, as based on pure reason and mathematics. The latter mean theory. Physics is on top of sciences, because it is mathematized to the highest degree, because it is theoretical. This is why it made so many technological advances, like mechanical tools, force of vapours, electricity, nuclear energy, electronics, materials, which are positive knowledge. All these technological advances are both very useful and very dangerous too, and our world and the human race depend now definitely on science and technology.

5 Experimental physics

Physics is a natural, or empirical, quest, and, as such, it makes discoveries. This is the experimental physics. However, without rudiments of theory the experimental physics would not be even able to talk about it discoveries, or to be conscious of them. Theory, in this repect, provides at least a dictionary for scientific language.

In the last about four hundreds years physics made a lot of discoveries. It discovered mechanical motion, *i.e.* machines, where machine and mechanical mean determined. It discovered, sound, vibration and waves in elastic bodies, gases, liquids and solids, and many other forms of organization of the condensed matter, their motion and their various properties. It discovered chemical elements, electricity and magnetism, light and electromagnetic waves, atom, electron, and many elementary particles, which are formed out of other elementary particles, with no end, apparently.

All these discoveries are made possible by measurements, and we have fundamental units like meter (m) for length, kilogram (kg) for mass, second (s) for time, Kelvin degree (K) for temperature, mole (mol) for amount of matter, and candela (cd) for luminous intensity. They all are conventional, and we have to get used with some, in order to get a feeling about the natural world.

Measurements give numbers, with some accuracy, while theory gives numbers in another fashion. For instance, theory involves frequently numbers like $\pi = 3.1415...$, or $e \cong 2.72$. More important, theory produces universal constants, which are measured. For instance, electron charge $e = 1.6 \times 10^{-19}C$ (Coulomb, for electric charge, or $e = 4.8 \times 10^{-10}$ electromagnetic units), electron mass $m = 9 \times 10^{-31}kg$, Planck's constant $\hbar = h/2\pi = 10^{-34}Js$ (J stands for an energy of one Joule), Bohr radius $a_H = \hbar^2/me^2 = 0.53\mathring{A}$ (Angstrom, $1\mathring{A} = 10^{-10}m$), Rydberg's constant $Ry = e^2/2a_H = 13.6eV$ (electronvolt, $1eV = 1.6 \times 10^{-19}J$), speed of light (in vacuum) $c = 3 \times 10^8 m/s$, Bohr's magneton $\mu_B = e\hbar/2mc = 0.9 \times 10^{-20} erg/Gs$ (erg, $1erg = 10^{-7}J$, Gauss (or

PHYSICS

NEWTON

MAXWELL

BOLTZMANN

EINSTEIN

Oerstedt, Oe) for magnetic field, $1Gs = 10^{-4}Ts$, Tesla, $1Ts = (1/4\pi) \times 10^7 A/m$), Avogadro's number $N = 6.022 \times 10^{23} mol^{-1}$, Boltzmann's constant $k_B = 1.38 \times 10^{-23} J/K$, proton mass, neutron mass $m_p = m_n = 1836m$, atomic mass unit $1amu = (1/N)g$ (g for gram, $1g = 10^{-3}kg$), gravitational constant $G = 6.67 \times 10^{-11} m^3/kgs^2$, etc. Every number in physics, including theory, is an approximation, the accuracy and rigour in physics, and science in general, is not with numbers, but with pure thinking.

6 Scales of measurement

Much more important than accurate numbers their order of magnitude are in physics, and the scales of measurement. It is of no use to computing electronically numbers with, say, 20 digits, as long as we already know their order of magnitude, and we have a reasonable estimation of them. Life is too short to spend it in endless and useless calculations. We are in theoretical physics where the mathematical rigour or computational accuracy are not only impossible, but they are not desirable either.

Much more interesting are the scales of measurement, because they provide us with a more realistic picture of what we are talking about in theoretical physics. For instance, you may know that the mc^2 energy is equated with a quantal confining energy $\hbar^2/m\lambda^2$ in order to get what is called the Compton wavelength $\lambda = \hbar/mc$ for, say, an electron; or, to the same end, we equate the mc^2 energy to the light quanta $\hbar c/\lambda$. Now, we may think of the duration of light passing through such an electron, and get $\tau = \lambda/c = 8 \times 10^{-21}s$ for such a crossing time. On the other hand, typical vibration time of an atom in a solid is $10^{-13}s$, which means that an atom in a solid vibrates 10^7 times slower than light passes through an electron. Now, a 10^7 factor is about how many seconds are in one third of a year, which means that if light would take one second to passs through an electron, then an atom needs about four months to return to its original position in a solid. I find that quite attractive, don't you?

At the other end of the time scale biologists believe that a biological species changes visibly over $\sim 3 \times 10^{13}s$, which means that we are not the same as we used to be 1 million years ago, and we know that, and we will change considerably in the next million of years. Similarly, Los Angeles will pass San Francisco in about $2 \times 10^{15}s$, *i.e.* in about 100 millions years, as a consequence of the continental drift. You may also know probably that it has been shown recently (in 1994) that three bodies interacting with gravitational forces, like Sun, Earth and Moon, for instance, move non-integrably, *i.e.* their motion can not be represented by functions, and chaotically, *i.e.* the slightest perturbation may lead to a quite different pattern of movement; for instance, Moon may suddenly start to rotate about Sun, and Earth may suddenly escape the elliptical orbit to a hyperbolic one, and so on. Now, we may know such a typical time of unstability of the solar system, it is of the order of $3 \times 10^{14}s$, *i.e.* about 10 millions years. As you see, nothing is for sure, or definite, in this world, except for theoretical physics. Even the proton, thought once to be very stable, may decay over $\sim 10^{39}s$, and a black hole in our Universe will evaporate in about $10^{73}s$.

Similarly, the scale lengths are very interesting. People belive that gravitation would be quantal below $10^{-35}m$, while a superstring would be a bit longer. Copper atoms are spaced by $2.6 \times 10^{-10}m$ (*i.e.* 2.6Å) in solid copper, molecular mean free path in atmosphere is about 700Å, a virus is about 0.1μ (micron, $1\mu = 10^{-6}m$), while an organic cell is about 4μ, and optical photon wavelength is 0.5μ. Human DNA strands are about $7cm$ when stretched out, man is about $1.8m$ in height, Everest goes up to cca $9km$ and the airliners cruise at $12km$; a comet is about $10km$ and the error we know the distance with to Jupiter is about $4km$. Earth crust is about $30km$ depth, radius of Earth is $6300km$, and the Great Wall of China is $3200km$. The distance to the Moon is 380 thousands kilometers, distance to the Sun is cca 150 millions kilometers, the nearest non-solar star is at cca 40000 billions kilometers, and the farthest quasar is probably at cca $10^{27}m$, *i.e.* 100 billions light-years.

Sea floor spreads at $3cm$ per year, San Andreas fault slips at cca $5cm$ per year, rainfall rate in a semi-arid climate is about $30cm$ per year, grass grows by cca $60cm$ per year, glaciers advance by cca $90m$ per year, humans run at $1m/s$ at most, the electrical pulse in the nervous system has $100m/s$ speed, sound speed in air is $330m/s$, molecules move with $480m/s$ in atmosphere, fighter jet speed is $600m/s$, seismic waves have a speed of cca $10km/s$, escape velocity from the Earth's surface is $11km/s$, the Earth rotates about the Sun at $29km/s$, a lightning flash strikes at $100km/s$, and the electron moves at 2 thousands kilometers per second about the hydrogen nucleus.

A green light photon weighs $4.2 \times 10^{-36}kg$, neutrino upper limit is about $10^{-31}kg$, an atmospheric molecule weighs about $5 \times 10^{-26}kg$ on the average, a mosquito weighs $10g$, typical human mass is $70kg$, a meteorite weighs $100kg$, the biomass of the Earth is about $10^{16}kg$, Earth's atmosphere weighs $5 \times 10^{18}kg$, mass of Europe is $4.8 \times 10^{22}kg$, the Earth's mass is $\sim 6 \times 10^{24}kg$, and the visible matter in the Universe weighs $\sim 10^{50}kg$.

The density of the $100 - 300MHz$ (M stands for mega= 10^6, Hertz, $1Hz = s^{-1}$) radio background is $2 \times 10^{-41}g/cm^3$, density of the visible Universe is $2 \times 10^{-32}g/cm^3$, the best vacuum achieved on the Earth at room temperature is $10^{-12}g/cm^3$, density of air is $1.3kg/m^3$, water has $1g/cm^3$ a density, gold has $19.3g/cm^3$, the nuclear density is $6 \times 10^{20}g/cm^3$, while the gravity becomes quantal at about $5 \times 10^{99}g/cm^3$.

One of the squintest time in the world is associated with the transition energy of molecular rotations, about $2.5meV$. Then, our electronics is based on the energy gap of cca $50meV$ between donor levels in a semiconductor and the edge of the conduction gap; a typical semiconductor gap is about $1eV$, while the depth of the Fermi sea in metallic copper is about $10eV$. Green light photon has $\sim 2eV$ an energy, hydrogen binding energy is $13.6eV$ (one Rydberg), electron rest energy is

$0.5MeV$, coulomb barrier height is $1MeV$ times charge (atomic) numbers, the nucleon binding energy is $10MeV$, fusion energy of He (from four H) is $\sim 30MeV$, a well hit tennis ball has an energy of cca $10J$ (*i.e.* $10/4.19 calories$, one calory is the energy needed to raise by one degree the temperature of $1g$ water, $1calory = 4.19J$), a light bulb burns about $0.2MJ$ during an hour, the human energy output in a lifetime is cca 200 billions Joules, an atomic bomb releases typically $1.5 \times 10^{14}J$, and the Earth's total heat content is $3 \times 10^{31}J$. One kilogram of food releases $2 \times 10^7 J$ in metabolism, one kilogram of hydrogen releases $6.3 \times 10^{14}J$ in fusion burning, and one kilogram of matter-antimatter annihilation yields $9 \times 10^{16}J$. Gravitational waves of the solar system carry $100W$ (watt, $1W = 1J/s$), human being yields normaly $150W$, a horse gives $750W$ (power-horse), a nuclear reactor gives $300MW$, and a powerful nanosecond laser yields $\sim 10^{14}W$.

Lasers can cool down atoms, for instance Cs at about $10^{-6}K$ (and atoms may thus become superfluid, via Bose-Einstein condensation). Liquid helium cools down to $0.3K$ by evaporation, and to $0.01K$ by dilution. He^4 becomes superfluid at $2.17K$, and boils at $4.18K$, while liquid He^3 boils at $3.2K$, and the cosmic microwave background is $2.73K$. The Joule-Thomson adiabatic relaxation may give $4K$, as the lowest temperature, while the noise of a typical radio receiver has a temperature of $6K$. Liquid N_2 boils at $77K$, and the high-T_c superconductors of today ($Hg - Ba -$copper oxides) have a critical temperature of $133K$. Water freezes at $273K$, human body has $38C$ at the surface (Celsius, $1C = 1K$), water boils at $100C$ (under normal conditions), while brimstone, *i.e.* sulphur, melts at $388K$. Obviously, the latter is the Hell temperature, and it is worth noting that my writings will survive all right the Hell flames, because paper burns at the much higher $506K$. The Sun has $5770K$ at the surface, a typical fusion experiment goes at $3MK$, electron-positron pair appears from vacuum light at $400MK$, while electrons become relativistic (half speed of light $c/2$) at $700MK$.

The best vacuum achieved on Earth is $5 \times 10^{-12}N/m^2$ (N/m^2 is also called Pascal, Pa, and N stands for Newton, $1N = 1kgm/s^2 = 1J/m$). The pressure of the solar radiation at the Earth is $5 \times 10^{-6}N/m^2$, while the human threshold of hearing is $10^{-5}N/m^2$ (twice sensitive our ear and we were hearing the Sun light falling down on the Earth). The human pain threshold is at $30N/m^2$, while the arterial blood has $10^4 N/m^2$. A standing person exerts a pressure of $1.5 \times 10^4 N/m^2$,

PROFESSORS

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and the atmospheric pressure is typically $10^5 N/m^2$ (which is also approximately one physical atmosphere, $1atm$, *i.e.* $760mm$ height of mercury, or $760torr$; and also a technical atmosphere, $1at$). A byke tire sustains $15at$, while the pressure at the bottom of the Marianas trench is about $1000at$. Diamond crystalizes naturally under $60Kat$, a typical laboratory press produces $0.1Mat$, and a diamond anvil cell gives $2Mat$.

The threshold of hearing is $10^{-12}W/m^2$ (which is an intensity I, say I_0, or flow of energy, or flux of power). Hearing is measured in decibells, dB, defined by $10\lg(I/I_0)$. The rustle of leaves is about $10dB$, a quiet wisper is $20dB$, a soft music is $30dB$, a residence is $45dB$, an ordinary conversation (at $0.5m$) is $65dB$, the unsafe sound level is $90dB$, a rock concert is $120dB$, the threshold of pain is at $130dB$. Suppose a loudspeaker of $100KW$ with an area of $1m^2$, *i.e.* an intensity $I = 100KW/m^2$. At $10m$ the intensity is $I = 1KW/m^2$, which means $150dB$, well beyond the pain threshold, or a jet plane at $30m$ which gives only $140dB$.

Quantal particles have a spin, which is their own angular momentum. For instance, an electron has a spin $s = 1/2$, which means a spin angular momentum $|s| = \sqrt{s(s+1)}\hbar \sim 10^{-34}Js$. The Earth has a rotational angular momentum of $\sim 6 \times 10^{33}Js$. Spins are very small, and have no classical correspondent (or limit). They add to orbital momenta, to give angular momenta of particles; which add themselves vectorially, so that most of atoms half mainly an integer angular momentum, and are Bose particles (or bosons, in contrast with those with a half-integer angular momentum, which are Fermi particles, or fermions); which add chaotically in macroscopic ensembles, so the latter have not much of an inherent angular momentum. Same is true for electrons, for instance, in macroscopic bodies, and controlling spin of such large ensembles is what spintronics wants to do today, especially in nanostructures. However, controlling spins, and in general, angular momenta, is not easy, because, at the most, they only respond to magnetic fields, which are not high (*i.e.* the involved energies are low).

Human brain produces $10^{-13}Ts$ magnetic field spontaneously, and $10^{-12}Ts$ on evoking; the human heart gives $10^{-11}Ts$, a good radio receiver has $10^{-12}Ts$, inside a building is $10^{-10}Ts$, and $10^{-9}Ts$ in

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a radio lobe. A cordless phone has $10^{-6}Ts$, and at the surface of the Earth is $3\times10^{-5}Ts$. Typical medical NMR magnetic fields are of $1Ts$, an electron in the hydrogen atom feels about $2Ts$, and in laboratory one can produce as high magnetic fields as $25Ts$, by superconducting magnets.

Lightning bolt electrical current is about 10^4A, and it has $300MV$ a voltage (Volt, $1V = 1J/C = 1W/A$); electric field in typical ionized air is about $3MV/m$.

Anything communicable can in principle be coded, *i.e.* expressed with a finite number of signs, which, in turn can be digitalized, *i.e.* written up binary. Then, $\log_2 N$, where N s the number of digits 1 appearing in the message gives the amount of information in bits b contained in that mesage. So, a virus genome has about $18Kb$, a single-spaced typed page contains $32Kb$, The Bible has $36Mb$, the human genome about $9Gb$ (G stands for giga= 10^9, *i.e.* a billion), while speed reading with perfect memory for 80 years is $1000Gb$, much higher than current computer hard drives. Typical reading speed is about $200b/s$, a high quality audio proceeds at $100Kb/s$ a rate, soliton carries information through an optical fibre at a rate of $30Gb/s$, and the genetic information is fully transmitted in a sexual reproduction act much more speedly, at a rate of $2\times10^{15}b/s$; this, either because of having not much to transmit, or because we are too hurried up.

Talking about measurement scale we can not let aside the money. The income of St. John's College in Cambridge was 9 millions 1994 USA $, which is approximately how much the Physics campus at Magurele, Romania needs in 2003. Typical holdings of an old wealthy Oxbridge college is about 150 millions $, about twice the scientific research budget of Romania per year. An Ariane rocket launch costs also 150 millions USD $, the USA senate election spending was 210 millions $ in 1994, Visa and MasterCard fraud was 1 billion $ in 1993, Barclays made 3.4 billions $ profit in 1994, and Microsoft 3.8 billions in 1993. USA spent 260 billions $ military, had 4400 billions $ national debt, 6400 billions $ GDP and 14000 billions $ in unfunded social liabilities all in 1994.

PHILOSOPHERS

PLATO

PLATO & ARISTOTLE

KANT

HEGEL

MARX

7 Theoretical physics

Theoretical physics is our ways of perceiving motion. We know four distinct such ways, and all are mathematical. They are Mechanics, where bodies have position which change in time along a trajectory; Electromagnetism, where electric and magnetic fields move in space-time relativistically and interact with electric charges and currents; Quantal Mechanics, where bodies move statistically as waves; and finally we have Statistical Physics, where ensembles of particles are distributed probabilistically over their mechanical states. These sciences are not reducible to one another, they are only compatible to each other. The overall development of the physical sciences has been made in the sense of enlarging the freedom. Inded, first, time was changed under a change of the reference frame, as space was, and so we were led to relativity and the dynamics of the fields; then, motion was freed of trajectory, and we get quantal waves; and finally, bodies lost also a well-determined mechanical state, and we had a statistical picture of the motion. For a few bodies the statistical picture is lost, for macroscopic motion the quantal picture becomes quasi-classical, and for velocities small in comparison with the speed of light the relativistic motion goes over into mechanical motion.

Any other branch of Theoretical Physics is only an application of the above mentioned fundamental sciences. For instance, Elasticity and Fluids are applications of Mechanics; Atomic, Molecular or Nuclear Physics are applications of Quantal Mechanics; Quantal Electrodynamics or Particles and Fields are applications of Quantal Mechanics and Electromagnetism, etc. A special place has Kinetics, which is an application of Statistical Physics to transport; and, the general theory of relativity, *i.e.* the gravitation theory, which is not necessary, but it is very useful. A particular attention deserves the Condensed Matter which includes a great number of applications of Quantal Mechanics and Statistical Physics. In fact, there are today two main directions of research in Physics: one is concerned with Condensed Matter, including materials, quantal chemistry and many other related fields, and another deals with atoms, atomic nuclei, particles and fields. It is worth noting that much of the modern research in the latter is based on concepts and methods of condensed matter. Condensed matter occupies indeed a central place in our knowledge of the natural world, because, after all, matter condenses on our scale of existence.

In doing theoretical physics we rely on Newton, Maxwell, Boltzmann and Einstein, who done the basic sciences, and a dozen of quantal theoreticians who done the Quantal Mechanics; we also rely on a few mathematicians like Pythagoras, Euclid, Descartes, Leibniz and Fourier, who done the basic mathematics in physics; on two great professors of theoretical physics who were Sommerfeld and Landau; and on Landau who done almost all the Condensed Matter. For a leisure time, we may also resort to philosophers like Plato, Aristotle, Spinoza, Kant, Hegel and Marx, who talked much about Nature, Science and man.

We learn something basical from all these guys, concerning the theoretical physics. First, we learn that we will never speak about something which does not exist; because our science was made for things which exist, not for those which do not. Second, we learn that in doing theoretical phsyics we must always look for the meaning of the things, which means to get a full, clear, accurate picture of what we are doing. In this respect it is basical to know the place of what we are talking about in the general frame of the physical theories, and to identify the limits of what we are saying with as great accuracy as possible. This is only possible by an extensive knowledge of the things, by contemplating a lot, by checking again and again, reformulating everything, and especially by appropriating the wonderful mathematical techniques of the theoretical physics. Then, we learn that always we must get numbers in theoretical physics, not just ideas. There are a lot of ideas in this world, by only a very few are clearly-cut supported by good numbers. Noteworthy, I do not say to compute numbers, I say to get numbers, which is something very different from what the so-called computational physics is doing. I also say mathematical techniques of the theoretical physics, not mathematical equations dealt with by the so-called mathematical physics. We also learn to stay apart from monstruosities like statistical mechanics, which tries in vain to ground the Statistical Physics on Mechanics, and others alike. Then, we learn to be very critical, the criticism being the only way we have to find out sure things. Then, we learn to stay away from false prophets, or famous professors like me, whose talking can damage our theoretical ear. Theoretical Physics is like music, if we listen over to bad music we end in spoiling out our own capacity of doing music. We learn also that theoretical physics is doing by talking much, first with ourselves, then with those knowledgable, who are a very few. We should not talk with many, because their image will take away our own visions. And finally, we learn that we all are able to do theoretical physics, because it is only pure reason, and it is bestowed upon all of us by God whose children we all are, and once entered it we will see that it is an infinite joy. It will also show us that nothing must be taken too seriously in this very short life, not even the theoretical phyiscs.