

FROM EXACT SCIENCES TO *FIDES ET RATIO* - PERSONAL EXPERIENCE*

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1. As a scientist I have to define first the scope and limits of my intervention in this very broad as well as relevant topic. Not being a professional philosopher or theologian I can only offer my own concrete experiences in exact sciences, after forty years of research and teaching in theoretical physics, as a brief contribution to the debate. Finally, I should like to connect my personal experience with the encyclical *Fides et ratio*, as the ultimate word of the Magisterium and for many intellectuals – not only Catholic – a precious guideline.

Fides et ratio discusses complementary roles of faith and reason in human existence, represented concretely by theology and philosophy. Even with this restriction to philosophy as a paradigm of rational comprehension of the world (or maybe by redefining philosophy in this more general sense?) I discovered essential agreement with my own experience in physics, which could be taken as a paradigm of exact sciences. It was most fascinating to discover in this context of philosophy – theology dialogue so many similarities with what I considered to be a typical experience of a practising scientist in one of the «hard» sciences, and, in fact, I have nothing to add to this magnificent document.

2. However, apart from this basic similarity and agreement, there are also specific differences between these disciplines, and at some point it becomes necessary to define and discuss them – differences in motivation, scope, methods, limitations, character and meaning of results, etc. between «exact» sciences, social sciences, arts and humanities, including philosophy and theology.

(In the following I shall refer to science in the narrow, Anglosaxon sense, which includes only natural or exact sciences, in contrast to the German (and European) tradition where "Wissenschaft" includes philosophy, theology, "soft" sciences, humanities etc.)

Though they all have common roots in the early partnership of theology and philosophy (including *philosophia naturalis*), where they shared the deductive method of reasoning, their subsequent growth in the framework of the Western Christian civilization led to diversification and specialization in the above mentioned elements; great advances were followed by fragmentation of knowledge, which often led to loss of the direction and meaning but also mutual misunderstandings and even conflicts.

One could e.g. trace here the origin of the well known conflict between science and religion, philosophy and theology, which culminated in the 19th century, concerning the origin of life and the origin of universe, confronting "evolutionists" vs. "creationists". It can be easily shown that this unhappy episode, in otherwise happy

and fruitful coexistence of science and religion in the Western Christianity, arose because of gross misunderstanding. Both sides behaved irrationally, one generalizing scientific results and extrapolating them “non-scientifically” and making unjustified claims, the other sticking to the literal and essentially naive interpretation of religious texts. One could say that both sides visualized a “mechanical” God who directly intervenes in the natural processes, completely in the spirit of the materialistic 19th century, forgetting that St. Augustin already in the 5th century warned against similar errors. Since then science made new advances and discoveries, we have learnt to be more careful and precise in understanding and interpreting scientific results, especially their limitations and implications. We know that the view of two opposed belief systems – scientific and religious - is misleading, but in order to bring them closer and achieve their synergy will require additional efforts on both sides.

3. I find therefore that it would be extremely useful to elaborate the essential messages of “Fides et ratio” by extending them from philosophy to other “rational” disciplines taking into account their specific aspects. As a “practitioner” in science I am convinced the results of such an analysis in the exact sciences would additionally support and illustrate these messages, especially the idea of complementarity of two modes of comprehension – faith and reason.

Here are a few brief comments in his direction, more as a review of relevant topics than a systematic discussion.

Scientific research – in practice

4. Scientific research is a fascinating and extremely demanding activity. Young person entering this adventure is faced with an enormous task of absorbing a huge quantity of facts and their mutual interconnections, causal relationships, and above all he has to learn the scientific method, procedures of scientific work, i.e. discovering new relationships, creating new knowledge on the basis of the existing and extending the limits of accepted knowledge to the previously “dark” regions of the unknown.

In this process a young scientist has to be and usually is helped by senior experienced researchers – the technique of scientific research turns out to be so complex that it cannot be copied from a written manual, but learnt as a craft from the masters of the profession. There is no known or well defined method to discover the unknown, only approximate methods combining extensions of already known with guesses based on experience with intuition, repeated attempts, and often even sheer luck. Though even such a lucky discovery is usually not accidental, it has to be deserved – recognized and appreciated, so that one could argue that this «luck» only comes to those who deserve it.

Young scientist gradually has to learn a new way of thinking, drawing consequences, making conclusions, following the rules which are often drastically different from those of everyday experience. If we want to understand physical phenomena, especially in the quantum world, whether in micro dimensions of the atomic, nuclear or subnuclear world, or in the world of cosmic dimensions, we have to accept the limitations of our reasoning apparatus, and at the same time continue to use it in a “fuzzy” way to explain the observed phenomena of nature.

All this leads to exciting moments of creative activity, joy of discovering new aspects of reality, but also to many disappointments.

Question of language

5. In philosophy and humanities in general language plays a dominant role not only a means of communication but often (at least until recently) also as a tool and medium of research, with direct mapping of intellectual results to the language of everyday experience. In (exact) sciences we have realized the dichotomy between them. We cannot establish direct correspondence between scientific results and the language which reflects our experience in the “macroscopic” world, and, as we have to use it anyway in order to communicate and even to try to visualize and “understand” the phenomena, we have learnt how to be careful and constantly control and “interpret” the verbal expressions to converge and describe *as accurately as possible* the scientific results.

This not only may lead to apparent “paradoxes” and “strange” phenomena, but is obviously a potential danger in the communication with philosophers and others (e.g. theologians) who cannot know what is “behind” a specific statement, but try to interpret it literally.

I should like to point out the analogy with similar problems that may occur e.g. with literal interpretation of the sacred texts. Again, one here finds apparent “paradoxes” which are then resolved as the articles of faith, and only *a posteriori* through the human experience. In both cases we have to support our limited ability of rational comprehension based personal experience with the effort of *faith*, which cannot be justified instantly and individually but requires a wider framework.

Scientist as a human being

6. Most scientists believe that they function in their life and profession guided by two separate codes of behaviour, and to a large extent this is true. As with other “ordinary” people their private lives are determined by their upbringing, family tradition, education, social environment, etc., which provides them with their moral, ethical, religious, political, and other aspects of their personalities. Scientific activity is governed by another set of rules, seemingly unrelated to those that define their personality. I shall argue that on the contrary – the scientist’s personality, as well as his professional and social environment, strongly influence his research, and his overall attitude towards science and its results.

You must have noticed that I already used the words joy, disappointment, believe, refused to accept, emotional attitude, etc. This is certainly in contrast with the standard picture of a scientist as a cool “thinking” machine and science as a purely rational activity. The main reason is simply that it is not possible to separate a scientist as a machine for rational application of scientific method from the rest of the human being, with his feelings, experiences, prejudices, etc. Similarly, the exchange of scientific results, communication in the scientific community, e.g. their evaluation and acceptance of these results, which is a crucial stage in the progress of science, is strongly influenced by presumed attitudes, “fashion” that depends e.g. on institutional affiliation, broader trends, and it even usually changes with time. Psychological and sociological studies of science and scientists abundantly confirm these statements.

7. However, I should like to argue that, even if we are not aware of this, underlying every scientific research there are certain important humanistic assumptions, which contain essential elements of faith. Among them are:

- belief in the existence of truth and our human capacity to discover it gradually and systematically;

- respect for authority based on established records and arguments;
- freedom to doubt and to question this same authority, and to modify or eliminate established beliefs through a systematic set of rational procedures.

It seems that reason cannot function alone, without these (and many other) elements of faith.

Of course, the existing social and spiritual environment should not only accept the belief in the existence of truth, but also provide a strong metaphysical motivation to search for it and glorify it as part of a wider existential framework.

8. Science and its institutions, above all the university, therefore, could and did start and flourish only in the framework of our (Western) Christian civilisation which provided enough motivation, but also enough social and spiritual freedom for its basic activity. The motivation – apart from the natural human curiosity – came from the religious teaching of the Catholic Church, where truth and beauty and rational comprehension of the world – among others – all contribute to celebrate the Creator. No wonder then that universities were promoted by and for centuries existed as institutions of the Catholic Church, *Ex Corde Ecclesiae*. Encyclical *Fides et ratio* is another confirmation of this close relationship.

This space of freedom was possible due to the intrinsic separation of church and state, of spiritual and temporal, which sometimes led to conflicts and tensions, but nevertheless provided neutral control mechanisms, intellectual “competition”, and certainly removed (or at least weakened) the possibility of a monopoly of power, truth, etc. In contrast, in most Eastern civilisations and societies, identification of religious institutions and leadership with secular powers (“*caesaropapism*”) limits this freedom, and thus sacrifices the search for truth for the sake of pragmatism.

How exact is science

9. We are usually told – either explicitly, or implicitly - that science is an exact activity – in other words that each statement or hypothesis could be proven to be right or wrong, correct or incorrect, true or false. It should be enough to apply correctly the rules of scientific method. The role of the scientist is to apply these rules, irrespective of his or her personality, emotions, background etc.

This is only partially true, or – at best – asymptotically true, as every scientist quickly learns from experience. In the following I shall argue that science is not at each stage an exact activity (as defined in this simplified way), but its results – after a complicated and very human procedure of verification – can be considered to be asymptotically correct and true. By this I mean that we have to accept the limitations of every hypothesis, and the possibility that one day they will form part of a wider and more general picture!

10. Every practising scientist has encountered situations where scientists vehemently disagreed over the value of certain results, with emotions and strong feelings mixing with scientific arguments. The best known case is that of great Albert Einstein, who until the end of his life simply refused to accept quantum theory, though he himself contributed to it in the beginning. In spite of all evidence of its validity, he could not believe in nonlocality and indeterminism which are in the basis of quantum physics, and which are directly related to the analysis of measurements in the microscopic world on the atomic scale. Together with two other famous physicists, Podolsky and Rosen, he wrote a paper formulating the famous EPR paradox, trying to refute the

standard “Copenhagen” interpretation of quantum theory promoted by Bohr, Heisenberg, Pauli, Born and others. His stubborn opposition to quantum theory, despite all its successes, though basically mistaken and – I emphasize this aspect – driven by his *emotional* attitudes and not by cool scientific reasoning – nevertheless led later to intense research and to useful clarification of the foundations of quantum physics.

11. Einstein’s opposition to quantum physics is even more striking when one remembers that his special theory of relativity is based on his careful analysis of measurements, specifically the impossibility of simultaneous measurement of time and position due to the finite speed of light. For some internal reason, he was unable to accept a very similar procedure – analysis of so-called “gedanken” experiments – which led to the development of quantum theory.

Facts and concepts in scientific research

12. I am certainly not trying not to diminish great achievements of exact sciences, but I have to comment on another popular myth – the claim that one starts scientific research by performing experiments or observations, collecting data, and then by inductive method comes to their theoretical explanation or hypothesis, which is then verified (or falsified). The truth is the opposite – one has to start with an *idea*, or a model, or a hypothesis, however naïve or wrong. Only *within this model* one can even start collecting data, gradually verifying and confirming the model, or abandoning it for a better one. Usually one combines these “up” and “down” procedures with strong elements of intuition, or one’s own “style” or more or less widely accepted routines. One “believes” in a certain explanation, “prefers” one hypothesis to another, “likes” or “dislikes” some results, follows a “hunch” – all non-scientific but very human actions and reactions in a strong creative effort, when confronted with the boundary of the unknown. But the real “discovery”, the step outside the known and into the unknown, is and will always remain a mystery.

In this controversy over the precedence of facts or theories it is interesting to mention that many of the greatest ideas in science actually appeared – and were accepted - when they seemed in conflict with the empirical evidence. When Copernicus proposed his heliocentric system the observations of celestial motions by Tycho Brache were in fact not better explained in this new model than by the old system of epicycles in the geocentric model of Ptolemaeus. Obviously, the *beauty* and *simplicity* of the new model played an important role, the heliocentric system was soon accepted, followed by the numerical accuracy and empirical confirmation (when Kepler introduced elliptic instead of circular planetary orbits).

The question of truth

13. One of the categories often leading to unnecessary confusion is the notion of “truth”. While essential in theology, popular in philosophy, this term has been abandoned in exact sciences in its original meaning, except colloquially and with caution. We have come to accept that reason can only asymptotically approach this ultimate goal. After arrogance and hubris of the 19th century science and materialist philosophy, enormous progress of science in the 20th century has in fact made scientists much humbler and realistic in their aspirations and expectations. While discovering ever new subtle secrets of nature, structure of matter and universe, studying the complexity of biological processes, etc., we see that each new discovery opens the door to more and more new questions and mysteries. Very few serious

scientists believe that there will be an “end of science”, that man will find the final answer, the final ”truth”; instead we realize that science is a *process*, with each step leading to better and better understanding of nature and man. And this is the crucial difference between the knowledge reached through reason, which is – however splendid and fascinating and satisfactory – only temporary and subject to change and improvement, and the knowledge obtained from revelation, i.e. from faith, which is absolute and final. This does not diminish the role and importance of rational knowledge, on the contrary – it simply emphasizes that man needs complementary knowledge from both sources, with their different character and role.

14. But it seems that this distinction – evident in *Fides et ratio* - is still far from accepted in many circles, including Catholic intellectuals. I was surprised when once in a dialogue with some theologians I realized that they believed in the existence of “scientific truth”, or “scientific picture of the world” as something absolute and unquestionable. And, they claimed, if theology wanted to become relevant and convincing in the modern world, it should thoroughly study this “picture”, “adopt it” and reformulate the religious teachings accordingly.

I certainly support the idea that theologians should learn more about science and scientists, and vice versa, in order to establish better communication between the two communities. Then both of these extremes – *scientism* as a blind belief in the “scientific truth” as well as the total rejection of science and its relevance - could be avoided, and a healthy complementarity announced in *Fides et ratio* could be achieved.

Science and values

15. When and how the two components of one’s life – personal and professional – come into contact and interfere, depends on a number of factors. As we are never isolated from the society, many of our dilemmas are actually imposed on us externally. One of them is related to ethical aspects of scientific research.

It was – and is – often claimed that science is value-free, it is an activity which produces results that are value-free, that this acquired knowledge is neither good nor bad *per se*. As pure knowledge obtained to satisfy basic human curiosity it has no direct practical use nor financial consequences. No ethical judgements can be made concerning scientific research – the only ethical requirement is correct application of scientific method and honest communication of its results. In other words: “No cheating!”

Of course, this is again only partially true, in an ideal situation, if we could isolate a scientist from the rest of his human nature and from the society. This has recently become very difficult, even more so because modern research is expensive and often requires huge organization and financial support. Giving this support the society usually seeks to obtain material benefits from science and its applications in the form of technologies, either for military or commercial purposes. This is a crucial step from pure science into technology: when previously value-free scientific results acquire a form of various technologies they actually leave the realm of science and its rules, they are no longer even controlled by the scientists. Connected with direct social, financial, political or military interests, their implications should certainly become subject to ethical judgement, as we have abundantly witnessed in the last century, e.g. with arms of mass destruction, environmental problems, aberrations in biotechnology,

etc . But it should be remembered that all this is already outside the scope of pure science, even though the boundary is not always easy to determine.

16. A scientist faced with the dilemma about the responsibility of science and of scientists should be able to turn to the disciplines created supposedly to answer these questions – e.g. philosophy and sociology of science, or recently ethics, especially its branch of bioethics. However these very soon became disciplines on their own, self oriented and mostly impenetrable to uninitiated scientists, creating their own rules and lines of research, their own interests and priorities, but not willing or able to offer simple and straightforward answers to the abovementioned dilemmas.

I want to argue here that no scientific discipline can provide these answers concerning social or moral responsibility, to questions involving meaning and value judgements, ethical concerns, and similar. Scientific results are – as emphasized before – value-free (at least in the asymptotic sense!), they follow the sequence “if – then”, so they are descriptive but certainly not prescriptive! The value-statements lie outside the scope of science as we understand it today (though they are crucially relevant to scientists!), and this is even as it should be: we would not like to have them changed every time and in the way the scientific theories are modified. After all, these answers have deeper existential and not just temporary and academic meaning for us.

17. The case of bioethics, with its numerous attempts to present itself as pure science, cutting links with its religious foundations, is the best example that a relevant ethical approach to the problems of life cannot be founded on some more or less sophisticated “scientific” scheme. It is interesting that even some Catholic thinkers try to invoke various and often strange “principles” on which to build the consistent theory, without realizing that no workable ethics is possible without reference to some absolute principle, and that can be found only in religion. Sooner or later somebody will remember that the best and simplest such universal principle can be reduced to “Love thy neighbour!”.

Therefore, in order to obtain the relevant answers we have to turn somewhere else, outside the pure rational sphere, and we all know that the only satisfactory and permanent answer can be found in the Gospel, in the revealed Truth. Only Faith, through its rational transmission in theology and philosophy, but – I add – also other rational disciplines including exact sciences, can give a complete and satisfactory answer in the human efforts to comprehend his existence.

In defence of *ratio*

18. Results of scientific research gradually spread into society and influence its behaviour, mostly in the form of an incredible number of new technologies (unfortunately the most destructive ones usually have the priority!) – but sometimes also in the form of new (or revived) ideas and concepts.

Indeterminism and non-locality inherent in quantum physics, special and general theories of relativity with the equivalence of mass and energy, infinite but bounded universe,... all of these and many other puzzling ideas drifted – often in a distorted and simplified form not only into popular usage but also e.g. into philosophy and sociology, where they started a life of their own, often unrelated to their original meaning. In science the words linked to these concepts always have a well defined meaning restricted by the context, but transferring them as words without their “operational” definitions into another context could lead (and did lead) to serious misinterpretation.

19. One such extreme episode of manipulation with science is an attempt by a group of sociologists of science, called, *inter alia*, “social constructivism”, or “ontological relativism”, or simply “constructivism”. Their claims e.g. that everything, including truth, reality, facts, knowledge, are just *negotiable social constructs*, threaten to destroy the basic tenets of science and scientific work – existence of truth and rationality, rational comprehension of the world and of oneself, and impose ultimate relativism and nihilism (even in “hard” sciences!).

One should here notice that this is in fact the second phase of an interesting, and dangerous, process. In the first phase the attack on religion was organized in the name of science, scientific materialism was to replace religion, which was considered to be (at least) useless because all truth was provided by science, and there was no other truth.

In this second phase even science, as well as all other achievements of reason, with their authority in some segments of human interests, became an obstacle because they indicated the existence of certain values, and therefore science was to be discarded!

It is perfectly valid to study social conditioning of scientific research and its results, the influence of various factors – from personal attitudes, group dynamics, to the funding system and even the civilization itself. I myself have emphasized the temporary and changing (“Work in progress!”) character of scientific hypotheses and paradigms, as well as the complicated process of their verification. However, all this does not allow one to extrapolate and generalize without adequate caution. One should not conclude that reason is powerless, that there is no way to establish scientific truth.

Apart from the disastrous results that would follow for science itself, what is really frightening about this suppression of rationality and of the existence of truth are its possible social and political consequences. This total relativism, now extended even to the previously “safe” area of exact sciences, would immediately imply the destruction of other values, morality, all norms of civilized, ethical behaviour, of social and political order, ... What is left would be only *power*, physical, military, financial, ...unrestricted by any other considerations, bare and brutal, absolute power!

20. Understandably, the reaction of the scientific community (“practitioners” and others!) was swift and overwhelmingly negative, but this will not be elaborated here. I quoted this latest attack on *ratio* as an extreme but not isolated event in the eternal struggle between the apollonian and the dyonisian, which I find relevant for the position of science and of spirituality today. And again, we find the most systematic defence of reason, of the importance and complementarity of both *ratio* and *fides* in the encyclical *Fides et ratio*.

But this last example also shows that certain ideas and initiatives, seemingly motivated by pure scientific and academic motifs, are strongly connected with events in the “outside” world and cannot be understood as pure academic problems. By promoting this ultimate relativism and suppression of rationality the involved sociologists (unconsciously or not) prepare the way for the already present and aggressive centres of power, and justify on “scientific” grounds their arrogance on the way to the totalitarian rule. Thus one can see that the defence of rationality and existence of truth in *Fides et ratio* is not only an academic issue, but in the first place a strong line of *defence of human freedom and dignity* in the very real sense! In times

when truth and justice are under attack from various corners this support is more than necessary.