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# PHYSICS AND PHILOSOPHY IN THE 20th CENTURY*

## 1. Introductory

The mutual relationship between physics and philosophy in the 20th century, a remarkable feature of the history of modern science most intriguing to historians and philosophers of science, is oddly inaccurate in its public presentation. Historians and philosophers freely launch remarks and categorical propositions that reflect cursory opinions based on supposedly "commonly known facts", rather than on any critical analysis of sources. Serious histories of physics and philosophy alike are of course available, yet generally they provide little insight into the mutual relationship between physics and philosophy. Still, there are exceptions. Early relativity theory and quantum mechanism are two cases in point. No meaningful study of those two can do without looking at the role philosophy played in the development and interpretation of the two physical theories. Historians of physics do acknowledge the role of philosophy, while historians of philosophy, if at all, end up making very general propositions.

While the mutual relationship between physics and philosophy in the 20th century needs to be submitted to systematic study, this article is not meant as a contribution towards that task. This essay is just a general survey of the mutual relationship of the two disciplines through the century now drawing to its close. I hope to furnish more than a handful of general comments for I base these observations on several studies of my own (and my coworkers') on such or other aspects or episodes of that complex process. I prefer to think of it as an essay, for I am aware that as one moves from even important aspects or episodes to general propositions one puts in a grain of generalization into propositions. This article also recapitulates my

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previous reflections, a circumstance I hope justifies the frequent references to my publications.

## 2. From conventionalism to positivism

Relativity theory and quantum mechanism had a far more pervasive effect than any other development on the relationship between 20th century philosophy and physics. Both theories emerged basically as tentative answers to strictly physical problems (a well-known fact I need not dwell upon), yet the "philosophical environment" of those problems growing towards a solution was not without importance, either. In fact, it was through the philosophical environment that the two theories impacted 20th century philosophy in what was a feedback type relationship.

The philosophical environment of physics at the turn of the 20th century was delimited by mechanicism and positivism, two philosophies purporting to answer the development of physics up to their time. Mechanicism, a belief that the study of the structure of the universe is reducible to the study of motions of matter in terms of classical mechanics, failed utterly in the face of the "new physics", and in the lifetime of one or two generations it got itself demoted to the rank of a theory of no significance beyond its historical meaning. It is essentially a closed case now[1]. Despite that mechanicism lingered on for several decades, as some people (quite a few, in fact) not abreast with developing science continue to think in terms of ideas taken from that particular current to this day.

Positivism presents a different case. No doubt its origins lie in philosophical (probably unhurried) reflections on findings of classical physics. Shortly before the end of the 19th century, however, the excessively self-important positivism provoked a sharp reaction of conventionalism, advocated especially by Poincaré and Duhem. Despite positivist claims to the contrary, physics cannot be reduced to "pure facts) (or, in Mach's words, a set of sensory perceptions), because experiment is always rooted in a number of conventions and so no proposition concerning experimental prediction can be isolated from other scientific propositions in order to submit it to experiment (what came to be known as Duhem's thesis[2]). Duhem justified his conventionalist (and other methodological propositions) by adducing evidence from the history of physics, which he knew intimately. Duhem's studies in the history of cosmological doctrines triggered important changes in the history of science, or, more properly, its establishment as an autonomous and fully critical scientific discipline. That discipline began to mark

[1] Cf. M. Heller, J. Życiński, *Wszechświat – maszyna czy myśl? Filozofia mechanicyzmu: powstanie – rozwój – upadek* [The Universe – machine or idea? The philosophy of mechanicism: birth – development – decline], Polskie Towarzystwo Teologiczne, Kraków, 1988.

[2] Or the Duhem-Quine thesis.

its presence in the philosophy of science in the last quarter of the 20th century only. Had that happened earlier, philosophy of science would probably have saved itself a great many errors and biased views.

Poincaré's case should be a warning for scientists who tend to put too much trust in their philosophical intuition. Conventionalism in his strictly literal interpretation actually barred Poincaré from discovering special relativity theory. He had all its elements on his hand, but if the choice of theory is ultimately dictated by convention (he believed it was), then why wouldn't one keep to a theory relying on the "simpler" Euclidean geometry? Philosophy is less innocuous a game than it may appear to be.

Yet contrary to expectations conventionalism did not deal a deathblow to positivism. Indeed it did the opposite: the conventionalist critique of the method and language of science (mainly of physics) made philosophers aware that such critical analysis was urgently necessary. The neo-positivism of the Vienna Circle with its application of modern logical methods was born out of that awareness. Historians and philosophers of science generally tend to believe the Vienna Circle positivism got a boost from the new physical theories, yet on the other hand it was eminently responsible for establishing views closely related to positivist as something like an official ideology of science for decades to come. The situation was actually less straightforward than that. A vast majority of so-called scientists and, through them, more broadly the community at large getting their knowledge from the media (the press and radio at that time) did succumb to positivist ideology (in a vulgarized version). The relationship between neo-positivism and proponents of relativity theory and quantum mechanics presents a different case. The story of those relations is interesting enough to deserve a close look.

### 3. Neo-positivism vs. relativity theory and quantum mechanics

Young Einstein's well-known fascination with positivism in its Machian version has largely been instrumental in the creation of special relativity theory. To be true, Einstein's measurement prescriptions had little in common with Mach's idea to reduce all of physics to sensory experiences, yet Mach's overall idea Einstein spotted in his argument – namely that theoretical constructs should have their point of departure in measurements – turned out quite an inspiring idea.

The inspiration he drew from Mach's work played an important part on Einstein's road to general relativity theory as well. Remarkably, this time it was not the general positivist program that did the trick but a explicit postulate of Mach who expressly demanded – in keeping with his philosophical belief – that matter be treated as a relative property of bodies (determined by the distribution of all masses in the universe). Einstein thought he had

meet that demand (he called the Mach principle) in his general relativity theory and his first cosmological model. He was disgruntled when it turned out he had not. But that is a side point we do not want to dwell upon[3].

Mach and then other philosophers of science wrote extensively on the nature of physical theories and its different properties, and Einstein created a theory of his own. General relativity theory, remarkably, was the work of one man all through from beginning to end, which does not happen often in physics. So Einstein was extremely competent as scientist to look at an issue philosophers were scrutinizing. Einstein thought himself a follower of Mach's philosophy even for some time after he created general relativity theory, but as he continued to reflect on his own accomplishments he slowly departed from that philosophy. His final surrender of Mach's philosophy came about, as Einstein wrote to Cornelius Lanczos, in this way: "Beginning with a skeptical empiricism, slightly in Mach's own style, I turned, thanks to my work on gravitation, into a believing rationalist, or someone who is looking to mathematical simplicity for the only source of truth. What is logically simple may not be physically true, of course, but what is physically true is logically simple."[4]

Einstein did not drop his belief in empirical corroboration as an essential criterion of validity of physical theory, yet he attributed no less important a role to what he called "inner perfection" of theory. This is not a place to present Einstein's philosophy of science, let us just point to the striking convergence of many views commonly accepted in philosophy today with what Einstein maintained decades ago. It seems to me Popper was indebted to Einstein a lot more than he was willing to acknowledge.

Given all that do not think, though, that neo-positivists no longer held relativity theory and its development as proof of validity of their methodological prescriptions. In fact, the positivist idea of science owed relativity theory (or just the special relativity theory) mainly the ideas that inspired Bridgman to come forward with his concept of operationism. I mean operationism in its moderate form, which functions in physics regardless of no matter what philosophical views anyone may subscribe to. Operationism, in its radical versions, did not survive criticism from different corners including logical positivists themselves.

While relativity theory (notably special relativity theory) was a source of inspiration to neo-positivists as well as an exercise ground on which they could construct their methodological positions, quantum mechanics was more than that to them: this time it was the neo-positivist philosophy of physics that should supply answers to interpretative questions of the nascent

[3] Cf. D. J. Raine, M. Heller, *Science of Space-Time*, Pachart, Tuscon, 1981.

[4] Quoted from G. Holton, *L'invention scientifique*, Presses Universitaires de France, Paris, 1982, p. 277. I wrote in detail on that in *How Einstein created his general relativity theory?* [in Polish], "Postępy Fizyki" 39, 1988, pp. 3–21.

theory. What came to be called the Copenhagen interpretation of quantum mechanics developed on impulses that no doubt came from Vienna. That is what happened. Quantum mechanics explored a world completely inaccessible to human sensory cognition, applying in the process mathematical structures associated with no straightforward conceptions. What is one to understand the meaning of terms such as "electron" or "quantum state", if they can be linked to nothing that is recognizable through sensory experience or indeed to anything our imagination is wonted to? Neo-positivist ideology, it seemed, could come up with a helpful answer, if it implied that all the mathematical framework of theory was something like a makeshift scaffolding erected for the purpose of construction work, something to pull down once the building of the theory has been finished. Only that which was directly observable or measurable in the macroscopic world perceived through the senses could be recognized to have cognitive value. That was a bold decision – for theorists do not easily deny cognitive value to mathematical structures, their basic tools of their work, after all – yet by doing so they got themselves out of the stall, at least temporarily.

In quantum mechanics, observables have counterparts in certain mathematical objects (operators in Hilbert space), so when shortly afterwards it turned out that all quantum mechanics can be formulated in the language of those objects, that news was received as strong evidence in favor of the neo-positivist strategy. The hitch was that the mechanical observables (spin or electron momentum) were as remote as ever from postulated positivist "direct sensory data". Things got easier when it was proved every operator representing an observable could be decomposed into what were called projection operators and each such projection operator represented a query to which a "yes" or "no" answer can be given. With some leniency towards neo-positivist doctrine one can equate those queries with the Vienna philosophers' notion of elementary propositions.

Anyway, inspiring impulses flowed from quantum mechanics to neo-positivism as well as in the opposition direction. That is a historical fact nobody can deny. But that is not to say that the development of quantum mechanics provided any retroactive proof of validity of the neo-positivist philosophy of science. I pointed out before[5] that the support for their ideas neo-positivists claimed to have found in quantum mechanics was a fortuitous coincidence more than anything else. The mathematical structure of quantum mechanics turned out to hold precisely as many observables as were necessary to express the theory all in their language. That is not the case in classical mechanics where the number of observables is just too large, in a sense. Explorations done in quantum gravitation theory, with observations practically non-existent, are not a case in point either. It is not true, then that any

[5] *Mechanika kwantowa i neopozytywizm* in: *Otwarta nauka i jej zwolennicy* [Open science and its advocates], ed. by M. Heller, J. Urbaniec, OBI, Kraków, Biblos, Tarnów, 1996, pp. 29–39.

physical theory can be expressed in the language of observables. Quite simply, the neo-positivist program to reform physics will not work.

That became clear much later only. For quite some time yet relativity theory and quantum mechanics were flaunted by neo-positivists as their "crown evidence". The main aim of Schlick's Vienna seminar was to arrive at a good understanding of the revolution that was going on in physics. The underlying noble intention did not prevent it being done too hastily. Neo-positivists viewed relativity theory and quantum mechanics as a revolution that had completed, yet the revolution lasts and continues to slip efforts of thinkers keen to hold it in a rigid frame of method.

## 4. The Lwów-Warsaw school

The Lwów-Warsaw School of philosophy was an interesting Polish group whose impact was actually world-wide. It is being acknowledged abroad of late (and its works translated into English), with occasional surprised murmurs that the Poles had known in the 1930s things that are beginning to dawn on some people in the West only now.

The Lwów-Warsaw School had its heyday roughly at the same time the Vienna Circle did. Contacts between Lwów – later Warsaw – and Vienna were close and lively. Kazimierz Twardowski, the founder of the school, came to Lwów from Vienna where he had embraced the same ideas that eventually led up to the emergence of the Vienna Circle. The Poles managed to keep clear of the Vienna neo-positivists' extremities, above all their extreme anti-metaphysical attitude. They shared with the Vienna philosophers their veneration of modern logic (which they called "logistics"), and occasionally they beat them to the peaks of logical excellence. It was the logical positivists of Vienna who learnt from innovative works by Łukasiewicz or Tarski.

What members of the Lwów-Warsaw School had in common was not so much a body of philosophical views as the same style of philosophical work. Most generally, their ambition was less to create philosophical systems than to resolve philosophical problems using logical tools and linguistic analysis. If some members of the School subscribed to something like philosophical minimalism in their attitude they did so not out of a against "great problems" as for a purely pragmatic reason of focusing on problems that could be tackled using the analytical tools on hand.

Issues in the borderland between physics and philosophy were studied above all by Zygmunt Zawirski, Henryk Mehlberg and Joachim Metallmann. While the last-named man formally did not belong to the School, his philosophical style did not differ a lot from that of the School.

The last decade has seen not only a revival of interest in the heritage of the Lwów-Warsaw School (with re-editions of works by its representatives

and publications of studies kept only in manuscript to date), but also in exercising philosophy clearly with references to its tradition.

## 5. Neo-Tomism and physics

Neo-Tomism entered the 20th century with a well-defined philosophy of nature. Rooted in Aristotle, it got enriched by an array of Scholastic currents, in particular by the interpretation given to it by Saint Thomas Aquinas (himself getting different interpretations from his successors). The neo-Thomist revival, ushered in by Pope Leo XIII in the latter half of the 19th century, opened up Thomism to natural science. The Thomist "opening" was of course understood differently by different authors, yet the Louvain version created under Cardinal Mercier's leadership soon gained a dominant position.

Surprisingly, the important mutual relationship between neo-Thomism and natural science has never yet been submitted to any systematic historical study. That is really a bit baffling, if you recall neo-Thomism was the strongest philosophical current in the former half of the 20th century, at least in terms of the number of active thinkers. In what follows I venture a tentative view of the situation, based on the episodic knowledge of that story now available.

The first thing that strikes a student of neo-Thomist studies of problems connected with natural science is that their critique (not always negative) of theories of nature was a rule done "from outside" science. Science, say physics, is known "from inside" only to "insiders". I could not name one neo-Thomist of the former half of the 20th century known to be personally engaged in any science himself (Teilhard de Chardin was active in biological anthropology, but not in neo-Thomist philosophy; Lemaître got involved in cosmology, but he in turn never considered himself a philosopher), yet many of them spoke out authoritatively on different points of physical theory. Quite naturally, they found themselves off course or going astray. Even the most pre-eminent neo-Thomists of the time contented themselves with analyzing statements regarding physical theory made by physicists, even though such utterances are well known to be little more than an ancillary tool to get an understanding of physics. Nobody can understand physics unless they explore the mathematical structures of physical theory first. Scanning neo-Thomist studies readers may come across the occasional "formula", yet all to often such mathematical expressions turn out to be quoted out of context and without understanding. It is not my intention to bash anyone so I am mentioning no names. But leaf through a few books or journals and you will easily find quite a few such philosophers.

Another striking feature of neo-Thomist attitudes towards science (to confine myself once more to physics) is that they viewed (evaluated) physical theories against what were essentially neo-Thomist criteria. However,

science does not easily yield to "external criteria". Recall Galileo's story, or the vicissitudes of science in the USSR, for two cases in point. Neo-Thomist criteria, derived from Aristotle's physics, often encroached upon the substance of physical theory.

Nor surprisingly, then, the neo-Thomist "opening up to natural science" spawned no genuine dialogue between the two. The presence of natural science in neo-Thomist texts certainly gave Thomism a deepened dimension. Thomisms also had an apologetic dimension, indeed on two fronts: towards Christianity at large – as it supplied answers to specific challenges from science; and towards Thomism itself, saving that philosophy against charges of obsoleteness. Scientists, for their part, showed no remarkable reaction to the neo-Thomist endeavors. Thomism apparently left natural science unimpressed.

Z. Wolak's analysis of Jacques Maritain's critique of relativity theory[6], and my own discussion of the sources of neo-Thomists' failure to start and inspiring dialogue with natural science[7], demonstrate that opinion as true.

## 6. Philosophical transformations of physics

Viewed from our perspective, physics is easily seen to have been gaining much more "philosophical weight" in the 1920s and 1930s than contemporary thinkers were able to see or willing to concede. To be true, many philosophers realized that "in the light of modern physics" several specific philosophical notions (determinism, causality, time, space) will have to be reexamined. Yet even they sometimes failed to see that physics *per se* had become a "philosophical fact" that called for in-adepth critical reflection. A new scrutiny of certain aspects of the very advanced philosophy of science was only part of the task. The "new physics" began to claim, not expressly though, the function long reserved for epistemology and ontology. Mathematical empirical method, outstandingly efficient in a world inaccessible to human senses (the world of quantum mechanics), had become so sophisticated as to render cognition and its boundaries something like an "internal affair" of physics itself. I shall have more to say on those "metaphysical transformations" of physics when referring to the latter half of the 20th century, a time the "philosophical payload" of physics became visible to the bare eye.

Were the greatest physicists of the time aware of the changes their science was undergoing then? I think they were, especially on those not infrequent occasions they looked back at their own accomplishments. Often enough they published their reflections in popular and jargon-free books or

[6] *Filozofia przyrody Maritaina a szczególna teoria względności* [Maritain's philosophy of nature and special relativity theory], "Zagadnienia Filozoficzne w Nauce" 13, 1991, 33–42.

[7] *Nowa fizyka i nowa teologia* [The new physics and the new theology], Biblos, Tarnów, chapter 4.

articles. Almost each of them wrote them (Einstein, Planck, Bohr, Schrödinger, Heisenberg and others). There was a catch to that though. Mindful of the nature of such books and articles the writers sought to use them to popularize science, rather than to address the new philosophical ideas they were bringing with them. The were referred to, at best, as "philosophizing physicists" (a category that had even made its way into history textbooks dealing with 20th century philosophy),- shrugged off a home-baked philosophers rediscovering what were long-known philosophical truths in a different context yet with less precision and in an amateurish manner.

Such lack of rapport (not to say worse, the gap) between physics and philosophy was not true of the neo-Thomist school alone. Physics and philosophy were two separate worlds, scornful of each other as a matter of principle. The only exception, perhaps, was neo-positivism, with its ceaseless invocations of physics and its determination to understand the methodology of physics.

Neo-positivism (or its vulgarized scientistic version) apparently conquered the hearts of a great many scientists and engineers, yet the greatest physicists either disdained the neo-positivist ideology (Einstein and Schröodinger are two of more cases in point) or completely ignored neo-positivists' methodological principles in their own work.

## 7. The phenomenon of the 1960s

The 1960s were an exceptional time. More than other decades, the 1960s were marked by unrest: in social life, crises broke out, and long-growing tensions exploded; in culture, various "new waves" were launched; in science, a number of surprise discoveries (e.g., of quasars or residual wave radiation, in observation cosmology) were made; in philosophy, the 1960s saw the sudden demise of neo-positivism. This last-named development is particularly interesting to us here, because it is to with the relationship between philosophy and physics, the topic of this presentation. There is no need to discuss that at length here because a number of studies dealing with this point are available. Let me just say a word or two on that from our point of view.

My feeling is that historians of philosophy do not make it as clear as they ought to that physics actually played a prime part in bringing neo-positivism into disrepute. Right from the start, physics was regarded as a "shining model" for neo-positivist analyses. I mentioned that before. Yet with time those analyses increasingly tended to be an art-for-art's-sake exercise, increasingly remote from what was really going on in physics. Studies the next generation of neo-positivists turned out were much more in the vein of formal logic dissertation than, say, analyses like those Schlick or Reichenbach wrote on relativity theory. Eventually, philosophers of the neo-positivist

school found themselves in a closed circle commenting or challenging one another; if they ventures into physics at all, then only to apply abstract logical tools to dissect mostly dull examples. Physics meanwhile continued to develop, doing so in disregard to methodological rules set up by the logical positivists. One of the gravest mistakes of the Vienna Circle was, as said before, that they viewed relativity theory and quantum theory as a finite scientific revolution (they sought to apprehend philosophically), for both theories were just the beginning of a revolution that was still under way then (stumbling through a series of crises, yet looking forward to its next stages). The development of physics itself outran the philosophy of physics the Vienna philosophers started.

Alongside with that another development was unfolding. The former half of the 20th century witnessed a renascence of history of science (with Pierre Duhem as its precursor), the latter half brought its flourishing time with it. This is not the right place to discuss that significant process. The history of physics (especially pre-19th century physics) was more accessible to philosophers (few of whom were physicists) than modern physical theories. Yet since philosophers occasionally desire to check their deliberations against "concrete cases", it was not really surprising that more and more often they ventured into the history of physics. What did they find? They found that classical physics, the one that emerged from historical research, never actually followed the path prescribed by positivist methodology either. One of the Vienna circle, a gentlemen at very advanced age, was quoted to have once said, "Had we in Vienna been better versed in the history of science, some of our contentions would never have been made".

The fall of neo-positivism had of course its "internal" causes as well. We are not going to discuss them in this place. I just want to explain that those were "internal" causes in that they were brought forward by neo-positivists against one another. Critical voices were of course also heard from "outside", mostly from representatives of other schools of philosophy, yet such criticism was as a rule to no avail.

Neo-positivism's demise was by no means anything like a "massive escape" from previous beliefs, or a "conversion" to other creeds. Several Vienna philosophers died, others embraced related views (mostly different versions of analytical philosophy). A new generation succeeded, who preferred to call themselves empiricists rather than neo-positivists or logical positivists, yet their empiricism took shapes rather remote from what empiricism meant to the Vienna philosophers at the turn of the 1920s and 1930s.

I should like to warn those who, for whatever reason (including for neo-positivists' critical attitude towards religion), frown upon neo-positivism: do not rejoice in its fall. First, do not mistake the "demise" for what it is not. Neo-positivism did indeed go, as a leading current, yet in its vulgar version it continues to influence society at large, indeed it even seems to

strengthen its grip. Today more than ever, the general public cherishes intellectual tastes that are molded by mechanisms having nothing in common with what is going on on the "intellectual Olympus". Even more, as said before, neo-positivism evolved "in a continuous fashion" into different versions of analytical philosophy, which only partly opens up to broader horizons.

Either way, the 1960s (with a bent to the following decade perhaps as well) must be viewed as the dividing line separating what were two clearly different epochs. Things that happened after the line was crossed are still too fresh in people's memories to allow any sensible reflection.

## 8. The last three decades

Let us take a look at the physics "landscape" over the last decades of the dying century. The general public perceive the progress of science as dominated by the "computer revolution". The computer revolution, which is a cultural revolution at the same time, has far-reaching effects that are hard even to fathom now, eclipsing anything happening in other sciences. "Standard" disciplines of physics, such as laser optics or solid state physics, are flourishing (along with their straightforward applications in technology), while fundamental research looks a little bit tired. It is a tiredness that does not lead to stagnation, indeed the opposite is true. An erratic search is going on – too many original ideas are being launched, a scatter of ideas spreads; towering abstract mathematical structures tend to establish themselves as new areas of mathematical research while having little or no reference to physics; increasingly sophisticated calculation techniques requiring special skills are employed by authors, to churn out unimportant contributions. The sense of tiredness seems to arise out of a growing sense of modern physics hitting the limits of what it is capable of doing. Of the borders physics has been hitting for some time now let us point out the limits of method, first of all: we are now probing layers of the universe so deep the tools used to date just do not work there any more; as well as the financial limits: even the world's richest nations just cannot afford building yet bigger accelerators to come to grips with even more elementary particles. That is why the unification of physics and quantum gravitation theory, two ultimate goals physicists have long sought to accomplish, seemingly at hand any moment, keep vanishing behind the horizon again and again. That process towards the borders has certainly philosophical implications. People moving about a borderland tend to experience a "metaphysical tremor", especially when faced with problems such as "the foundations of existence of the Universe", the beginning of time and space, or, finally, the grand finale of the Cosmos. Theses matters gained added color since the 1960s as cosmology was provided with a very solid observational base that gave it indisputably a status

of a full-fledged member of the family of physical sciences. As the new technologies now enable people to peek straight into some 90% of the history of the Universe to find that existing cosmological models generally truthfully relive the history, even the "marginal hypotheses" of cosmology are lent credence to and philosophical fascinations the study of science always tends to generate get a new boost.

However, what if the above-described position of physics is an immanent condition of physics? After all, since Isaac Newton physics has coped with problems located close to the limits of its possibilities, has it not? No doubt that is the case, in a sense, if you recall the very idea of progress: the front of research efforts keeps delimiting the borders of the knowable, yet the border keeps receding as research is progressing. However, it seems to be different story this time, as we seem to be hitting borders that are unlikely to move away with progress as such. I do not believe physics is likely to grind to a halt, or that it will merely go on scrutinizing self-generated pseudo-problems (plus any progress in applications, of course). While such a scenario is still conceivable, I think that if it wants to make a radically far ahead, physics must embark on some radically new strategies first.

As said before, problems of modern physics are shadowed by philosophical, indeed metaphysical, emotions, as the popular scientific literature of the last three decades of this outgoing century amply shows. I feel the philosophical emotions are merely an outward sign of much deeper-cutting changes. I should say modern physics, more than ever, is performing the tasks previously reserved for philosophy. Let me now explain and justify this proposition.

## 9. Physics as philosophy

Physics has performed philosophical functions for a long time. Recall mechanicism, for example, which had its ontology, its theory of cognition, its philosophy of man. Physics of course can play the role of philosophy only if it is appropriately interpreted, but then, the belief that physics can exist with no interpretation at all is equally illusory as insisting that meaningful philosophy can be practiced in isolation from science. Physics today performs certain "philosophical functions" as well, only it does so, first, in growing independence from what is called professional philosophy, and next, increasingly often it supplies (along with other sciences) information without which no one can responsibly scan many a traditional philosophical problem.

Both propositions call for comments. Each person (physicists included) in his or her intellectual effort is immersed in a "cultural entirety" and no philosophical query can be asked in isolation from the tradition the culture generated. If I maintain that modern physics increasingly often performs philosophical functions, and indeed independently from professional philo-

sophy, I mean to say that any thinking physicist, even one that never dabbled in philosophy before, is bound to start asking himself questions that are philosophical *per se*. A quantum physicist, pondering the foundations of his science, cannot help wondering about points of cognitive theory or causality. In fact, he will find professional philosophy to be of little help there. It can supply him with notional distinctions or categorical classifications in which he can "box" his problem. It can be of help directing his attention to certain specific methods he should (or should not) employ. But it cannot intervene in the problem itself, which is precisely the heart of the problem without grasping which the physicist cannot come anywhere near a solution. Yet even in using those tools a physicist must keep utmost caution. More often than not, he finds himself forced to step outside existing framework of categories and to design new study methods; in doing so, if he keeps rigidly to his philosophical findings he may obstruct his own progress.

That physics (as well as other sciences) supply information without which no one can responsibly scan many a problem in traditional philosophy calls for justification only because some thinkers continue to refuse to concede this truth. Take the problem of time. Time as a notion penetrates many areas of traditional philosophy: from the philosophy of nature through philosophical anthropology to as far as theodicy. Any instance of probing into matters involving time in the context of those philosophical disciplines with no resource to what modern physics has to say about them (I mean not only relativity theory but some models admitting the extra-temporal existence of physical objects as well[8]) not only strips the discourse of much of its meaning but sometimes may invalidate it altogether.

When physics takes to problems previously reserved for philosophy it does so increasingly often not by itself but in the company of other sciences. The human psyche and awareness is a good case in point. Or look at another, no less standard case, the "Kantian problem" of whether or not our cognition reflects the real world? This problem has become largely one of natural science in the world today. As it moved from philosophy to the sciences, this problem was significantly reworded, of course, yet it is no less obvious that the philosophical version of the problem can no longer be evoked with no reference to its natural counterpart. We do now know quite precisely, for instance, what happens to light quanta when hitting the retina. Photons are then transformed into electric impulses which is then sent to the brain through a nerve. The signal is transformed several times on its way, and we can now largely reconstruct the mathematical transformations it undergoes. The image is being produced in stages, in what is computer-like processing, even before it reaches the brain. Despite that it certainly is no straightforward

[8] The hypothetical character of such models does not disqualify them as partners in dialogue with physics. The fact that a mathematical model of a phenomenon has been developed is at least proof of its non-contradictoriness, and that is enough to join in philosophical analysis.

"reflection" of the real world but at least as much the effect of external impulses as of the many "honing" processes it is subjected to in the human nervous system.

There is evidence that the 21st century will be witnessing a fantastic progress of what are called cognitive sciences and so their invasion of areas heretofore reserved for strictly philosophical disciplines. Even today there is talk of so-called naturalistic philosophy which employs natural methods and results to solve philosophical issues.

## 10. The third culture

The phenomenon of "philosophizing physicists" (and other scientists) is likely to gain special significance in such a situation. That is indeed what is going on now. The flood of popular scientific literature in recent years has made it harder to notice what is going on. Because of its commercial focus that huge phenomenon puts the value of that literature in dubious light. Yet even there you may come across works of major significance (especially if they are written by the greatest scientists). It is inconceivable that strictly scientific journal should publish philosophical reflections (only the biggest thinkers can afford to make marginal remarks of philosophical character). Since eminent scientists happen to have to say a word or two on such matters, they are happy to do so in popular scientific publications. Paradoxically, then scientific tend to communicate their philosophical reflections to wide reading audiences, ignoring professional philosophers. The professional philosophers, incidentally, are among the "wide reading audiences" as well but they no longer act out the role of producers of "philosophical reviews of science". John Brockman[9] coined the term "third culture" to describe that phenomenon, to distinguish it from Snow's two cultures, the humanist (philosophical) culture and the scientific culture[10].

## 11. A forecast

Before I conclude, let me make a forecast. The closing decades of the outgoing century are witnessing a systematic lowering of cultural standards in so-called civilized (i.e., rich) countries. That process is gaining momentum. Optimists are calling a cultural revolution is under way from which something completely new is going to emerge, and that we alone, the people living in the dying decades of an epoch, perceive that as a deep-cutting crisis. Pessimists quite simply decry it as the vulgarization and fall of culture. A lot has been written on that and there is no need to recall that criticism

[9] *Trzecia kultura* [The third culture], Wydawnictwo CIS, Warsaw, 1996.

[10] For a discussion of the "third culture" see my book *Czy fizyka jest nauką humanistyczną?* [Is physics a human science?], Biblos, Tarnów, pp. 9–15.

now. Signs are that the factors causing the current changes are anything but temporary in nature and that the process will continue. One consequence of it will be a split into great masses of "culture eaters" and elitist groups of the "chosen few". The expressions in quotation marks are metaphors, of course, which I am using as intellectual shorthand to make the discourse easier. Among the "culture eaters" you may find a certain class of "intellectuals" whom I do not class with "the chosen" class. Those intellectuals often churn out ideology for the masses, a "vicarious philosophy" having nothing in common with what the "chosen" people do. The chosen people breed science, technology, as well as their sister philosophy. The "culture eaters" for their part often ridicule or even combat science and technology, even though consuming their products in everyday life and treating them as magic wands that mysteriously work with no one knowing why.

This part of my forecast is not strictly a forecast but a sketchy outline of the state of things now. My forecast is simply that the process will continue to unfold, and that the contrast between "culture eaters" and the "chosen few" will grow worse. My optimism tells me though that the "culture eaters" will ultimately not be able to swallow the "chosen few". Should that happen at all, the present system of values would have to break down („the whole culture would be eaten up").

What consequences that would have to the relationship between sciences and philosophy is not difficult to see. Philosophy is already seen to be in dualism today: there is philosophy that is practiced by the "chosen few" (to keep to the metaphors) and philosophy performing ideological functions for the "culture eaters". The latter of the two seems to dominate the stage, as the former is seems to be marginalized. The reason for that, of course, is that the "chosen few" are elitist (and thus few) while the "culture eaters" are in masses.

Those are processes embracing culture as a whole. And so they absorb theology and religiousness at large as well. The religiousness of "culture eaters" is essentially different from the religiousness of the "chosen few". I leave it to specialists to describe the two types of religiousness. Theologists and religious leaders, because of their pastoral commitments (or maybe because most of them are descended from "culture eaters" – simply because they are more numerous), mostly put themselves behind "the masses". That process is now well seen to be going on. One of its consequences will be (in fact, it is already) that the vision of religion adapted to the needs and possibilities of the "culture eaters" will be unpalatable to those whom I symbolically dubbed the "chosen few". So the community of the "chosen few" may either become increasingly indifferent in its attitudes or – a more likely prospect – for many of its members to embark on developing a specific non-confessional philosophical sense of Transcendence.

Over the last centuries European culture managed to survive several historical crises owing to the wise work of people of the Church. Today, culture is more secularized than it was in the old times and the Church no longer has the possibilities it did have previously of putting its import behind culture. However, culture is a human value, so if you stand on the side of culture you are on the side of man.

Tarnów, 30 April 1999