Chapter XV

Final remarks:

Becoming aware of our fundamental limits in knowing and doing, implications for the question of the existence of God.

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Having arrived at the end of this book the reader may not be completely satisfied. He has read about mathematics, about physics and about the way others think about science. But, so what? Why has this wide-ranging material been brought together? Are there firm conclusions regarding what the title promises: the existence of God? A comparison already mentioned in the Introduction could help answer these questions. Consider the parts of a puzzle, representing in their totality a masterpiece of art. The parts on their own are only small, colored pieces of cardboard. In this book we tried to deliver some important pieces of that puzzle, indicated by the set of questions. The reader should decide whether the pieces result in more than a random distribution of colored pieces. Being optimistic the editors and probably others, will see the vague but certainly discernible contours of a reality beyond the things we can touch, see, hear, smell or taste. In any case, however, we are aware that we have not reached completeness in solving our puzzle; some pieces are still missing that further reflection should work out.

The first piece of the puzzle is supplied by mathematics. Turing and Gödel have proved that in any formal (arithmetic) system one can formulate true statements, which are undecidable within the formal system in question. As a consequence, each formal arithmetic system lacks completeness. This means that man never can explore the full richness of mathematics, not because of limitations in our time or ability, but because of fundamental limits always present in any non-trivial formal system. The undecidability and lack of completeness in formal systems also have consequences for the origin of mathematical truth. The access of man to mathematical truth is fundamentally incomplete. Mathematical truth, therefore, cannot be an exclusive construction of the human mind.

The second piece of the puzzle, somewhat related to the foregoing, arises from the experience of mathematicians of down the ages. There is information, knowledge of abstract relations, which can be 'discovered' by man, but which is not a product of the human mind. In a certain sense the information discovered in mathematics at a certain moment has always existed and will exist forever. It is reasonable to relate this information to a reality, because information is something, it is not nothing. The

question then arises: who, or which principle, supports this information? The human mind, with its limited access to mathematical information, surely cannot be considered the only candidate.

Coming now to physics a new set of pieces of the puzzle can be found. Since Laplace, and even before his time, the ideal of physics has been to find or derive a set of equations, which allow a complete description of the reality accessible by the methods of physics. In other words, physicists try to find a unique correspondence between physical phenomena and representations in a formal system. This formal system would permit, at least in principle, the calculation of all physical events. It is obvious that enormous progress has been made in physics that has resulted in a quantitative description of many physical effects. Nevertheless, the equations of physics are at best a well-developed formal system. And regarding these systems Gödel and Turing have proved that these can never be complete. There will therefore be physical events that cannot be adequately described by the formal system in question. It is therefore an illusion to hope that physical reality can be perfectly matched with a formal system, and therefore that physics can describe physical reality completely. Physical reality always will be more than a set of equations.

The foregoing was an argument about an inherent shortcoming of any physical theory based on a mathematical description of reality. And the “weak point” was in mathematics rather than in physics itself. One could argue that physics could somehow circumvent this problem. The questions now arise whether there are fundamental limits to physics itself and whether physics can be considered to give a complete description of the phenomena. The Einstein-Podolsky-Rosen paradox one could consider as the next part of the puzzle we are trying to solve. The EPR paradox - a two-particle gedanken experiment - and the consequent work by Bell, brings the physicist face to face with nonlocal correlations. And nonlocality contradicts all traditional physical theories. But things are more subtle. When we give a theoretical description of EPR-like experiments using the relevant physical theory (in this case Quantum Mechanics) we come up with results that are in complete agreement with experiment. We should remark, however, that these theoretical predictions are presented as probabilities that can be verified only by a large number of events. This probabilistic description therefore seems to be a correct approach. Only if one considers the single event, has one to assume unobservable causes which result in nonlocality.

The apparent contradiction could be solved if one assumes a fundamental incompleteness in physical theories. In some cases phenomena - or observable causes - which obey physical laws, are not the only actors that take part in the realization of the event. Other, unobservable actors that are not in contradiction with the statistical nature of our physical theories seem to affect the single physical effect. Consider for instance a quantum experiment in which the two output ports of a beam splitter are monitored by detectors D1 and D2. The fact that one of two detectors clicks may be explained by observable causes alone. But the particular alternative that D1 clicks and D2 remains at rest, or conversely, cannot be explained by observable causes alone. In general it can be stated that phenomena cannot be explained by a temporal chain of causes consisting of other phenomena.

Also single particle events in nature, like a decay of a radioactive atom, seem to demonstrate the lack of completeness in physical theories like Quantum Mechanics. We can predict the decay rate with high precision, but we can say nothing about a single atom, when it will decay. It is even less known why it decays in that certain moment. The philosophically not so satisfying answer is that we may not ask these questions or that it happens by chance. In the case of the EPR experiment (an essential two-particle experiment) one has to give up the “chance” explanation. There is experimental evidence of a correlation between the two particles even in the case of a single event, which can not be the result of local hidden variables (Bell). Could it not be possible that also in single particle events the “chance” theory should be given up with the consequence of accepting the incompleteness of our physical theories?

With the pieces of the puzzle presented above, are we now in a position to come to some conclusions about the total picture? The *first* could be that man, with his formal approach in science, precisely due to this approach misses part of the information contained in physical reality. The *second* is that man will never have complete control over nature because in technology he uses exclusively physical observable causality. It seems that observable causes produce necessarily the expected effect but are not sufficient causes for a particular event.

Is this a question of our present ignorance? Will a future generation of mathematicians and scientists circumvent these difficulties? Or are we discovering traces of a powerful actor or acting principle who, as the support of information, has intelligence and is causing events in reality according to the physical laws? Certainly, we will not return to former primitive times when people appealed to a supernatural power in order to explain why the sun appears to go round the earth. But neither can we claim that we do not need such a being any more, simply because with modern science we now know considerably more about the reason why. And if we are obliged to give up the position that science will enable man to master all mysteries, the road to avoid absurdity may be the road that leads to a transcendent being. This is our *third* tentative conclusion.

But does this not mean to return to the *God-of-the-gaps*, a cosmic magician invoked to explain all those mysteries about nature that currently have the scientists stumped, as P. Davies¹ expresses? Is this not a dangerous position, as well? Probably not, because we have evidence that the gaps in our knowledge and in our ability to determine events are structural. It is not a question of knowing or doing more or less. In a certain sense nature can be considered to be a miracle, as Davies himself states, because natural phenomena have unobservable causes beyond the reach of any human power. There always will be unsolved mathematical problems, and we have to live with nonlocality.

Finally, we would like to comment on an apparently paradoxical situation. Modern science which accepts man’s fundamental limits in knowing and doing, comes out to be more efficient than the science which believed that man will some day be able to know all. Now, when we have given up the postulate of absolute predictability, we predict and control better as ever before. We become capable of doing more and more marvelous things just because we have accepted that we will never be able to do everything.

¹ P. Davies, *Physics and the mind of God*, this book, chapter XIII.

Looking back now at the present book, we surely have not given a complete answer to all of the problems related to the title. Some results have been presented and conclusions have been given. One should bear in mind, however, that science is not the only access to reality. The rich world of human feelings and thoughts as expressed, for example, in literature, art, humanities and also in conversations in daily life, provides alternative routes to reality in all its dimensions. Could it be that the intelligent and powerful actor, whose outline, after much effort, seems becoming visible to the scientist, is identical with what people call God?