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REFLECTIONS ON KEY BOOKS AND PUBLICATIONS

BY PROFESSOR BERNARD d'ESPAGNAT

Conceptions de la physique contemporaine (*Conceptions of Contemporary Physics*). Paris: Hermann, 1965.

While serving as assistant professor at the University of Paris-Orsay, I spent half of my working time at CERN in Geneva. It was during the pleasant and fruitful collaboration with brilliant fellow researchers at both places on theoretical questions then considered significant that I wrote my first book. One of my revelations during my service at the university and CERN was that almost all of my colleagues were as good as blind to even harder (interpretational) questions than the theoretical ones we typically faced, questions that, in my opinion, quantum physics raised. This book was meant to, at least, make these more difficult questions explicit and sketch what deep changes in the current outlook seemed necessary for removing them.

Foundations of Quantum Mechanics. Proceedings of the International School of Physics, Enrico Fermi, Course 1949. New York: Academic Press (collective work, B. d'Espagnat, editor), 1971.

After the publication of my first book and various papers on quantum measurement and the "improper mixture" notion, the Italian Physical Society asked me to organize and direct the 1970 course of the Enrico Fermi International Summer School in Varenna on the shores of beautiful Lake Como. This book is just the proceedings of this event, which was the first meeting where the newly discovered Bell inequalities and the path they opened to experimentally answering some of the above mentioned interpretational questions were extensively discussed, with the help of John Bell himself.

Conceptual Foundations of Quantum Mechanics. 1st edition, Menlo Park, Calif.: Benjamin, 1971. 2nd edition revised, enlarged, reset, Reading, Mass.: Benjamin, 1976. 3rd edition, Reading, Mass.: Addison-Wesley, 1989. 4th edition, Boulder, Col.: Westview Press, 1999.

An introduction to quantum mechanics, this book aimed to show that while quantum mechanics is crystal clear when used for *predicting observational results*, it raises hard conceptual problems when tentatively interpreted as *describing* atomic entities. In particular, it puts forward the (by now well accepted) distinction between *proper* and *improper* mixtures and explicates the quantum measurement riddle. Interestingly for me, while writing it I discovered, quite by chance, that while I was at CERN, I was not the only physicist privately reflecting on interpretational matters: I had a mate in the person of John Bell who, shortly afterward, published his famous inequalities, confirming our common misgivings. Needless to say, the book deals with this as well.

À la recherche du réel, le regard d'un physicien. Paris: Gauthier-Villars, 1979. Published in English as **In Search of Reality, the Outlook of a Physicist**. New York: Springer-Verlag, 1983.

Some scientists say they have their best ideas traveling by train. For me, something like this was the case. Even now I clearly remember the railroad car compartment where, sometime in the mid-1970s, I suddenly realized that since the Bell inequalities 1) have a most important impact on our admissible world views, and 2) may be derived without mathematics from their premises, it was both useful and possible to make them known to a non-specialized educated public. I also suspected that the public might well be interested by what I considered could be inferred from all this. The book was a huge success in France with practically every important newspaper and magazine making it the subject of a long article.

The Quantum Theory and Reality. *Scientific American* 241:5, November 1979.

In the late 1970s, the staff at *Scientific American* magazine asked me to contribute an article explaining what the consequences on our conception of reality would be if some experiments then in progress were to confirm (as, some years later, they did) that the Bell inequalities are violated in situations where quantum mechanics predicts they are. What the article showed is that we would then be forced (as indeed we now are!) to give up at least one of three general ideas all deeply ingrained in our mind, namely realism, induction, and Einsteinian separability (no superluminal influences).

Un atome de sagesse: propos d'un physicien sur le réel voilé (*An Atom of Wisdom: Writings by a Physicist on Veiled Reality*). Paris: Le Seuil, 1982.

Scientists are also human beings. Most educated human beings (writers included) freely express ideas on a variety of subjects issuing partly from what they know, but partly also from their own personality (which explains the differences between them). Why shouldn't a scientist take the liberty of writing a book in that spirit, provided he or she made the spirit of the book crystal clear, without pretending to be "speaking in the name of science"? Such was the guiding idea of this little book, simply a collection of my short (one page or less) reflections, grouped in themes that range from our various conceptions of reality to critical analyses of some thinkers' methods, hedonism, risky views on sociology, and my own brand of spirituality.

Une incertaine réalité, le monde quantique, la connaissance et la durée (*An Uncertain Reality, the Quantum World, Knowledge and Duration*). Paris: Gauthier-Villars, 1985. Published in English as **Reality and the Physicist: Knowledge, Duration and the Quantum World**. Cambridge: Cambridge University Press, 1989.

The general orientation of this three-part book is philosophical. Part I attempts to examine, from the point of view of a physicist, how current ideas in the philosophy of science actually apply to contemporary physics and deals with such matters as methodological instrumentalism, fallibilism (which claims that a theory that has no experimentally testable consequence is of no value) physical

realism, and causality. Part II shows that in view of recent experiments proving nonseparability, physical realism turns out to be in considerable difficulty. Part III explores the consequences of this for our understanding of what science can seek to know of reality.

Georges d'Espagnat. Paris: La Bibliothèque des Arts, 1990.

My father, the painter Georges d'Espagnat, created works now in the collections of the Orsay and Modern Art museums in Paris as well as in many museums in various countries. This book – a collective one – contains some two hundred reproductions of his works, texts by the well-known French art historian Elie Faure, fine arts expert Jean-Dominique Jacquemond, critic and historian Georges Lecomte, and myself, as well as reproductions of letters addressed to my father at various periods of his life by Pierre Bonnard, Claude Monet, Auguste Renoir, Paul Signac, the poet Paul Valéry, and others.

Le réel voilé, analyse des concepts quantiques. Paris: Fayard, 1994. Published in English as **Veiled Reality, An Analysis of Present-Day Quantum Mechanical Concepts**. Reading, Mass.: Addison-Wesley, 1995; Boulder, Col.: Westview Press, reprint 2003.

This is the second of the two books of mine (the first one is *Conceptual Foundations*…) introducing quantum mechanics in the way I consider it should be done and exploring its conceptual framework. Its writing was motivated by the fact that, during the late 1970s and 1980s, new proposals had emerged and significant advances had taken place. The book analyzes those proposals and shows that, contrary to some hints from their authors, they do not restore conventional realism. Then, it describes the advances – essentially, ascertainment of nonseparability and an explanation, known as *decoherence*, of the appearance of classicality – and extensively explains why in view of all this the notion of a *veiled* ultimate reality is what appears most reasonable.

Traité de physique et de philosophie. Paris: Fayard, 2002. Published in English as **On Physics and Philosophy**. Princeton, NJ: Princeton University Press, 2006.

Shortly after having been elected to the *Académie des Sciences morales et politiques*, I was asked to give my fellow members a small talk on the conceptual issues raised by contemporary physics. Since my listeners belonged to various disciplines, I prepared a paper that educated non-specialists could understand. This book, of which that text constitutes the first chapter, was entirely written in that spirit. In its first part the necessary physical information is given. Then, in its light, several conceptions such as materialism, Kantism, positivism, and structural realism are critically examined. The last chapters describe what I take to be the most explicit account of my present views on the "big problems."

Since I prepared the 2006 English translation for Princeton University Press myself, I took the opportunity to introduce in it minor additions and improvements, which will also be included in future new editions of the French version.

Candide et le physicien (*Candide and the Physicist*) (with Claude Saliceti). Paris: Fayard, 2008.

After reading *Traité de physique et de philosophie*, Dr. Claude Saliceti, a physician and philosopher, submitted to me some 50 questions inspired by it. They were very clear and appropriate and on reading them it occurred to me that just simply answering them might appreciably help interested nonscientists. Indeed Dr. Saliceti had purposely couched them in a candid, straightforward form, which enabled me to better pinpoint – and correct – the specific preconceived ideas making it difficult for people 'not in the know' to understand the conceptual changes contemporary physics forces upon us. As a by-product this enterprise also led me to express myself somewhat more precisely concerning the nature of the glimpses that we may tentatively conjecture we get on ultimate reality.

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