

Appreciating a Hiley Respected Colleague

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One cannot sensibly introduce Basil Hiley's work as a mathematical physicist without his collaboration with David Bohm, lasting from 1962, when Basil went to Birkbeck College, to Bohm's death in 1992. The beginning of their careers shows an astonishing similarity in the study of collective phenomena—Bohm in plasmas, Basil in molecules. However, their topics changed drastically over time, and their style of work was different: While Bohm tended to subordinate formal details under conceptual issues, Basil would keep being worried if the math had not been done even if it seemed clear how a problem should be understood. This fruitful complementarity of inclinations was one of the driving forces behind their more than twenty joint papers between 1970 and 1989 and their book “The Undivided Universe”, first published in 1993.

The main themes of Basil's work can be seen under two topics devised by Bohm: the *quantum potential* and the *implicate order*. The first of them arose from Bohm's 1952 paper (the “B52”, as they used to call it at Birkbeck) on a novel way to look at the Schrödinger equation of quantum mechanics. This new look was achieved by a simple mathematical reformulation leading to a classical Hamilton-Jacobi equation plus an additional term called the quantum potential. Although this paper explicitly focused on hidden variables beneath the level of Hilbert space quantum theory, both Bohm and Basil soon realized that classical hidden variables fall short of the actual lesson of the quantum potential: the nonlocality, or holism, of quantum theory. Sys-

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tems do not present themselves as collections of parts but as wholes that need to be decomposed in order to obtain parts.

As innocent as this may sound, it turns the conceptual background of much of current science upside down—it substitutes the traditional atomistic picture of nature by a fundamentally holistic one. Today, Basil occasionally cartoons the quantum potential as a simplifying ancillary tool (sometimes he says a “Mickey Mouse” version) to illustrate quantum holism and yield an intuitive path to study it in particular situations. They range from the double-slit experiment to the Stern-Gerlach effect, from delayed-choice scenarios to the quantum eraser. And he does not become weary of emphasizing that many adherents of a “Bohmian mechanics”, who ignore radically new features such as the implicate order and active information, are missing an important part of the ontological substance of what Bohm and Hiley stress. If “Bohmian mechanics” was the true spirit of the whole approach, both Bohm and Hiley would be truly poor “Bohmians”!

To realize that nature presents itself as a whole that has no parts to begin with, stands at the origin of Bohm’s concept of an implicate order whose decomposition leads to (possibly complementary) explicate orders. In the Hilbert space representation of quantum theory, this non-classical implicate order is hidden indeed, so how is it possible to address it or even find out about it? This question implies that the standard Hilbert space approach puts severe limits for our understanding of quantum theory, something that John von Neumann realized already in 1935 with his famous statement: “I would like to make a confession which may seem immoral: I do not believe absolutely in Hilbert space anymore.”

The idea to find a mathematically formalizable background theory behind Hilbert space quantum mechanics has kept occupying Basil in the twenty years from 1990 to the present. In these two decades, he has made significant steps beyond the joint work with Bohm, suggested new ideas, obtained new results, and achieved new insights. The basic move is quite straightforward: identify representation-free structures whose representation (for instance in a Hilbert space) reinstantiates the known aspects of quantum mechanics. It is then tempting to try and interpret the representation-free structure as an ontologically real implicate order—a “veiled reality”, as Bernard d’Espagnat has called it.

In this sense Basil has taken von Neumann’s message very seriously, even insofar as his candidate for a representation-free structure is a Clifford algebra. (Clifford algebras are a special case of C^* -algebras which von Neumann applied to quantum physics in a series of papers with Murray after 1935.) From basic elements, the idempotents, of such Clifford algebras, Basil’s program has been to reconstruct quantum theory from aspatial and atemporal concepts of being and becoming. One thrilling example: the quantum potential arises precisely as a consequence of the representation of the appropriate Clifford algebra in Hilbert space. And an intriguing speculation, already raised by Wolfgang Pauli, and featuring in some of Basil’s more recent papers (Basil Hiley publications, this issue): ultimately there should be a veiled reality transcending even the mind-matter distinction.

Let me conclude this preface with an anecdotal reminiscence referring back to a conference in Våxjö, Sweden, a few years ago. Marlan Scully presented his ideas about the quantum eraser, with the particular purpose of challenging Basil, the

next speaker, for his interpretation of it. After Scully had finished, Basil started his talk speeding up very fast right from the beginning, so that he almost ran out of breath. Theo Niewenhuizen, who was the chairman of the session, tried to calm him: “Basil—relax!” Whereupon Basil replied: “How can I relax if this is so exciting!”

This is the response of a man with a passion for science—a passion to aspire across limits of current knowledge and to explore novel avenues beyond it. Since this species is not proliferating very well these days, it deserves being especially distinguished and encouraged. The contributions in this volume, selected from a symposium at Helsinki in appreciation of Basil’s work on the occasion of his 75th birthday, may serve this purpose. In Basil’s retrospect after the symposium, they are all

“trying to break the confining constraints of what I call ‘safe physics’. (I could describe it in different words, but I won’t!) It was good to hear all the things that are going on. Let’s keep it going!”