'Mind from Matter ? As Essay on Evolutionary Epistemology'

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'Mind from Matter ? As Essay on Evolutionary Epistemology'
by Max Delbrück
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Max Delbrück began his scientific career as a theoretical physicist. However, inspired by a 1932 lecture by Niels Bohr titled "Light and Life", where Bohr suggested the importance of the Complementarity Principle of quantum mechanics for the understanding of life, he decided to devote the rest of his scientific career to molecular biology. He became one of those who created this new field, and grew to attain an almost mythical status in it. And he reflected upon his own experiences in a 1949 essay "A Physicist looks at Biology", and again in 1969 in "A Physicist's Renewed Look at Biology – Twenty years Later".

During 1974–75 Delbrück gave an extempore twenty lecture course at the California Institute of Technology, with the broad aim of assessing whether Niels Bohr's expectations had been fulfilled. The present book grew out of his notes for these lectures, organized and edited by his colleagues after his death in 1981.

The range of topics covered is breathtakingly vast, all the way from our present understanding of the cosmic evolution of the universe to the emergence of the quantum mechanical understanding of microscopic phenomena; and against this canvas, the formation of the solar system and the planets, and the emergence of life on the earth. Each relatively short chapter gives an incisive account of one or another aspect of this enormous picture.

The main grand question before Delbrück is: can we understand how mind arose from an initially mindless 'material' universe? In building up to his answer, he provides masterly surveys of the growth of mathematics and of physics from their beginnings down to modern times, including the intricacies of the Gödel theorems on the one hand and of quantum mechanics on the other. Mechanics, electromagnetism, statistical physics and the relativity theories are covered on the way. Major philosophical developments such as the Cartesian cut and the later Kantian notion of a priori categories of thought are also brought into the discussion.

Initially Delbrück adopts the naïve realist standpoint, which takes the world as existing on its own 'out there', while our senses present a faithful picure of it to our minds. This standpoint suffices for an account of the initial occurrence of life on earth some three billion years ago; the appearance of photosynthesis; and then the spreading out of the many branches of the 'tree of life' guided by natural selection. Delbrück emphasizes both the unity and the continuity of the myriad forms of life – in the material biochemical sense, and in the psychic sense of organisms sensing their surroundings and reacting to them. But by the time he comes to describing the way the senses and the mind actually work, the limitations of the naïve realist point of view become clear. The intricate – and not yet fully mapped out – pathways of the various senses in the brain, and the way in which the brain – mind ? – creates for itself a specifically and selectively treated image of the external world, are astounding. The human observer is seen to be far from passive.

As part of this account, Delbrück brings in the ideas of Konrad Lorenz on the one hand, and the results of Jean Piaget on development and child psychology on the other. Lorenz's explanation of the relative roles of phylogeny and ontogeny – the development of the species over enormous periods of evolutionary time versus the experience of one individual member of the species during one lifetime – as an explanation of Kant's ideas is simply fascinating. This helps us understand the basis for the Kantian a priori categories of thought, based on Darwinian evolution, in a way not available to Kant in his own lifetime. The description of Piaget's findings – acknowledging that according to professional psychologists there has been much progress since – illustrates the ways in which the innate potentialities in every individual, thanks to slow evolutionary development, are realised and put to use based on individual experience of and interaction with the world. The unique role of the language faculty in humans is also covered in the discussion.

Delbrück's final answer to his main question is that the mind is not mysterious at all – it is a capacity resulting from selective pressures in the world of life. Quoting him: "The point of view of the evolutionist forces us to view mind in the context of other aspects of evolution.... In the context of evolution, the mind of the adult human ... ceases to be a mysterious phenomenon, a thing unto itself. Rather, mind is seen to be an adaptive response to selective pressures, just as is nearly everything else in the living world." It also transpires that the 'riddle of life' has been solved, thanks to Watson and Crick, in much simpler and merely mechanical ways than Bohr had expected. In that sense, the mysterious features of quantum mechanics lie beyond an explanation of the phenomenon of life! However it is good to remind oneself that another very distinguished thinker, Erwin Schrödinger, had in "*What is Life ?*" traced the very possibility of life – specifically, the gene – to the principles of quantum mechanics.

This book is full of treasures, and needs a mature mind to absorb the points it makes. And it needs to be read more than once. The sweep, the grandeur of the canvas are stunning. One may prefer one's own conclusions at the end, but one would have been infinitely better informed by reading Delbrück than otherwise.

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Complex Variables – Introduction and Applications

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Complex Variables – Introduction and Applications
M J Ablowitz and A S Fokas
Cambridge Texts in Applied Mathematics
Cambridge University, (South Asian Edition published by Foundation Books, New Delhi), pp. 647, Price: Rs 275/-

One of the popular books on science in my college days was George Gamow's *One, Two, Three ... Infinity.* In the section dealing with complex numbers, we find the following quotation from Euler's book on algebra: "All such expressions $(-1)^{1/2}$, $(-2)^{1/2}$ as etc. are impossible or imaginary numbers, since they represent roots of negative quantities, and of such numbers we may truly assert that they are neither nothing, nor greater than nothing, nor less than nothing, which necessarily constitutes them imaginary or impossible."

But inspite of all these excuses and abuses, as Gamow says, complex numbers have now become as unavoidable in mathematics as fractions or radicals and one could practically not get anywhere without them. Both as a research discipline in its own right, and as an analytic tool with numerous applications, complex analysis is now a topic of study in the mainstream of mathematics.

Today, complex analysis is an integral part of any reasonable mathematics curriculum and we have numerous texts on this subject. Thus, writing yet another text capable of making a mark becomes increasingly difficult. The book under review is an addition to this growing collection of texts on the subject and its novelty and value stem from its emphasis on applications.

The book is divided into two parts. The first part covers what is now generally accepted as basic material in any introductory text on complex variables – complex numbers, elementary functions, analytic functions, complex integration, Cauchy's theorem, series and product developments, residue calculus and so on.

Applications form an integral part of this book and start appearing from the very beginning. Differential equations are introduced as early as in section 1.4 and the velocity potential and stream function of ideal fluid flows appear just after the derivation of the Cauchy–Riemann equations. Series solutions to differential equations with regular singular points are discussed in chapter 3. This last mentioned section ends with a slightly more esoteric topic – Painleve equations. Computational issues are frequently addressed.

Simpler proofs are given wherever possible at the expense of generality but in the interest of faster development of ideas. However, all the major results are stated and rigorously proved. For instance, a very short proof of Cauchy's theorem (Theorem 2.5.2) based on Green's formula is first given using the additional assumption that an analytic function is continuously differentiable, a fact later deduced from the Cauchy integral formula (Theorem 2.6.3). A proof without this extra hypothesis, due to Goursat, is outlined in section 2.7.

Discussions of a more abstract or purely theoretical nature are often relegated to a separate section entitled something like 'Theoretical Developments' in several chapters. These sections are starred and can be skipped if one is not interested in such discussions and at the same time they make the book complete as a work of reference.

The second part of this book makes it really very different from other books on this subject. It is devoted to applications of complex analysis. It consists of three chapters (chapters 5–7). Of course, chapter 5 is on a standard topic, conformal mappings but covers a very wide range of applications.

Chapter 6 is indeed one of the most useful ones in the book. It deals with the asymptotic evaluation of integrals, a tool very necessary for analysts. It discusses a variety of techniques such as the Laplace method, the stationary phase method, the method of steepest descent, the WKB method and the Mellin transform method, to quote a few.

Given two function f and g and a closed contour C, the Riemann–Hilbert problem is to find analytic functions ϕ^+ inside C and ϕ^- outside C such that

$$\phi^+(t) - g(t)\,\phi^-(t) = f(t) \text{ on } C.$$

This general problem covers a host of problems from diverse areas like integral equations, partial differential equations, inverse scattering theory and the inversion of the Radon transform. A closely related problem is the DBAR problem which involves solving the equation

$$\partial\phi(x,y)/\partial\bar{z} = g(x,y),\ z = x + iy \in D$$

for a given function $g(x, y)$ in D, a region in the complex plane. These problems occur in connection with some multidimensional inverse problems and some nonlinear partial differential equations. The last chapter discusses the Riemann–Hilbert problem and also the DBAR problem and some applications.

Throughout the book, numerous examples are worked out. There are a wealth of helpful illustrations. Each section has a fairly large collection of exercises and home-work problems. The book also has a useful index and a bibliography.

The book is certainly a must for every library as it is valuable both as a text and as a work of reference. It can be used as a text for a course at the master's level in India. Many Indian universities have now introduced a course entitled MSc (Applied Mathematics). Given the bias towards applications in this book, I would strongly recommend it as a text in complex analysis for such courses.

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