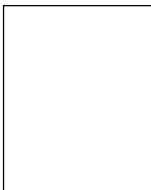


Dreams of a Final Theory – The Search for the Fundamental Laws of Nature

V Balakrishnan



*Dreams of a Final Theory – The
Search for the Fundamental Laws of
Nature*

S. Weinberg, Vintage, London, 1993

‘Popular science’ books by pioneering scientists come in many varieties, but are almost always worth waiting for. Such books would certainly be authoritative accounts of the subject matter. What is more important, however, is that they give the reader a really unique perspective. The genre includes straightforward expositions of a technical topic, an early example being the classic little book on relativity by Einstein himself. More often – and perhaps of greater value, in the long run – one has a collection of essays on widely varying themes. These reflect, directly or indirectly, the motivations, the compulsions, the stance, the personal scientific philosophy – in short, the credo – of a great scientist, giving the reader valuable insight into the working of a first-rate mind in a manner that even the best of biographies can only approximate. Restricting oneself to examples taken from physics and related areas, some wonderful examples of this class are Wigner’s *Symmetries and Reflections*, Chandrasekhar’s *Truth and Beauty*, Feynman’s *The Character of Physical Law*,

and Dyson’s *Disturbing the Universe*.

Although this is not explicitly stated, *Dreams of a Final Theory* by Steven Weinberg is a personal statement of precisely this sort. Weinberg, eminent theoretical physicist and author of monographs on gravitation and quantum field theory that are masterpieces, co-winner of the 1979 Nobel Prize in Physics for his work on the unification of electromagnetism and weak interactions, is perhaps best known to non-physicists as the author of the best-selling account of modern cosmology, *The First Three Minutes*. In that book, Weinberg used his formidable powers of exposition to present a gripping narration of perhaps the greatest story of them all, the origin of the universe. In *Dreams of a Final Theory*, Weinberg ranges much farther and wider: what is scientific methodology and what is not; the contrast between the approaches of science and philosophy to knowledge; the meaning of quantum mechanics and its implications for a physical universe governed by it; what one means by a ‘final’ theory – its scope, limitations and likely form; the implicit reductionism involved in any application of scientific methodology; and even the (ultimate ?) question, “What about God?” Never one to mince words or to resort to equivocation or mere semantics even when discussing the most subtle issues, Weinberg presents his considered thoughts on these deep matters in a remarkably clear, forthright and persuasive manner, with verve and feeling. In his preface, he states his objective of laying out the issues raised by the idea of a final



theory for readers with no prior knowledge of physics or higher mathematics. The text remains true to this objective without any sacrifice of accuracy or clarity; and this is no mean task, given the topics involved.

What is this ‘final theory’ to which the title of the book refers? In the 80’s, theoretical high energy physics (the ‘elementary particle physics’ of an earlier era) appeared to be on the verge of attaining its ‘ultimate’ goal – the unification of all the four fundamental forces of nature, including gravity, into a single theoretical framework. This framework (‘superstring theory’) is required to be consistent with the two cornerstones of modern physics, namely, quantum mechanics and relativity. Of course, it turned out to inescapably involve newer ingredients such as supersymmetry and extra dimensions. Several long-standing and difficult technical problems in the realisation of this programme were resolved after a fashion. In the euphoria induced by these successes, many physicists began to feel that a ‘theory of everything’, a ‘final’ theory, was in the offing. These initial expectations have certainly not been borne out. However, some progress has indeed been made in recent years – notably, in gaining a deeper understanding of what is actually meant by a ‘final theory’ in this context, of how it is likely to turn out to be a unification of *classes* of theories rather than a single specific theory, and, finally, of the very idea of space-time itself. The quest is still very much on. One presumes that it is now being pursued in a desirably more sober spirit. Solemn phrases

such as ‘the first string revolution’ and the ‘second string revolution’ do continue to make their appearance, and may even be justified on purely technical grounds. However, given the potential for misunderstanding such phrases have among the non-expert public, it is perhaps not unfair to attribute the cavalier use of such terms to the general sociological tendency in this information age to write instant history based on last week’s happenings.

Weinberg takes great pains to put these matters in their proper perspective (as on the date of writing, August 1992). In particular, he states unequivocally that “the discovery of a final theory [defined in the context described above] would not end the enterprise of science”. He reassures the reader that the basic problems such as the formation of galaxies or the origin of the genetic mechanism or the storage of memories in the brain are unlikely to be affected by the discovery of such a final theory, and that the same thing is true for certain deep problems in physics itself such as turbulence or high-temperature superconductivity. Why, then, has the book led to much debate and discussion, and even provoked criticism from some physicists? The answer lies in two related but distinct issues:

High energy physics, truly the ‘fundamental’ part of physics in a specific sense as Weinberg carefully and correctly explains, is faced with a dilemma. While the theoretical side has advanced considerably, the crucial experimental side is nearing the limits of its current capabilities. To learn more



about the way nature actually is (as opposed to how our theories say it should be!), we need to go to significantly higher energies than are available in today's particle accelerators. In fact, at the level of the 'final' unification (inclusion of gravity), no accelerator in the conceivable future can ever hope to yield the energies required. However, crucial tests of whether we are on the right track or not, going just beyond the currently-accepted 'standard model' of particle physics, can be performed – provided significantly improved accelerators, notably the 'Superconducting Super Collider' (SSC), were to be built. Weinberg played an important role as a proponent of the SSC, and 'Dreams of a Final Theory' came to be seen in many quarters as powerful propaganda for the SSC. And as its cost would have precluded the funding of important proposals in many other areas of physics, a very heated debate arose. This brought in the second aspect: the claim that high energy physics was the most fundamental aspect of physics was bitterly disputed. Inevitably, the perennial debate between 'reductionism' and 'holism' entered the picture, with its attendant observations about the possibility of reductionism missing out on collective or emergent properties that a holistic approach alone would presumably capture. While the reductionism-versus-holism debate is one of those things that is likely to continue forever (like good versus evil, or, somewhat more appositely, the discrete versus the continuous), the particular issue that gave rise to it in the present context is a dead one, at least for the present: the SSC

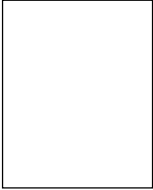
has been given up. Whether this was a good thing, or whether it was a mistake with serious long-term consequences for our civilization (a 'failure of imagination', as Arthur Clarke would put it), only time can tell.

As far as *Dreams of a Final Theory* is concerned, however, it appears that the criticism is unfounded, when the SSC is decoupled from the discussion. Whatever be one's views on the desirability of the SSC, the careful qualifiers and caveats in 'Dreams' ought not to escape the reader's attention. Read carefully, the parts of the book dealing with issues much deeper than the SSC (and this means most of the book) would be most instructive to general readers as well as physicists. In the chapter 'Facing Finality', Weinberg admits that 'it would be foolish to expect that any discovery of science could in itself purge the human race of all its misconceptions', but goes on to add that 'the discovery of the final laws of nature will at least leave less room in the imagination for irrational beliefs' – because this will make it more difficult 'for people to hope that some day their own favourite irrationalities [irrational beliefs] will find a respectable place within the structure of science'. Optimistic words; but a reading of *Dreams of a Final Theory* may itself help one take a step towards the fulfilment of this ideal.

V Balakrishnan, Department of Physics, Indian Institute of Technology, Madras 600 036, India.

Elemental Mind: Human Consciousness and the New Physics

P N Tandon



*Elemental Mind: Human
Consciousness and the New Physics*

Nick Herbert

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paper back)

Human mind, often considered synonymous with consciousness, has been called the last frontier of science. In addition to neurobiologists, psychologists and cognitive scientists, in recent years it has increasingly attracted the attention of physicists. This book is yet another in the series by a physicist who believes that, “there is no excuse save lack of imagination for physical science not to attempt to provide a technical solution to the mind/body problem”. The author adds a new dimension to the unresolved conflict between the monoists who believe that mind is an emergent feature of certain electrochemical events occurring in the brain, and the dualists who like Descartes consider brain and mind to be distinct independent entities. The author argues that, “mind is a fundamental process in its own right, as widespread and deeply embedded in nature as light or electricity”. He claims, “Mind is, in a word, elemental, and it interacts with matter at an equally elemental level”. To support his hypothesis he invokes some features of

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quantum theory “for understanding how mind might enter matter at the quantum level”. Like most authors, he uses the term mind and consciousness interchangeably.

The book is divided into eleven chapters. Chapter 1 deals with ‘steps towards a science of consciousness’. Recognising the difficulty of giving a definition of consciousness, the author resolves the issue thus: “Consciousness seems not to be concerned so much with what an entity does as with what it experiences while doing it”. Obviously the real challenge for experimental scientists is to devise ways and means to measure the presence of subjective experience. He refers to several theoretical possibilities like ‘cogitons’, ‘mental telepathy’, ‘mind links’ and his own, and others’ efforts – so far unsuccessful – to construct a conscious machine. In the light of these experiences he reflects upon the limitations of the two dominant hypotheses of mind – monoistic and dualistic. The author also tries to answer the important question, “How will we recognize a good theory of consciousness when we see it?”. He proposes twelve parameters for the same.

Chapter 2, 'Consciousness from Inside: Prominent Landmarks of Inner Space' deals with some psychobiological aspects of consciousness. He emphasises its most important feature, the experienced unity of human consciousness. To dissect it further he attempts to provide some quantitative information regarding the various inner spaces like the five senses along with thinking space, feeling space, memory and other higher functions; he points out that in its single-minded pursuit of unity, consciousness strives to integrate sensations, memories, emotions, cognition into one ongoing inner experience.

Chapter 3 'Consciousness from outside: a tour of mind's mansion' gives a brief account of brain in embryo, its development to adult state, and its various parts. It goes on to provide some information regarding its energy consumption in various states – normal awake, sleep, coma, mental arithmetic etc. He argues, "If consciousness is a new form of energy, we should be able to measure a number in brains of conscious creatures that represents its energetic equivalent". He gives a very brief account of various imaging techniques currently used for 'looking into the brain', and an outline of the electro-chemical basis of the functioning of the brain. This is followed by the possible role of different parts of the brain in search for location of human awareness. The rest of the chapter is devoted to an elaboration of the work of James Culbertson, author of several books like "The Minds of Robots",

"Sensations, Memories and the Flow of Time", "Consciousness – Natural and Artificial". The author concludes Culbertson's work is the first step towards a new science - the science of *artificial awareness*.

The author then turns to physical principles which may provide a link between the mind and matter. Next five chapters are thus devoted to elaboration of various aspects of quantum theory and its possible application to explain human consciousness/mind. The author elegantly summarises the problem of quantum reality in chapter 5. "Quantum theory is our most upto date theory of the physical world. It has been flawlessly successful in describing the world at all levels from quarks to quasars".

He then elaborates the eight tentative pictures of the quantum world e.g. there is no deep reality, reality is created by observation, undivided wholeness, the many-worlds interpretation, quantum logic, neorealism, consciousness creates reality, and the Duplex world of Werner Heisenberg.

One may wonder, what has all this to do with consciousness/mind? He goes on to argue that "The quantum reality problem is, strictly speaking, not a physics question at all, but a problem in metaphysics". One of the most important use of metaphysical pictures is to help extend quantum physics into new areas like models of mind.

The author claims that for the construction of models of mind and clues to the true role



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of consciousness in the universe-as-a-whole, these eight quantum realities (with two exceptions) offer tantalizing suggestions. Thus von Neumann extending the Copenhagen picture of quantum reality gives mind “an independent role to play in constructing the phenomenal world”. His model of reality treats mind as “elemental”, as fundamental as quarks and gluons for the proper functioning of the universe. In the von Neumann interpretation of quantum reality, consciousness is a process lying outside the laws that govern the material world. It is obvious that such theories tend to support the dualistic model of mind.

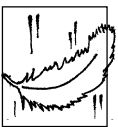
The significance of quantum inseparability for models of mind is two-fold. First the peculiar variety of wholeness possible for quantum systems may offer a possible mechanism for achieving the unity of experience observed in so many (human) minds. Second, the notion that mind operates by influencing the occurrence of otherwise random events giving rise to the possibility that mind can influence distant matter in a decidedly non-local manner.

Some interesting experiments which may throw light on views, like The Denver experiments on photons, Schmidt machines, Princeton, San Antonio, and San Francisco experiments have been briefly referred to. The author then describes his own groups’ work on developing a *metaphase typewriter*.

In the final chapter the author considers possible research directions that might take the mind/body problem out of the province of philosophers and theologians and into the physics lab.

Unlike several other books on mind/consciousness written by physicists and mathematicians, it is easy to read and comprehend, though it may not be so for completely uninitiated. The title of the book, as also its Introduction, arouses much hope as if the author has resolved this vexed issue, when he declares, “I propose, in fact, that mind is elemental, (or a kind of “quantum animism”) my dear Watson!” Without being flippant one could ask, “where is the proof, my dear Sherlock Holmes!”. Nevertheless, both biologists and physical scientists wishing to develop an interdisciplinary dialogue will benefit by reading it.

P N Tandon, Neurosciences Centre, Department of Neurosurgery, All India Institute of Medical Sciences, Ansari Nagar, New Delhi 110 029, India.

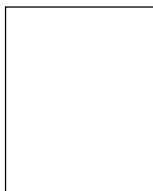


Science seeks generally only the most useful systems of classification: these it regards for the time being, until more useful classifications are invented, as true.

S I Hayakawa

The Chemistry of Conscious States – Toward a Unified Model of the Brain and the Mind

Upinder Bhalla



*The Chemistry of Conscious States –
Toward a Unified Model of the Brain
and the Mind*

J Allan Hobson

Back Bay Books, Little, Brown and
Company, Boston, New York, Toronto
and London, 1994, pp.300+xiii, \$13.95

In *The Chemistry of Conscious States*, J Allan Hobson takes us on a tour of the chemical brain. He brings all the insights and perspectives of a neurologist and researcher, which provide wonderful anecdotes but also sometimes limit the scope of the book. Although this book is written for the interested layperson, there is much in it even for the professionals in the field.

The book revolves around the two themes of the title: the chemistry of the brain, and its states: wakefulness, sleep, and sometimes, insanity. The brain *is* the mind, asserts the author. He follows the ‘brain-mind’ through wakefulness, deep sleep, and dreaming, and draws interesting parallels between the dreaming brain and psychotic states. These ‘mind’ states emerge from the interplay between two of the major brain regulatory chemicals, in the cholinergic and aminergic systems. He illustrates how the mind itself can go out of kilter when this chemical balance is upset. The author concludes the

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first section with a proposal for considering brain function in terms of activation level, information source, and chemical mode. This sets the stage for his discussion of the functioning of the brain in later chapters.

In the second section of the book, the author examines major faculties of the brain: orientation, memory, perception, emotion, attention and energy. In an account richly embellished with case histories and research findings, he considers each in terms of his overall scheme for brain function. The crux of the book is reached when he brings all of these ideas together to discuss consciousness and the mind. He boldly asserts: “The mind is all the information in the brain..... Consciousness is the brain’s awareness of some of that information”.

In the final section of the book, the author returns to his medical roots and asks how his insights into the mind-brain might help cure it. He takes on the doctor’s traditional admonishment to “sleep well”, and reinforces it with his pleasantly familiar mix of brain chemistry, medical stories, and common sense. The last chapter is a sobering commentary on drugs and the brain: abuse, overprescription, and a poignant sense of loss for his first patient, for whom the insights



in this book came too late.

This book is tantalising. It raises fascinating issues, and has a marvellous supply of anecdotes and titbits to illustrate the daily chemical ballet in the brain. It does a particularly good job of stressing the known physical and chemical basis of mental function and dysfunction. But it often leaves the reader with the feeling of being at the point of a deeper insight, but never quite getting there.

The author does not shy away from controversial topics. Early on in the book, he takes the issue of the *psychoanalysis* of Freud and the *behaviouralism* of Skinner. In this, he departs from traditional medical and educational practice, and sides clearly with the mainstream of modern neuroscience. It is a welcome debunking. He also takes aim at the even more contentious issue of the brain-mind problem, and comes out squarely on the side of those who regard them as one and the same.

There is always the question of how much depth a topic warrants, specially in a book written for a general audience. Unfortunately, the author has chosen not to tax the reader with too many pros and cons. Many of the interesting discussions in science arise out of disagreements, and the study of the brain is particularly rich in them. The author, however, has chosen to present only his viewpoint in any depth, and does not really

examine the other ideas that challenge them. This is particularly regrettable in the core chapter of the book: *What is consciousness? What is the mind?* There is such a wonderful intellectual ferment in this area that it is a shame to miss out on some of the ongoing debates. A lesser issue with the book is that it doesn't really branch out to other ways of looking at the brain. Indeed, among cognitive neuroscientists, the 'chemical' viewpoint expounded in this book is actually accorded far less prominence than the 'network' viewpoint of brain function. Neuronal networks receive only a brief mention in the book, but surely they merit more, if only as supporting the different ways of looking at the same phenomena. Finally, one wishes that there were some pictures.

Even with these points in mind, I would recommend the book unhesitatingly to readers of all backgrounds. For those first venturing into the vast topic of the brain, the book uses everyday landmarks like sleep, dream, and emotion to build up to some profound questions. For students of biology, there are many new concepts and a different slant on many familiar ones. And for all those with a fascination for the most mysterious of organs, here is as modern and holistic a view as you are likely to find outside the textbooks.

Upinder S Bhalla, National Centre for Biological Sciences, TIFR Centre, Indian Institute of Science Campus, Bangalore 560 012, India