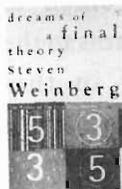


## Dreams of a Final Theory – The Search for the Fundamental Laws of Nature

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.