Dreams of a final theory

S.Weinberg

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Weinberg is a reductionist. For this he has gotten a lot of criticism. Yet, of course, he sticks to it because how could he otherwise dream of a final theory.

What does he mean by reductionism, and why does he believe that there is such a thing as a final theory of the universe, and what form would it take? After all, as every exasperated parent knows, the string of why-questions asked by an inquisitive (or merely naughty) child is potentially infinite. Popper, of course, rejects the notion of ultimate explanations, instead envisioning an unending sucession of theories, the one deeper than the other. The dread of reductionism is in the end the dread of death. For one thing what shall we do when everything is discovered and explained? There is still plenty to do, Weinberg assures us, although he admits that future physicists will envy those of his generation to whom the final theory was still to be discovered, thus admitting that the act of discovery is usually sweeter than discovery itself.

Of course from a formal point of view a final theory can be likened to have a complete set of irreducible axioms in mathematics. We all know everything about Euclidean space by the axioms thatv characterize it. Nothing fundamental of that nature will ever be discovered, but that does of course not mean that no 'new' thing will be discovered, on the contrary having the axioms only mean that now you can start in earnest. Thus physics, and ultimately science is plyaing a game, the rules of which are still in a limbo. The final theory is going to rectify this, set everything on a firmer basis. Many people find such an ambition naive. Of course it is naive and that is the whole point. Weinberg does not have a very high opinion of philosophers, especially academic ones, but ultimately philosophical stands are inevitable, and the stand of Weinberg, like most scientists is one of faith, a faith in an independant reality out there, independant of our wishes and methods, one which we seek to understand, not just for our own survival and comfort, but out of insatiable curiosity, for its own sake, whatever that will entail. This is in one sense not only a philosophical attitude but a religious conviction, albeit one not concerned with a traditional caring God. It is, although most scientists would be loath to admit it, a celebration of Platonism. Weinberg certainly would be embarrassed being thought of as a Platonist, and would certainly dismiss any such characterization as stretching the notion of Platonism to make it almost meaningless, just as liberal interpretations of God. Yet, the various interpretations of Platonism (with which you may or may not agree) are just shadows of an underlying Platonism.

Now what is reductionism? Of course it is the very idea of explanation. A true explanation involves deriving something complicated from something simple. Sometimes this derivation is very complicated itself, and we then refer to it as a calculation. Sometimes such calculations are so complicated that they cannot be performed in practice. (Chemistry is in principle derived from Quantum mechanics, but this is feasible only in very simple situations). Thus the nature of an explanation is not a detailed sequence of arguments,

as those can be too complicated to contemplate, but the realization that a few simple principles lie behind. This is what gives this intellectual kick, this sense of revelation. [1] Now science exhibits many instances of such explanations. They are like arrows pointing from the simple and the fundamental to the complicated and actual. Now such clusters of arrows are in themselves connected by arrows, allowing more and more fundamental explanations. This is what the history of science is all about. Finding such explanations to satisfy our intellectual hunger. In this general pattern, Weinberg senses a convergence, not unlike that of the converging parallels of longitudes homing into the North Pole. The Final Theory is simply the North Pole of Science, a quest bound to ultimately succeed.

The traditional view of science stems from Bacon. It is simply a matter of patient and humble observation of nature. We ask the questions and Nature supplies the answers. It is known as empiricism. This view of Bacon has of course been vulgarized. The asking of questions is of course the key, and the interplay between Man and Nature is rather subtle. For one thing there is no such thing as an unprejudiced observation, we all have preconceived notions, we create theories to structure the world, and only within those frameworks can we start making observations. The notion of falsiability proposed by Popper is also not so straightforward as it is made to appear. A theory has consequences, test those consequences, and if they do not occur, scrap the theory. No, inconvenient facts sometimes are meant to be ignored, if a theory is beautiful enough, in the sense that the kind of explanations it gives have the touch of inevitability, one should be wary of rejecting it because of lack of empirical confirmation, even when it would be in opposition to empirical facts, because empirical testing is by itself a highly complicated and subtle process.

One may say that 20th century physics is characterized by two major things. General Relativity and Quantum Mechanics. They are profoundly different. General Relativity is a work of art. In a sense it is entirely mathematical created by pure thinking based on some simple principles. To teach and to learn it is simply to follow in the thoughts of Einstein. The intellectual beauty is compelling, and this can be made more precise, as Weinberg is at pains to point out, because it is not merely a subjective beauty, it is a beauty of economy and rigidity, that while Newtonian physics can be modified, Einsteinian cannot without destroying it altogether. Beautiful maybe but true? Hermann Weyl famously claimed that if he would be forced to choose between beauty and truth, he would choose beauty. In physics you can have it both ways. Over and over again beauty has proved to trumph truth ultimately being vindicated and embraced by the latter[2] In biology on the other hand, this does not hold, if there is an elegant explanation it is bound to be false[3]. The true story of the experimental verification of general relativity is not as straightforward as we have been told to believe. The prediction that the mass of the sun would deflect the rays of stars with a certain amount was supposedly verified by the 1919 solar eclipse expedition. In fact the experimental verification was biased by the expectation. They were not out to prove

[1] Mathematical equations set up by physicists can be extremly messy to solve, yet they can exhibit intrinsic features, like symmetries, allowing us through a higher level so to speak appreciate qualitive properties of solutions without mindless calculations.

[2] Dirac is a prime example of this attitude.

[3] admittedly Weinberg makes a distinction between mere elegance and beauty

Einstein wrong but right, thus they were satisfied with results that confirmed, without pressing ahead in order to truly falsify. In fact later expeditions actually obtained readings that contradicted Einstein, but no fuss was ever made of that. In fact the strongest proof for Einsteins theory was not the prediction but the retrodiction of the procession of the perhelion of Mercury. One is often suspicious of retrodiction, and for very good reasons, because theories can always be doctored to retroactively confirm with what you already know. In the case of general relativity this is different, as Weinberg recalls to the reader. The theory of relativity was a deduction based on simple principles, and nowhere was there any fudging into it. Anyone (in principle) can reconstruct the reasoning. Thus to Einstein the explanation of the Mercury precession came as a complete surprise. (And of course those measurements of the precessions, which by available technology could be done with great precision, were made with no particular expectations in mind). Of course eventually the accurate empirical testings of lightray deflections and many other predictable consequences were made vindicating the theory.

Quantum Mechanics on the contrary should be seen as a mathematical formalism that miracolously works, and no one understands why. It is magic and it is patchwork and the attitude of most physicists is that do not worry about its ontological interpretations, any such interpreation will be misleading anyway, just perform the calculations and be happy that it is in perfect harmony with experimental results. One may take the view that just as computers extend our merely computational powers, mathematics brings us beyond our powers of understanding as such[4]. This feature of Quantum Mechanics is to many people intellectually dissatisfying. Also the attitude of a physicist to the mathematical formalism of Quantum theory is abhorrent to mathematicians, to whom mathematical objects have a solid reality and are constrained by logical necessities, not something you can bend and manipulate at will to accomodate an elusive goal.

Nevertheless as most modern physicists, Weinberg has truly accepted it and is convinced that whatever form the final theory will take it will incorporate Quantum theory.

The book is written in the early 90's. The supercollider SCC is very much on the mind of the scientific community. Weinberg is of course in favour, and testifies in Congress. Congress blowing hot and cold, sometimes appropriating funds, sometimes denying them. A mathematician would of course never ask for billions of dollars in order to satisfy his curiosity, physicists are different, and for very good reasons. There is no final theory of mathematics, but supposedly there is a final theory of the universe. Mathematicians are free to let their fancies lead them wherever they go, thus creating a wide delta spread out in the landscape, while physicists are far more focused, going in the other direction in order to discover the sources of the river. Weinberg also points out that when it comes to projects of this magnitude they have a dynamism of their own, including job-opportunities, and should thus be compared with other kind of public works. Also he remarks that ironically would the SCC have been even more expensive it might have been easier to justify politically. And there are many other scientific endeavours, such a space stations and manned space

[4] One may also argue that the pictures of the constituents of matter,which we have inherited from the ancient Greeks, confuse us with their inappropriateness. Is the electron a particle or a wave? An electron is an electron, neither a particle nor a wave, not accessible to our imagination, only to our mathematical formalism

missions, which scientifically are far less interesting but enjoy political protection. The final dumping of the project because of reasons of fiscal responsibility was mostly an act of symbolism.

June 7, 2007 **Ulf Persson:** *Prof.em, Chalmers U.of Tech., Göteborg Sweden* ulfp@chalmers.se