"A Different Universe: Reinventing Physics from the Bottom Down"
by Robert Laughlin
Basic Books: 2005. 304 pp. $26, ?19.99
Book review by Philip Anderson Nature, 434(04/2005) 701f

I should make my interests clear right at the start. For many years I have thought that a book such as this should be written, and have been urged to write it myself. I didn't do so, and couldn't possibly have written one as suited as this is for its target audience. A Different Universe is a book about what physics really is; it is not only unique, it is an almost indispensable counterbalance to the recent proliferation of books by Brian Greene, Stephen Hawking and their fellows, who promulgate the idea that physics is a science predominantly of deep, quasi-theological speculations about the ultimate nature of things. The enterprise of writing this book has my strong endorsement, then, and any disagreements or criticisms should be read in that light.

The central theme of the book is the triumph of emergence over reductionism: that large objects such as ourselves are the product of principles of organization and of collective behaviour that cannot in any meaningful sense be reduced to the behaviour of our elementary constituents. Large objects are often more constrained by those principles than by what the principles act upon. The underlying laws of physics have no sense of time, give us no clue either to measuring or locating ourselves in space, and provide no clue to identity — we are all made up of nothing but waves in a nonexistent medium (an analogy that Robert Laughlin draws from Christina Rossetti's poem Who Has Seen the Wind?). Our identity and perceptions are all the collective behaviour of 'ghosts', who borrow their reality from each other.

Laughlin gives the reader a quick tour through much of physics (without a single equation). There is a slight emphasis on the quantum theory of condensed matter, in so far as it explains such things as computers (with a sceptical side glance at quantum computation), the properties of ordinary metals, and the like. There is an enlightening discussion of the special quantum phenomena, the Hall and Josephson effects, which through the 'protection' of collective behaviour allow the measurement of Planck's constant and electric charge with enormous accuracy. The term 'protection' was coined by Laughlin and David Pines to express the fact that precise behaviours of large objects can result from, and even benefit from, disorderly behaviour at the atomic level. Some of this will be hard for the layman to follow, but at almost no point is it out of his reach. The pedagogy is leavened by anecdotes, occasional eloquence, and characteristically pungent diction (Laughlin once interrupted a scientific talk with "Liar, liar, pants on fire!").

There are idiosyncratic views of a wide variety of scientific topics.
Laughlin reveals his view of nanotechnology with a chapter entitled "Carnival of the baubles" (a view with which one can concur). He gives us some inside information on the Star Wars defence project and its notoriously fraudulent X-ray laser weapon. He continues, comparing unfavourably the 'nanobaubles' of technology with those of life, the biomolecules, for which he has considerable admiration. Then we hear his own ideas on biology, which will not be to everyone's taste but are certainly thought-provoking. Finally, his view of complexity science surprised and pleased me with its relative benevolence.

Despite the above fulsome praise, this is not by any means a perfect book, even for its purpose. Laughlin is not reliably careful with facts, whether scientific or historical. For example, it has rhetorical value to give his great hero (and winner of two Nobel prizes) John Bardeen mythic status, and to demonize the "engineer" William Shockley, but this is incorrect. Shockley was verifiably contrary and sometimes mean, but he was also a great physicist. It was Shockley, rather than Bardeen, who was responsible for creating the great

research centre at Bell Labs with James Fisk and Mervin Kelly. He also hired Bardeen, as well as many of the other stars who graced the place, such as Charles H. Townes, Conyers Herring and Bernd Matthias. Bardeen was human, and was wrong as often as he was right. It would have been instructive to point out that he published two mistaken theories of superconductivity 15 and 7 years before he got the right one. Laughlin's history and emphases are too much those of his generation.

Laughlin makes too much of the role of the renormalization group — a way of averaging out and getting 'universal' properties at the macroscopic level from the messy microscopic details — and other protection principles, as opposed to mechanism, in determining the properties of things. Was it Pierre Weiss, with his mysterious molecular field and Weiss magnetons, who explained ferromagnetism? Or was it, as I believe, Werner Heisenberg, with quantum theory? Laughlin misleadingly accuses two unnamed physicists of predicting that superconductors be limited to below 30 K (the actual figure was 40 K), when what they said applied specifically to a particular mechanism for which it is true.

In my experience, which incidentally is greater than Laughlin's, underlying causes often enlighten our conceptual thinking as much as precise numbers do, something that Laughlin seems to deny. After condemning astroparticle types for overemphasizing deep thoughts and broad vistas, he seems to reveal a certain measure of 'particle envy' and distaste for the messy, quarrelsome but absorbing ways of doing the sciences in the real world. What made Bardeen great, as indeed he was, was his stubbornness and experimental taste, and Laughlin dismisses these values.

Those who devour the work of Greene, or decorate their coffee table with Hawking, will find this book a useful antidote. It should spike the interest of those who read the physics popularizers, although in its personalized coverage and opinionated style it is sui generis. My message is this: buy the book.