Review of: "Twentieth Century Physics", edited by Laurie M. Brown, Abraham Pais and Brian Pippard, Institute of Physics Publishing, Bristol and the American Institute of Physics Press, New York. 1995. 3 vols.

Napoleon, on receiving a copy of Laplace's "Mécanique Celeste" acknowledged it adding: "The first six months which I can spare will be employed in reading it". This magnificent compilation also demands six months, comparable to the work which many of the authors must have devoted to it. Here, 29 distinguished authors have extended themselves to give careful accounts of the physics culture and the development of physics over the last hundred or so years, but they do not just comment on physics, but give the hard stuff itself, and some parts are really quite hard, demanding serious work, while others are more immediately intelligible. Biographical material is included in boxes, emphasising that science is independent of personalities and their national and religious affiliations, although the paths to understanding may be various.

In our culture communication has become dominant; writing, television and now the Internet bear witness to this. The world of science is one like the global economy and the environment. In this matrix science and technology develop, not perhaps directly connected, but moving in alternation (in Derek Price's metaphor) now one and now the other leading the dance. Science has proved to be the way to understand the universe and mankind itself, providing the reliable knowledge not available from "revelation". In distinction to other ideological systems, science has mechanisms of self-correction and, given means of information transfer, has accumulated progressively. Physics is part of our noösphere and our culture and as such has a history or at least a path to its present state. Perhaps, as with functions of a complex variable, the integral from one point to another may be independent of path. Physics, like the genome, "is" its present state. The path to this state may be interesting but inessential. Earlier states are its history and it requires skill to imagine what they were like and to "un-know" recent advances. (Scientists speak only of "advances".)

Among the population at large, science is by no means the dominant ideology and, even in the most educated circles, there are attempts to represent that science is only one among a number of equally valid ideological systems. These debates are intensifying in spite of the increasingly technological nature of civilisation. Modern political history is largely the doings of the various "military-industrial complexes" and nation states but neither this aspect of physics nor the ideological struggles with religions, superstitions and monetarism figure greatly in this book until we get to the last section containing Philip Anderson's excellent historical essay.

Before 1900, physics was much like engineering, the quantitative treatment of phenomena that were much like common experience, but since then there has been a

dramatic change and it emerges that the worlds of the very small and of the very large are not at all like everyday life and are often counter intuitive. This has meant that, with quantum mechanics and relativity, physics has become largely inaccessible to non-scientists and often even to professional physicists -- and there must now be hardly any amateur physicists. Since physics should be part of our culture this brings many difficulties for education.

At the beginning of science, in the second century BC in Africa, Eratosthenes performed one of the greatest feats of the human intellect and calculated the radius of the Earth from measurements of distances on the ground and the length of shadows. Later, in 415 AD, also in Alexandria, the woman philosopher and mathematician, Hypatia was murdered by religious zealots who had an entirely different way of understanding the universe. Today science is still a minority activity and physicists pursue a lonely path, among anti-scientific movements of many kinds, from religious fanatics to post-modernists, which are as powerful as ever. The relations of scientists to the rest of society are still fraught with difficulties. Each party depends on the other, rather like the early traders in the South Seas who cautiously left goods on the beach in exchange for natural products. These social interactions are not here directly discussed until we reach the end section with essays by Philip Anderson, Steven Weinberg and John Ziman This history of physics in our century gives us the solid physics, not the deconstruction.

Brown, Pais and Pippard have produced a magnificent book, with masterly articles by the best people, comparable in size to Gibbon`s Roman Empire. The problem is that most literate people can read Gibbon right through with understanding. To understand modern physics is an entirely different proposition. "At the beginning of the century there were a few leading physicists who kept in touch with almost every active line of research, but now there are none." (Preface). How much more so for this reviewer who must take the section on solid-state structure analysis as a sample. The various studies are solid meat - not by any means popular accounts. Each author gives us the material straight, without concessions to ignorance or intellectual frailty. The styles and lengths of the 29 articles vary agreeable with the authors but I can point only to a few, confessing a greater personal interest in the atomic scale phenomena than in the very small and the very large extremes.

For example, William Cochran gives a excellent summary of the development of crystallography, covering all the key papers (262 are referenced) with exactly the relevant illustrations. Perhaps subverting the unifying aim of the whole compendium, it would be convenient if individual sections were to be made available separately for wider circulation. This section, for example, should be essential reading for M.Sc. and Ph.D. crystallographers. It is a substantial course in itself indicating what people ought to know about. Other long sections cover other

topics in with similar thoroughness.

Brian Pippard himself furnishes core sections on "Physics in 1900" and "Electron in Solids" and the other editor, Abraham Pais, introduces "Atoms and their nuclei" so that the centre of gravity of the book is in solid state physics and the atomic level with appropriate supplementation in cosmology and particle physics.

Mitchell Feigenbaum, in contrast, has a fascinating more personal account "Computer-generated Physics", beginning with his acquisition of an HP-65 calculator, (fascinating even though I did not fully understand the matter) vividly recounting how he came to the Feigenbaum number and persuaded orthodoxy to believe in it. "Every novel paper of mine, without exception, has been rejected by the refereeing process" but he circulated preprints to make his work known. He expresses well the emotions and personal stresses of the scientific life, and the rivalry and comradeship of the "Republic of Science" (Clifford's phrase), in the search for understanding. His essay also touches on the traditional ethic of science which is under increasing pressure as capitalism appears to have triumphed over alternative systems. For example some Russian scientists in their present period of hardship preserve the traditional ethic. "They meant a sort of marble stele of the mind; incised upon it are the moral commandments to which the life of a scientist is dedicated. These commandments include the commitments to truth, to loyal comradeship, to intellectual and personal self-discipline, to an ascesis indifferent to discomfort or money." (Neal Ascherson, "The Black Sea"). But very recently a Nature editorial (about exploitation of the human genome) said: "there are signs of a culture made sick by commercial interest to an extent that is unprecedented in science." and Anderson touches on this change in ethic. Otherwise "the bomb" and its effects on physics and physicists are hardly mentioned.

Tom Mulvey deals with the development of electron beam instruments and brings new information about the commercialisation of the electron microscope which has given us immediate access to the atomic level of matter.

Robert Cahn, with the physics of materials, describes historically how physics has led to the understanding of the actual materials of commerce and industry and P. G. de Gennes, in a shorter chapter opens the interface with biology with the "Soft Matter" involved in polymers, liquid crystals and surfactants.

There is an excellent account by John Mallard of medical physics, the various imaging methods which are responsible for the advances in understanding of the operation of the brain bringing much of the humanities within the ambit of physics and

of the techniques which physicists will meet sooner or later as mortal people falling into the hands of the physicians.

Churchill wrote: "I knew nothing of science, but I knew something of scientists and had had great experience as a Minister in handling things I did not understand." That this is a major problem for our society is today sharply exemplified by the BSE affair. As Feynman said too about the Challenger disaster: "Reality must take precedence over public relations, for nature cannot be fooled". Physics deals with the behaviour of the real world and the contents of this book can be ignored only at our peril. It stands as a monument to the belief that physicists have produced something of permanent value however much the tides of politics, sociology may attempt to erode it. If ignored, even states may trip up. In any case, physicists should enjoy reading it a little bit at a time, venturing out from their specialisations and other people should know that physics exists.