

single numbers like β which start with one in each chapter. A corollary of theorem α, β can be tagged with α, β, γ where γ is an integer.

The index can be expanded to yield a more complete representation of the results. There are no references to other books. The authors employ nomenclature that is difficult to find in available books. For instance, *the fundamental theorem of algebra* is well known. *Two fundamental theorems* (of linear algebra) are not mentioned in other books. Is the Cayley–Hamilton theorem known as the Hamilton–Cayley theorem? The authors must check all nomenclature in their book to bring it in line with some standard reference, say, *The Encyclopedia of Mathematics* (Kluwer). If a theorem is known by a particular name in another work, a reference to that work will also be useful to the interested reader.

There are a few misprints (p. 25, p. 343) and ambiguities (p. 259, below definition 7.4). Some definitions are either assumed tacitly or not prominently set down (commutative diagram on p. 137; the \sim -symbol on p. 155).

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Interpreting Bodies: Classical and Quantum Objects in Modern Physics. Elena Castellani (ed.). Princeton University Press, 41 William Street, Princeton, New Jersey 08540. 1998. 329 pp. Price: US\$ 19.95.

This book is the outcome of a project to understand the nature of physical objects in the light of modern physics. The editor has brought together physicists, philosophers and logicians in an attempt to probe this question from different points of view.

The volume contains essays by well-known physicists of the past like Born, Heisenberg and Schrödinger, as well as writings contributed by present day physicists. It also contains a blend of old and new writings by philosophers and logicians.

Being a theoretical physicist by training, I was naturally inclined to read the physics articles with greater interest. The articles by Max Born, Erwin Schrödinger and Werner Heisenberg which have been reprinted in this volume are classics. Present-day physics students will certainly derive inspiration from these articles. Here, I summarize the key issues addressed in these articles. Max Born deals with the notion of reality. The main point he makes is 'The idea of invariant is the clue to a rational concept of reality, not only in physics but in every aspect of the world'. The idea of an invariant is an old one in mathematics dating back to Sylvester, but has come to the fore in twentieth-century physics in the theory of elementary particles. He reinforces his point of view by giving several examples from our everyday experience. For instance, if we look at the shadow of a circle cut out from a piece of cardboard and observe its shadow on the wall, we find that the shadow, in general looks like an ellipse and one can change the lengths of the axes of the ellipse by turning the cardboard piece around. However, if we see several such shadows at different places, we can reconstruct the original circle and determine its radius. Thus, the radius is an 'invariant' of these transformations. He emphasizes that 'The feature which suggests reality is always some kind of invariance of a structure independent of the aspect, the projection. This feature, however, is the same in ordinary life and in science...'. Schrödinger deals with the question of what one means by an elementary particle. He discusses the dual identity of an elementary particle – an amalgamation of particle and wave identities and emphasizes that all observations point to the fact that microscopic particles are indistinguishable and do not have clearly defined identities as individuals. Heisenberg offers the interesting view (which was quite popular during the fifties): 'There is no difference in principle between elementary particles and compound systems. This is probably the most important experimental result of the past fifty years.'

Elena Castellani's article deals with a group-theoretic approach to the problem of physical objects. In this approach, one views objects as 'sets of invariants' which emerge from certain symmetry

properties of groups. Max Born's article serves as a conceptual foundation for Castellani's article. This article is informative, well written and mathematically quite precise.

Gian Carlo Ghirardi's article addresses the relation between the worlds of microscopic and macroscopic objects. This issue, which is closely related to the problem of measurement in quantum mechanics has been analysed within the framework of dynamical reduction theories. Diederik Aerts' article is also along similar lines. He compares and contrasts his 'creation–discovery' view with other alternative points of view. Giulio Peruzzi gives an overview of contemporary particle physics experiments in the light of present day theoretical particle physics.

Now, I give a brief summary of the philosophy articles compiled here. Hans Reichenbach's article on the genidentity of quantum particles has been reprinted here. The central point that he makes is that in the quantum domain, all our common sense notions of identification of particles break down and we need to 'replace an individual examination of particles by inferences based on statistical properties of an assemblage of particles'. Peter Mittelstaedt tries to accommodate the notion of a quantum object within the purview of Kantian philosophy. Seen in this light, quantum mechanical objects are 'incomplete' or 'unsharp' objects, while classical objects are completely determined. Giuliano Toraldo di Francia's article gives a historical overview of the general issue of the identity of an individual object. He gives a sketch of the evolution of ideas in this field from ancient times to the more modern developments in the realm of foundations of quantum physics. David Lewis has touched upon the relation between the constituents of an object and the physical identity of the object. Tim Maudlin addresses similar issues. He emphasizes the difference between a 'reductionist' approach and a 'holistic' approach and points out that in the quantum domain because of entanglement, it is not always clear how to assign properties to 'individual' systems which are 'parts' of composite systems. Bas van Fraassen has dealt with the notion of permutation invariance of indistinguishable particles in the context of quantum physics. Steven French

focuses attention on the nature of physical objects in the quantum domain. He makes the point that in quantum physics, physical objects can no longer be viewed as individuals, rather they must be seen as 'non-individuals'. Paul Teller in his article introduces the term 'haecceity' to mark the idea that an object is distinct from all others in some manner that transcends all properties in any usual sense of the word 'property'. He then analyses the central question of the distinctness and identity of quantum entities in terms of haecceities. Finally, Maria Luisa Dalla Chiara, Roberto Giuntini and Decio Krause have tried to understand 'nonindividual' quantum objects in a logical framework by introducing the idea of 'quasisets' for describing collections of objects having cardinality but no ordinality, i.e. objects which cannot be studied within the realm of classical logic. They compare two different approaches to the notion of a quasiset.

I am not a specialist in philosophy and I cannot competently judge the articles written by philosophers. However, I would like to respond as a physicist and nonexpert to these articles. My overall impression of the book is positive. I feel that it is useful to have such a book in a physics research library. Researchers directly dealing with foundational issues of quantum mechanics will certainly benefit from reading this book. The relation between physics and philosophy has always been a troubled one. Many physicists are impatient with philosophical debates and it has happened in the past (as in the case of Boltzmann) that philosophy has been detrimental to physicists (if not to physics). But, there are also situations (as with John Bell) that philosophical arguments provide the impetus to formulate foundational problems in physics in a precise and testable manner. In general, it is perhaps good for physicists to widen their horizons by reading this book.

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Ecology Today. B. Gopal, P. S. Pathak and K. G. Saxena (eds). International Scientific Publications, 50-B, Pocket C, Sidhartha Extension, New Delhi 110 014. 1998. 472 pp. Price: US \$90.

When this reviewer was a student of B Sc Hons. School in Botany in 1945 at the Panjab University, Lahore (now in Pakistan), contrary to other subjects, ecology was taught by a professor from a local private college. At the time of final examination, out of the six papers and three practicals, the share of ecology was hardly one or, at the most, two questions. One could easily omit studying ecology. No good student, who wanted to ensure a first class, ever took research in ecology for MSc Hons. School. Anyone who ventured to do that, invariably got a third division in MSc Hons. School, which otherwise was a rarity. One could assign many reasons for this. The basic fact is that ecology was a down-the-line subject and was treated as a 'frill'. There were no good teachers. The subject was drab, uninteresting and did not evoke curiosity, and thus was not treated as a 'respectable' discipline. Two words were often repeated: *autecology* and *synecology*. To this day, this reviewer is not clear as to what these words mean in exact terms. It looks like these words in the current parlance mean population ecology/genecology, and community/ecosystem ecology, respectively. In short, there is no doubt that in the mid-1940s this subject was much maligned and accordingly no good student ventured to study this branch of science. This was the state of ecology at the Punjab University (Lahore) which I feel was also true of India as a whole.

On the contrary, today ecology is a respectable science with which our long-range ecological security is irrecoverably intertwined. We have to address the ecological crises facing our planet and humankind, because the future of all biota including human beings and that of the planet as a whole is intertwined with it. If the human race does not heed the warning bells, the short-sighted rich individuals and nations will become 'richer' and will eat into the vitals of humanity's future well-being. The human race as a whole is now becoming increasingly cognizant of the

dangers of such a short-term outlook. Therefore, it is not surprising that ecology today is an interdisciplinary science and with it is tied the well-being and the health of the whole biosphere of which humans are an integral part. Among other things, the subject has an interface with not only all sciences, particularly biological ones, but also economics, sociology, ethics and morality; and its frontiers are ever-widening.

Against this background, the publication of the book *Ecology Today* is indeed most welcome. It is essentially a collection of essays on different facets of this subject. Ecology inherently operates in a two-way road: local to global and vice versa, and each road is multi-lane. It is, however, true that ecology has regrettably also become a buzzword.

During the last 50 years or so, the subject of ecology has seen many vicissitudes. At one time it was a descriptive science involving distributional patterns of biota *vis-à-vis* edaphic and other factors, but today it is an all-pervading science with which the future of the human race is irrecoverably tied. Regrettably, today all shades of people have joined the 'band wagon' so that anyone who has no vocation has become an ecologist and/or environmentalist. Furthermore, today ecology has assumed a very wide meaning and has developed cross-links with a variety of subjects. It has a major contribution in making sustainable development a reality. A large number of compound words have been coined by prefixing the word *eco-* (short form of ecology) before these; we also now read about Political Ecology. The underlying idea is to make all tasks ecologically benign: we now have *eco-economics* and *eco-technology* (*sensu* M. S. Swaminathan), the underlying idea is to make economy and technology ecologically acceptable. Despite these changes, the subject of ecology is still in a flux and the final picture has yet to emerge.

The book opens with a thought-provoking paper by Francisco diCastri, entitled 'Ecology in Global Economy'. The two subjects, as indicated above, are interconnected, interrelated and interdependent. These have to be closely interlinked so as to make sustainable development a reality. Other essays have discussed specific issues ranging from atmosphere, hydrosphere,