

view it might be objected that as far as the *S*-matrix theory goes, the dispersion relations are pure conjecture not particularly well supported by later approximate calculations. For the student's sake it might be better to show how the analyticity suggested by the properties of the *S*-matrix actually follows from the unassailable principles of quantum field theory.

The least satisfying part of the book is the description of attempts to use analyticity and unitarity to make approximate calculations of strong-interaction processes, such as pion-pion and pion-nucleon scattering. This is through no fault of the author, who valiantly develops in a limited space the mass of necessary formulas, but is more a function of the highly unsatisfactory state of strong-interaction calculations. Here, as in many other places in physics,

the approximations necessary to achieve tractable equations are so violent that the results are not really credible. Nonetheless, there are many useful and suggestive ideas, such as that of the bootstrap, which are adequately discussed.

The final chapters are in the nature of a morale-builder and reward to the persevering reader. It is shown how the ideas and machinery built up for strong-interaction physics, with not much in the way of final results, work beautifully for electrodynamics, allowing one to make calculations without ever encountering infinities. It is hoped that this tantalizing success will encourage people to persevere in the line of work reviewed by this excellent book.

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The Possibility of Perfecting Our Knowledge

Completeness in Science. RICHARD SCHLEGEL. Appleton, Century, Crofts, New York, 1967. xvi + 280 pp., illus. \$7.50.

There are many fascinating problems associated with the question of how far science can describe and explain the universe, so it is very interesting to see a book that attempts to tackle them. Unfortunately this book is guided by a conception of the problem that makes it far from satisfactory.

A book with such a title must naturally cover a wide range of issues, and if it is not to deal with them in a superficial fashion it will make large demands upon its author. If he decides to deal with the subject matter of science in order to discuss the possibility of its completion, his task is all the more enormous. Schlegel in fact spends more than half the book describing, in what is usually a straightforward way, the substance of the sciences he chooses to deal with—cosmology and quantum theory. It is in terms of these extremes of science, the very large and the very small, that most of his discussion is formulated. Schlegel is a physicist with a special interest in the philosophy of physics, and with the simple confidence in his field of which only a physicist is capable he sets aside every other scientific field as being of only peripheral importance. Perhaps without such an extreme manner of bringing the problem of completeness down to size a book like

this could never have been written.

Because he is so much concerned with presenting the results of modern physics, Schlegel does not realize how much he is taking for granted in his subject. He seems unaware of the relevance of the history of science to a general discussion of how complete science can be. Invariably the passage of time has shown that the science of a given period was less complete and less certain than its advocates thought it to be. Cosmology is likely to have changed radically within a decade, and it would be an unscientific prediction to claim that quantum physics is now in its final form. One wonders why Schlegel spends so much of his book presenting the results of studies that the next generation may well dismiss as misdirected.

In addition to ignoring the historical perspectives of his problem, Schlegel slides over the epistemological aspects. To think that science can be completed one must have a very special conception of the relationship of language, sensory experience, and the natural world. Different theories of knowledge will give different conceptions of what science can and cannot do. Perhaps because he is so prepared to accept as permanent the results that physics now claims, Schlegel neglects the epistemological underpinnings for such claims. He briefly develops the theory of knowledge he has adopted, but with-

out consideration of alternatives or of the traditional objections to what can count as knowledge.

Schlegel mentions the better-known arguments against the possibility of completing any description (especially if it involves describing the descriptive records being made), but he does not make it clear why one should discuss the problem of completeness further than this. He offers few arguments to show that science can be completed, and in fact the possibility arises for him only in the context of a particular science that has solved all the problems that can be raised in terms of its concepts. He does not take into account the fact that sciences can do this only by so limiting and idealizing their concepts that any new phenomena discovered will be irrelevant to them, just as the complexities of diffraction and interference are irrelevant to geometric optics. This sort of completeness is like the conceptual framework of a prescientific culture in which all the questions that may be asked may also be answered without any need to observe phenomena any more carefully, so that the whole system can never be found to be wrong. Indeed it might be suspected that if a science could be considered complete there would be something seriously wrong with it. It is the openness of science which gives it its special and valuable characteristics.

In spite of its avowed theme then, this book is primarily about contemporary cosmology and quantum theory and what it would be like to complete science on the basis they provide. The result is an adequate and stimulating introduction to some interesting issues in the philosophy of physics, but nothing to satisfy anyone who has wondered at all about the problem of completeness in science.

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Birds

Ornithology. An Introduction. AUSTIN L. RAND. Norton, New York, 1967. 311 pp., illus. \$8.50. World Naturalist series.

This is a concise, but comprehensive, survey of the birds of the world from the standpoint of their various relationships to their environment, to their ancestry, and to each other as illustrated