Book Reviews

The Events at Dayton

The Great Monkey Trial. L. SPRAGUE DE CAMP. Doubleday, Garden City, N.Y., 1968. xiv + 538 pp., illus. $6.95.

This broadly inclusive, thoroughly documented narrative of the trial of John T. Scopes in Dayton, Tennessee, in July 1925 for violating the Tennessee "anti-evolution law" is without doubt to be rated as the definitive account of that episode in the cultural evolution of mankind. It is written in dramatic style with a flair for the "human interest angle" and is right in the middle of the truth-is-stranger-than-fiction category. It includes the events that led up to the trial, the curious atmosphere of bigotry, ignorance, and fear that spawned the legislation, the extravaganza of the trial itself, and its aftermath, with respect both to the lives of the principal participants and to the anti-intellectual crusade of which it was a part.

There are numerous interesting details not found in any of the half-dozen books previously written on the subject. These range in revelance from the smudge of soot on William Jennings Bryan's nose when he first arrived in Dayton and the flapper-style rolled stockings of Judge John T. Raulston's daughters to the death of the last of the jurors in 1966 at the age of 84.

De Camp deals adroitly with the fantasies and lurid exaggerations of such reporters as Henry L. Mencken and resolves most of the inconsistencies and contradictions in the spate of journalistic accounts in the contemporary news media. His reliance for the truly important facts was upon the official record of the trial in the Rhea County courthouse, the archives of the American Civil Liberties Union, and personal interviews with surviving participants and spectators in 1965 and 1966. So far as I can check his factual statements by my own recollection—I was in Dayton for only five days at the end of the trial—he is an impeccable and trustworthy historian.

In only one place did I find a statement that might possibly be misleading. On page 420, de Camp reports correctly the question raised by Attorney General A. T. Stewart concerning Judge Raulston's announced intention to assess a fine of $100 should the jury find Scopes guilty and not recommend a heavier fine. By way of explanation of Stewart's interruption of the judge, de Camp then adds: "He referred to" the article in the Tennessee constitution which forbids that particular procedure. That reference may well have been in Stewart's mind, but it was certainly not voiced in the courtroom; had it been, the lawyers for the defense would have been alerted to that obscure and unusual point of Tennessee law and would surely have done their best to prevent the judge from making the technical error that later permitted the State Supreme Court to thwart their plans to test the constitutionality of the "anti-evolution law" in the U.S. Supreme Court.

The extensive, painstaking, and obviously time-consuming research that undergirds this superb bit of historical writing is worthy of the highest commendation. The book is a significant contribution to the social sciences, although it avoids the jargon of those disciplines, and is a worthy source book for the historian of the life sciences. There are, however, more typographical errors than I would have expected in a Doubleday book. Most of these are obviously errors, but a couple of them that involve me are not. I was interviewed on 28 May 1965, not 1925 as stated on page 506 (the correct date is given twice on page 512); and my essay "Geology and Genesis" (it is "and," not "or") listed on page 521 was published in 1964, not 1954.

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Describing Particle Reactions

The Theory of the Scattering Matrix for the Interactions of Fundamental Particles. A. O. BARUT. Macmillan, New York, 1967. xiv + 350 pp., illus. $13.95.

The attempt to make a self-contained theory of particle reactions based on the *S*-matrix has occupied a large number of theoretical physicists for a long time. In spite of the great conceptual charm of this program, progress toward the ultimate goal has been distressingly slight. What has become clear along the way, however, is that whether or not independent machinery, such as quantum field theory, is needed to calculate the *S*-matrix, it evidently is a uniquely convenient language for discussing elementary-particle physics. For that reason, a book such as this one, which describes the properties of the *S*-matrix and how one attempts to make calculations with it, should be very useful.

The most successful and, in my opinion, the most useful part of the book is what one might call the study of the kinematic properties of the *S*-matrix. The dependence of a reaction amplitude on momenta and spins is determined in large measure by Lorentz invariance. To write down the correct forms for particles with spins greater than one-half is not a trivial task and requires a relatively powerful machinery derived from the properties of the Poincaré group. Barut's development of this machinery is elegant, intelligible, and complete. The pesky questions of zero-mass particles and gauge invariance are also given a proper airing. Indeed, after a study of the chapters in question one feels fully armed against the rigors of the kinematics of general particle reactions.

The next step in the development of a theory of the *S*-matrix is the establishment of the properties of analyticity and their connection with unitarity. Unitarity requires the presence of singularities which are directly connected to the scattering properties of physical states. If there are no other singularities, one can write down dispersion relations of various kinds which are essentially consistency conditions on *S*-matrix elements. The derivation of dispersion relations in a single variable is carried out in this book in a compact but intelligible fashion, and the important Mandelstam conjecture of double dispersion relations is introduced. From the pedagogical point of

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 without 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