IN THE BALLPARK: THE PHYSICS OF CORKED BATS AND SCUFFED BALLS

The Physics of Baseball

Robert K. Adair
Harper and Row, New York, 1990. 110 pp. $7.95 pb
ISBN 0-06-096461-8

Reviewed by Geoffrey F. Chew

Although physicists tend to see their discipline as fundamental and all encompassing, the usefulness of physics stems in fact from approximations tailored to some very special and limited range of phenomena. No physical laws are exact: The areas of their application derive legitimacy from large (or small) ratios whose origin is accepted without explanation. The mysterious values of the fine-structure constant and the electron–proton mass ratio, for example, provide legitimacy for separate consideration of particle physics, nuclear physics, atomic physics and molecular physics. Smallness (or largeness) of special parameters allows books with titles such as "Plasma Physics" or "Optics" to focus usefully on some restricted aspect of the universe.

Following this hallowed tradition Bob Adair, a distinguished high-energy experimenter and Sterling Professor of physics at Yale University, has identified an extremely restricted but entertaining domain associated with the American game invented in the mid-19th Century that is called "baseball." Adair's charming monograph, based on approximations tailored to the mass, spatial dimensions and elasticity of baseballs and bats compared to properties of the atmosphere-enveloped earth, will be a delight to any baseball fan who is curious about laws of nature and to any physicist who has an affection for this remarkable pastime. Adair overflows with a contagious affection for the sport.

When I was a college freshman, my physics instructor illustrated the Bernoulli effect by presenting the "curveball" thrown by baseball pitchers. The instructor however had never played baseball and so did not know the direction in which baseball spin induces deviation from a straight-line trajectory. The dominant physical mechanism behind the curveball as discussed by Adair is in fact simpler than the Bernoulli effect, which my 1940 instructor unhappily and unwittingly applied so as to yield curvature of a sign *opposite* to that observed by batters. The curving baseball trajectory turns out to be understandable from momentum transfer in elastic collisions between the baseball and air molecules. My relief after 50 years of puzzlement may be imagined.

Adair emphasizes how the qualitative nature of the game of baseball derives from the similar order of magnitude of atmospheric and gravitational forces acting on the ball. Also important is the operative range of ball speed, which spans a transition between smooth and turbulent motion of adjacent air. With humor and affection Adair relates such notions to a sweep of baseball lore that is wider than has ever been approached as physical phenomena. Readers will gain an appreciation not only of curveballs, but knuckleballs, sliders, screwballs and hopping fastballs, and will learn what pitchers accomplish by (illegally) scuffing a baseball's surface.

Bats and batting—the complement to pitching—get meticulous attention, with geometrical illumination of the difference in bat trajectories employed by "sluggers," who attempt to hit home runs, and "line-drive" hitters, who seek to maximize the probability of reaching first base. The flight path of batted balls is discussed in intriguing detail. Bat elasticity and bat vibration, as factors in the game, are lovingly considered.

For the needs of a baseball addict, nothing yet in print approaches Adair's monograph in its power to satisfy. Adair's gem combines a mastery of physics with love and a deep understanding of this unique piece of Americana.

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Femtophysics: A Short Course on Particle Physics

M. G. Bowler
Pergamon, New York, 1990. 207 pp. $35.00 pb
ISBN 0-08-036942

Most textbooks on modern physics arise from lectures or courses in physics given by the authors. A notable exception is the 1964 *PCT, Spin and Statistics, and All That* by Raymond F. Streater and Arthur S. Wightman. In their preface the authors of that classic text state "the idea of this book arose in a conversation with H. A. Bethe, who remarked that a little book about modern field theory which contained only Memorable Results would be a Good Thing." The spectacular success of that approach in historical research—as compared with Walter C. Sellars and Robert J. Yeatman's, *1066 and All That*—possibly suggested to Michael G. Bowler of Oxford University that such a technique would work in the rapidly changing world of particle physics. He might also have followed the late Jun John Sakurai, who began the preface to his 1967 book *Advanced Quantum Mechanics* with the words, "the purpose of this book is to present the major advances in the fundamentals of quantum physics from 1927 to the present in a manner that cannot be made any simpler."

Even though Bowler's book did arise from a short course in nuclear and particle physics for advanced undergraduates offered between 1986 and 1989 at Oxford University, he has apparently followed the scheme of Streater and Wightman, albeit on a

different subject. Specifically, in his preface Bowler states "I have restricted myself to those aspects of the subjects which I regard as established and likely to stand, regardless of developments in the future." Accordingly, the approach is phenomenological with a strong emphasis on the properties of the fundamental quarks and leptons and their interactions.

Although it is the most recent of the three, Bowler's book really occupies a place between two other books that also grew out of courses in particle physics. The first is *Introduction to High Energy Physics* by Donald H. Perkins, which uses a traditional or historical approach. This book starts with accelerators and detectors and then proceeds through invariance principles and conservation laws to hadronic interactions, the static quark model, electromagnetic and weak interactions, the quark–parton model, QCD and finally unification. The second is *Modern Elementary Particle Physics* by Gordon Kane, which presents the standard model of electroweak interactions plus QCD. It begins with three generations of fundamental quarks and leptons and the Lagrangian describing their interactions; explores the phenomenology of the gauge bosons (W and Z); and proceeds to QCD, accelerators and detectors, mesons, baryons, deep inelastic lepton–hadron scattering and recent developments, such as speculation beyond the standard model.

I suspect that theorists generally will prefer Kane's approach as it is logically more coherent, and it emphasizes the intellectual as opposed to historical development of the subject. A drawback to this approach is that it presents the standard model as having appeared, fully grown and fully armed, out of the brow of Zeus. It fails to give a true picture of how progress is actually achieved in high energy physics, and it creates the impression that there are no false starts, no blind alleys and no incorrect results. The uninitiated thus hears nothing about the split A_2, the high-y anomaly, monojets, Regge poles, R parity and so on. Unfortunately, in a short course (and in a correspondingly brief book), time and space do not permit exploration of the once popular but now generally discarded or disregarded ideas.

Bowler has rather cleverly avoided this problem by gearing his material toward the past development of our current understanding of the standard model, but he does not present this development as canonical. The crucial role played by experiment at every stage in the process is always before the reader. Moreover, some of Bowler's explanations are real gems of clarity and precision. I especially enjoyed the development of SU(2) and isospin in Chapter 11.

If I have any criticism of this book, it is the order of presentation. It might make more sense to precede the discussion of the development of the quark model with an explanation of charge independence and SU(2), to proceed via the introduction of strangeness to SU(3) and then to SU(3)-color. All this should be done before introducing quarks, color forces and so on.

In general this is a good book, suitable for a short course in high-energy physics, with the emphasis on short. The amount of material presented is significantly less than that presented in Perkins's and Kane's books, either of which would be more appropriate for a one-semester course for first-year graduate students. Nevertheless, there is a real niche for Bowler's book at the advanced undergraduate level, and I recommend it.

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Verification and Compliance: A Problem Solving Approach

Edited by Michael Krepon and Mary Umberger
Ballinger, Cambridge, Mass., 1988. 325 pp. $26.95 hc
ISBN 0-88730-326-9

Toward A Comprehensive Test Ban

Steve Fetter
Ballinger, Cambridge, Mass., 1988. 308 pp. $29.95 hc
ISBN 0-88730-281-5

Making Space Defense Work: Must the Superpowers Cooperate?

A. Fenner Milton, M. Scott Davis and John Parmentola
Pergamon-Brassey's, Washington, D. C., 1989. 220 pp. $23.00 hc
ISBN 0-08-035980

Never before in the history of superpower relations has there been more optimism about negotiating stable nuclear arms control treaties. In the past, the Soviet Union would not accept intrusive verification measures, but under Mikhail Gorbachev, it has turned the verification issue on its head. The Soviets are now willing