

The author writes concisely and well, and has been very fair in assessing the evidence and the alternative explanations found for so much of the evidence.

ROBERT H. COLE
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Space, Time, and Spacetime

L. Sklar
423 pp. U. of California Press, Berkeley,
1974. \$15.00

"You can't do very good philosophy unless you get your science right. But you can't do science in full self-conscious understanding, unless you realize how much it depends upon philosophical modes of reasoning as well." Thus, Lawrence Sklar ends his stimulating book, and, reading it, one sees with new perspective how well his remark is justified. He leads one carefully, though occasionally at hair-raising speed, through the dual thickets of philosophical strife and scientific theorizing about space and time.

Refreshingly, he offers few positive answers. Rather, he explores the various philosophical views and shows how very vulnerable they are. Primarily, he is a philosopher—associate professor of philosophy at the University of Michigan. But he is gratifyingly at home in the relevant science, which he sketches with sure strokes for non-scientific readers even as he outlines philosophical issues for readers not trained in philosophy. He tells of the Newtonian concept of substantial space, the relationist views of Gottfried Leibniz, the conventionalism of Henri Poincaré, and much much more. He makes devastating philosophical use of the possibilities of strange topologies in the spacetime of general relativity. He is far from accepting any causal theory of time, summing up his views neatly by saying, "The philosophical version of the causal theory of time seems incorrect, but there may be a correct philosophical theory of causation!"

Sklar stresses that the problem of the direction of time is little related to the symmetry or asymmetry of physical laws under time reversal. He argues persuasively that, for example, the second law of thermodynamics cannot resolve the problem because attempts to define "before" and "after" in terms of physical laws must appeal to our prior intuitive local knowledge of before and after.

Not being trained in philosophy, I must leave the philosophical evaluation of Sklar's various arguments to the philosophers.

Occasionally one finds incredibly

complex sentences—for example, the one occupying nine lines near the end of page 229. There is the usual quota of minor misprints. Surprisingly, one consistently finds "Michelson-Morely" in both text and captions, though the index has it correctly as "Morley."

A brief review cannot convey the riches in Sklar's presentation. Though his book may seem to end up having gone nowhere, it has a clear direction: towards ever increasing depth. And the intellectual thrust and parry along the way make for a lively, enlightening and often exciting journey.

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Frequency Response Testing in Nuclear Reactors

T. W. Kerlin
175 pp. Academic Press, New York,
1974. \$19.00

Frequency response testing has its roots in the electronics and communications sciences, where amplifiers and transducers were routinely subjected to this mode of testing in the 1930's. With the development of feedback theory (Black, Nyquist and Bode), the use of open-circuit frequency response methods in order to determine closed-loop performance without risk to equipment was developed. World War II saw the introduction of these techniques into the design and development of mechanical, hydraulic and combination systems (Hall, Brown). These applications generally stimulated the addition of non-linear-mechanics techniques and the use of linearization and small amplitude testing.

Parallel efforts in the field of aircraft flutter stimulated development of distributed-parameter system analysis, with use of combinations of time domain and orthogonal function synthesis of space-domain phenomena. The space program introduced random excitation methods in hardware testing, once again, transferring technology from the communications world. The high-speed digital computer opened the door to use of more elaborate system models and to the processing of enormous amounts of data generated by frequency-response and complex-wave techniques.

In many ways, the nuclear reactor, with its associated control and safety systems, represents the ultimate challenge to the sophisticated response experimentalist. The nuclear system abounds in distributed-parameter geometry, multi-energy neutron physics, complex heat transfer mechanisms, nonlinear time delays, cooling-system

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transmission-line effects, and an assortment of control devices. The latter have seldom been designed with ease of frequency-response analysis in mind. In addition to the technical challenges afforded by the system, a well developed regimen of safety policy and practice has developed to ensure that the experimentalist will be constrained in his testing program. As a consequence of cost and complexity, the degree to which forced-input testing has been used in the nuclear field is extremely limited in comparison with that found in more conventional control industries.

In the book, T. W. Kerlin sets out to "collect and cull the required information" to "design, implement, analyze and interpret" testing using nonsinusoidal perturbations. The result is a highly compressed dissertation on the broad range of subject matter associated with the experimental determination of frequency-response characteristics of reactor systems and components. Early chapters concentrate on development of the body of mathematical and test-signal descriptive material. Considerable emphasis is given to the subject of data analysis with computer techniques to effect required transformations and convenient approximations thereto. The last third of the book presents a simplified description of the dynamics of typical reactors and examples of tests reported in the literature. Details include descriptions of typical control-rod drive mechanisms and very brief descriptions of the several types of reactors. Testing experiences for pressure water, boiling water, fast, gas-cooled and heavy-water reactors are summarized and referenced. The author's conclusion reflects the general tone of the work: "A great deal of theoretical and practical experience with frequency response testing in nuclear reactors has been accumulated. This experience has demonstrated that methods for planning, performing and interpreting these tests are suitably developed for routine use in power reactors."

Frequency Response Testing in Nuclear Reactors is a useful introduction to the literature and general theory of the application of nonsinusoidal input perturbations to explore the frequency-response characteristics of nuclear reactors. Chapters 1 through 4 are equally applicable to essentially any other complex system. Chapters 5 through 8 provide a nuclear introduction for the well grounded dynamicist who seeks a ready access to the literature. The citations on interpretation of results and testing experiences are numerous and authoritative. The text is disappointingly brief in its description of the nuclear-reactor frequency response, problems associated with the conducting of tests and the utility of results obtained from

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actual experience. An important service has been performed in amassing the source material provided. A critical treatment of reactor frequency-response measurement experience, *per se*, would be a valuable addition to the literature.

CHARLES K. LEEPER
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new books

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Experimental Meson Spectroscopy— 1974. (AIP Conf. Proc., Boston 26, 27 April 1974). D. A. Garelick, ed. 452 pp. American Institute of Physics, New York, 1974. \$19.00

High Energy Hadron Physics. M. L. Perl. 562 pp. Wiley, New York, 1974. \$21.95

Particle Interactions at Very High Energies, Parts A and B. (NATO Advanced Study Inst. Series B, Vol. 4). F. Halzen, D. Speiser, J. Weyers, eds. Plenum, New York, 1974. Part A, \$28.00; Part B, \$25.00

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Molecular Complexes Vol. 2. R. Foster, ed. 305 pp. Crane, Russak, New York, 1974. \$26.50

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Applied Spectroscopy Reviews, Vol. 8, Part B. E. G. Brame Jr, ed. 143 pp. Marcel Dekker, New York, 1974. \$29.50

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Encyclopedia of Electrochemistry of the Elements, Vol. 2. A. J. Bard, ed. 515 pp. Marcel Dekker, New York, 1974. \$60.00

Introduction to the Theory of Space-Charge Optics. Gy. A. Nagy, M. Szilágyi. 514 pp. Halsted, New York, 1974. \$24.50

Molecular Collision Theory. M. S. Child. 300 pp. Academic, New York, 1974. \$22.00

The Practice of NMR Spectroscopy with Spectra-Structure Correlations for Hydrogen-1. N. F. Chamberlain. 424 pp. Plenum, New York, 1974. \$29.50

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Chemical and Biochemical Applications of Lasers, Vol. 1. C. B. Moore, ed. 398 pp. Academic, New York, 1974. \$29.50

Laser Spectroscopy. (Proc. of Int. Conf. on Laser Spectroscopy, Vail, Colorado, 25-29 June 1973). R. G. Brewer, A. Mooradian, eds. 671 pp. Plenum, New York, 1974. \$34.50

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