According to the author, the principle that cause precedes effect means that particles of imaginary mass (commonly called tachyons) could be emitted only in a random fashion that could not be used to send signals with superluminal velocities. Nevertheless many ordinary particles that are emitted randomly (beta rays for example) can be used to emit signals with the help of movable absorbers that act as shutters. Tachyons would thus have to have special properties to preclude sending controlled signals with such arrangements.

The difficulty with particles of negative mass is that in collisions with ordinary particles they would on the average lose energy as the ordinary particles gained energy. They would provide an inexhaustible supply of energy to ordinary matter, thereby violating the second law of thermodynamics. As stated by Terletskii, because we have not noticed violations of the second law means that there can not be many such particles in our neighborhood and also that their interactions with ordinary matter must be of short range. Thus particles of negative mass could not be charged; yet according to the author, such particles might have cosmological significance, for example as the source of the energy of quasars.

The author's attacks on the name "relativity" and on the philosophy of logical positivism are not relevant to the rest of the book. In this same vein are his arguments that the theory of relativity is comparable with dialectical materialism.

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The reviewer, a professor at Indiana University, has contributed to the literature on the paradoxes of special relativity, taking the orthodox point of view that the theory is self-consistent.

Tracking particles

BUBBLE CHAMBERS. By Yu. Aleksandrov, G. S. Voronov, V. M. Gorbunkov, N. B. Delone, Yu. I. Nechayev. 371 pp. Indiana University Press, Indiana, 1967. $17.50

by EDWARD G. PEWITT

For the past several years bubble-chamber physics has been on a plateau with only minor changes and improvements in the many chambers now operating. The number of photographs taken has roughly been doubling every two years and analysis systems in universities and laboratories have kept pace.

For the most energetic beams now being used, the present 2-meter long chambers are of marginal precision. This, together with the need for chambers of very large volume to study neutrino interactions, stimulated several groups to design and build a new generation of giant bubble chambers with useful volumes of 10 m^3 or more, which should be operating within a few years at the high-energy laboratories.

The design of the new chamber eliminates the full-size glass window for viewing and achieves economy by using several small hemispherical windows and wide-angle lenses for photography. Other innovations include bubble illumination by light reflected from Scotchlite papered over the walls and superconducting coils to generate the magnetic field in three of the five chambers under construction.

Bubble Chambers is mostly of historical interest because the latest references are unfortunately only from 1962 (US work up to 1960). The authors have presented their work under three categories: physical principles of bubble chamber operation, design of bubble chambers and particle identification. Detailed treatment is given to bubble growth and bubble illumination on which the authors are knowledgeable. The discussion is weighted toward heavy-liquid cham-

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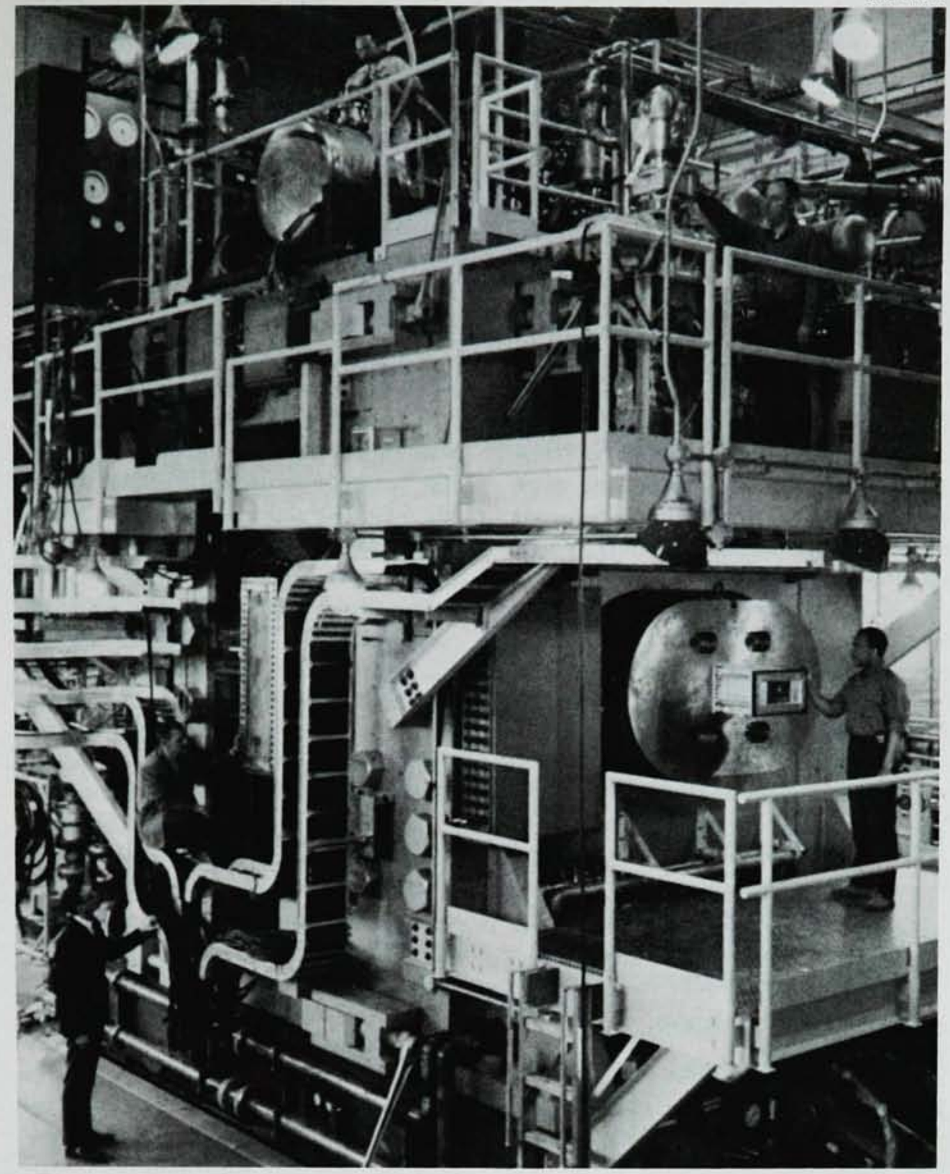

BUBBLE CHAMBER. This 80-in. instrument is used with the alternating-gradient synchrotron at Brookhaven National Laboratory. The large aperture at lower right is for the source of illumination; around it are four smaller apertures for cameras. The hydraulic ram below the chamber moves the entire assembly along a rail track.

bers that have received major Russian effort. The figures are small and lack detail. Insufficient space is devoted to the design of bubble-chamber magnets, and superconductivity is only briefly mentioned. The problems of automatically processing bubble-chamber photographs are not discussed in any detail.

Although the book has an old-fashioned flavor, it contains many points that may be of reference value to bubble-chamber builders and users, students and those with a general interest in experimental technique. For a later and more comprehensive work on this subject, the reader is referred to *Bubble and Spark Chambers*, edited by R. P. Shutt (1967).

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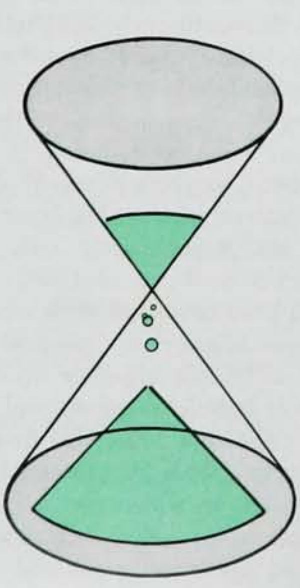
Fundamentals of time

LE TEMPS ET LA PENSEE PHYSIQUE CONTEMPORAINE. J. L. Rigal, ed. 149 pp. Dunod, Paris, 1968. Paper 16.50 F

by LADISLAUS MARTON

This book, entitled *Time and Contemporary Physical Thinking*, is part of the new series, *Realités de la Science*. The whole series attempts to present what the editor calls an "initiation into fundamental principles" and a "clarification of what these principles want to say and what they do not say."

Let us start by stating that the present volume succeeds in that preset task reasonably well. I say reasonably well because the 12 contributions by different authors vary considerably not only in presentation but also in scientific rigor. The contributions are separated into four parts of the book: "Time in Classical Physics," "Space and Time," "On Time and Information in Probability Physics" and "Idea of Time in Microphysics." Each of these parts is preceded by a lengthy introduction and discussion by the editor, J. L. Rigal, a professor at the University of Besançon. The editor mentions in his preface that it took about five years to gather the material for this relatively short book—which seems to be an excessive time for such a condensed publication.



The first part is divided into six contributions. These articles are on the sources of time measurements, time in classical mechanics, time in astronomy, atomic and molecular clocks, distributed time and the age of celestial bodies. The discussions center quite a bit on the precision attained with different devices. Surprisingly, although the precision is amply discussed, there is absolutely no indication about the lack of agreement or lack of accuracy in defining the epoch.

The second part of the book discusses some "old paradoxes, discovery of space–time, and the principle of relativity and equivalence between space and time." Rigal states that the time concept may vary with the physical circumstances and that the fourth dimension of space–time is not necessarily identical with ordinary classical time.

In the third part of the book there are two chapters entitled "The Second Principle of the Science of Time" and "Time and Information, Probability Concepts." The final chapter is "The Idea of Time in Modern Physics."

Some of these presentations are quite good. Others are on a rather elementary level, or they present a more literary than factual consideration of the topics. I have a few comments that are not quite favorable. First there are too many typographical errors. There are altogether too many errors to make comfortable reading for a reader who is not French. Another objection is the typographical setup. There are about 20 different typefaces used throughout the book.

Last but not least, there is a summary bibliography on the last page. About six items are listed with a remark indicating that all the other bibliographies are presented at the end of each chapter. However, out of 12 chapters, only three have bibliographies.

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Techniques for coherent sources

LASER PARAMETER MEASUREMENTS HANDBOOK. H. G. Heard, ed. 489 pp. Wiley, New York, 1968. $15.95

by RICHARD B. ZIPIN

The subject of this review is a laboratory reference on the measurement techniques peculiar to laser technology. It is the eighth book of the Wiley series in *Pure and Applied Optics*, and the fifth book of the series treating some aspect of lasers. 37 contributors are listed, in addition to the editor, Harry G. Heard, whose credentials are well known to workers in the field. It is a good book and, considering the difficult job it is to edit a volume such as this one, Heard is to be commended. A reader can detect the effects of multiple authorship, but he can also see the effects of a hard-working editor.

The contents include an introductory chapter, one on beam sampling techniques, and then chapters treating the measurement of beam parameters, energy and power, gain parameters, wavelength, bandwidth and temporal coherence and frequency stability. The final chapter discusses the measurement of noise and modulation of laser carriers for communication. The emphasis is on laboratory techniques, and there are many tables of data that will be useful in a laboratory. I expected to find data on lasers per se and perhaps some discussion on the design criteria used to achieve the various parameters whose measurements are treated; however, I was disappointed. It seems unfortunate, for example, that in a book about the measurement of laser parameters there is a 38-page chapter devoted to wavelength measurements in which there is no mention of the literature reporting such measurements. There is not even a list of some of the typical nominal wavelengths available from known laser materials.

Each chapter contains an extensive list of references and a table of the