

BOOKS

Plasma spectroscopy

The physics of plasma (a mixture of neutral and ionized gas) is a relative new-comer as a subject of advanced studies. It presents a fascinating field of research, worthy of an attention comparable to that lent to high-energy physics and solid-state physics. Among the interesting questions posed by plasma physicists one may quote the following:

- It seems that plasma mechanics may be partly responsible for many phenomena in the evolution of the cosmos, notably the formation of planetary systems. What is the connexion with other better-known forces, such as static and dynamic gravitation?
- The most promising experiments aiming at controlled fusion in the laboratory have so far been performed with plasma. However, all attempts to maintain the fusion for any considerable time, let alone gain energy from it, have failed. Is it perhaps theoretically (or practically) impossible to 'tame the H force'?
- What are the mechanics of the many instabilities shown by plasma?

Only further studies can answer these questions. Direct studies on the cosmic scale have so far been possible solely by using the emitted electromagnetic waves, mainly light*. In laboratories, also, one is limited to optical observation if one wants a fool-proof means of communication with the plasma.

Probes have been widely used but experience shows that the plasma is always disturbed**, often in an unexpected manner; it bends and twists away from the probe as if it resented the intrusion. The main parameters one wants to determine are temperature (when such can be considered), degree of ionization, and density, all as functions of time; they are hence preferably deduced from optical information.

Plasma spectroscopy, by Hans R. Griem (New York, McGraw Hill Book Company, 1964; \$18.50) deals in a very thorough way with everything embraced by the title and is (so the cover tells us) the first book entirely devoted to the subject. It is to be read at the graduate level and is a very up-to-date work.

The first eight chapters of the book are theoretical and start with a revision of classical and quantum electrodynamics. They further contain an extensive theoretical and numerical discussion of all germane sources of information inherent in the emitted light, such as line strength, Stark broadening, Doppler shift and radiation from recombination. A whole chapter is devoted to equilibrium relations, especially the validity of the important concept of 'local thermal equilibrium' (LTE). The seventh and eighth chapters deal with radiation from extended sources and radiation energy losses. In the following chapters, plasma spectroscopy is discussed in practice, featuring different types of plasma and important optical instruments and detectors. Three chapters describe temperature and density measurements (especially the use of the famous Saha equation in LTE) and measurements of atomic para-

meters. A long series of tables (150 pages), including data related to our best-known spectral lines, ends the book.

The work is clearly intended to be a very complete text-book as well as a reference book on all matters related to its topic. The text is straight to the point, clear and unambiguous, mostly avoiding introductory remarks whenever a new subject is opened, which makes the book extremely useful for the second purpose. It may be more difficult to read as a text-book, in particular as there are very few (if any) indications as to which constitute the more important sections. Most commendable is the author's choice of the rationalized MKSA system of units throughout a book which unites parts of classical, quantum and statistical mechanics, electromagnetism, aerodynamics, hydrodynamics and optics. Also one appreciates the extensive list of references at the end of each chapter as well the aesthetic typography throughout. For the student a few problems are added to each chapter, with solutions at the end of the book. The index, however, is rather meagre.

K. Soop

The nuclear reactor, by Alan Salmon (London, Methuen & Co. Ltd., 1964; 16s.), is intended for 'the Honours Physics student, and as an introduction and guide to the research worker from another field', but is unfortunately not up to the usual standard of the *Methuen Monograph* series. Although the title suggests a general account of reactors, the book in fact concerns the physics of thermal reactors, and most of the development of the subject is related to the graphite-moderated, gas-cooled, natural-uranium power reactors of the British and French nuclear-power programmes. 'Very little attention is paid to the physics of fast reactors, and there is comparatively little discussion of the relative merits or characteristics of other types of thermal reactors.'

Within this more limited scope, the theory of the neutron cycle in a reactor is developed up to an elementary level, principally using diffusion theory. There are also chapters concerning optimum fuel cycles and flux flattening, heat transfer, shielding, reactor control, the design and applications of research reactors, and some discussion of the economics of nuclear power. In a small book such as this there must be omissions, but one would have thought that physicists should be given some idea of the methods of calculation of neutron flux, fine structure, and hence thermal utilization, and also some account of the cross-section of the plutonium isotopes and their effects on the long-term behaviour of power reactors.

For the reader who already has some ideas on the principles of operation of reactors, this book may be useful to broaden his knowledge of the subject, but for the reader completely new to the field the often confused presentation will only slow his progress. For example, there is the sentence beginning: 'Due to the general decrease of neutron cross-sections with energy...', and also the curious sentence (especially in a book concerning thermal reactors): 'Some nuclei exhibit resonance behaviour in their scattering, depending on the nucleus involved the neutron energy may be low (~ 1 keV) or high (~ 1 MeV)'. In a very early paragraph, designed to give a broad outline of the design of a typical power reactor, we are given the thickness of

* One hopes in the next few years to be able to use information inherent in emitted neutrinos.

** Use of laser light as a probe has recently been proposed.

the pressure vessel, and a '20 T crane' is referred to, whilst no mention is made of the geometry of the core, the nature of the fuel or the operating temperatures. There is also the somewhat alarming assertion that: 'The carbon dioxide coolant, at a pressure of 283 lbf/in², transports the energy produced by fission to the heat exchangers from whence it is carried in the steam to the turbine'.

It seems to me that there are many dangers in teaching reactor physics to undergraduates as an isolated subject, for the basic principles of reactor design result from a complex interweaving of various disciplines. For example, one of the most important components in a reactor from the point of view of expense and design complexity is the fuel element, and here the design must take into account chemistry, metallurgy, and basic engineering principles as well as physics. Dr. Salmon's book makes no mention of the subject.

C. R. Symons

Also received

Theory of crystal dislocations, by A. H. Cottrell (New York, Gordon and Breach Science Publishers Inc., 1964; paper \$2.50, cloth \$4.50) — first in a new series entitled *Documents on modern physics*, intended to make available selected reviews, lecture notes, conference proceedings and important collections of papers in branches of physics of special current interest; this text is basically that of lectures given at Les Houches in 1956, revised to July 1962.

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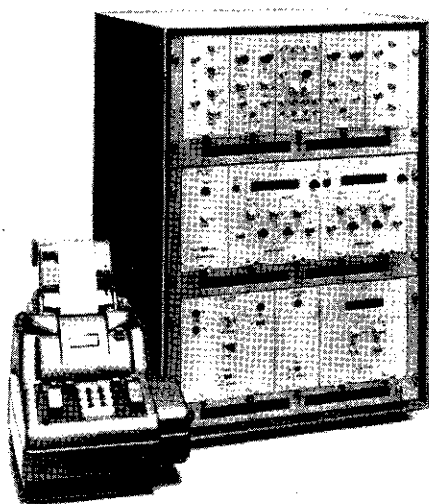
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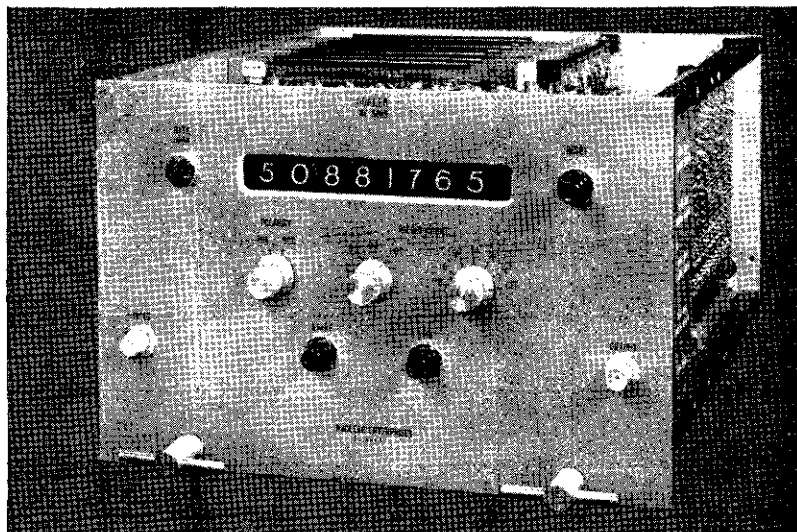
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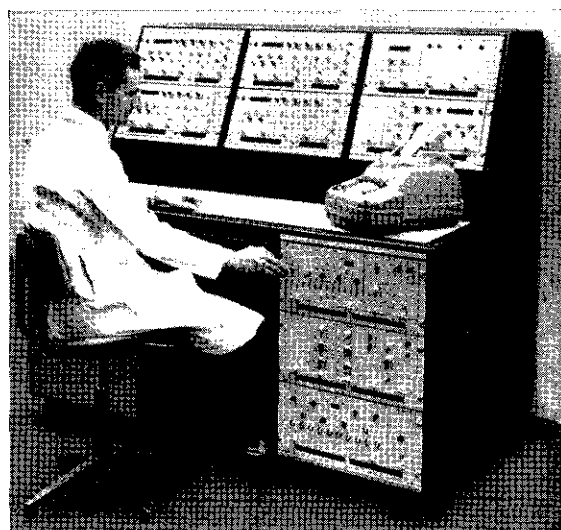
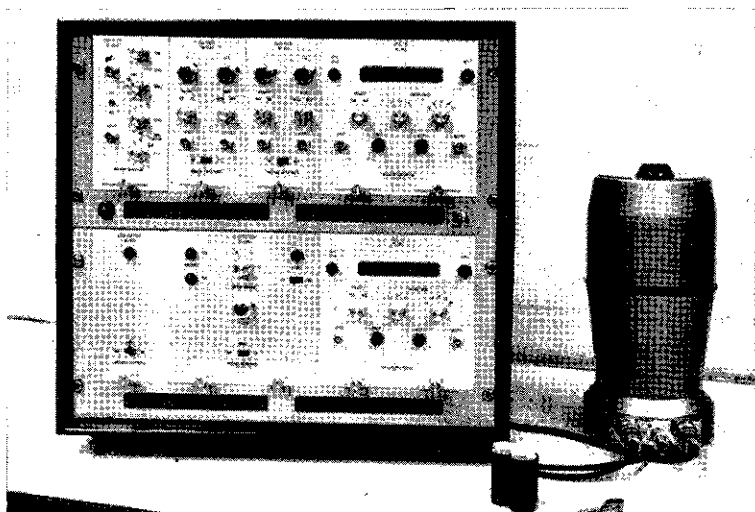
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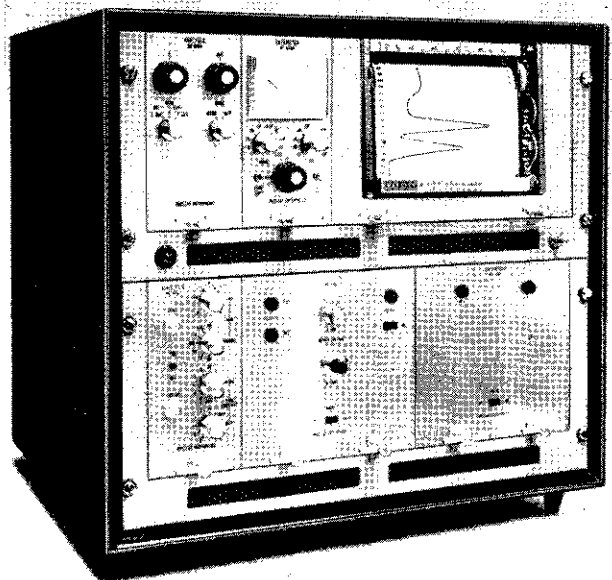
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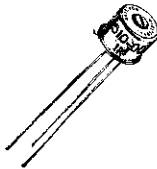
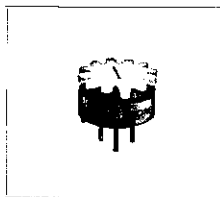
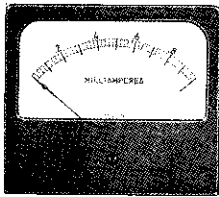
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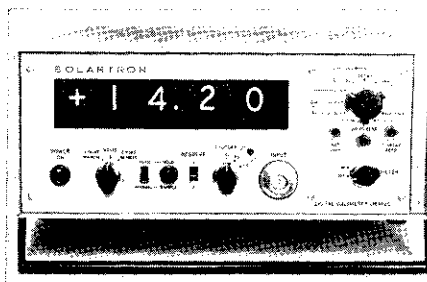
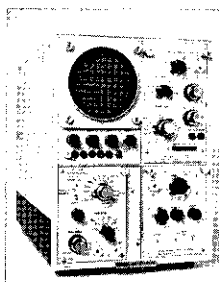
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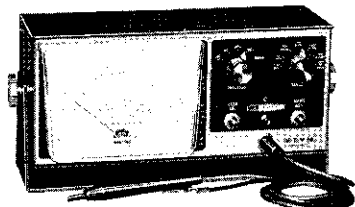
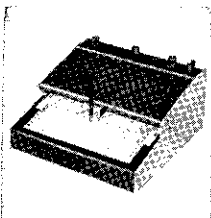
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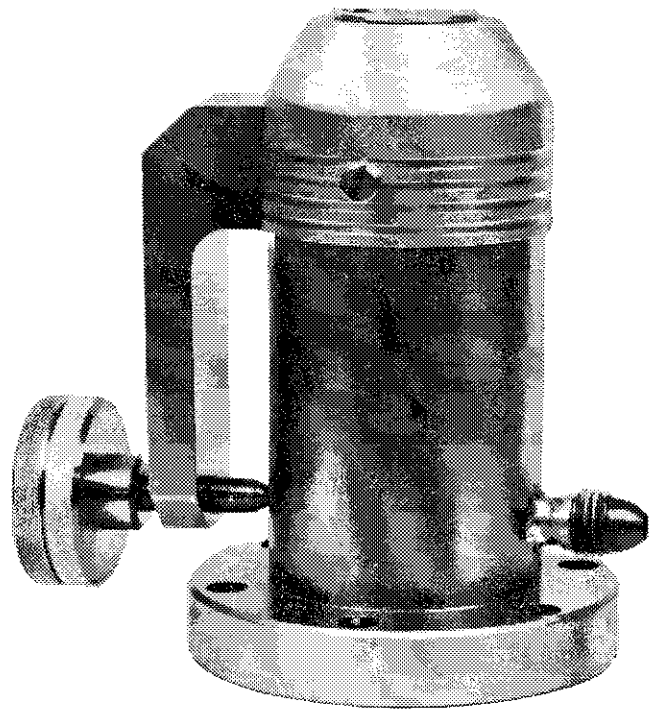
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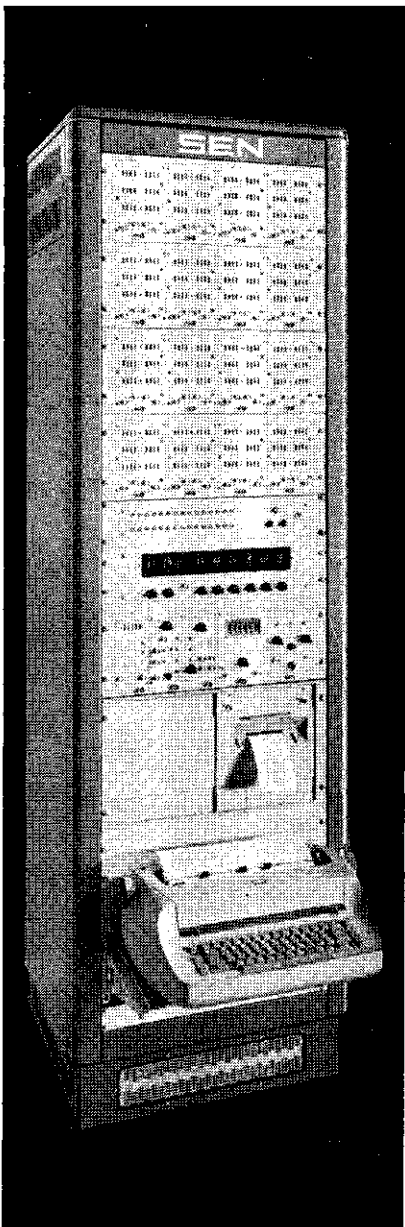
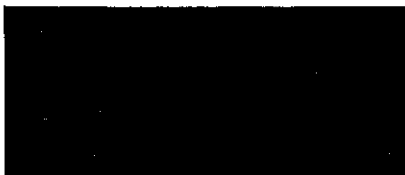
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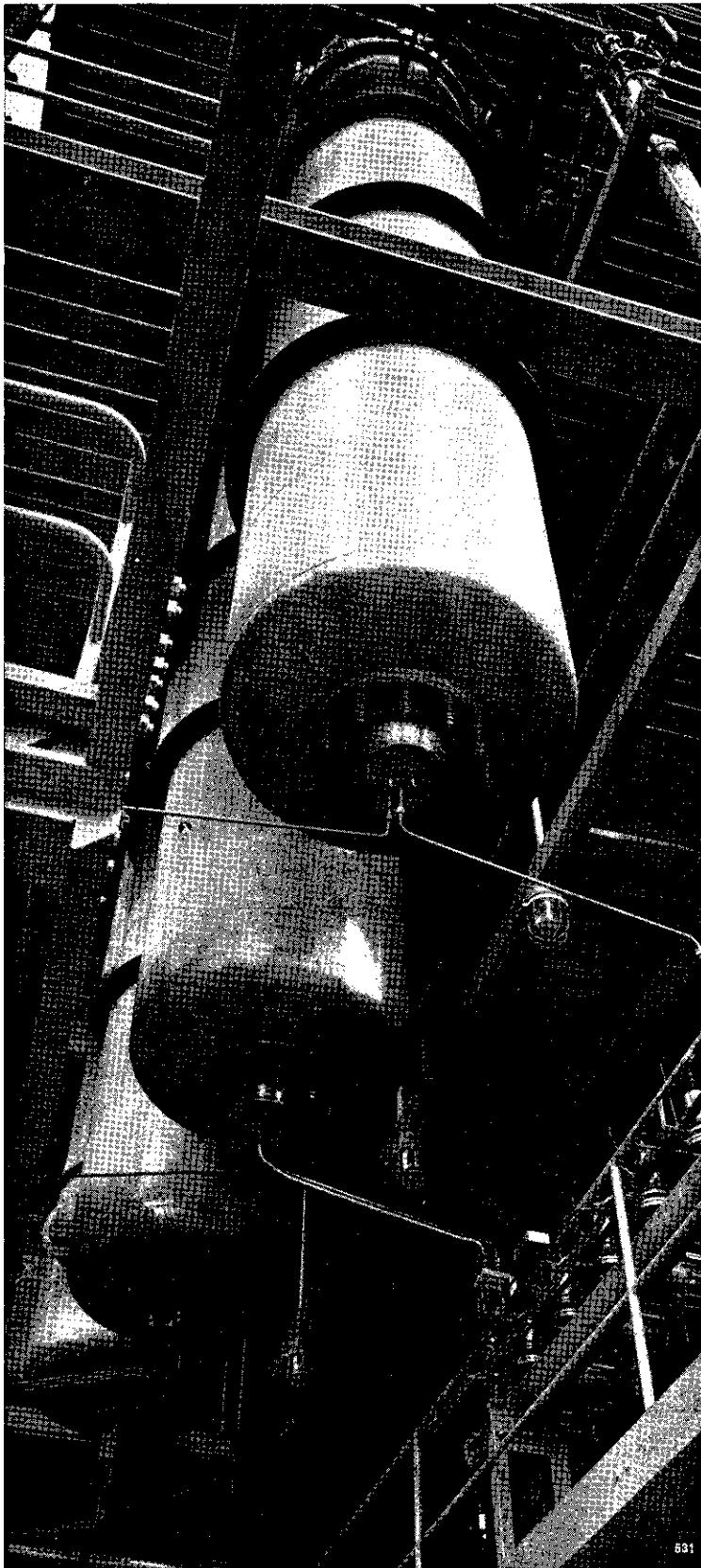
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