

POWER MODULE



Model 2202

To regulate an AC-line connected load by means of a small DC signal from an automatic control instrument. It supplies large amounts of power for control of resistive heaters, thermo-electric elements, light sources, etc. in temperature controlled ovens, vacuum deposition equipment, infrared heat sources, temperature baths and other applications. The instrument features a pulse-width-modulated zero crossing - fires TRIAC circuit to minimize RF Interference, electronic protection against current overloads and voltage transient, and provides linear control to a AC power line up to 25 Amp. (110 V or 220 V).

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LABORATORY Temperature Controller



Model 5301-E

With an input circuitry designed to accept resistance or voltage generating temperature sensors such as GaS-diodes, thermocouples, Ge & Pt Sensors, Carbon Resistors and Thermistors. The 5301-E, three mode controller offers temperature regulation to better than 0.01°K (or °C) in Vacuum chambers, Cryogenic dewars, Optical ovens, Tensile strength test apparatus, etc. for physics, metallurgy, chemistry and other scientific fields where the control and temperature range requirements are broad or change frequently. Set point readout is either directly in mV or Ohms (4-terminal measurement), with unlimited temperature range. Proportional, rate and reset modes are all internally adjustable, allowing to tune the controller to the thermal time constants of the process. 100 Watts, DC output or up to 5KW with Model 2202.

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ered by the table of contents, is an ambitious task. The discussion is often sketchy and the reader is not always provided with an introduction, with which he is able to assess whether a subject is fully understood or whether there are still aspects not satisfactorily resolved (such as spicules and flares). Some very pertinent aspects of magnetic fields, relevant to these phenomena, have been glossed over with little discussion (for example, force-free fields) and the authors do not emphasize, with sufficient clarity, the dangers inherent in assuming ideal conditions for mathematical analyses. The long time in turning the lectures into a book (six years) necessarily makes an up-to-date introduction to the current status of the field problematic. Also, some of the references are incomplete. In view of these limitations, the book is a disappointment either as a comprehensive textbook suitable for graduate students and advanced undergraduates or as an authoritative research monograph for active workers in the field. However, the two students who attended the summer school from my department enjoyed the course and found the lecture notes a valuable supplement. I would, therefore, have preferred to see an inexpensive paperback edition quickly published after the lectures, for the benefit of those who did not attend the summer school.

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The Physics of Liquid Crystals

P. G. de Gennes

333 pp. Oxford U. P., New York, 1974.
\$32.50

Scientists have known about liquid crystals for a long time, but they were pretty much neglected after the 1930's. The reawakening of interest came in the 1960's; and in recent years liquid-crystal physics and chemistry has been the basis of a promising technology and some very elegant scientific ideas. The reawakening and the technology just happened. The elegant physics, however, is to a remarkable extent associated with one man, P. G. de Gennes. Therefore, when de Gennes writes a book on liquid crystals, it is expected to be the book in the field. *The Physics of Liquid Crystals* is just that. It does not cover everything about liquid crystals, but it covers all of the important ideas and principles and explains their relation to the rest of physics. I highly recommend the book to anyone with an interest in this peculiar form of matter.

The discovery of liquid crystals is usually ascribed to F. Reinitzer who confirmed in 1888 that some pure organic compounds have an intermediate phase between the solid and the liquid. They first melt to a phase that is fluid, but cloudy, as if it were a suspension of little crystallites. At a higher temperature the cloudy liquid "melts" again, this time to an ordinary clear liquid. There is a sharp latent heat at the latter as well as the former transition and there is no evidence of a lack of equilibrium such as would be implied by a suspension of one phase in another. Why then the cloudiness? By the 1920's this was pretty much answered. The molecules in the liquid are orientationally ordered in regions large enough to give an average optical anisotropy. The meanderings and fluctuations in this anisotropy strongly scatter light. The local anisotropy axis of a liquid crystal is conveniently described by a unit vector called the "director." The bending, twisting and splaying of the director field are relatively easily accomplished by electric or magnetic fields and by motions in the liquid, but they do cost energy. For "nematic" liquid crystals the lowest energy state would have the director parallel throughout the liquid. Cholesteric liquid crystals prefer a twisted director field. Then there are also liquid crystals for which the molecules are ordered in layers, usually perpendicular to the director. These are the smectics.

The recent spurt in activity in liquid crystals coincided with the publication of George Gray's book, *Molecular Structure and Properties of Liquid Crystals* in 1962. Just about then there developed a suspicion that the special optical properties of an anisotropic liquid might be useful in devices, and many groups, both with practical and with fundamental interests seemed almost at once to get involved. It turns out that light scattering and polarizing properties of liquid crystals can be controlled by electric fields, and this can be used in displays. Also the cholesterics have interesting changeable iridescent colors which has led to applications in thermometers as well as toys which seem to fulfill some people's psychological needs. Concurrent with the applications, we have seen a new sophistication in our thinking about order and phase transitions, transport and hydrodynamics of liquid crystals. The often confusing phenomenology has given way to theory and the theory has predicted things which have been measured. Indeed liquid crystals seem to lend themselves to beautiful experiments since even their defects represent a well defined equilibrium situation.

de Gennes' book reflects the recently achieved maturity of liquid-crystal science. Where Gray's book was a com-



A cholesteric liquid crystal will show its "fingerprint" or "focal conical" when subjected to a low frequency, medium-strength electric field. The photograph is from the Laboratoires d'Electronique et de Physique appliquée, the French member of Philips Research Labs.

presented for student and researcher alike. It will be profitably read by all those who want to know what liquid crystals are about.

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Linear and Nonlinear Waves

G. B. Whitham
636 pp. Wiley, New York, 1974. \$22.50

In the long history of wave phenomena, many books have been written about special waves and special aspects of special waves, but very few authors have tried to present a generalized analysis. The brief 1952 book, *Waves, A Mathematical Account of the Common Types of Wave Motion* by Charles Coulson (Oliver & Boyd, Edinburgh) was a well known early attempt at this, but actually resulted in a grouping of only slightly related essays on several different wave varieties.

Gerald Whitham has now attacked this problem in an elegant and thorough manner. He divides solution approaches into two classes: those for waves that obey a hyperbolic system of differential equations, and those that are described by a function propagating in a field governed by elliptic equations such as the Laplace equation together with boundary conditions. The latter class, one not widely recognized by physicists, he terms "dispersive" waves, because their dispersion relation is central to any solutions. In neither class does he restrict his analysis to linear waves alone, but proceeds successively through linearized treatments of nonlinearities to an examination of methods for dealing exactly with non-linear hyperbolic equations, and with non-linear behavior of dispersive waves of large amplitude. Among the non-linear effects dealt with are such intriguing topics as wave hierarchies and solitary waves. Contributions as recent as 1972 are included, while older methods such as geometrical optics and the eikonal equation are not ignored, but firmly dealt with.

Every scientist or engineer who must deal with waves in situations ranging from the ocean's surface to the generation of optical harmonics will almost certainly find something here to add to his arsenal of methods. The book is replete with exemplary solutions. Traffic flow, flood waves, bores, glaciers, sound waves, ocean wave guides, MHD waves, shock waves, sonic booms, ship waves anisotropic media, Stokes waves and solutions of the Burgers, Klein-Gordon, Sine-Gordon, Korteweg-deVries, Boussinesq, and cubic Schrödinger

COMPUTER PLOTTING



Model 1653

A high speed, 22 inch recorder designed to operate on-line to scientific and general purpose computers in graphic output applications.

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