zation in relation to morphogenesis. In addition, the present expanded volume contains information on plant embryogenesis, tissue differentiation, and flowering and a brief examination of selected morphogenetic studies on nonvascular plants. These topics are considered largely in terms of the developmental changes occurring at and above the cellular level. Although some attention is given to cytological and biochemical studies, the paucity of ultrastructural and biochemical data, particularly in the section on embryogenesis, will no doubt disappoint those whose attempts to understand plant morphogenesis have led them to study factors controlling changes in form at the subcellular level. Many readers will question the omission of references to the recent exciting studies on oriented cell divisions, mitotic spindles, and microtubules which already have contributed to our understanding of morphogenetic events.

Selected recent contributions from the literature on growth and form in plants are used to illustrate advances in specific topics. Unfortunately, they do not clarify materially such terms as "physico-chemical reaction systems," "physiological fields," and "growth centers," which are used frequently throughout the book to explain various morphogenetic phenomena.

It is not clear what audience the author had in mind when writing the book. The treatment is too detailed to permit its use as an introductory text in plant morphogenesis or for courses where developmental aspects of plants are briefly considered. A background in plant morphology and physiology is necessary if one is adequately to follow the author as he summarizes and integrates results of numerous investigators from Goethe (1790) to Waris (1967). The book is best suited for the advanced student and active worker in the field, who will find it useful for the comprehensive summation of experimental work performed on apical meristems.

More than half of the book is directly concerned with apical organization. The surgical experiments developed by Wardlaw and his colleagues and used so successfully during the past two decades to investigate the potentialities of the shoot apex are considered in great detail. These contributions have been extensively reviewed elsewhere, and readers will find much familiar material in this volume. Some will undoubtedly question the value of the present treatment, since much of the same material is covered in the authoritative chapters contributed by Wardlaw to the *Encyclopedia of Plant Physiology*. To others who, like myself, early followed closely the exciting developments in plant morphogenesis depicted in Wardlaw's writings, the book may be a poignant reminder of how little is known of whole-plant morphogenesis and how much remains to be accomplished.

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A Question in Astrophysics

Spectral Line Formation. JOHN T. JEFFERIES. Blaisdell (Ginn), Waltham, Mass., 1968. xxii + 298 pp., illus. $10.50.

Much of the total information we obtain from the solar atmosphere and almost all our data concerning stellar atmospheres come from the shapes and total intensities of the dark lines in their spectra. Accordingly, astrophysicists have devoted much effort to trying to understand the exact mechanisms involved in spectral line formation. The shape, or profile, of a spectral line is determined by a number of factors, including line broadening due, for example, to Doppler effects produced by thermal motions of atoms or by their mass motions (turbulence); "density" broadening due to encounters between radiating atoms and perturbing particles; natural broadening (radiation damping); and—for some elements such as manganese—hyperfine structure. Stellar rotation or magnetic fields also tend to broaden spectral lines. Precise calculation of the profile of any line becomes a formidable task. One must know certain atomic constants such as transition probabilities and collisional line-broadening parameters, how the number of atoms capable of absorbing the line varies with depth in the stellar atmosphere, and finally the "mechanism" of line formation. Are the absorption and emission of radiation determined entirely by the local temperature and density (assumption of local thermodynamic equilibrium = LTE) or are they fixed primarily by the radiation field (non-LTE)? Earlier work on stellar atmospheres employed the simple LTE approach—which fortunately turns out to be a better approximation than we might have deserved. Some of the earlier work on non-LTE effects yielded spurious results because of bad observational and experimental data. With an improved understanding of stellar atmospheres and better data this situation is being remedied.

Jefferies' admirable contribution to the literature on the theory of spectral line formation constitutes a volume which every serious student of astrophysics will want on his shelf within easy reach. Emphasis is placed more on basic physics than on applications. The book is particularly valuable in the context of line-formation problems where deviations from LTE must be taken into account; these include the most important and challenging tasks in spectral-line-formation theory. One of the most difficult of these is to determine the solar iron abundance. If solar and chondritic silicon : iron ratios are indeed identical and the transition probabilities are not wrong, there is something very fundamental about spectral line formation we do not understand. Deviations from LTE apparently cannot remove this discrepancy in silicon : iron ratio. Publication time lags being what they are, there is no reference to promising brand-new developments such as the technique of spectrum synthesis developed by B. J. O'Mara and John Ross whereby the exact shape of even complicated regions of the solar spectrum can be reproduced.

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Analytical Technique

The Practice of Gas Chromatography. LESLIE S. ETTRE and ALBERT ZLATIKIS, Eds. Interscience (Wiley), New York, 1967. xvi + 591 pp., illus. $14.95.

Despite a welter of theory on gas chromatography it is still difficult for an analyst, even if he has digested the theory, to make precise decisions on the design of his analyses, and much remains a matter of judgment. This book provides guidance for the necessary judgments without requiring the reader to absorb more than the bare minimum of theory.

Inevitably this leaves the reader at the mercy of the authors of the chapters. At times their guidance is not what this reviewer would have given; however, this occurs only where differ-

ences of opinion are legitimate and of small importance, and the uninformed reader may submit himself with confidence to their advice.

In places the attempt to avoid this dependence leads to confusion: the chapter on detectors describes nearly 50 detectors, few of which are in common use or commercially available, and the novice may well feel an *embarras de richesse* which does not exist. Neither the reviewer nor his students could follow the explanation of the gas density balance.

Editorial policy is at times puzzling. The choice, for example, of automatic process systems and digital systems for separate chapters while preparative scale separations are omitted almost completely is curious. However, the introductory chapters on basic technique, column design, sampling and sample preparation, and interpretation of results are of universal value and will repay the reading time even of the experienced chromatographer.

The book will be widely used for reference on particular problems, as introductory reading for novitiates in gas chromatography, and for experienced chromatographers proposing to use a specialized technique for the first time.

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High Energy Physics

Bubble Chambers. YU. A. ALEKSANDROV, G. S. VORONOV, V. M. GORBUNKOV, N. B. DELONE, and YU. I. NECHAYEV. Translated from the Russian edition by Scripta Technica. William R. Frisken, Translation Ed. Indiana University Press, Bloomington, 1968. xii + 371 pp., illus. $17.50.

At the end of at least one of the beams from almost every accelerator of ≳ 2-BeV particles in the world can be found a bubble chamber. At many accelerators, the normal number is greater than one (for example, three at both Brookhaven National Laboratory's 33-BeV Alternating Gradient Synchrotron and the 28-BeV Proton Synchrotron at CERN in Geneva, Switzerland). Although spark chambers or counters, or both, with their excellent time resolution, are often used in arrays designed to accomplish one specific experiment, the bubble chamber, with superior spatial resolution, has become the ubiquitous workhorse of high energy physics. Well over 10^8 photographs (stereo multiplets) have been taken in experiments since bubble chambers began to be useful tools, with approximately 10^5 being the number for a typical experiment.

Perhaps such a well-established and complicated technique deserves a standard text, even though it is largely an assemblage of portions of other, more general techniques. The authors have attempted to produce such a text. It is systematic and pedagogic in tone, and written at about the level of a graduate engineering course.

The four chapters by Voronov on theory of bubble formation, growth to photographable size, and recondensation in superheated liquids are more nearly complete than anything I have previously seen published as applied to bubble chambers. There is a good introduction by Delone which would be worthwhile reading for all engineers and technical specialists charged with responsibility for the operation of bubble chambers. The chapter by Gorbunkov is a thorough treatise on the theory of illumination and photography of vapor bubbles in liquids, though it contains one important error. The author obtains a $\cos^6\theta$ relationship between the intensity of illumination in the image formed by a lens and field angle θ. This is escalated to $\cos^7\theta$ by a typographic error. If it were true, it would be disastrous for wide-angle photography, but, fortunately, the correct result is only $\cos^4\theta$.

Other chapters deal with the design of actual bubble chambers, and although the recitation of principles to be remembered in design and operation is acceptable, the illustrations of their application are badly out of date. Chambers which have operated for five years are referred to as though they were in preliminary design, and many important techniques introduced within the last five or six years are not mentioned. These include the use of hydrogen-neon mixtures in liquid hydrogen chambers to give a single chamber with density continuously variable from 0.06 gm/cm^3 to 1.2 gm/cm^3, and radiation length ranging from 1000 cm to 25 cm (1965); the use of "superinsulation" to reduce radiation losses in cryogenic chambers to near-negligible levels (1963); and the use of small-angle Scotchlite as a retrodirector of illuminating light (1963), which suddenly made feasible the design of very large bubble chambers (>10 m^3). Indeed, the book contains no reference later than 1963.

Although the translation is generally good in that the language seems fairly relaxed and normal, many minor errors have crept in somewhere during the process. These range from the merely amusing (Massey and Burhop become "Messi and Barhop") to the downright irritating (wrong exponents on important variables in functional relationships).

A final section in the book is devoted to the elements of methods for deciphering bubble chamber pictures. It is suitable for the uninitiate, though poor reproduction will prevent him from obtaining a clear idea of what bubble-chamber pictures actually look like from the few included.

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Books Received

Addiction and Opiates. Alfred R. Lindesmith. Aldine, Chicago, ed. 2, 1968. viii + 295 pp. $7.50.

Advances in Atomic and Molecular Physics. Vol. 4. D. R. Bates and Immanuel Estermann, Eds. Academic Press, New York, 1968. xiv + 465 pp., illus. $20.

Algebraic Theory of Machines, Languages, and Semigroups. Michael A. Arbib, Ed. Academic Press, New York, 1968. xviii + 359 pp., illus. $16.

The American Challenge. J.-J. Servan-Schreiber. Translated from the French edition (1967) by Ronald Steel. Atheneum, New York, 1968. xviii + 298 pp., illus. $6.95.

American Indian Mythology. Alice Marriott and Carol K. Rachlin. Crowell, New York, 1968. xiv + 211 pp., illus. $7.95.

Among the People. Encounters with the Poor. Irwin Deutscher and Elizabeth J. Thompson, Eds. Basic Books, New York, 1968. xviii + 408 pp. $10.

Analysis and Simulation of Multiport Systems. The Bond Graph Approach to Physical System Dynamics. Dean Karnopp and Ronald C. Rosenberg. M.I.T. Press, Cambridge, Mass., 1968. xiv + 221 pp., illus. $10.

Astronomical Objects for Southern Telescopes, with an Addendum for Northern Observatories. A Handbook for Amateur Observers. E. J. Hartung. Cambridge University Press, New York, 1968. x + 338 pp., illus. $8.50.

Astronomischer Jahresbericht. Vol. 66, Die Literatur des Jahres 1966. W. Lohmann, F. Henn, and U. Güntzel-Lingner, Eds. De Gruyter, Berlin, 1968. xii + 848 pp. DM 80.

The Battle of Majuba Hill. The First Boer War. Oliver Ransford. Crowell, New York, 1968. x + 154 pp., illus. $5.95.

The Beetles of the United States (A Manual for Identification). Ross H. Ar-

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