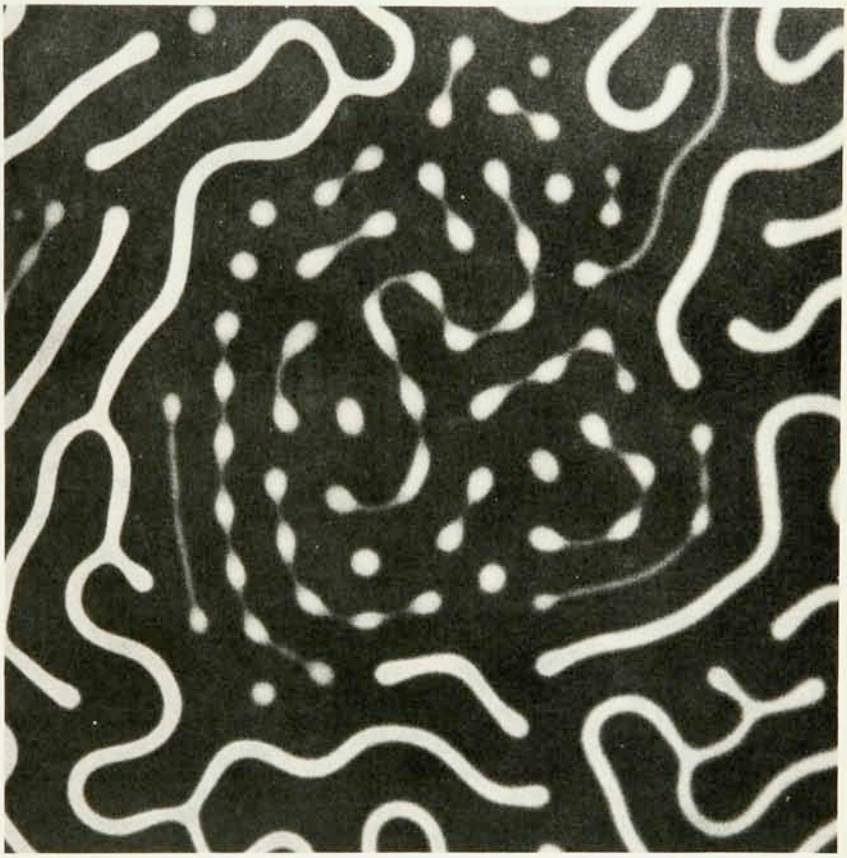
# books

## The first textbook on a new memory device

### Magnetic Bubble Technology

**A. H. Eschenfelder**
328 pp. Springer, New York, 1980. $49.80

*Reviewed by Andrew H. Bobeck*



**Magnetic domains in a bi-layer magnetic film** shown at approximately 250 times its actual size. The use of these phenomena as memory devices is described in Eschenfelder's book.

The search for the so-called "ideal" memory continues relentlessly. Even the transplanted human brain with an estimated storage capacity of perhaps $10^{14}$ bits would fall short of fulfilling the needs of today's data and communications systems. In fact, the performance of the scratch-pad memory in today's modern digital computer—random retrieval of data blocks at very high data rates—would be difficult if not impossible to duplicate in a memory suited to archival storage. The silicon integrated circuit Random Access Memory exemplifies the former, magnetic disks or tapes, the latter. Magnetic bubble memory, a recent entry in the marketplace, combines the non-volatile nature inherent in magnetic storage in a solid-state structure very similar to a silicon integrated circuit. Magnetic bubbles are stable cylindrical island domains of reversed magnetization in thin films of particular magnetic materials. The author of *Magnetic Bubble Technology*, Andrew Eschenfelder, has been associated with the evolution of magnetic bubble technology for many years. His book was written as a text for a one-semester course but treats the subject in sufficient depth to interest both the inquisitive as well as the established worker in the field. Indeed, this first textbook on magnetic bubbles could well become the standard by which others are judged.

One reason for the popularity of magnetic bubbles, especially at the intellectual level, is that this technology touches many facts of theoretical and applied scientific endeavor. For example, the applied theoretician can characterize epitaxially-grown garnet films by delving into stress- and growth-induced anisotropy, and magnetic bubble statics and dynamics. Similarly the crystal grower can develop growth techniques for the bubble-supportive magnetic films as well as for the substrates upon which these films are prepared. He can also formulate new compositions for improved temperature behavior, lower defect densities and so on.

Eschenfelder carefully selected and organized the material in this text. Aspects of current importance such as the mechanism of growth-induced anisotropy in garnets are thoroughly treated, whereas items of more historical significance are touched upon rather briefly. He includes discussions of the static and dynamic properties of magnetic bubbles, field-access permalloy-driven devices, and the more exotic device forms of bi-level permalloy, ion-implanted contiguous-disk, bubble lattic and current sheet. The chapter on magnetic materials is especially well-written. Others cover chip fabrication, chip packaging and device applications. Lastly, the author places the future of this technology in perspective.

Device testing is the single important area not covered in depth. Bubbles, streaming along photolithographically-defined paths, retain information in either their pattern (that is, through their presence or absence) or in the details of their domain wall structure. Since bubble devices can contain up to ten million storage positions on a single chip, a device must be rigorously tested for performance before it is installed in a system.

Nonetheless, Eschenfelder has prepared a text that is clear in style, with superb illustrations. I heartily recommend that it find a position on your bookshelf.

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## Stellar Formation

**V. C. Reddish**
287 pp. Pergamon, Elmsford, N.Y.
$30.00 clothbound, $15.00 paperbound.

It is clear that luminous main sequence stars found in the spiral galaxies must have formed recently from the relatively dense interstellar clouds of gas and dust concentrated in the arms. That we can say this is indicative of the progress that has been made in understanding the characteristics of young stars and the distribution and physical conditions inside dense interstellar clouds. However, star formation is an exceedingly complex topic, and many interesting and fundamental questions remain unsolved. V. C. Reddish's *Stellar Formation* is a concise and well-written discussion of observational and theoretical studies in this important field.

The observed frequency distribution of stars as a function of mass can be used to determine the relative number of stars formed per unit range of mass. Throughout much of our Galaxy the stellar birth rate function, which is called the Salpeter function, has the simple form $\phi = Km^{-x}$ ($x \simeq 2.35$) for stellar masses $\gtrsim 0.25\ M_{\odot}$. Any satisfactory theory of star formation must explain the observed mass dependence of the Salpeter function as well as the rate at which stars form at different locations within the Galaxy. If stars form by the collapse of observed interstellar clouds then the frequency distribution of clouds and stars should be related. On the other hand, if stars form as a result of the fragmentation of massive interstellar clouds (most likely molecular clouds) the frequency of massive clouds and aggregates of stars should be related. The number of compact HII regions is a measure of the rate of formation of luminous main sequence stars. It is likely that the rate of star formation is associated with the distribution of $H_2$. Observations of the 2.6 mm radiation from carbon monoxide provide the best means of inferring the distribution of $H_2$ throughout the Galaxy. *Stellar Formation* discusses attempts the explain the rate at which stars of different mass are formed as well as the observations that are the basis of these efforts.

The ordering of clouds and young