peals to the lay reader and educates him, painlessly, on an important subject.

There have been times when the USAEC was seriously interested in safeguards problems: 1959, when the IAEA came into being; 1966, with USA–USSR agreement on the nuclear nonproliferation treaty and now. There have been other times when the problem had low priority. In fact, the large amounts of high enriched uranium and plutonium produced and handled in AEC facilities for the weapons program, naval reactors and experimental reactors have been attractive targets if anyone had wanted to divert. The development of nuclear power with recycle of plutonium to light water reactors, highly enriched uranium for gas-cooled reactors and breeders of fissionable isotopes extends the vulnerabilities geographically and quantitatively. As Willrich and Taylor say: "The AEC should design a detailed system of safeguards for each of the fuel cycles based on use of the best available technology and institutional mechanisms." With them, I believe that the problems can be solved to the extent that nuclear or radiological threats by terrorists or other dissidents can be reduced to a very low level indeed, with far less impact on the cost of power than the recent increase in the price of oil created by the Arabs.

In conclusion, not all of the safeguards problems have been fully explained in these two books, nor have all of the solutions been identified. Our appreciation of the problems and our comprehension of how best to deal with them will continue to develop as time goes on, providing we continue to worry about them.

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Lie Groups, Lie Algebras, and Some of Their Applications

R. Gilmore
587 pp. Wiley, New York, 1974. $24.95

Lie-group theory is one of the areas of mathematics that is most useful in theoretical physics, but is also one of the most difficult for physicists to learn to use correctly and efficiently. A major cause of this difficulty is that to understand the subject it is useful to have a good knowledge of the mathematical foundations of Lie-group theory, particularly algebra (for example, "linear and multilinear algebra," in its modern, coordinate-free form) and differential geometry. Unfortunately, these are subjects in which physicists receive too little training. They are not, in principle, too difficult to learn by self-study, but here one runs into the dominant ideology among physicists that mathematics is "useless" unless it is learned in connection with a specific physical problem. Ironically, theoreticians in other disciplines, such as engineering and economics, are much more willing than physicists to learn seemingly "useless" mathematics, and, perhaps as a consequence, there have been more major breakthroughs in these areas involving the application of mathematics developed in the last thirty years.

Especially welcome because it breaks with the sterile tradition of mathematical "pragmatism" in physics is Robert Gilmore's text. He has written a long and enthusiastic *mathematics* book to teach physicists about Lie-group theory in which he tries to fill the gap between the classic treatises by Racah and Wigner and the typically "modern" mathematics book by Helgason, *Differential Geometry and Symmetric Spaces.* Unfortunately, he has not paid sufficient attention to the prerequisites, and the mathematical level is uneven—one moment assuming only the minimal knowledge of algebra and geometry that is typical of current literature in theoretical physics, the next attempting to describe quite sophisticated modern concepts.

It has many good pedagogical features—nice pictures, interesting examples (too few physical ones though), many advanced topics treated with flair and a major effort to explain intuitive ideas. However, it is flawed by many seriously deficient, confused or mistaken descriptions and definitions of basic topics. For example, the abstract notion of "Lie group" and the relation between Lie groups and Lie algebras—which is the heart of the subject to the mathematician—are handled poorly. Many of the advanced "global" concepts, especially those in connection with symmetric-space theory, could have been written in a more authoritative way. The serious physicist reader should, therefore, also consult pure mathematics books to fill in these gaps. I recommend *Introduction to Lie Groups and Lie Algebras* by Sagle and Walde and *Notes on Lie Algebras* by Samelson. *Symmetry Groups and Their Applications* by W. Miller, and my "Lectures" in *Mathematical Physics, Vol. 2* offer a more modern version of the material in

group theory traditionally used by physicists, and might also be useful.

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From the Black Hole to the Infinite Universe

D. Goldsmith, D. Levy
330 pp. Holden-Day, San Francisco, 1974. $6.95

The approach of this paperback book, intertwining a science fiction story with textual material, is interesting, but often the connection between the two is artificial. For example, in the science-fiction part of chapter 8, "Lumps of Matter," space hero Cyril Zaki happens to reminisce about the school classes he had muddled through with formulas such as "PeeVee equals Arty" and then later the chapter describes the bulk properties of gases. Also, the fifteen chapters themselves do not follow an obvious order; each appears to be a nearly self-contained description of one selected astrophysical phenomenon or concept.

The authors, D. Goldsmith and D. Levy, have keen insight, and a number of their descriptions (such as presenting the Doppler shift in terms of the photon's energy) were very enlightening. The figures and captions, with a casual style, are generally good and informative although sometimes misleading. The Hertzsprung-Russell diagram, plotted with temperature increasing toward the right, may be a logical manner of presenting the information, but it is one of a kind because the convention in astronomy and astrophysics is always to have temperature increase toward the left. Two colleagues to whom I showed this figure immediately remarked "Hey, that must be Goldsmith's book!" He was considered the most likely astronomer to ignore the traditions of the field.

By putting the mathematical developments at the end of the chapters after the descriptive explanations, the authors have attempted to tell a wide audience that "understanding modern astrophysics is fun." Much of the discussion is still complex, however, or presupposes knowledge given later, such as the suggestion in chapter 1 that black holes may provide enough mass to reverse the present expansion of the universe, a concept not discussed until chapter 9. Thus the book is recommended as fun reading for scientists and might be a useful text in a one-semester course for people who have had at least a good high-school physics course or its equivalent.

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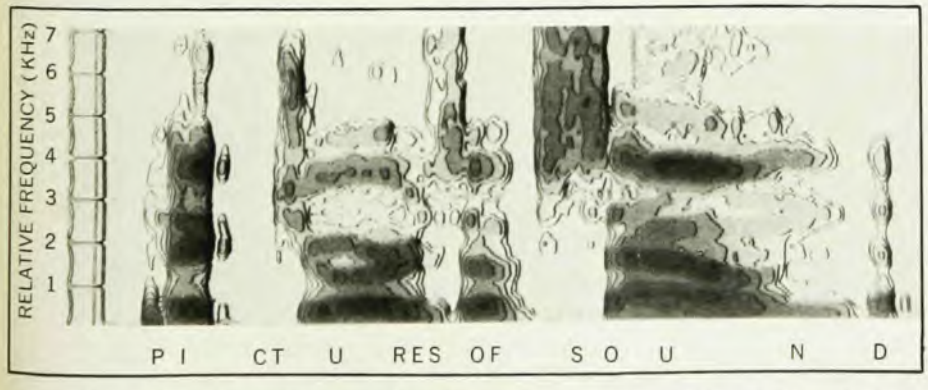
Speech Synthesis

J. L. Flanagan, L. R. Rabiner, eds.
511 pp. Dowden, Hutchinson & Ross, Stroudsburg, Pa., 1973. $22.00

Of the various problems that have been the concern of speech scientists over the past few decades, the synthesis of speech has come closest to achieving a degree of success in practical application. Speech synthesis has also provided an effective tool for the study of the speech process, because it can be used to produce well-controlled stimuli for investigation of speech perception and it involves modelling of the speech production mechanisms. It is appropriate, therefore, that a collection of papers in the area of speech synthesis constitutes one of the series of books entitled "Benchmark Papers on Acoustics." A group of 46 papers, selected carefully by the editors, James L. Flanagan and Lawrence R. Rabiner, represent a wide variety of subjects ranging from those that are of historical interest (but formed significant and exciting contributions at the time they appeared) to more recent topics on digital techniques for synthesis of speech and on com-



The words "pictures of sound" are graphically displayed on a contour spectrogram. This type of representation provides for more accurate amplitude measurements. Photo from Bell Labs.