been modified. Most of these papers would have had more interest if they had been published immediately in a less attractive but cheaper and more rapidly produced format. One paper, that on the dynamics of a dissociating gas by Freeman, has been available for over a year as AGARD Report No. 133. Massey's paper on scientific applications is the only one on a purely physical topic, the use of rockets and satellites to obtain upper-atmosphere data, although Lines' discussion of instrumentation and guidance with its emphasis on electronics is closely related. The other papers cover the topics of rocket engine design, the Vanguard and Skylark rockets, use of aerodynamic lift upon re-entry for recovery of satellites, high-temperature materials, and space medical problems. Because of the various specialized fields covered and the different backgrounds of the participants, the papers all have a high expository level, consequently are well written and are a pleasure to read.

Symposium on Information Theory in Biology (Gatlinburg, Tenn., Oct. 1956). Edited by Hubert P. Yockey, Robert L. Platzman, Henry Quastler. 418 pp. Pergamon Press, London & New York, 1958. $12.00.
Reviewed by J. R. Pierce, Bell Telephone Laboratories.

INFORMATION theory as Shannon devised it is concerned with the statistics of message sources and the statistics of communication channels. It shows that with an ergodic source there can be associated an entropy or rate of production of information, measured in bits per second, and that with a noisy channel there can be associated a channel capacity, also measured in bits per second. If the capacity of a channel is less than the entropy of the source by however small an amount, the messages produced by the source can be sent over the channel with a vanishingly small error, providing encoding is done properly in very long blocks.

Information theory has called to the attention of the world a number of internally useful ideas concerning conditional probabilities and entropies and complex encoding. Some physicists, psychologists, and biologists have been anxious to use these in their own fields. It is hard to judge their success, for what they seek to do is rather apart from the original aim of information theory.

Happily, Quastler in "A Primer on Information Theory", the first paper in this book, shows a familiarity with and understanding of the subject which is all too uncommon among those who wish to extend its applications. Many of the other papers in the book are closely related to the ideas of information theory in that they are concerned with the idea of coding in chromosomes, proteins, and protein synthesis, with fluctuations in neural thresholds, with statistical considerations in connection with membrane phenomena, with statistical aspects of radiation damage phenomena, and with other statistical matters.

The book as a whole is baffling, at least to me. I don't have enough knowledge of biology to judge the

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soundness of the papers, and it seems likely to me that few biologists would be able to tell whether the mathematical content is really either sound or novel or closely related to information theory. All I can say is that the book is full of intriguing phenomena and facts and interesting speculations.

The Upper Atmosphere. By H. S. W. Massey and R. L. F. Boyd. 333 pp. Philosophical Library, Inc., New York, 1959. $17.50. *Reviewed by S. F. Singer, University of Maryland.*

IN a field which involves so many disciplines, and advances as rapidly as upper-atmosphere research, the writing of a book is a difficult undertaking. The authors, who are both distinguished upper-atmosphere physicists (one theoretical, the other experimental), have done a remarkably successful job. They cover the field of the upper atmosphere quite adequately, yet they write so that the nonspecialist can easily follow the discussion. Comparing it for example to the standard treatise by Mitra, the present book is much less detailed, makes much easier reading, and is of course more up to date. It should become immensely useful to the general physicist who wants to be informed about the field, but even the specialist on any particular phase of upper-atmosphere physics will find the book very valuable. It will be useful also to the student as a reference or as a textbook; courses in upper-atmosphere physics, including cosmic rays, aurorae, geomagnetism, and solar effects may become more widespread in the future.

But the book covers more than just upper-atmosphere physics. It gives first of all a brief survey of the physical basis of various upper-atmosphere prenomena before describing the phenomenological atmosphere. A large chapter is devoted to balloon and rocket research techniques followed by a description of probing techniques using sound waves and radio waves. The electromagnetic radiations from the sun produce the ozonosphere and the ionosphere which are discussed in separate chapters, following which there is a treatment of the effects of solar corpuscular radiation in producing the aurora and various magnetic effects. This discussion is of necessity incomplete since this is a field of very active current research. In a revision of the volume, I am sure, the authors would give great attention to the various geophysical effects of trapped corpuscular radiation from the sun.

Finally there are very concisely written chapters giving methods of observation of meteors and major results, as well as a summary of the properties of the primary cosmic radiation and its time variations. A final chapter on artificial satellites with summaries of the three Sputnik rockets and the earliest US satellites brings the material up to date.

Coming at the end of the International Geophysical Year, the authors were able to include throughout their volume much recent material. Quite remarkable are the color photographs of the aurora. There are many excel-