tional errors), not from a common convergent point. The reality of these groups can be further checked by their H-R diagrams and, in some cases, by the peculiarities of their spectra and of their ultraviolet excesses. If most stars have been born in just a few groups, as seems possible, this would have many far-reaching implications. Eggen's groups, in Woolley's view, are the ghosts of old spiral arms. Identification of new moving groups and of new stars in known groups is greatly hampered by the appalling inaccuracy of the proper motions presently available. For example, more than 27,000 of the 33,342 stars in the *Boss General Catalogue* have proper motions less than 0.01 sec/yr and with probable errors of the order of half that figure. Clearly it is important to take the more than a hundred recent positional catalogs and derive more accurate proper motions, and this is being done. Even more desirable for the future would be the photography of the entire sky with wide-angle astrographs having focal lengths from three to five times longer than those that have been used in the past; this, most unfortunately, is not being done.

Perhaps the most outstanding contribution in the book is Jesse Greenstein's chapter on subluminous stars (chap. 17). This experienced astrophysicist has had continued access to the magnificent and (unfortunately) unique spectroscopic instrumentation available at Palomar. This equipment is ideal for the spectroscopic investigation of faint blue stars and of the faint, nearby stars of large proper motion. Much of his chapter is new and fundamental to our understanding of these objects. One should remember, however, that Greenstein's work has been made possible by astronomers such as Luyten who, during the years, have patiently and laboriously sorted out these unusual specimens—by means of a blink microscope—from tens of millions of ordinary star images. Greenstein lists seven major groups of subluminous blue stars, all of them objects of considerable astrophysical interest. An eighth major group of faint blue "stars" was identified by Sandage after the chapter was written, a group that is even more interesting. These are the extragalactic and superluminous quasi-stellar galaxies, the faintest of which are at the edge of the observable universe. Although there may be more than 100,000 of these objects brighter than 19th photographic magnitude, scarcely a hint of their possible existence can be found in Greenstein's chapter or in Luyten's chapter on blue stars at high latitudes.

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Mathematics

One finds no new subject matter in this book, **The Theory of Sets and Transfinite Arithmetic** (Saunders, Philadelphia, 1965. 420 pp., $10), by Alexander Abian. It is a basic treatment of the classical theory of sets, designed specifically for upper university or graduate students in mathematics. The coverage of the theory is complete and fairly rigorous. In sequence, one finds the study of sets and logic; axiomatic set theory; the algebra of sets; Boolean rings; order relations; equivalence and real numbers; finite and infinite sets and denumerability; similarity and ordinal arithmetic; and the cardinal numbers.

In good pedagogical style, sets and logic are introduced simultaneously with a minimum of symbolic language. All concepts are defined in terms of the fundamental set $\{x, \exists, \epsilon, \sim, V, \text{and } (,)\}$. This leads to clarity and simplicity.

The presentation is clear, with the mathematical theory elaborated by descriptive paragraphs which sometimes become repetitive. While making a clear distinction between a theory and a model of the theory, the author does not make a fetish of such metamathematics. The set theory is based on the six axioms of Zermelo-Fraenkel. The real numbers are achieved by a set theoretic development in the common order, cardinal-integers-rationals-irrationals-reals. The treatment of denumerability, finite sets, equipolent sets, and Bernstein's theorem reflects the classical treatment of these topics by Cantor himself. The text closes with a rather voluminous treatment of similarity, ordinality—although ordinal types are not developed—and cardinality.

The book is not for the initiate. For one who has read or used elementary notions of sets, for example, Halmos's *Naive Set Theory*, this is an excellent subsequent treatise.

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Ornithology

In this little book, **Birds Around the World: A Geographical Look at Evolution and Birds** (published for the American Museum of Natural History by Natural History Press, Garden City, N.Y., 1966. 187 pp., $3.95), the author, Dean Amadon, attempts to express in nontechnical language the problems and ideas associated with a study of the distribution and evolution of various kinds and families of birds of the world. Starting with simple questions—for example, "Why does one bird occur only in a very restricted area, while another, fairly similar one has a wide geographic range, or why do some areas have many kinds of woodpeckers while other equally forested places have few or even none"—Amadon goes on to explain how the present picture may be clarified in terms of the past history and evolution of species and of faunas. This is the content of the introductory chapter, properly entitled "First principles."

Several chapters deal with the limiting effects on distribution of physical barriers (for example, land and water), of ecological requirements of individual species (such as vegetational types, food, shelter, and migratory paths), and of other factors (climate and the impact of man's inroads on the environment which has resulted in the disappearance of forests or swamps, or the production of new types of local terrain).

All of this leads to a discussion of how species react (in the long-range, historical sense) to areal movement—what happens when similar species meet, why some species are declining and others are becoming more abundant. Then, on the basis of these individual cases, the author leads into a discussion of the existing distribution of families and higher groups of birds, and, in turn, to a discussion of the distinctive features of avifaunas in several parts of the world, what evolutionary significance these geographic aggregates of higher systematic units may have, and how recently each began or was cut off from others. The discussion terminates with a brief description of life zones, biotic provinces, and biomes.

Throughout, the author has drawn on significant examples from all parts of the world, and his presentation has the clarity and understandability necessary to reach and to inform the lay audience for which it is intended. On

the whole the book is well produced, although one unfortunate slip (on p. 4) places the East Indies as part of the great ". . . archipelagos of the Middle East." There is a slight tendency to stress work associated with the American Museum of Natural History, as though that institution was the primary source of our present knowledge, but this is perhaps understandable since the book is published for the American Museum. Amadon's little volume should serve a real purpose, for it gives a reliable and balanced description of its subject.

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Inorganic Chemistry

When the original edition of Robert Sosman's *The Properties of Silica* was published (1927), the substance silica, SiO_2, was considered to have seven phases. Since that time methods of attaining and measuring high pressures and temperatures have been greatly improved and methods of determining structures have become precise so that silica is now found in at least 22 phases. The number of phases is so great and their interrelationships so intricate that silica is probably the most complex of the inorganic binary compounds. The present book, Sosman's **The Phases of Silica** (Rutgers University Press, New Brunswick, N.J., ed. 2, 1965. 398 pp., $10), is a completely revised form of those chapters in the original edition (chapters 1 to 14) which dealt with the phases of silica and their interrelations. Chapters 15 to 17 considered hypotheses of structure because, at that time, little was known of the actual structures of any of the phases except low quartz. These chapters are replaced by chapters 12 to 14 of the present volume, which give the results of structure analyses of the phases by modern methods. Other chapters deal with the composition and leptonic (electronic) constitution of silica, the transitions among the phases, the effects of twinning and of defects, and the amorphous forms and the microforms. Because the presence of water affects so profoundly the phase relations of silica, a short chapter on the system SiO_2-H_2O has been added at the end of the volume.

The financial support of the Edward Orton Jr. Ceramic Foundation enabled Sosman to devote space to brief discussions of thermodynamic theory and methods of structure determination and graphic portrayal so that the intelligent nonspecialist can understand phase relations and structural descriptions without difficulty.

The book is comprehensive, detailed, and precise. At the same time it is written in such a relaxed and easy style that it is a pleasure to read as well as being highly informative. The binding is good, the paper is of high quality, the print is very easy to read, the illustrations are well reproduced, and the price, relative to that of most modern scientific books, is moderate. Everyone interested in silica will be grateful for this important book and will await impatiently the promised appearance of the second part dealing with the interrelations of the properties of silica.

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Archeology and Prehistory

Prehistoric and Early Wales (Humanities Press, New York; Routledge and Kegan Paul, London, 1965. 256 pp., $10), edited by I. Ll. Foster and Glyn Daniel, consists of eight chapters based on as many lectures given by leading specialists at the British Summer School of Archaeology in 1959. The introduction, by Glyn Daniel, is a history of antiquarian thought and subsequent archeological research in Wales. It makes humbling reading. The antiquaries of old relied on two basic sources of information, the Bible and the classics. Nowadays we smile at their conclusions. Modern archeologists are daily acquiring more scientific gadgets. But, a couple of centuries hence, will not students of the past smile at our conclusions?

The second chapter deals with Wales in the Pleistocene at a time when Britain was a peninsula of Europe. Although the material left behind by the tiny population of hunter-gatherers is not large, much is done to relate it to the rest of Britain and the Continent. All may not agree with this interpretation, but the views expressed are stimulating, though unhappily without references or bibliography such as accompany the other chapters.

The first farmers appeared in about the third millennium B.C., but their knowledge of agriculture like their date is inferred from the rest of Britain rather than confirmed by Welsh evidence. The shoreline of their time fluctuated, and was sometimes more than 20 feet below today's shoreline. Hence many of their settlements may have been lost, especially since much of the surviving material is from the best lands along the present coast. But these folk began clearing the Atlantic-sub-Boreal forests in the valleys, and their axes made of igneous rock were widely traded in Britain. Their monumental tombs also attest their connection by sea with the continental shores.

By the beginning of the Bronze Age, about 1800 B.C., the warmer and drier sub-Boreal climate had improved the upland pastures and encouraged the use of higher ground for pastoralism. The maritime routes to the Continent became less important, and Wales became a frontier zone between the diverse cultures of England and Ireland. With the Late Bronze Age, from about 1000 B.C., the usefulness of the uplands was again reduced by the colder and wetter sub-Atlantic climate which encouraged settlement on lower ground, and this situation continued in the Iron Age. By the time of the final stage of the Late Bronze Age, the archeological material falls into four groups that largely correspond to the four tribal areas of the Iron Age, observed by the Romans in the early centuries A.D.

As for the Iron Age itself, the scene is now dominated by quite new fortified towns and "castles," a sharp contrast to the Late Bronze Age denoted by graves and bronze implements. No author commits himself about when the first Celtic settlement took place, although one of them ventures to say, but without further comment, that the Celts came largely by sea. But the builders of the Iron Age fortifications were surely Celts, and the great find of Iron Age treasure evidently sacrificed in a sacred lake in Angelsey suggests a connection with the Druids' sanctuary there, which was destroyed by the Romans.

The final chapters deal with the Roman military occupation, the Celtic co-existence with it, and the Celtic resurgence after its withdrawal.

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