Books

A Trend in Astrophysics

Stellar Evolution. By Otto Struve. 266 pp. Princeton University Press, Princeton, New Jersey, 1950. $4.00.

The rapid development of astrophysics during the past two decades has had several causes. The understanding and analysis of atomic spectra have been a stimulus to astronomical spectroscopy. New instruments and new techniques have increased the scope and precision of the data. But more important than either has been the instinct for significant phenomena that has given a new impetus to astrophysics, and the leader of the movement has been Otto Struve himself. An astonishingly large fraction of the observational work that forms the basis of his study of stellar evolution has been his own, and much of the rest has been done under his guidance. And although the contributions of atomic theory and new instruments should not be underrated, much of the groundwork of Struve's argument consists of a re-evaluation of facts that are almost classical—the properties of the W Ursae Majoris stars and the bright-line B stars, the anomalies of Beta Lyrae and U Cephei have been essentially recognized for decades, but he has not been afraid to look at them from a new angle.

A generation ago the approach to the problem of stellar evolution was static. The data were arranged in plausible sequence, along which development was supposed to carry them. The over-simplification that rendered the problem easier tended to regard anomalies as abnormalities. The essence of the new approach is to treat the anomalies as cardinal facts, which provide the clue to development. The modern approach to stellar evolution is essentially dynamic.

The course of stellar evolution that the author outlines is documented on every page by observational material. The wealth of factual detail that accompanies every turn of the argument will delight the practical astronomer. His main criticism will inevitably be in the form of regret that no bibliography is provided.

The first section deals with the chemical composition of the stars, the most important emphasis being laid on hydrogen content as evidence for, and an index of, stellar development. There is an important section dealing with the "Trumpler stars", which seem in the past to have borne a disproportionate part of the weight of the theory of stellar constitution. Struve shows conclusively that the excessive masses previously ascribed to them are not real. There is a discussion of deviations from the mass-luminosity law, which the author does not hesitate to acknowledge and make use of. Previous work has tended to gloss over these discrepancies; Struve uses them as an essential step in the understanding of the development of double stars. The section on anomalous abundances of the chemical elements in stellar envelopes is an extremely valuable one, though it raises more problems than it solves. By the end of the first section the author has suggested two possible evolutionary courses for a star: one in which a hot, bright star "slides down the Main Sequence"; another, in which it may move in the direction of the red giant stars.

The second section discusses the mechanism of stellar development. Expansion and rotational break-up are compared as evolutionary processes, and the preponderance of evidence points in the direction of the latter, at least for most stellar objects. Struve's study of the spectroscopic evidences for stellar rotation and the formation of unstable envelopes around rotating stars, begun many years ago, has led directly to this phase of the subject, and has finally carried conviction with many who (like the present writer) were originally skeptical of his far-reaching conclusions. Evidently Struve accepts the views that von Weizsäcker has recently put forward on the theory of the development of stars (and stellar systems). These views are extremely attractive and stimulating, but the theoretical basis for these new applications of hydrodynamics and turbulence theory is as yet incompletely formulated. Detailed spectroscopic evidence carries more conviction with the working astronomer than a (possibly fortuitous) concurrence with views reached on purely theoretical grounds.

The third section of the book deals with the evolution of binary systems. The great commonness of binary stars renders it likely that they are rightly made to bear the brunt of the evolutionary process. The concluding diagram, in which various possible courses are sketched for developing stars, and the less likely ones systematically eliminated, carries great conviction. It displays the star as developing from a cloud, through a single hot star of large angular momentum, a double star of high luminosity, a W Ursae Majoris star, to the final stage of a single star of low angular momentum, surrounded by a planetary system. "All in all," says the author, "we are fairly safe in our conclusion." It is difficult to gainsay him, although much is yet unproved, much unaccounted for. Many astronomers will disagree with the suggestion that supernovae are connected with the genesis of double stars (though the omission of this idea would affect the main argument but little).

It is sometimes the fate of a theory to be too successful. It may seem to take phenomena into account so satisfactorily that interest in the subject wanes. Such will not be the case of the ideas developed by Struve in this book. He freely points out, at every turn, facts that are inconsistent and unexplained. No working astronomer can read the book without seeing a new problem suggested on every page, and it may well inaugurate a new trend in astrophysics. A book that embodies half a lifetime of observational research might well be regarded as a monument. But the present one is more than a monument; it is a signpost.

Cecilia Payne-Gaposchkin
Harvard Observatory

Cosmic Rays

Cosmic Rays. By Louis Leprince-Ringuet (translated by Fay Ajzenberg). 290 pp. Prentice-Hall, Inc., New York, 1950. $6.65.

The strongest impression left by reading Professor Leprince-Ringuet's most attractive little book *Cosmic Rays* is a realization of its very broad scope. In a mere 290 pages an unusually comprehensive introduction to the field of cosmic ray physics is presented. The topics covered range from restricted relativity and meson theory through methods and results of high altitude research, the latitude effect, cascade showers, artificial mesons, nuclear effects, and many other subjects, to concluding chapters on the origin of