THE END OF AN ERA

Cecilia Payne-Gaposchkin and Her Last Book

Stars and Clusters, by Cecilia Payne-Gaposchkin, Harvard University Press, Cambridge, MA, July 1979, 262pp., $22.50.

"The end of an era!" That was how numerous astronomers reacted to the sad news of the death, on December 7, of Cecilia Payne-Gaposchkin (1900-1979). Her last book, Stars and Clusters, had only recently come off the press. Dedicated to "that bright particular star," her husband, Sergei Gaposchkin, this book lives up to her reputation as both scientist and author. It also lives up to my own definition of "descriptive astronomy" in the highest sense of that unfortunately obsolescent term: namely, without the use of mathematics (except for simple use of exponents and logarithms) it presents a clear picture of what has been observed, what can logically be inferred from the observations, and the problems that still need to be solved for understanding the evolution of the stars, double stars, and clusters.

Initially an able theoretical astrophysicist, Cecilia Payne began her career as a student in Cambridge, England, under the guidance of Sir Arthur Eddington. In 1925 she was granted the first Ph.D. degree ever awarded in Astronomy at Harvard or Radcliffe. Several years after the publication in 1925 of her thesis, Stellar Atmospheres, the eminent Otto Struve, then Director of the Yerkes Observatory, commented that this was "the best Ph.D. thesis ever written."

Since 1934 her work has dealt mainly with variable stars. In 1937 she headed the Milton Bureau established for the purpose of determining from Harvard patrol plates the light curves for all the known variables brighter than tenth photographic magnitude at maximum. The results for some 1200 variables, each examined on an average of 1000 plates, are published jointly with her husband in the Annals of the Harvard College Observatory, Vol. 113, Nos. 1-4, 1942-1954. My own fear at the time she undertook this tremendous task was that she would be neglecting theoretical astrophysics and analyses of intricate peculiar stellar spectra, fields in which few were competent, in order to conduct an intrinsically important routine job which, however, would hardly make demands on her superior capabilities. Fortunately, she did muster all those abilities in the interpretation of the vast accumulation of observations. She has to her credit more than one hundred fifty technical papers, and four important monographs on variable stars.

Although she was head and shoulders above most of her ablest male contemporaries, she suffered keenly from the prevalent discrimination against women in professional ranks. The recipient of numerous honorary degrees and other honors, Mrs. Gaposchkin was finally, in 1956, named Phillips Professor of Astronomy and became the first woman at Harvard to be named chairman of a department (Astronomy).

When I was young at Harvard Observatory, Harlow Shapley stressed the need for good writing and good oral presentation of papers. Accordingly, he advised me to pay particular attention to how Mrs. Gaposchkin lectured. I watched her intently, and was disappointed that she seemed, shyly, never to look at her audience. Instead, she looked at the ceiling. In fact, she seemed to be looking right through the ceiling, as though communicating directly with the heavens above, and letting us in on the conversation. Her lectures were

lucid, stimulating, exciting, and they were presented with an unusually rich and varied vocabulary, and best of all, impeccable English construction. In this, as well as in other ways, her passing marks the end of an era: nowadays, does a day ever pass when we do not hear a mistake in grammar by advertisers, news commentators, politicians, or science professors, to say nothing of the "educated" public? The treatise under review refreshingly lives up to Cecilia Payne-Gaposchkin's high standards.

The title headings, from Chapter 1, "All the World's a Stage - the Galaxy," to Chapter 16, "Finale - Pas de Deux," illustrate her sense of the dramatic. This captivates the reader who might otherwise think of science as prosaic. In this book we are asked to take for granted the applicable theories of stellar evolution, which are only briefly outlined. Theories predict, for a given assumed chemical composition, what the progress of stars of different masses should be: how long after the beginning of its evolution off the "zero-age main sequence," a star should spend in its various stages, from infancy to ripe old age. "Indeed, one star 'in his time plays many parts.' Yesterday a blue supergiant, today a Cepheid variable, tomorrow perhaps a supernova. Yesterday a star like the sun, today a Mira variable, tomorrow perhaps a planetary nebula."

Among the open clusters, stellar composition does not appear to differ appreciably from one cluster to another. All the members of a given cluster are assumed to be the same age. Intercomparison of color-magnitude diagrams for the different clusters, compared with evolutionary theories, can thus be used to derive the ages of the individual clusters. The ages range anywhere from under one million to over a thousand million years. For the older globular clusters the relative ages are not estimated. Here, differences in composition from one cluster to another complicate the problem. Very much more theoretical work on stellar models is needed for stars with different degrees of metal abundance.

If open clusters seem fairly well understood, one might expect double stars (considered as mini-clusters) to have been all the better explained. This, however, is not the case; sometimes stars that appear to be young are dynamically associated with companions showing the characteristics of old age. Some, but probably not all, of the problems may be related to mass-transfer from one component to the other.

Variable stars, often cited as the only kinds of stars in which evolution can actually be observed, play a great role in solving problems of the evolution of the clusters in which variable stars are found. The text is therefore enriched with descriptions of individual variables and the galactic structure revealed by their groupings.

This book, like all the others by its author, is a goldmine for information on what is already known about clusters and variable stars, where further observational work is desirable, what relevant problems require more theoretical investigation, and finally healthy, exciting speculation. Witness her final sentence. Commenting that the central cores of globular clusters "must inevitably collapse within 10^{10} years," she concludes, "Such an event, a massive supernova, would be more spectacular than anything we have yet witnessed on the restricted stage of our own galaxy."

I should have liked an additional chapter summarizing the contents and the conclusions reached, and outlining the major problems yet to be solved. But that might have seemed anti-climactic after the sentence just quoted.

Stars and Clusters is highly recommended to all AAVSO members. (Note that the AAVSO Atlas is reproduced as an appendix.) For college teachers it could serve for supplementary reading assignments or as a text for an intermediate level course. Professionals will find it a useful reference work.

Especially for the AAVSO I should like to call attention to a few variables Mrs. Gaposchkin indicated as needing further attention. The following six eclipsing stars (cf. p. 221) show some characteristics of novae or dwarf novae at minimum, but no major outbursts have ever been recorded: TT Ari (10.2-11.8 p), EM Cyg (11.9-14.4 p), VV Pup (14.6-17.1 V), VZ Scl (15.6-16.1 V), RW Tri (13.50-16.04 B), and UX UMa (12.7-13.8 p). At least the brighter of these should be incorporated into nova-search programs.

This brings us to the close of Cecilia Payne-Gaposchkin's era. She was unquestionably the greatest woman astronomer of the mid-twentieth century. Hers represents the acme of scientific writing that is both good science and excellent literary composition. She marks (we hope) the end of taken-for-granted discrimination against professional women.

Perhaps hers also marks an era of transition in observational astronomy. At the turn of the century, greatest emphasis was given the vast accumulation of survey data on positions, motions, magnitudes, spectra, and the apparent groupings of celestial objects. These data were needed to stimulate the formulation of basic theories on the structure, composition and evolution of the universe. Progressively, the emphasis in optical observational astronomy has shifted. In 1925 Cecilia Payne wrote (Stellar Atmospheres, page 191) in regard to the Henry Draper system of spectral classification, "Instead, then, of examining the possible merits of the best theoretical classification system, it appears to be more useful to examine the physical implications of the most representative classification that has been found possible to make in practice." On the future of astrophysics she stated (ibid., page 199), "The direction in which progress lies will depend on the material available, on the development of theory, and on the trend of thought." Nowadays it is largely the astrophysical theory itself that dictates what further observations are still required for its verification and ultimate perfection. Statistical surveys have moved from the visual and photographic range into the far ultra-violet, x-ray and infra-red, and at all wavelengths from our local cluster of galaxies toward the ultimate limits of the observable universe. Cecilia Payne-Gaposchkin has done more than her fair share in the interpretation of the universe, and has, moreover, stimulated many younger astronomers to progress still farther into the promised land of understanding.

ERRATA AND MISCELLANEOUS COMMENTS

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Figure 4.14. The designations h and chi Per are interchanged, the center diagram being for h Per.

Throughout the volume the abscissae of the color-magnitude diagrams are sometimes given as B-V, sometimes $(B-V)_o$. The text does not call attention to any distinction. Normally the latter refers to the colors corrected for extinction. By comparison with the diagrams published by Gretchen Hagen (Pub. DDO, 4, 1970) we find that for all except Figure 7.12, p. 105 (where the coordinates for the Perseus clusters differ from those in Figure 4.14) the abscissae should be $(B-V)_o$. This correction, however,

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plays little role in the discussions in the text.

Legend for Figure 4.14: the omitted reference to Robert L. Wildey is Astrophys. Journ. Supp. 8, 439, 1964.

97 Middle of page. It is unfortunate that the designation o^2 Cygni is continued here. Kukarkin (private communication) assigned the designation V1488 to the star previously designated o^2 in the GCVS simply because of the frequent confusion in the literature as to which of the three Flamsteed numbers 30, 31 and 32 Cyg should be called o^1, which o^2, all three being variable or variable suspect.

98 It is stated that there are no double stars among the supergiants noted in the 13 clusters listed in Table 7.2. In fact, in NGC 457 the supergiant, ϕ Cas, is part of ADS 1073, a quintuple system; and α Per in Mel 20 is included in the Lick Catalogue of Double Stars where it is noted to have an $11^m.9$ companion at 67". However, it is not determined whether this is a physical or an optical companion.

129-130 Capella is referred to as a red giant. It is yellow.

160 Last line. Word not omitted, "are not confined."

208 V695 and V1488 Cyg are Flamsteed numbers 31 and 32, not 41 and 42, respectively.

226 5th line from bottom of text, "periods between 750 and 850 days," but one of the stars included has a period of 855 days.

Last line of text notes that CI Cygni "has undergone at least one nova-like outburst." Actually three outbursts, in 1911, 1937, and 1971, and a peculiar activity in 1975 have been observed.

THE BOOKS BY CECILIA HELENA PAYNE-GAPOSCHKIN

1. Stellar Atmospheres, Harvard University Press, 1925 (C. H. Payne).
2. Stars of High Luminosity, McGraw Hill, 1930 (C. H. Payne).
3. Variable Stars, Harvard University Press, 1938, with S. Gaposchkin.
4. Stars in the Making, Harvard University Press, 1952.
5. Variable Stars & Galactic Structure, Athlone Press, London, 1954.
6. Introduction to Astronomy, Prentice Hall, 1954.
7. The Galactic Novae, North Holland Publishing Co., 1957.
8. Introduction to Astronomy, 2nd Ed., Prentice Hall, 1970, with K. Haramundanis, her daughter.
9. Stars and Clusters, Harvard University Press, 1979.

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