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The death of Sir Arthur Eddington deprives astrophysics of its most distinguished representative. The history of its advance during the past generation and the story of his work are inseparable.

Those who have been responsible for filling the major posts in English science have been remarkably successful in picking the best men young and giving them the opportunities by which they could profit. Appointments as chief assistant at Greenwich have been so judiciously made that a large proportion of those who later took the leading parts in British astronomy have held this position. Rarely, if ever, was it offered to a younger man than when, in 1906, Eddington, at the age of twenty-four, began his astronomical career; and never was it offered more wisely.

The new assistant had been senior wrangler two years before, and he was fully equipped with that capacity to apply mathematical methods to practical problems which belongs to the great tradition of Cambridge. His first published paper (1907), on the systematic motions of the stars, is a fine example. It treated Kapteyn's two-drift hypothesis (then new) by methods elegant analytically and practical in numerical application. Several papers in the next few years dealt with other problems of stellar motion and distribution and culminated in his first book, *Stellar Movements*, in 1914. A group of papers on the dynamics of star clusters are related to these studies.

Meanwhile he showed his mettle in a very different field. The floating photographic zenith telescope, designed by Bryan Cookson, failed, at the start, to give results of the anticipated precision. The untimely death of its originator left these problems unsolved. Eddington took on this discouraging problem and found that, by changing the program of observation so that the star trails were observed only in a small central region of each plate, the trouble was eliminated. Thus rehabilitated, the instrument was started on a career of almost thirty years of successful operation (interrupted only by the present war). Outstanding small but systematic errors were attributed to local disturbances of refraction, dependent partly on the wind—a conclusion confirmed by the later observations.

In 1913 Eddington was elected, at the age of thirty-one, to the historic Plumian professorship at Cambridge, as Sir George Darwin's successor. Again the sound judgment of the electors was fully justified.

His interest in physical problems, which had already been shown in work on the envelopes of Morehouse's Comet, now became predominant; and his earlier work—excellent and varied as it had been—appears as little more than a prelude to that of the great period which was inaugurated in 1916–1917 with his two papers on the radiative equilibrium of the stars. Here he pointed out, for the first time, the importance of radiation pressure in the internal equilibrium of a star and derived the equation for determining it which has ever since borne his name. He derived the equation of radiative equilibrium and showed that by a simple assumption it became integrable and led to the polytropic sphere with $n = 3$ (now usually described as "Eddington's model"). In the second of these papers he recognized that the ionization in the interior of a star must be so high that the mean molecular weight is small and that, in consequence, the luminosity of a star should be a rapidly increasing function of its mass.

It was not until 1924, however, that—guided partly by observational data—he realized that this highly ionized matter would behave practically like a perfect gas up to very high densities. With this obstacle disposed of and with the aid of Kramers' opacity formula, he made the second great step, in 1924, which led to the mass-luminosity relation in substantially its present form, disposed of the older theories of stellar evolution, and showed that only enormous masses of matter could shine and that the fundamental properties of atoms compelled such bodies to be luminous stars. A year later, by inventing the point-source model and calculating it by quadratures, he showed that the influence of the internal density-distribution upon the mass-luminosity relation was small.

Finally, in 1932, he pointed out that the luminosity for a given mass varied very considerably with the hydrogen content and permitted a determination of the latter. (Strömgren independently reached the same conclusions, publishing these a month earlier.)

This series of investigations forms one of the most original and fertile contributions by which astrophysics has yet benefited. All but the last were collected and summarized in his *Internal Constitution of the Stars*. This volume has every claim to be regarded as a masterpiece of the first rank.

The importance, novelty, and convincing character of its results justify high praise—but its distinctive merit is the unrivaled elegance and lucidity of the presentation. Many good scientific books are compilations—more or less well edited—of separate original papers; but here Eddington has followed Austin Dobson's exhortation:

See that thy form demand
The labour of the file.

The book is itself a work of art. The short introductory chapters on the thermodynamics of radiation and the quantum theory provide the student with all he needs and no more, and so skilfully that the novice will not realize what struggles he has been spared. From beginning to end, the presentation is integrated—the product of a great teacher as well as a great investigator.

Every student of physical science might well be required to read, mark, and inwardly digest the admirable discussion[1] of the relative functions of mathematical rigor and physical insight, which ends: "Whereas, for the mathematician, insight is one of the tools and proof the finished product, for the physicist proof is one of the tools, and insight the finished product."

Other related investigations of Eddington's are given place in the volume. His discussion of the pulsation theory of Cepheid variables has formed the basis of all later work. His treatment of the "reflection" effect in eclipsing variables (along with Milne's contribution made at the same time) is still the last word on the subject. The highly original chapter on diffuse matter in space initiated the interpretation of interstellar lines.

Perhaps the most remarkable characteristic of the book is how well it holds up after nearly twenty years. For some topics, such as the source of stellar energy, the physical basis for a valid theory was not then available. For others, such as the equilibrium of stellar atmospheres and the behavior of absorption lines, so much progress has been

[1] Pp. 102–103 (1926 ed.).

made that a modern treatment would be very different—though here Eddington contributed approximate solutions which are still very useful.

But the main discussion is still required reading for the advanced student, and his teachers do not have to put him seriously on his guard lest he accept outdated concepts. Eddington's physical insight was amazingly sound.

This book marks the culmination of the second phase of his career, and his later contributions in the field were largely amplifications of special points.

He had long been deeply interested in relativistic theory and had published two standard works—one technical, the other more popular. In the third phase of his activity he became more and more deeply convinced that the primary properties of matter and of its ultimate constituents—especially those which are represented by the dimensionless constants which occur in nature—were neither arbitrary nor independent but had simple, and often integral, values, which could be predicted by abstract epistemological reasoning from very general considerations—and that other constants, such as that which relates the apparent velocity of recession of a nebula to its distance, were similarly predictable.

Upon these investigations the present reviewer is not qualified to speak, save to note that, for the most part, they appear to be still *sub judice,* while his disagreement with the ordinary formulation of relativistic degeneracy appears to have been shared with no one else.

A quite different side of his interests is represented by the Gifford Lectures on "The Nature of the Physical World," one of the most notable contributions of our times to the discussion of the relation between the realm of "pointer-readings" and that of values.

No summary of his work would be complete without mention of his gift of epigrammatic wit. Everyone knows the "hotter place"; fewer, perhaps, know his imaginary Scottish professor of "geloelogy," who had a comprehensive knowledge of this hypothetical science of humor and could infallibly classify any kind of joke—without ever having *seen* one!

Less familiar, because buried in a British Association report from which the writer is obliged to quote from memory, is: "When an investigator has developed a formula which gives a complete representation of the phenomena within a certain range, he may be prone to a certain satisfaction. Would not he be wiser if he should say 'Foiled again! I can find out no more about Nature along this line.' " At times he turned the joke upon himself. In a cloakroom at the Stockholm meeting of the International Astronomical Union in 1938, he said: "I always hang my hat on peg 137"—suiting the action to the word!

Few people cared less for formal distinction. A very vivid memory from the same meeting is of the delegates gathering at their hotel before a formal banquet, at which courtesy demanded the wearing of decorations, and of Eddington in the crowd, with an ancient raincoat, buttoned tightly at the neck—to hide the Order of Merit!

He came of a family of quiet people—long and sincerely devoted to the principles of the Society of Friends—and, apart from the honors brought him by his work, his life was uneventful. He never married; his widowed mother and his sister (who survives him) made for him a home perfectly adapted to his temperament and his work.

After a short illness, the gravity of which did not reveal itself until near the end, he died, on November 21, 1944, leaving a name which will endure in the annals of science and warm memories among a host of friends.

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