

THE STUDY OF STELLAR EVOLUTION

The Study of Stellar Evolution: An account of some recent methods of astrophysical research. By George Ellery Hale.

COULD we unravel the history of the growth and decay of an oak by inspection of a random assortment of oaks in all stages of growth? Most of us would probably answer in the affirmative; we should feel hopeful of arranging the specimens in rough sequence, and should then only have to decide whether the progression was from acorn to deadwood or deadwood to acorn, says the London Times. Professor Hale has accordingly chosen this illustration in order to render cheerful the prospect of solving the problem of stellar evolution; for it is his way to treat some difficulties as non-existent and to make light of others, and the difficulties respond in marvellous fashion to his estimate. What looked impossible yesterday Professor Hale shows to be feasible today, and will accomplish tomorrow.

But the problem of unravelling the life-history of a star is in reality immensely more complex than the illustration just given. Let us add specimens of other trees to the collection of oaks alone; let us "dwarf" the individuals in all degrees, as the light of the stars is dwarfed indefinitely by unknown remoteness; finally, let us remove the whole collection, with the exception of one single tree, to such a distance that we can no longer distinguish form in any individual, but only the general color of the leaves; we shall then approximate more nearly to the complexities presented by the problem of arranging the stars according to their life-history. The one tree which is not to be transported corresponds, of course, to our own sun, the one star which we can study in some detail, though its place in the series remains to be assigned. We have, however, now exaggerated the difficulties in one particular. In banishing the trees generally to a distance where they lose form, like the stars, we have taken no account of the nebulae, which have recognizable forms. It seems probable that the stars are born from nebulae, as oaks from acorns. It is estimated that there are 120,000 nebulae, scattered over the sky, within reach of our present telescopes; and that about half of them are spiral in form. This is a fact of undoubted importance for our problem; and to make our analogy fair we must therefore add some corresponding knowledge of the forms of tree-seeds, as, for instance, that about half of them are acorns.

But it may be doubted whether this will help us much. In face of such a problem it would not be surprising to find several alternative arrangements of the trees in sequence; and we need not be surprised that there are several tentative solutions, differing widely in character, of the problem of stellar evolution. The difficulties of the problem are, indeed, very serious; some of them may remain for ever insurmountable. Meanwhile, it is encouraging to find that one or two which looked terrifying have yielded to resolute attack, so that considerable advances have been made. For example, it is little more than half a century since the way seemed blocked by the limitations of star color. The stars certainly differed in color, but what could this tell us? Suddenly came the spectroscopic, assigning a new and fuller meaning to color, and showing that, with proper analysis, color gave the clue to chemical composition; the limitation was swept away as by an advancing flood; and we are still being carried forward on the wave-crest. Again, less than twenty years ago another barrier stood between us and better knowledge of our sun, the one star placed within our easy reach. It seemed as though his very proximity were a disadvantage, for his fierce light blotted out the delicate details which we wish to study. We knew that his chemical structure varied from point to point of his surface, but the general glare prevented our realising the knowledge. Then (in 1892) Professor Hale, the author of the book before us, invented the spectroheliograph, and it became possible to photograph any locality on the sun in infinite variety, according to the distribution of the various chemical elements. With this marvellous instrument it is possible virtually to cut successive chemical sections of the sun's surroundings, much as a naturalist cuts sections of a plant or other organism for examination in the microscope. Once again, it seemed, three years ago, that the spectra of sunspots could not be adequately photographed, though it was possible to make a laborious scrutiny of them by visual methods. To Professor Hale is again due the credit of removing this disability; and he has, within the last few months, followed up this success by making the important discovery that the phenomena of sunspots are magnetic in character. Our knowledge of the sun's surface is, in fact, growing almost beyond recognition, and the growth is largely due to the ability and untiring energy of Professor Hale.

Now, when a man is rapidly exploring untrodden ground, it is not easy for him to find time for giving a popular account of his explorations. Sometimes travellers write such accounts at home, after their journey is ended; but the end of Professor Hale's journey is, let us hope, not yet in sight. We are the more fortunate to get from him in mid-travel so lucid an account of his enterprise as is given in the book before us. It was originally intended, he tells us, as a handbook to the great Yerkes Observatory of Chicago University,

the funds for which were supplied by the late Mr. C. T. Yerkes, while the initiative, the planning of the building, and the organizing of the work were due to Professor Hale. And it seemed until a few years ago as though the establishment of such an observatory provided a sufficient theme for one book, and a sufficient ambition for one man. But since 1904 the same man, armed with the ample resources of

tically with a high tower and a deep well; how a large mirror, five feet in diameter (nearly as large as Lord Rosse's famous six-foot) is also being mounted there, and how a gigantic mirror of eight feet four inches is being constructed. We may read further why mountain air is needed for these giant telescopes, and of the toil of transporting them 6,000 feet up to the top of Mount Wilson, to which the

night after night that they might give exposures to the photographs of star-spectra long enough to suit the great dispersion of the giant spectroscopes. But we may also read of the ultimate successes which justified all this anxious toil and expenditure, and can even see them for ourselves, in the beautiful pictures with which the book is profusely illustrated. These wonderful photographs, which we may

they had wrested from nature; nowadays those whose resources enable them to climb most rapidly are eager to shower down on those expectant below the fruits they gather; and the two great observatories founded by Professor Hale have been conspicuous for such generosity.

Does the installation of the huge instruments in these great observatories mean that small telescopes are now superseded and that there is no place for the worker with modest means? We might as well ask whether the invention of the steam engine has put an end to walking. Nevertheless the contemplation of these vast resources has produced an uneasy feeling in some quarters that it is futile to work with small telescopes in poor climates. A chapter in the book before us is specially devoted to the dispelling of this misconception: "If this feeling were well-grounded," writes the founder of two great observatories, "it might fairly be asked whether the great observatories are worth their cost. For the history of astronomy teaches that much of the pioneer work has been done by amateurs, usually with modest means and in unfavorable climates. To discourage this class of workers would be of serious error, hardly to be atoned for by any services the larger observatories can render." Professor Hale writes with all the deeper feeling on this matter because he himself began with small apparatus, and has never forgotten the delights of his early work: "None of the pleasures of later years during which I have enjoyed the privilege of using larger and more powerful instruments has surpassed the delight of the initial work, much of which was done with simple and inexpensive apparatus of my own construction." In reading of his successive advances from this early stage we realize more fully how a man who had learned how to pass from small to large could use his experience to pass from large to gigantic. The seeds of the man's successes were no doubt sown by the crude essays of the boy. What further successes are to come can scarcely be even guessed; we may quote the following characteristic paragraph as a conclusion: "It is impossible to predict the dimensions that reflectors will ultimately attain. Atmospheric disturbances, rather than mechanical or optical difficulties, seem most likely to stand in the way. But perhaps even these, by some process now unknown, may at last be swept aside. If so, the astronomer will secure results far surpassing his present expectations."

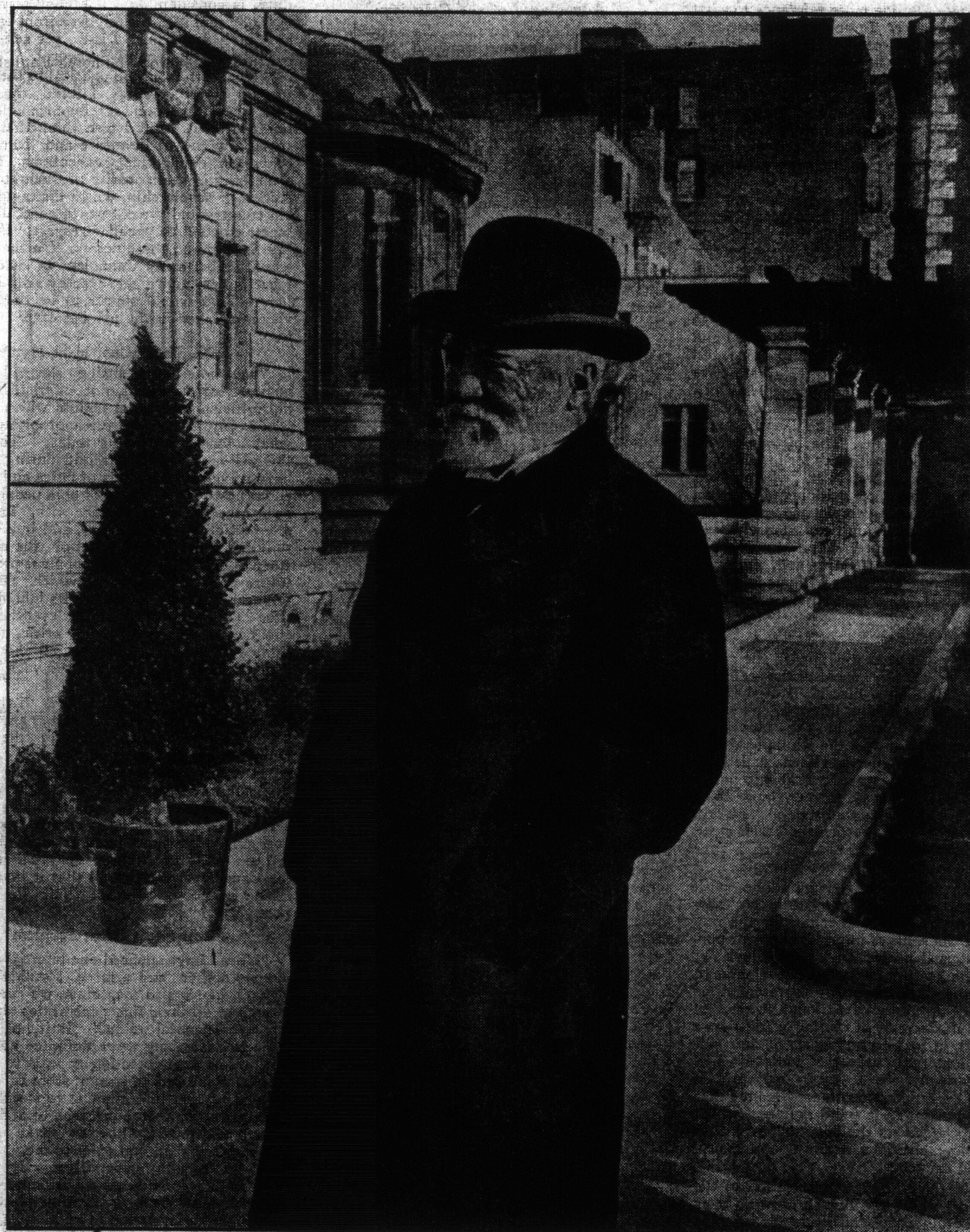
A PRETENDER'S JOKE

A little story of the Duke of Orleans is going the rounds in Paris. It is no secret that Duke Philippe is not always very careful of his jokes, and when a practical joker is the pretender to the throne of France he should be careful. Some time ago the Duke of Orleans needed money for the cause. He was yachting at the time, and it was arranged that a multi-millionaire, who was believed to be willing to invest money in the fortunes of the Fleur-de-Lys, should meet the Duke and lunch with him on board his yacht.

At table, to see what he would do, the Duke had the bad taste to empty the contents of a salt-cellar into his guest's glass. "He has eaten my bread, and I wonder," he said, "whether he will drink my salt." The millionaire had seen the trick in a looking glass opposite him. He pretended not to have noticed it, and drank up the objectionable mixture. He took leave of the Duke of Orleans without a word about the cause, and when he had been put on shore said quietly to the secretary who escorted him: "Pray tell his highness that I had the idea of offering him a well-lit little bit of sugar for the bird. I noticed at luncheon, however, that he—er—prefers salt, so I refrained from doing so."—London Express.

The coolness between the Kaiser Wilhelm and the Princesse de Lippe-Detmold is, says the Manchester Guardian, of long standing. It dates in fact from the time when Count Ernest of Lippe-Biesterfeld, the father of the present reigning Prince, Leopold IV, assumed the Regency of Lippe-Detmold on account of the mental incapacity of the then reigning Prince, Charles Alexander. According to the hyperstrict rules of the German reigning houses, Count Ernest was barred from succeeding to the throne himself on account of a marriage of one of his immediate ancestors with a lady of non-Royal rank. However, the people of Lippe were determined to have him for Regent. The arrangement by no means suited the Emperor, who had a candidate of his own for the coveted post in his brother-in-law, Prince Adolf of Schaumburg-Lippe. This Prince was a younger brother of Prince George of Schaumburg. Prince George was the direct heir to the throne if the Biesterfeld branch were ruled out as morganatic, but, as he already held a principality, he would have stood aside for his younger brother, the Kaiser's brother-in-law. However, on the death of the Regent, Count Ernest, his son, Count Leopold, succeeded to the Regency, notwithstanding the fact that his mother also was non-Royal.

The man with a boil on his neck doesn't borrow trouble. He has all he wants.



FOUNDER OF THE FUND FOR THE HEROES OF CIVILIZATION: MR. ANDREW CARNEGIE, PHILANTHROPIST TO THE EXTENT OF TWENTY-FIVE MILLION POUNDS.

Mr. Carnegie has set apart one and three-quarter millions of dollars in five per cent Bonds, yielding £12,500 a year, for the making of money grants to injured heroes and their families during the disability of those heroes, and to the widows and children of heroes who may have lost their lives in the United Kingdom. In the course of his letter announcing the formation of the trust, Mr. Carnegie says: "We live in an heroic age. Not seldom are we thrilled by deeds of heroism where men or women are injured or lose their lives in attempting to preserve or rescue their fellows; such are the heroes of civilization. The false heroes of barbarism maimed or killed their."

The Dunfermline trustees have as yet made no arrangements for the management of the Carnegie Hero Fund. They have been convened for next Thursday, but it is not likely that then any definite scheme will be adopted. The truth is that the work assigned them has come upon them very much as a surprise. It is true that on the occasion of their visit to Skibo several weeks ago Mr. Carnegie foreshadowed his purpose of establishing some new project or institution in connexion with which he would like their aid, but he did not specify the particular purpose he had in view. In a long, earnest, confidential talk he had with them he spoke of service for humanity as the truest form of religion, assured them of his grateful appreciation of their administration of the Dunfermline Trust, and expressed his confident anticipation of their co-operation with him if he instituted a scheme of national advantage to be worked from Dunfermline. The idea formed in the minds of most of the trustees by this earnest commendation of service for the public benefit and the appeal for co-operation was that some enlargement of the Lauder Technical School, erected in Dunfermline in memory of his uncle, or of the School of Hygiene, projected by the trustees in consultation with the Education Department, was likely to be undertaken, and little or no thought of the possibility of the new benefaction taking the form of a British Hero Fund seemed to have entered the minds of the trustees until a few days ago, when copies of the report of the operations of the American fund were circulated. Neither time nor opportunity, therefore, has been given the trustees for the elaboration of principles or rules for their guidance, but it is generally assumed that they will follow pretty closely the methods which have been adopted for the American fund.

A large and commodious building lately acquired by the Commercial Bank and adjoining the Carnegie free library is being altered to make it suitable for the headquarters of the trust, with board and committee rooms and accommodations for the necessary secretarial staff. The work of the trustees during the past five years encourages the expectation that, as administrators of the hero fund for the British Isles, Dr. Ross (the chairman), and his colleagues will prove equal to the responsibilities placed upon them. Dr. Ross, who is private legal agent for Mr. Carnegie, and treasurer of the Scottish University Trust, is a man of high character and wide experience, keenly interested in educational advancements and moral reform. Associated with him as trustees are two representatives of the clerical and the medical, as well as the legal professions, of the local linen industry, of the town council, and of the school board, with two workmen leaders, all of them citizens of character and capacity and held in high respect by the community in which most of them have spent all their days. Undoubtedly their local patriotism is ardent, but they are considered to be singularly free from the influence of a narrow provincialism and capable of taking a wide and intelligent view of national claims and service.—London Times.

the Carnegie Institution, has founded an even more surprising observatory on the summit of Mount Wilson, in California; and the book has been expanded to include these new wonders. Herein accordingly we may read not only how the biggest lens in the world has been mounted and set to work near Chicago, but also how the two longest telescopes in the world have been set up on Mount Wilson, one horizontally along the ground, and one ver-

only access is a narrow mule track; of the great snowstorm which delayed the work, and how repairs and extensions of the narrow track which had been carried out with much labor and expense were washed away in heart-breaking fashion; of the difficulties made, after these others had been conquered, by the shy sun himself, who tried to elude scrutiny by distorting his own image with his own fierce heat; of the long vigils of the workers

study in our own armchairs, practically put us in possession of the same knowledge which has been won by others with so much labor; there is no need for us to erect a huge telescope for ourselves, or even to look through one already erected; we can learn much more by the careful study of these and similar photographs, all readily accessible. The world has, indeed, travelled far from the time when discoverers concealed in anagrams the secrets



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