OUR ASTRONOMICAL COLUMN.

ROTATION PERIOD OF VENUS.—A telegram just received from Herr Backlund, through the Centralstelle at Kiel, reads as follows:—"From four spectrograms Belopolsky has been able to confirm the *short* rotation period of Venus."

ELLIPTIC ELEMENTS OF THE VARIABLE Y CYGNI.—Prof. N. C. Dunér, of Upsala, has computed the elliptic elements of the Algol Variable Y Cygni, and gives his results with a derived ephemeris in the *Astronomische Nachrichten*, Bd. 152, No. 3633.

Elements of Y Cygni.

Epoch	$t_0 = 1885{\cdot}0 + 342{\cdot}8930d.$
Anomalistic motion of apse line ..	$\omega = 0^\circ{\cdot}035928$
Eccentricity	$e = 0^\circ{\cdot}14535$
Anomalistic revolution	$U - 2{\cdot}996933d.$
Semi-major axis	$A - 8{\cdot}0$

PHOTOMETRIC OBSERVATIONS OF MERCURY DURING SOLAR ECLIPSES.—Dr. G. Müller, of Potsdam, has for some years made systematic measurements of the brightness of the planet Mercury for phase-angles varying from 50° to 120°. No observations could be made nearer than 50° from the sun. From his results, he finds that the relation giving the light-curve of Mercury is almost identical with that obtained by other workers in the case of the moon. This similarity could be very severely tested if the brightness of the planet could be determined directly at the phase-angles from 0° to 50°. In the *Astrophysical Journal* xi. pp. 144–147, he suggests that an excellent opportunity to carry out this work will be presented during the coming total eclipse in May 1900. The phase-angle for Mercury at the time of the eclipse will be about 7°, and its angular distance from the sun about 2°.

Venus will be the most suitable object for comparison, being about 40′ east of the sun at the time of the eclipse, with a phase-angle of 113°. It will be advisable to use small objectives of very short focus, so that the images of the planets may appear as practically points of light; it is also desirable to employ only those photometers with which (as is the case of Zöllner's) the effect of the different brightness of sky background is eliminated.

VARIATION OF LATITUDE.—Prof. Th. Albrecht, of Potsdam, gives a *résumé* in the *Astronomische Nachrichten*, Bd. 152, No. 3633, of his continued discussion of the results obtained at various stations for the motion of the earth's pole. The observations have been made at the following stations:—Tokyo, Kasan, Moscow, Pulkowa, Prague, Potsdam, Lyons, New York, Philadelphia and Washington, during various periods extending from 1892·3 to 1899·9. The co-ordinates of the pole as deduced from these new results are plotted in continuation of Prof. Albrecht's former curve. During the period 1895·0 to 1895·6, the motion appears from the curve to have been in the opposite direction to that followed since, although several complete revolutions have taken place.

PLANETARY WORK AT THE MANORA OBSERVATORY.—Herr Leo Brenner communicates to the *Naturwissenschaftliche Wochenschrift*, Bd. xv. No. 13, pp. 145–150, his report of the work done at the Manora Observatory during the past year. Besides the drawings of the planetary markings, which is the chief undertaking of the institution, the scope of routine work included observations of the sun, zodiacal light, double stars and meteors. The report is illustrated by twenty-eight reproductions of drawings of the planets Mars, Jupiter and Saturn, showing the various markings mentioned in the text. The spots on the ball of Saturn appear to have been continually seen.

THE DEVELOPMENT OF ASTRONOMY IN AMERICA.

SIXTY years ago the United States had scarcely a single observatory properly equipped for the pursuit of astronomical studies. To-day that country is possessed of the finest observatories in the world, manned by observers of the greatest skill, who devote themselves untiringly to the advancement of the oldest of the sciences.

The success of the American astronomers during this short period has been remarkable. To them we owe important discoveries and precious records in nearly every branch of theoretical and practical astronomy, and especially of late years in the department of astronomical physics. It is impossible here to recount the whole fruits of their labours, but it is worth while to recall a few of the results which we owe to their industry.

The first striking discovery in America was that of Hyperion, the seventh satellite of Saturn, by G. P. Bond, in 1848. In the same line of work, Hall was rewarded in 1877 by the discovery of the tiny satellites of Mars, and more recently Barnard astonished the world by his detection of the fifth satellite of Jupiter, while Pickering claims to have established the existence of a ninth satellite of Saturn. In planetary studies generally, the Americans have been well to the front, and we have seen the unusual spectacle of a powerful refractor primarily devoted with marked success, by Mr. Lowell, to the delineation of the surfaces of our nearest planetary neighbours. Numerous measurements of the dimensions of the various members of the solar system have also been made, and the theory of their motions has been greatly advanced, notably by the well-known investigations of Newcomb.

Cometary astronomy has likewise benefited by their zeal, many new discoveries having been made, and the orbits of a large number calculated; in this branch the Americans are now more active than ever, no less than six of the seven new comets discovered in 1898 being to their credit. Important investigations relating to meteorites and the orbits of meteor swarms have also been carried out, and the name of Prof. H. A. Newton will always be associated with this department of astronomical research.

Sidereal astronomy has been enriched by numerous star catalogues, and double-star observation has been brought to a high standard of perfection by the assiduous efforts of Burnham, Hall and See; while Pickering's "Harvard Photometry" has given us an invaluable record of the magnitudes of thousands of the brighter stars. The study of variable stars has also been very productive, our most important catalogue of these objects being due to Chandler, while a unique atlas of variable stars is in course of publication by Prof. Hagen; here, as in many other directions, Prof. Pickering's ingenuity has been displayed, and he has shown among other things how variables of short period can be readily detected, and the changes studied, by photographic means.

Our catalogues of nebulæ discovered since the time of the Herschels include a large number of entries to the credit of American observers, Lewis Swift having specially distinguished himself in this field of work.

Notable work has also been done in the domain of solar physics. Young's observations of the chromospheric spectrum have only been surpassed by the most recent eclipse photographs, and Prof. Hale was the first to initiate a regular photographic record of the forms of the chromosphere and prominences. Quite recently, the great telescope of the Yerkes Observatory has been used for a very detailed examination of the spectrum of the chromosphere, and even the most minute structure of the carbon flutings in the green has been successfully observed. To Prof. Rowland we owe a great catalogue of close upon twenty thousand of the Fraunhofer lines, the positions of which are stated with a degree of accuracy never before attempted; and physicists and astronomers throughout the world are indebted to this observer for the magnificent diffraction gratings which his skill has placed at their disposal. By the invention of the bolometer, Langley has opened up a new region of the spectrum, and has made numerous important observations by its aid. At the present time a committee of American astronomers is organising the work to be undertaken during the total eclipse of the sun next May, and from a preliminary report which has been issued we gather that they are fully alive to the opportunities which such an event affords.

Astronomy owes an immense debt to photography, and it should not be forgotten that the first photographic impression of a star was obtained on the other side of the Atlantic, by Prof. Bond, in 1850. Among those who early recognised the possibilities of astronomical photography was Rutherfurd, of New York, who obtained numerous pictures of the sun, moon and stars in the early seventies, the full value of which has only lately begun to appear. It was there also that Dr. Draper, in 1872, secured the first photograph of a stellar spectrum which revealed anything relating to the composition of a star, and that Barnard, in 1892, made the first discovery of a comet by the aid of the camera.

The story, however, by no means ends with this pioneer work; celestial photography has been pursued with the

greatest success in every direction, notable among the results being Barnard's photographic delineation of comets, nebulæ, and the Milky Way, and the magnificent spectroscopic work of the Henry Draper Memorial carried on by Prof. Pickering at Harvard College.

Within the last few years the energetic director of the Harvard College Observatory has been enabled to extend his operations by the erection of a well-equipped observatory in the clear air of Arequipa, Peru, spectroscopic and other data on a uniform plan for the whole celestial vault being thus secured. Prof. Pickering has, in fact, developed the photographic side of his work into a wonderful detective force, so perfectly organised that no new star of reasonable brightness can escape detection, and no important change in a known star go unrecorded. The munificent gifts to the Harvard Observatory have thus, in Prof. Pickering's hands, been put to the best possible uses.

The work of the Lick Observatory is also largely photographic. Here, the great refractor has been employed with the greatest success by Prof. Campbell in photographing the spectra of nebulæ and bright line stars. More recently special attention has been given to the photographic determination of stellar velocities in the line of sight, with the result that a dozen or so of spectroscopic binaries have already been detected, Polaris and Capella being among the most interesting systems thus recognised. Quite recently, marvellous results have been obtained by Prof. Keeler in photographing the forms of nebulæ with the Crossley reflector. The Director's report for the year ending September 1, 1899, indicates a remarkable state of activity among the comparatively small staff of this observatory. The success of these observers is doubtless in some measure due to the wisdom displayed in the limitations which they have set to their work. A well-defined programme, and concentration upon it, appears to be the policy adopted, and the truly scientific spirit which controls their investigations is exhibited by the following remarks from Prof. Keeler's last report: "Comets which are bright enough to be easily seen at the leading observatories receive only occasional attention, while comets which, by reason of their faintness or unfavourable position, are difficult of observation, are followed as closely as possible. . . . The Lick Observatory makes the most of its natural advantages; and extended theoretical researches, which can be made as well in a city as at a fine observing station, do not form part of our general plan." In this way the output of useful observations is greatly increased, and the co-ordination of different facts can be carried on by workers generally. The same spirit prevails at Harvard Observatory, where "precedence has been given to physical work, since less attention is paid to such work elsewhere," and the photographic records there accumulated have been placed at the service of any one properly qualified to discuss them.

The Yerkes telescope, in the hands of Burnham, Barnard and Hale, has already been very productive. One of the most important pieces of work undertaken here is the photographic registration of the spectra of the Piscian (III.*b*) stars; and the wealth of detail recorded in such difficult objects is truly remarkable.

But it is by no means only in observatories furnished with giant telescopes that astronomical science has been advanced. Admirable work has also been done in unpretentious establishments, and, indeed, with no observatories at all. Gould's investigation of the Milky Way and the distribution of stars is a case in point, and to take another example, a vast amount of energy has been expended in perfecting the *American Ephemeris* and *Nautical Almanac*. Chandler's masterly investigations of the variations of terrestrial latitude also demand separate mention.

Terrestrial researches bearing on astronomical phenomena have not been neglected. Newcomb and Michelson's determinations of the velocity of light are classical examples, and among more recent work reference may be made to Rowland's determinations of the origins of a vast number of Fraunhofer lines, and to Humphrey's and Möhler's investigations of the displacement of spectrum lines due to pressure.

It will be seen, even from this incomplete statement, that the output of astronomical work in America has been very great, and there is every indication that it will go on increasing. The rapid development is doubtless due to various causes, not least among them being the unstinted support given by private benefactors. The American astronomers undoubtedly also owe a great debt to their opticians and engineers, the Lick and Yerkes refractors, with their apertures of 36 and 40 inches respectively, being the crowning triumphs of the instrument makers. Messrs. Alvan Clark's telescopic object glasses have long been justly held in high estimation all over the world, and the skill of Messrs. Warner and Swasey has been fully equal to the task of successfully mounting their mammoth productions.

Some of the success of the Americans may perhaps be attributed to their wise selection of sites for their instruments, when they have been free to exercise their judgment. The Lick Observatory, at an elevation of 4000 feet, is favoured with exceptionally good atmospheric conditions, and the sites of the Yerkes and various other observatories were only decided upon after very careful trials.

Instrumental equipment and good climate, however, are not the only requisites for a successful observatory. Much depends upon the men at the little ends of the telescope tubes, and, we may add, upon the men at their desks or in their laboratories, who bring their minds to bear upon the explanation or utilisation of the phenomena observed, besides suggesting further observations. The training of astronomers is therefore of as much importance as the provision of instruments. Fortunately, America can boast of unparalleled facilities for this necessary training. Students' observatories abound, and in many cases instruction of the most advanced character is obtainable. Of elementary instruction it is scarcely necessary to speak; but American students are to be congratulated if the teaching generally is on such enlightened lines as those indicated in Miss Byrd's "Laboratory Manual of Astronomy," and Prof. Todd's "New Astronomy." A most valuable paper, by Prof. E. S. Holden, on the teaching of astronomy in primary and secondary schools and in the university has recently been published.[1] During the early years of a child's school-life, the lessons must necessarily be simple; and Prof. Holden gives an extremely suggestive sketch of the methods which should be followed, bearing in mind that "the main point is to open the eyes and mind, and the sun and stars are convenient for the purpose." To the teachers of astronomy in secondary schools Prof. Holden also gives many valuable hints. Here astronomy is to be regarded as an "information study," as well as an educative one, and suggestions as to simple apparatus to facilitate the teaching are given.

From our present point of view, however, the most interesting part of Prof. Holden's paper is that referring to the courses of instruction in astronomy offered by some of the American universities and colleges. Particulars are here given of the instruction carried on in fifteen institutions, and they illustrate in the most satisfactory manner the advantages enjoyed by the American student who wishes to acquire an extended knowledge of the subject. The courses are in several cases remarkably comprehensive, and in five of them astrophysics takes an important place in the curriculum. In every case there appears to be an adequate supply of instruments and observatories, and for students desiring to specialise there are abundant opportunities of entering even the best observatories.

The course at the University of Chicago is perhaps the most complete, but the syllabus is too long for quotation; suffice it to say that it includes every department of theoretical and practical astronomy, the astrophysical instruction being carried on at the Yerkes Observatory by the distinguished staff of resident professors and observers. The Director of the Yerkes Observatory some time ago made the following statement as to the relation of that establishment to the work of students:—

"After completing the necessary preliminary work in Chicago, students who desire to devote special attention to observational astronomy or to astrophysics are admitted to the Yerkes Observatory at Lake Geneva, where they are given every possible facility. In addition to pursuing the courses of instruction enumerated in the *Annual Register* of the University of Chicago, students at the observatory may take part in the regular work of research. As soon as they have had sufficient preliminary training, they are encouraged to undertake original investigations of their own." From other notices we gather that this privilege is not restricted to students from Chicago.

At the University of California also an admirable course of astronomy is offered, one item of which may be quoted as illustrating the attention given to practical work:—

"4 A. Practical astronomy. Lectures and observatory work. Navigation and nautical astronomy. Practical work in the

[1] "Report of the Commissioner of Education, 1897-98." Vol. i. p. 869. (Washington, 1899.)

observatory. Six hours observatory, first half. Three hours lecture and six hours observatory, second half."

The University possesses an excellently equipped students' observatory, in addition to the world-famous establishment on Mount Hamilton. Graduates of the University, or indeed of other universities of equal standing, are received at the Lick Observatory to pursue a higher course of instruction in astronomy; every facility consistent with the scientific work of the establishment will be given them, and they will usually be assigned as assistants to some of the astronomers. An illustration of the bond between the greater and lesser establishments is afforded by the recent computation at the students' observatory of the elements of a comet from observations telegraphed by the astronomers at Lick. (Pub. Ast. Soc. *Proc.* vol. xi. No. 70 p. 190.)

From the information which Prof. Holden has collected, we gather that special students of promise have also the privilege of entering into the regular work of the observatories at Harvard College, and the Universities of Yale, Michigan, Virginia, Wisconsin and Pennsylvania.

The special value to the student of this association with the staff of an observatory is admirably stated by Prof. Holden in a report on the Lick Observatory, from which he makes the following quotation: "No institution in the world is better fitted to give such instruction, and there is a special impetus to be gained in an observatory which is regularly pursuing work of discovery and research. The student comes directly into the current, and learns far more by observation of the methods of others than by the study of text-books. He can take part in the regular work of the observatory also." This happy arrangement is not only beneficial to the student. Prof. Holden further remarks: "It is a great advantage to the university as a whole to count among its members a considerable number of active and ambitious young men who are able to work with some independence to advance science, and not merely to acquire what is already known. They set a standard of scholarship to all the undergraduates. Such students can take a useful part in the actual observations of every day as assistants, and after some practice they become valuable aids in our work of computation and observation, and supplement the permanent force of the observatory in an important degree."

No wonder that with advantages like these there is an adequate supply of highly-trained young astronomers capable of fully developing the great resources which the scientific spirit of wealthy Americans has placed at their disposal. It appears to us that it is precisely for want of opportunities for securing the necessary technical training to future observers that the astronomical development of our own country proceeds less rapidly than that of America. While it is possible to obtain a certain amount of tuition in spherical astronomy, and here and there a modicum of practical instruction in the older branches of the subject, facilities for the study of astrophysics are almost completely lacking, and it is a deplorable fact that the universities are especially deficient in this respect.

Under the Science and Art Department a general study of astronomy is encouraged, but the subject is incorporated with a variety of other subjects, under the comprehensive title of Physiography, and no separate certificate for astronomy is granted.

At the universities, astronomical teaching appears to remain in much the same position as the teaching of chemistry and physics before the introduction of practical work in those subjects, the prevailing idea apparently being that if a mathematician can be placed at the head of affairs in an observatory, it matters little who makes the actual observations, or whether observations are made or not. There can be little doubt that means exist for establishing schools of astronomy comparable with those which have arisen for other branches of science, and we sincerely hope that the need for serious attention to practical teaching in astronomy will soon be recognised.

So far as we know, there is only one institution in Great Britain where any attempt is made to give practical instruction in astronomical physics, and even in this case the greater part of the instruction is necessarily of a somewhat elementary character, in consequence of the small amount of time available for the subject.

It is a natural consequence of our inadequate provision for technical education in astronomy—more particularly in the newer branches—that vacancies in our observatories must be filled by observers who have still to make practical acquaintance with the work expected of them. Much loss of time and apparent inactivity is the result.

It may be urged that benefactors of the science of astronomy are less numerous here than in America, but the generous gifts of Dr. F. McClean to Cambridge University and the Cape Observatory, and of Sir Henry Thompson to the Royal Observatory, Greenwich, remind us that they are not wholly wanting. Besides, there are already numerous observatories scattered throughout the country which might be made more productive by putting them in the hands of observers who have received adequate training. Public interest in astronomy is by no means absent, and British observatories would, perhaps, receive a much increased measure of support if it were not for the possible impression that the best work can only be done in America, and that instruments of the largest size are alone useful.

THE FLIGHTLESS RAIL OF NEW ZEALAND.

THE most important ornithological event in New Zealand, in recent years, was the capture of a fourth specimen of the Takahe (*Notornis hochstetteri*), on the west side of Lake Te Anau, in August 1898. Prof. W. B Benham sent us an interesting description of the bird at the time of its capture (vol. lviii. p. 547), and a more detailed account by him is referred to in a paper, by Sir Walter L. Buller, in vol. xxxi of

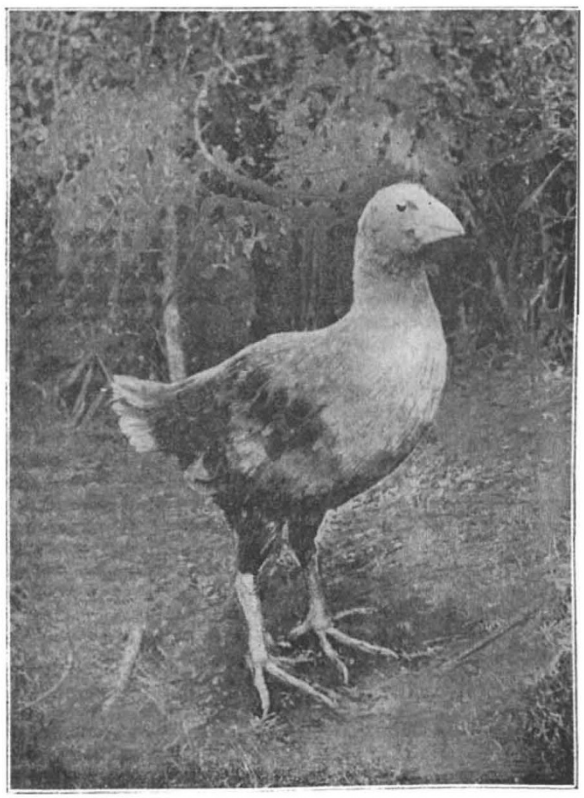

FIG. 1.—The rare *Notornis* of New Zealand.

the *Transactions* of the New Zealand Institute (1898), which has just reached this country. The following particulars, with the accompanying illustration, have been derived from this source:—

In size the bird is like a goose, but in colouration it resembles the Pukeko; its breast is a beautiful rich dark blue, becoming duller on the neck, head, abdomen and legs. These last are clothed with feathers for a greater distance than in the native turkey, but they are relatively shorter and much thicker than in the latter bird. One of the most noticeable characteristics of the bird is its beak—a large equilateral triangle of hard pink