consuming the thirteen pages on which he discusses the factor of light entirely, with explanations of the physiological influence, although in passing he mentions its ecologic value as follows:

"The importance of light from the standpoint of plant geography, although in its influence upon form and life of the plant significant, is much less than that of temperature and hydrometeors; the differences in light intensity from climate to climate are insignificant in comparison with these factors. Yet, until Wiesner accentuated this influence it had usually been undervalued. The difference in intensity of light in the different climatic zones and the increasing duration of sunlight from the equator to the poles leave their impression upon the vegetation. Still more important, to be sure, is the significance of light for plant topography, since for the characterization of the single formations of a region the great differences of lighting are important."

But for any expansion on this part, namely, the topographic importance of light, we look in vain.

The relative tolerance or endurance of light among the tree species within a given climatic range is probably the most important ecologic factor which determines the character of the association. The tolerant, if adapted to climate and soil, must ultimately drive out or reduce in number the intolerant or light-needing, even though perfectly adapted to climate and soil. This accounts for the sporadic occurrence in the mixed maple-beech-hemlock-spruce forest of such light-needing species as the black cherry, the ash, the elm. It accounts for the existence of the most intolerant bald cypress or larch in the swamps, where their competitors could not follow. It accounts for the change of forest type under the influence of man, the alternation of species observed on burns and slashings.

An ecological study of the relative shade endurance of our important species is the most important need of the silviculturist.

And so we might enumerate any number of problems of practical importance for the solution of which the practitioner is waiting. And as in other sciences, which were first deduced from empirics and now direct the practice, so for ecology has come the time to direct the practice.

B. E. FERNOW.
CORNELL UNIVERSITY.

WORK OF THE LICK OBSERVATORY.*

THE Lick Observatory suffered an irreparable loss in the untimely death on August 12, 1900, of Dr. James Edward Keeler, director from June 1, 1898. Our appreciation of his worth has not grown dim with time. Dr. Keeler's last observations were made with the Crossley Reflector in the hope of recording the image of a ninth satellite of Saturn, reported to exist by Professor W. H. Pickering. No trace of the satellite was detected, but the plate of June 28, 1900, led to the discovery of an asteroid, 1900 GA—probably the faintest one known.

While the Observatory is preeminently an observation station, yet it is not so in a narrow sense. Success in observational work demands: (1) Knowledge of what has been done by others; (2) knowledge of pending problems, and of the most promising methods for their solution; (3) knowledge as to how observations will be used, and when they should be made, in order that they may bear most efficiently upon the problem. An institution whose efforts were confined strictly to securing observations would soon be making inferior observations. Progressive observers must be acquainted with the theories of their

* Abstract of the Director's Biennial Report, Lick Observatory, University of California, July 1, 1900, to July 1, 1902.

subjects, and must undertake occasional theoretical studies, as well as computations of considerable extent.

The hydraulic engine for turning the dome of the great telescope had been working badly for several years, limiting to an appreciable extent the productiveness of the telescope itself. It was found that the brass feed-cylinders of the engine were badly worn, permitting very considerable leakage, thereby in effect decreasing the hydraulic pressure on the pistons. The cylinders were drilled true, and new piston-heads were provided. It is gratifying to report that the dome and its entire mechanism now perform at least as satisfactorily as they did when new.

The original design of the great telescope did not provide for power to wind the driving clock; it was wound by hand. A Pelton water-wheel was installed for this purpose in 1890, but it never had sufficient power to do the work without assistance from the observer. In the past year the water power has been applied more directly to the wheel. The winding apparatus now acts immediately, without assistance from the observer.

Further to increase its efficiency, Mr. Wright has designed, and the instrument-maker has constructed, a device for turning the water power on and off automatically. This will be put in place in the near future; and it is hoped that the observer's duties in connection with the clock will be confined to starting it in the evening and stopping it in the morning.

The need of a wind screen in the opening of the dome had been felt for many years. The violent vibration of the telescope when the opening was turned toward the wind made it impossible to secure accurate observations. An effective screen was erected in 1901.

The efficiency of the thirty-six-inch equatorial was enormously increased a few years ago by illuminating the setting circles by means of electric lights operated from the eye end, thereby making it unnecessary for the observer to climb the high mounting, as he had theretofore done many times per night. Astronomer Hussey has recently equipped the twelve-inch equatorial (under his charge) in a similar manner, with good results.

Many minor improvements on the mounting of the Crossley Reflector have contributed somewhat to its stability, but the necessity for providing this instrument with a new mounting has become more apparent with time to all who have used it. Director Keeler's remarkable success was achieved at enormous expense of time and physical energy. On the average, it was necessary for him to make four or five exposures on an object before a suitable negative was secured; and in many cases he had to be satisfied with enlarged and elongated star images. His experiences have been those of Assistant Astronomer Perrine, who is now in charge of the instrument. If the mirror were provided with a suitable mounting, observers possessing their great skill should have no difficulty in obtaining three successful negatives out of four attempts. The regents in 1901 authorized the construction of a new mounting, and it is well under way.

A generation ago the astronomer ordered his telescope, and expected it to meet all his requirements. This is no longer sufficient. The wonderful developments of our science call for special instruments to do special work, and the so-called universal instrument is out of date. This is especially true in investigations along astrophysical lines. The successful instrument must have maximum efficiency in the problem to be solved. Every observatory of our class requires an instrument-making shop near at hand. This requirement is especially pressing here, on account of our unusual isolation.

The shops at the Lick Observatory were entirely inadequate for their purpose, and I decided to utilize the first available funds for their proper equipment. The thoughtful generosity of Mrs. Hearst, regent of the university, has enabled me to complete them sooner than was expected.

The observatory early in 1901 began to publish the results of its observations in the *Lick Observatory Bulletin*. The earlier papers by members of the staff had appeared in various astronomical journals. While this plan relieved the university of expense and considerable labor, yet the vexatious delays sometimes occurring in the issue of important papers, and the appearance of the papers in so many mediums, were serious objections. The new plan has worked well. The bulletins have been supplied gratis to other observatories, to academies of sciences, and to the principal investigators.

The observatory library is growing rapidly, as far as growth by exchange of publications is concerned, but early volumes of several scientific periodicals, early volumes of observatory reports now obtainable only from second-hand dealers, and many standard books, both old and recent, are greatly needed. It is planned to supply a few of the most pressing of these needs in the near future from the funds provided by Mrs. Hearst. The library contains about 5,000 volumes and 4,800 pamphlets.

It was Director Keeler's purpose to secure with the Crossley Reflector satisfactory photographs of about one hundred of the principal nebulæ and star clusters. The portions of his program available for observation in our clear summer weather were practically complete at the time of his death, but those in position during the cloudy winter months were incomplete. We have made it a duty to carry on this work as rapidly as possible. As soon as satisfactory negatives of all the objects have been obtained, the results should be published in the best possible manner.

Visitors continue to come to Mt. Hamilton in great numbers, aggregating about five or six thousand per annum. Provision is made for explaining to them the principal features of the observatory in the day time, and for permitting them to look through the thirty-six-inch and twelve-inch equatorials on Saturday nights. In nearly all cases these privileges are appreciated. This work is useful in many ways, perhaps most of all in its resemblance to instruction along university extension lines.

The daily service of accurate time signals to the Southern Pacific Company has been continued. The signals sounding in all the offices of the system are available to the inhabitants of the regions traversed by their lines: north to Portland, east to Ogden, and south to El Paso.

The total value of gifts to the observatory in the period covered by this report has been $35,200.

Through the continued generosity of Mr. William H. Crocker, a well-equipped expedition, in charge of Acting Astronomer Perrine, accompanied by Assistant Ralph H. Curtiss, sailed from San Francisco in February, 1901, to observe the total solar eclipse of May 18, on the west coast of Sumatra. The ten instruments were duly mounted and placed in perfect adjustment. Fifteen volunteer assistants, Dutch residents in Sumatra, were trained to their duties, and the entire program of photographic exposures outlined for the expedition went through without a hitch. All went well, save that the eclipsed sun was obscured at the beginning of totality by thin clouds, which gradually thickened during the six and one half minutes of the eclipse. Nevertheless, when the negatives were developed it was found that the observations were extremely satisfactory, valuable results having been secured with all of the ten instruments.

The photographs obtained with the forty-foot camera are admirable, the general features of the inner and middle corona being shown as well as if there had been no clouds. A most interesting and unique coronal disturbance was recorded in position angle 60°. A comparison of the solar photographs with those made on the days preceding and following the date of the eclipse by English observers in India, led to the very important conclusion that the coronal disturbance was situated immediately above the prominent and only sunspot visible on those days.

The spectrographic and polarigraphic results were completely successful, perhaps more so than would have resulted from an unobscured eclipse. They established that the spectrum of the outer corona is identical with that of ordinary sunlight, and therefore that the light of the outer corona is not inherent, but is reflected light originating in the main body of the sun; that the spectrum of the inner corona is continuous, and therefore is not reflected sunlight; that the outer corona shows the strong polarization effects that would be expected to result from its character as reflected light; and that the inner corona gives only slight evidence of polarization, as would be expected from light largely of an inherent character.

Mr. Perrine has carefully examined the plates secured with four cameras for the purpose of detecting any possible intra-Mercurial planets. The instruments gave splendid definition, and in the unobscured areas surrounding the sun stars down to the ninth magnitude were recorded. The search was highly satisfactory for more than two thirds of the area under examination, but the clouds prevented complete success in the remaining one third. All the images on the plates were identified as those of known stars.

The discovery of the minor planet Eros in 1898, and the recognition of the unusual opportunities offered by it for an improvement in our knowledge of the distance of the sun, led to the organization of a cooperative scheme on the part of forty or fifty leading observatories, to secure the necessary observations in the fall of 1900. The Lick Observatory entered energetically upon the program outlined. Astronomer Tucker secured more than two thousand meridian circle observations of the 678 reference stars, required as a basis for the entire problem. The microscopes were read by Dr. R. T. Crawford for about 1,600 of the observations, and he rendered some assistance in the computations, but Mr. Tucker was unassisted in the bulk of the reductions. The prompt completion and publication of this extensive piece of work, long in advance of the appearance of results from other observatories, called forth many expressions of admiration for the energy and skill of the astronomer in charge.

Micrometer measures of the position of Eros were obtained by Astronomer Hussey and Assistant Astronomer Aitken, with the thirty-six-inch equatorial. The former made 832 measures in right ascension, and 896 in declination; the latter 1,650 in right ascension and 729 in declination. Photographic observations were secured with the Crossley Reflector by Assistant Astronomer Perrine, assisted by Fellow H. K. Palmer. They include 344 plates on sixty-three nights for accurate meridian places of the planet; 511 plates on thirty-seven nights for a parallax; 110 charting and connecting plates; total, 965 plates, of which 854 contain short exposures for measurement, carrying over four thousand images of the asteroid. The measurement and reduction of these plates will be an enormous task. Fortunately, Professor Rees, director of Columbia College Observatory, has agreed to undertake that work. His efficient bureau of measurement and reduction, in immediate charge of Professor Jacoby, has already measured and reduced a number of the plates.

Perhaps the most interesting astronomical events of recent years relate to the new star in Perseus, discovered in Edinburgh on February 22, 1901. The Lick Observatory, in common with all similar institutions, made immediate plans to bring every available resource to bear upon the study of this star. Its position was measured by Mr. Tucker with the meridian circle, and by Mr. Aitken with the thirty-six-inch equatorial on several occasions in the spring and summer of 1901. It is clear from their observations, amply confirmed by those made elsewhere, that the new star is at least as far away as the faint stars surrounding it, and that its motion with reference to the surrounding stars is so slight as to elude detection for the present. The spectroscopic observations by Messrs. Campbell, Wright, Reese and Stebbins were extremely fruitful in results.

A photograph by Wolf, of Heidelberg, on August 23, 1901, had led to the discovery of masses of nebulosity in the vicinity of the new star. A photograph by Ritchey of the Yerkes Observatory on September 20 confirmed and extended the discovery, showing that the new star was apparently situated in a nebulous mass nearly circular in form, and of great extent. The photograph of this region made by Mr. Perrine with the Crossley Reflector on November 7 and 8 when compared with Ritchey's published photograph of September 20, led to the extraordinary discovery that the well-defined nuclei in the nebula were apparently in rapid motion; the magnitude of the apparent motion being at least seventy-five times as great as any sidereal motion previously known. Telegraphic announcement of this discovery was made at once, and intense interest was taken in the subject. A photograph made by Ritchey at the Yerkes Observatory, on November 9, afforded full and independent confirmation of Mr. Perrine's remarkable discovery. Photographs made at intervals throughout the winter have enabled us to follow the motions of the brighter masses.

Later examination of our early photographs of this region, by Mr. Perrine in January, 1902, led to the discovery that two rings of nebulosity surrounding the new star were beautifully recorded on the plate of March 29. We were thus able to extend the history of the phenomenon backward five months.

The nature of the phenomenon is a mooted question. The favorite theory is that invisible masses of nebulosity existed in this region previous to the formation of the new star; and that the great wave of light, sent out when the brightness of the star was at a maximum, was sufficient to illuminate the dark masses and make them visible to us by reflected light. Bearing upon this question, Mr. Perrine secured valuable polariscopic evidences. A photograph of the nebula was obtained after passing the light through a double-image prism, placed at a short distance in front of the plate holder in the Crossley Reflector. Two images of each of the principal nuclei were recorded in such a way as to make it certain that the polarization effects to be expected from reflected light are entirely absent.

The consensus of opinion is that the new star is the result of a violent collision between two dark stars, or between a dark star and a nebula. It can easily be shown that the kinetic energy of two such bodies, approaching and colliding with enormous relative speed, would be converted into heat in sufficient quantities to transform the dark bodies into incandescent gases. The history of previous new stars had led us to expect that the spectrum would gradually change into that of a nebula, and in this we were not disappointed. For a suitable study of the present nebular spectrum of the new star it was necessary that further and more accurate investigations be made upon the spectra of the well-known nebulæ. These investigations were undertaken with great success by Assistant Astronomer Wright. He determined the positions of many well-known nebular lines more accurately than had previously been done, and a number of very interesting new lines were detected.

Very little attention has been given to the subject of comet-seeking, on account of pressure of work in other lines.

Micrometer observations of comets in the past two years have been secured, as follows:

Comet	*a* 1900,	Aitken	3	nights,	Perrine 4	nights.
"	*b* 1900,	"	10	"	" 3	"
"	*c* 1900,	"	6	"		
"	*a* 1901,	"	2	"		
"	*a* 1902,	"	2	"		

Valuable photographs of comet *a* 1901 were secured by Mr. Perrine at the Eclipse Station in Sumatra. An orbit of comet *b* 1900 was computed by Mr. Perrine, and of comet *c* 1900 by Mr. Aitken. Some very interesting photographs of comet *b* 1900 were secured by Mr. Palmer.

Extensive series of measures of satellites of planets were obtained by various members of the staff, observations being limited in all cases to those most desired by investigators of their orbits.

Two hundred and fifteen observations of the relative positions of the satellites of Saturn were made by Mr. Hussey with the thirty-six-inch equatorial.

Mr. Aitken made the following observations with the thirty-six-inch equatorial:

Satellites of Uranus,	27	nights.
" " Neptune,	13	"
" " Mars,	7	"
Fifth satellite of Jupiter,	2	"

At the request of Professor Newcomb, Mr. Perrine photographed the planet Neptune and its satellite on thirty plates, in January, 1902, with the Crossley Reflector. The measurements of these plates furnish fifty-one determinations of the position of the satellite, with reference to its primary. Photographic methods have been but little used in this line of work, and it is interesting to note that the smallness of the errors of observation justifies the application of the method in all possible cases.

The work with the meridian circle has been most efficiently prosecuted. Since July 1, 1900, Mr. Tucker has obtained 6,500 complete observations. These include observations of Eros comparison stars; of Eros itself; of Nova Persei; and of zodiacal stars, greatly needed at the present time, to be used as a basis for improving the orbits of the major planets.

The manuscript for 'Lick Observatory Publications,' Volume VI., is entirely ready for the printer. The volume will contain results of meridian circle work from July, 1896, to March, 1901, and will include about 14,000 complete observations of 4,500 stars.

Fellow R. T. Crawford assisted in meridian circle work during the years 1898–1901. At the end of his service he received the degree of doctor of philosophy, having taken for his thesis the subject of 'The Refraction Constant at Mt. Hamilton.'

The department of astronomy known as double stars has been most ably advanced by Messrs. Hussey and Aitken. Their programs have been admirably developed and systematized, and results of prime importance have been surprisingly numerous. It is not too much to say that their discoveries and observations of new double stars, and their measures of known double stars, outnumber several-fold the corresponding output of all other observatories in the past two years. Both observers have devoted a portion of their time to the discovery of new pairs. Mr. Hussey has found 312 systems in the past two years, and 564 since 1898. They may be classified as follows:

Distances between	0″.00	and	0″.25,	41	pairs.
	0 .26	"	0 .50,	103	"
	0 .51	"	1 .00,	123	"
	1 .01	"	2 .00,	128	"
	2 .01	"	5 .00,	168	"
		Over	5 .00,	1	"
			Total	564	"

The corresponding discoveries by Mr. Aitken have been 249 since July, 1900, and 345 since 1898, as follows:

Distances between	0″.00	and	0″.25,	20	pairs.
	0 .26	"	0 .50,	55	"
	0 .51	"	1 .00,	78	"
	1 .01	"	2 .00,	91	"
	2 .01	"	5 .25,	101	"
			Total	345	"

By way of explanation, it should be said that in general the closer the components of a pair the more interesting and important it is. The majority of stars in which orbital motions have been detected are closer than 1″. Up to the present time about 1,500 double stars with distances under 1″ have been discovered at all the observatories. More than one third of these have been found at the Lick Observatory, and more than one fourth of the whole number have been discovered here within the last three years.

Many interesting results have come from the systematic observation of the well-known interesting pairs. Of these, the most striking case is Delta Equulei. It was supposed that its period of revolution was eleven and four tenths years—surpassed in rapidity of motion only by Kappa Pegasi, period eleven and one third years. In the fall of 1900 it was noticed by Mr. Aitken that the components of Delta Equulei were not following the paths marked out for them by the orbit hitherto accepted as substantially final. Mr. Hussey investigated the question of their orbit, making use of all the known observations. He came to the conclusion that the chances were greatly in favor of a period only one half the length of that previously assumed, namely, five and seven tenths years. Systematic observations by Messrs. Hussey and Aitken during the past year have established the correctness of this view. The period of this interesting binary is fifty per cent. shorter than that of any other known double star. Observations of this system obtained with the Mills spectrograph are in harmony with Mr. Hussey's theory.

Mr. Hussey has also in the past two years secured 1,899 observations of W. Struve, Otto Struve, miscellaneous and new doubles.

Mr. Aitken has obtained 1,431 observations, his observing list being mainly composed of known rapid binaries, and other close and difficult pairs. He has likewise computed orbits for 99 Herculis, Zeta Sagittarii and Beta Delphini.

Mr. Hussey completed his observations and discussions of the Otto Struve Double Stars, and his work was issued in the summer of 1901 as Volume V., 'Publications of the Lick Observatory.'

The Crossley Reflector has been busy on practically every good night. In addition to the observations already referred to, Messrs. Palmer and Dall made thirty-three exposures on the nebulæ contained in Professor Keeler's program, in the first half of 1901. Mr. Perrine has since secured twenty-three exposures on these nebulæ, twenty-eight exposures on the Rumford variable star regions referred to above, and twenty-five exposures for miscellaneous purposes.

A small slitless spectograph was designed by Professor Keeler for use on faint objects with the Crossley reflector. It was completed on the day of his departure from the mountain. It was tested promptly by Messrs. Campbell and Palmer, who found it necessary to use convex and concave quartz lenses in connection with the quartz prism, in order that the rays should be parallel when passing through the quartz prism. These changes were designed by Mr. Palmer, and the instrument was used extensively by him. He secured seventy spectrograms of the smaller planetary nebulæ and of other small objects. Many interesting facts resulted from these observations. I shall refer only to his success in photographing extremely faint spectra. A strong image of the spectrum of Nova Cygni, visual magnitude about 15.5, was obtained with ease. Successful exposures could probably be made on stars at least a magnitude fainter. His photograph of Nova Cygni demonstrates that the spectrum, which was nebular in 1877, has now become continuous, like that of the ordinary stars.

In addition to the observations of Eros, positions of asteroids 1900 GA, Ohio, and Palatia, were determined by Mr. Palmer, from photographs taken with the Crossley reflector. Mr. Hussey secured eight observations of the asteroids Minerva, Edna, 440, and Chicago. Messrs. Palmer and Curtiss have recently secured photographs of several asteroids whose positions were requested.

Three nights per week with the thirty-six-inch equatorial have been devoted to the determination of the motions of the brighter stars in the line of sight, with the Mills spectrograph, during the past six years. The accuracy of the Lick Observatory determinations has steadily progressed until, for the stars containing fine lines, the probable error of a single determination of velocity is only about 0.25 kilometer.

To the list of fifteen spectroscopic binaries discovered prior to Director Keeler's report of July 1, 1900, I desire to make twenty-three additions, as follows:

Beta Herculis,	12 Persei,
Xi Ursae Majoris	93 Leonis,
Delta Bootis,	Beta Scuti,
113 Herculis,	2 Scuti,
Eta Andromedæ,	Kappa Pegasi,
Pi Cephei,	31 Cygni,
Xi Piscium,	Tau Persei,
Xi Prime Ceti,	Epsilon Hydræ,
Delta Equulei,	Alpha Equulei,
Zeta Herculis,	Phi Persei,
Omicron Andromedæ,	Eta Geminorum.
Gamma Canis Minoris,	

These thirty-eight systems have been discovered since 1898.

There is room for reference to only two of the stars on the above list: Zeta Herculis is a short-period visual binary star, completing a revolution in about thirty-three years. The velocity of the principal star in the line of sight is slowly varying. Kappa Pegasi is one of the most interesting visual binaries known, period eleven and one third years. Until the discovery of the true period of Delta Equulei, this was supposed to be the shortest period known. One of the components of Kappa Pegasi is a spectroscopic binary, having a period of only six days.

These binary systems have been discovered in the process of determining the velocities of about 350 stars; in this list of 350 previous observers had discovered three binaries. Without taking into account a list of several suspected binaries, it is apparent that of the brighter stars at least one in every seven or eight is attended by an invisible companion. When we consider that spectroscopic methods are at present capable of discovering only the larger variations, that very few stars of long periods have probably been advantageously observed as yet, and that the velocity of our sun, due to the orbital motions of the planets attending it, has a double amplitude of only two or three hundredths of a mile per second, there can be no doubt that the number of spectroscopic binaries must be very great. It is probable that the star unattended by dark companions will be found to be the exception rather than the rule.

Mr. Wright has computed the orbit of the spectroscopic binary Chi Draconis; Dr. Reese, that of Capella; Director Campbell, that of the variable star and spectroscopic binary Zeta Geminorum; and Dr. Crawford, that of Eta Pegasi.

Dr. Reese investigated the question of the diffraction of light of variable intensity, with special reference to the Mills spectrograph, as a guide in designing a more powerful instrument. He has likewise investigated the cause of the discrepancies between measures of spectrograms made with the violet end to the left, and with the violet end to the right, as a result of which he established the purely physiological cause of the discrepancy.

Dr. Reese has also designed a new mounting for the Mills spectrograph.

Photographs and preliminary measures of several hundred spectra have been made by Messrs. Campbell, Wright and Reese; and a considerable number of definitive measures have been made.

In December, 1900, the director utilized the results obtained for the velocities of 280 stars situated north of —20 declination in determining the speed and direction of the motion of the solar system through space. The result for the speed of the solar system comes out 19.9 kilometers, or 12.4 miles per second. The apex of the motion is in R.A. 277° 30′, declination +20°. The result for speed is very satisfactory. On account of the absence of material from the southern hemisphere, and the consequent irregular distribution of the observed stars over the sky, the direction assigned must be regarded as a rough approximation.

The average velocity in space of the 280 stars is 34.1 kilometers per second. The velocity of the solar system is therefore much less than the average for the other stars.

Another result of great interest is to the effect that the fainter stars are moving much more rapidly than the brighter ones.

The velocities of the stars have been observed to bear all values between sixty miles approach and sixty miles recession per second.

Investigations in this line have been shown to be practically endless, by our measurements of the velocity of the star Groombridge, 1830. A special effort was made to measure its velocity, as this is the star which up to three years ago had the largest known proper motion. Its photographic magnitude is in the neighborhood of 7.5. The results obtained have shown that the observations may be extended by present methods to stars perhaps a magnitude fainter. Stars available for measurement are therefore numbered by thousands. As soon as half a dozen of the eight or ten great telescopes now engaged in this work have been made to produce accurate results, it will be highly desirable that the interested observatories arrange and carry out a scheme of cooperation on a large scale.

From Mt. Hamilton it is possible to secure the speeds of the stars between the north pole and 30° south declination. The stars in the quarter of the sky from 30°

south to the south pole remain unobserved. For many years it has been my desire to organize an expedition to the southern hemisphere for the purpose of measuring the velocity of these stars. With the approval and endorsement of the president, the subject was brought to the attention of Mr. D. O. Mills, who most generously offered to provide funds for constructing the instruments, for defraying traveling expenses, and for paying the salaries of the astronomers engaging in the work.

For this work, a Cassegrain reflecting telescope is nearing completion. The parabolic mirror of thirty-six and one half inches clear diameter and the convex mirror of nine and four tenths inches are being constructed by the John A. Brashear Company.

A powerful three-prism spectrograph, designed by the director for use with the reflecting telescope, is completed. The delicate parts of the mounting were constructed by our instrument-maker, and the optical parts by the John A. Brashear Company. Mr. Wright has submitted the whole spectrograph to severe tests. Its performance appears to be superior even to that of the original Mills spectrograph. A modern steel dome was built for the expedition by the Warner and Swasey Company. The minor pieces of apparatus required have all been provided. It is planned to select a suitable observing station in the vicinity of Santiago, Chili. It is confidently hoped that this work will be at least as fruitful as that carried on with the Mills spectrograph attached to the thirty-six inch equatorial.

The director wishes to make full acknowledgment of the enthusiastic support afforded him by the members of the observatory staff. Every man has been ready to make the most of the opportunities supplied by the splendid instruments, by the unexcelled climatic conditions, and by the excellent policy inaugurated for the observatory by the officers of the University of California.

W. W. Campbell,
Director of the Lick Observatory.

SCIENTIFIC BOOKS.

Der Hercynische Florenbezirk. Grundzüge der Pflanzenverbreitung im mitteldeutschen Berg- und Hügellande vom Harz bis zur Rhön, bis zur Lausitz und dem Böhmer Walde. Von O. Drude. Leipzig, Engelmann. 1902. Pp. xix + 671.

This is the sixth volume in the series of monographs of Engler and Drude under the general title of 'Vegetation der Erde.' Having been specially elaborated by Dr. Drude, it may be taken to represent the standard adopted and the principles which it is designed to embody as the work progresses farther. The region covered includes central Germany, and is familiar to the author, as he tells us, through thirty years of field and herbarium work.

As indicated in previous volumes, the scope of the general work is a study of the vegetation of the earth from the standpoint of geological development, on the one hand, and adaptations to environment, on the other. By a natural division of material and labor, two lines of work have been developed, namely, floristic observations and the study of biological relations. It is to the first of these that the present volume is mainly, though not exclusively, devoted.

The discussion of geographical and climatological data is followed by a brief statistical résumé, in which it appears that, within the limits of the Hercynian region, 1,564 vascular plants occur, besides some 645 species of bryophytes, and possibly 2,000 or more thallophytes. The flora is a composite in which occur numerous Baltic elements associated with northern Alpine forms, and in which north Atlantic species as well as circumpolar Arctic ones are also represented. There are in the whole region but few, and these not strongly marked, species that do not occur in