The Photographic Methods of Up-to-date Astronomy

Cambridge, Mass., Nov. 17.—Of the fourteen new stars discovered since Tycho Brahe found the celebrated Nova in Cassiopeia in 1572 six were first noted on negatives preserved in what Dr. E. B. Knobel, the president of the Royal Astronomical Society of London, has recently referred to as that "enormous treasure" of astronomical photographs stored up for the perpetual use of astronomers at the Harvard Observatory. These six stars, all of which were found by Mrs. W. P. Fleming, who has had charge during the last fifteen years of the Harvard photographic collections, are Nova Normae, Nova Cattigae, Nova Centauri, Nova Sagittarii, Nova Aquilae, and Nova Persei—not the Nova Persei of this year, which is known as No. 2, but an earlier Nova in the same constellation which appeared in 1887. The record of photography appears even better when one recalls the fact that in the period during which these six stars were found only two others were discovered elsewhere—both of them visually by Dr. T. D. Anderson, of Edinburgh, the discoverer of Nova Persei No. 2. Then, when it is remembered that stellar photography has been practiced for little more than fifty years, and for about fifteen years systematically, the significance of this list of new stars in illustrating the increasing importance of the camera in astronomical work will be better appreciated.

Harvard, as it so happens, is now, and always has been, the centre of astronomical photography. The first star photograph ever made was taken at the Harvard Observatory in 1850 by George P. Bond, afterwards the second director, but at that time acting as an assistant to his father, William Cranch Bond, the first director. Prof. Bond used the old-fashioned daguerreotype plate in 1850 and wet plates in 1857, the dry plate which is now universally used by astronomers not having then been invented, but the results which he obtained were remarkably interesting, and his three papers, published in 1857, dealing with the methods and aims of his work, foreshadow its recent wide application and still possess practical value.

At present over 110,000 negatives, ranging in size from four by five inches up to 20 to 24, are carefully filed away in a three-story, fire proof, brick building in the observatory grounds which is devoted exclusively to photographic work. Many of these negatives have been taken in Cambridge; many under the clear skies of Arequipa, Peru, where Harvard maintains its permanent southern station; while others are the result of such expeditions as the one recently sent out to the Island of Jamaica, where a notable series of photographs of the moon, which later will be incorporated in a new atlas of the moon, has been made under exceptionally favorable atmospheric conditions. The plates used in this widely extended work are all distributed from Cambridge. Those intended for Arequipa, for example, go from the makers by rail to New York, by water to Panama, across the Isthmus by rail, thence by steamer again to Mollendo, Peru, and after being put ashore on lighters are carried, first by rail and then by pack mules, to their final destination in the Andes. When used, they are developed at Arequipa and sent back to Cambridge by the same route, each with a record for travel that few persons, perhaps, would equal in a lifetime.

Whether a plate comes from Arequipa or Jamaica or the developing laboratory in Cambridge, however, it is subject to the same routine in the Cambridge photographic department. First it is examined by Mrs. Fleming—the original negative, and not a print from it, being used throughout—who rates it as to quality on a scale of five: plates which are practically worthless; that is, being marked 1, and plates which are practically perfect 5. Poor plates which may yet be useful in completing a series are marked 2; better plates, good enough for making estimates of light or position, are 3; while plates which are sufficiently clear and distinct for measurements of precision are marked 4. All the plates, before exposure, are lettered and numbered—the latter representing the series to which the plate belongs, showing by what telescope it was taken, and in what class of work the telescope was used; while the numbering in each series is chronological. The position of the center of the plate—its right ascension and declination, that is, as recorded by the instrument at the time the photograph was taken—is noted, together with the date of taking and the period of exposure, these data, of course, being forwarded by the observer. A negative then goes to an assistant, who places it on a star chart, drawn in general on the same scale as the plate itself, so that the negative may be moved about until the stars in the center coincide with the stars on the chart, and in this way the real position of the center of the plate in the sky obtained, and any possible error in the record at the instrument corrected. It is thus possible, without delay, to verify in Cambridge work done at Arequipa, thousands of miles away.

After this the disposition of the plate depends upon the class to which it happens to belong. If it is a chart plate—that is to say, a plate taken without the interposition of a prism—it is filed in a stack, unless immediately required for some special piece of work, and indexed in a catalogue, so that the astronomer may at once refer to it if any question comes up as to the position or character of a star which is included in its field. If it is a negative showing the spectra of the stars, it is laid for Mrs. Fleming personally, who examines it in detail with a magnifying eye-piece. Any variation from the normal in the character of a star is carefully noted in ink on the back of the plate, with a separate record elsewhere, so that even if the first record should be erased the object might still be identified. Not only were the six new stars previously mentioned discovered as a result of this careful examination, but hundreds of variable stars, so-called have been found in the same way.

There are two very interesting differences in chart plates, due to different methods in taking them. In the more common form the instrument and the plate have followed the stars, which thus appear as points of light, while the planets, faint planets, or asteroids, appear as lines of light. For very faint planets, on the other hand, a method has lately been used with much success in which the plate follows the planet, the stars forming meteor-like trails and the planets points. Again, in photometric work, in which the comparative light of the stars is to be measured and where photography is often of the greatest use, the camera is purposely set out of focus, so that the stars appear as surfaces, instead of either points or lines, thus making it easier to compare one with another.

The instruments by which the photographs are taken are quite as interesting as the negatives themselves. For the small telescopes, such as the four-inch transit photometers which are used every clear night at both Arequipa and Cambridge to photograph every star crossing the meridian from sunset to sunrise, an apparatus of clockwork is used, of sufficient accuracy to follow the star upon which the center of the plate is set; but in larger telescopes this is not practical. For one thing, atmospheric refraction so increases from the zenith to the horizon that a star at the horizon is raised a distance equal to the diameter of the sun. Again, the stars do not move directly from the horizon to the zenith, or from the zenith to the horizon, but swing in a circle around the Pole Star, so that the path upward or downward is in the form of a long curve. Moreover, as a telescope moves from the zenith toward the horizon the tube of even the best instrument is subject to what is called a "flexure," or "spring," with a similar trouble in the mounting, the difficulty increasing, of course, with the size of the telescope. Thus a series of motions, none of which is constant, other than the apparent motion of the stars, must be taken into account.

Mr. E. S. King, one of the assistants at the observatory, has, it is true, devised an intricate driving apparatus to meet these various difficulties, and a small telescope mounted in accordance with his plan is in daily use at Cambridge, but the eye is still required to correct the machinery of the larger instruments. For instance, the Bruce 24-inch doublet photographic telescope at Arequipa, the largest and most powerful star camera in the world, is equipped with clockwork which keeps it set with approximate precision, but in addition there is also a movable eye-piece for visual observation, by means of which the least variation from the guiding star may be immediately detected and corrected.

The amount of photographic work annually accomplished by the Harvard Observatory is little less than astonishing. For several years the entire sky was photographed at least twice a year at the two stations, but of late the work has been extended until now the entire sky is photographed at least once a month both at Arequipa and in Cambridge. In addition, various sections where the stars for some reason have special astronomical interest are photographed even oftener. Arequipa, being nearer the equator, takes in more of the Northern stars than Cambridge does of the Southern, but the two overlap sufficiently to give a fairly complete record of the heavens each month, in spite of occasional unfavorable weather conditions at one station or the other. The work requires the constant service of the four-inch transit photometers already spoken of, two eight-inch doublets, one at each station, the eleven-inch Draper photographic telescope at Cambridge, and the thirteen-inch Boyden telescope at Arequipa. To the great Bruce doublet at Arequipa falls the work of photographing the fainter stars and the clusters and nebulae.

It is often asked why so many photographs are necessary when there is no apparent variation in the stars and when the great majority of the plates are merely filed away without special examination. The answer is that a continuous record may at any time be required—a fact which was notably in evidence in the case of the planet Eros, when it appeared in 1898. Search was then made through the Harvard plates, and images of the planet were discovered upon twenty-six negatives, twenty between October, 1893 and May, 1894, and six two years later, so that its position and path during the entire time that it was near the earth could be accurately and conveniently determined from data which could never have been gathered, even, except for the photographic camera. And this is only one of a great number of such instances, where the Harvard collection of photographs, as the largest and most valuable in the world, has been useful not only to the Harvard astronomers but to astronomers all over the world.

An idea not only of the really extraordinary extent of the Harvard photographic work but of its great variety may be obtained in the number of plates recorded in some of the different series. From the eight-inch Bache doublet at Arequipa, for example, no less than 27,810 plates have been received in Cambridge, while several hundred more are now in transit or are awaiting shipment. From the eight-inch doublet at Cambridge 27,446 negatives have been obtained. The great twenty-four-inch Bruce doublet has taken 5,432 plates; 13,486 have come from the eleven-inch Draper photographic telescope in Cambridge, and the thirteen-inch Boyden telescope in Arequipa has furnished 10,247. Besides these there are many plates from special apparatus. The telescope camera set upon the Pole Star at Arequipa has taken 2,297; 1,726 negatives of sections of the sky thirty degrees square have been secured with the Cook lens camera; the transit photometer in Cambridge has taken 4,202; the Pole Star apparatus in Cambridge 4,086; and 973 out-of-focus plates have been taken with the Ross lens at Arequipa. One need not know either astronomy or photography to appreciate something of the amount of sheer work involved in such figures as these.

There is one other use which the director of the Harvard Observatory finds for the camera, and this use the unscientific may find equally interesting with the strictly astronomical work on which it is ordinarily employed. By means of photographs which are constantly being forwarded to him in Cambridge he is able to exercise the closest supervision over all the work of the Harvard stations in other parts of the world. The astronomer in charge of the station at Arequipa or Jamaica writes to Cambridge recommending certain changes and illustrating his suggestions with photographs of existing conditions. If the work is authorized, photographs showing what progress is being made are taken almost day by day, so that the director, thousands of miles away, is able to keep track of what is being done almost as well as if he were on the spot. As a result there is a series of plates in Cambridge which show in detail the development of the Arequipa and Jamaica stations, including the preparation of the mountain sites, and the installation and condition of every piece of apparatus.

George W. Brooks Relates a Close Call

From the Atlanta Journal.

Much is being written now of reminiscences of the civil war, "Close Calls," etc.

I wonder how many know how near the country was to being plunged into the civil strife four years before it was and how that war was averted and deferred for four years.

By your permission I will relate a circumstance which came under my personal observation and which has never before been published and is known to comparatively few. But before I relate the occurrence I will preface it with this: The repeal of the Missouri compromise in 1850 and the Kansas and Nebraska legislation and the excitement incident thereto had greatly depleted the Democratic ranks in the North, with corresponding accretions to the number of their opponents, when in 1856 the Republican party was organized with Gen. John C. Fremont, of the United States army, as their nominee for the Presidency. He was called the great "path finder," and his name was aglow with the fame of his having crossed the great Rocky mountains to explore the then comparatively unknown Californias. He had married Miss Jessie Benton, the brilliant and accomplished daughter of Thomas H. Benton, the United States Senator for thirty years from the State of Missouri. She had been reared chiefly in Washington and had been petted and favored by most of the public men of the country. Probably no woman of her age was better known than she, which was supposed to be another element of strength for Fremont. Freesoilism and anti-slavery propaganda were more aggressive, all of which sent an apprehensive fear, dread and alarm throughout the country, especially in the South.

The Democratic party surveyed the field, saw the only hope and chance was to carry the doubtful State of Pennsylvania and that it could be done only by nominating James Buchanan, of that State, which consideration caused the sacrifice of so good a man as President Franklin Pierce, who was so much entitled other wise to a second term.

The campaign opened and progressed. Noses were counted, with an increasing fear and dread that Fremont would be elected. And now comes the incident promised.

With such a result staring the country in the face Henry A. Wise, then Governor of Virginia, wrote private letters to all the Governors of the Southern States to meet him in Raleigh, N. C., on a certain day to consider what the South should do in case of Gen. Fremont's election. The time came, I think in August or early in September. The whole thing was kept a profound secret, lest it might be exaggerated to the injury of the Democratic nominee, Mr. Buchanan.

I was living in Raleigh at that time, but three years out of college. Thomas Bragg was Governor of North Carolina, a brother of "A-little-more-grape-Captain Bragg," then of the United States army, and afterwards Gen. Braxton Bragg, of the Confederate army.

Governor Bragg sent me a message that afternoon by his private secretary, Mr. Pulaski Cowper, to come to the mansion that night. I went and found there Wise, Bragg and Governor Adams of South Carolina, and four other gentlemen of the city, to-wit: Messrs. A. M. and R. G. Lewis, Edward Cantwell and Quentin Busbee, all Democratic lawyers. I was the youngest man of the company except one, Mr. Pulaski Cowper.

Wise was greatly disappointed and chagrined that the other Southern Governors had not met him as requested. After supper had been disposed of and some little time spent in conversation in courtesy to Mrs. Bragg, the conference was begun.

Wise was in favor of forcible resistance to Fremont's inauguration in case he should be elected. Adams approved. Bragg was more conservative, as were also those of us whom he had invited. We all appreciated the gravity of the crisis upon the country, but could not see the way clear for forcible resistance. Governor Wise did the talking, chiefly, while Adams laughed approvingly at his "wise" sayings. Bragg felt that a great responsibility was upon him and he smoked his pipe furiously, while great drops of perspiration rolled down his face. The rest of us were content with giving Governor Wise with questions to bring him out on the different phases of the situation and the remedy proposed.

Among the many things he said in his own peculiar style I remember this: "If the South tamely submits to the inauguration of such a sectional candidate as Fremont they will stink in the nostrils of all the world and of all generations to come."

Late in the night, when all the city was in slumber, Mr. Wise, at a climax of thought and feeling, sprang from his chair to his feet as if touched with fire. With his hand uplifted and index finger pointing to heaven (and no man ever had such an index finger as Henry A. Wise), he said: "Gentlemen, Virginia has within her borders 70,000 stands of arms, and by the help of the God who made me, before John C. Fremont shall be inaugurated the President of the United States I will command them in the streets of Washington."

For the want of the other Southern Governors, no co-operation was determined upon, and the conference adjourned at a late hour of the night. As we escorted the two visiting Governors back to their hotel up Fayetteville street the chickens were crowing for day.

After they had departed for their respective States those of us who knew what had occurred, and believing that Wise meant every word he had uttered, got together at different times and counseled among ourselves. We felt that the great fight ought to be made at the polls.

At this juncture an appeal came from the national Democratic committee asking for funds to defray the expenses of the campaign. We had no millionaires then to furnish the money, and their plan was to send speakers from the South into Pennsylvania, the real battleground, to pledge the people there if they would vote for their own honored statesman, James Buchanan, the South would give him in return every electoral vote south of the Potomac and the Ohio. We were not bloated bondholders, but we gave our little money for that purpose as freely as if it were water.

The November election came, and Pennsylvania was saved by the skin of the teeth. Fremont was defeated, the crisis was averted, and the war deferred for four years. Peace reigned again in Warsaw.

Truly, this was a "close call" for the whole country. War would as certainly have broken out on the election of Fremont as it did four years afterward at the election of Lincoln. Wise would have seized Fortress Monroe, Harper's Ferry and every other point of vantage in Virginia, he being in the saddle himself to command.

South Carolina would have supported him as Governor Adams had pledged that famous night; the Gulf States were known to be more extreme than the Atlantic States, and if they had not supported Wise by State action, thousands would have flocked to his standard on their individual responsibility. He would have been able to haul an army upon the city of Washington equal in numbers to that which the Confederates marshaled at Manassas in the spring of 1861. He would have seized the government at Washington with all the archives, its immense treasury, and all the arms and munitions of war within reach. He would have been the chief—like Jackson in Florida, he would not have stickled about the law, nor would he have carried into the execution of his purposes the red-tape dignity which Jeff Davis did; nor would he have known any such fabian policies as characterized the campaigns of Lee, Beauregard and the Johnstons. His fight would have been furious and fast; his war-cry would have been heard amid the shock and din of battle.

I do not say it would have been a better fight than was made four years afterwards, but I say it would have been a different one. It could not have resulted any worse; it might have ended better. Henry A. Wise proved his devotion to his country by following the Confederate flag, from the beginning to the end at Appomattox; stood in the ditches up to his knees in mud and water like other soldiers. But it was well known that he was not himself under command, as in command. His was a proud, imperious nature, born to lead and to command.

In a letter from him in 1872 to this writer, he said, "I remember well my visit to Governor Bragg, and have always thought that if the other Southern Governors had met Bragg, Adams and myself at that time, and acted promptly and prudently, the late civil war might have been prevented, or the South might have been prepared for it, and due preparation would have caused it to end very soon. But, alas, we were Pharaohs, and the pillars of cloud and of flames were no guide for our course."

Of the gentlemen who participated in the conference I have described but one now lives, the writer.

One by one they have gone down to the tombs of their fathers—soon there will be none left to tell the story of an incident which no one of the participants ever forgot.

GEORGE W. BROOKS.