

ART. XXVIII.—*Nova Andromedæ* ; by ASAPH HALL.

(Communicated by Geo. E. Belknap, Commodore U. S. N., Superintendent.)

AT the end of last August Dr. Hartwig, of Dorpat, announced the appearance of a new star in the great Nebula of Andromeda. This announcement aroused much interest and brought out a great deal of speculation on the origin of these new stars, and on the nature of the nebulæ and their connection with our sidereal system. Quite naturally in such a case,

much of this speculation was of the wildest character, and some very uncertain inferences were drawn. The new star has now faded away to a mere speck of light, visible only in our largest telescopes. Unfortunately, and perhaps unavoidably, we have learned but little more from this new star concerning the nature of nebulae and variable stars than we knew before its appearance. But the history of its discovery, its observation, and of its gradual fading out, is interesting enough to hold our attention for a little while.

The appearance of the new star was announced by Dr. Hartwig on August 31st, but it had been seen by him on the preceding night with a small telescope, and he had suspected some change in the nebula as early as the 20th of August, but bad weather, and a lack of instrumental means for making the matter certain, deferred the announcement until the 31st. From the various estimates at that time the star was probably a little brighter than the seventh magnitude, or just below the limit of visibility to the naked eye. The announcement of course turned a host of observers to the new star, and many erroneous estimates and statements were made. Some observers estimated the brightness far too great, and several, on account of errors in the observations, announced that the new star was moving with an enormous velocity. It required the lapse of a few weeks to clear away and correct all this error.

After Dr. Hartwig's announcement, it appeared that several others had seen the new star, but for some reason, perhaps want of familiarity with this nebula and lack of confidence that a new star had really appeared, they did not make a public announcement. Thus the Baroness Podmaniczky, of Eastern Hungary, saw the new star on August 22d or 23d, with a 3½-inch comet seeker, and called the attention of a visitor to it, but they do not seem to have been certain that the object was new. This lady looked at the nebula on August 13, and did not see the new star. Mr. H. S. Moore, of McKinney, Texas, saw the new star on August 30. The circumstances indicate that this is a *bona fide* observation. A really independent discovery was made by Freiherr von Spiessen, of Winkel im Rheingau, who found the new star on August 30, and immediately sent a postal card to the Bonn Observatory where it was received on the evening of the 31st, or about a day before Hartwig's announcement. Mr. Isaac W. Ward, of Belfast, Ireland, claims that he saw the new star on August 19, when it was of the 9½ magnitude. Finally, Professor Ludovic Grell, of Rouen, says that he saw the new star on the 17th of August, and showed it to several friends and students. On the other hand Mr. Tempel, of Florence, Italy, who has done much work on nebulae, and who is well acquainted with the great nebula

of Andromeda, says that he is confident there was no star in the place of the new one which was easily visible in his telescope on the 15th and 16th of August. This testimony is important, and serves to fix the time of the appearance of the *nova*, or at least the time it became an easy object in telescopes, within very narrow limits. This time must have been between the 16th and 20th of August, 1885. It is probable that the star increased rapidly in brightness, since on August 31st it was of the seventh magnitude. It never, I think, became much brighter, though statements were made early in September that it was of the second or third magnitude, and easily visible to the naked eye. Its diminution of brightness began about August 31, and has gone on pretty steadily until the present time. There have been several attempts to show that there were fluctuations in its brightness, but these are so uncertain that we must wait for the complete evidence.

At first, the position of the new star was confounded with that of the bright point of the nebula, and as this mistake added interest to the discovery, it was some time before it could be generally corrected. The coincidence with the nucleus of the nebula seemed to indicate that we had before our eyes the formation of a sun from nebulous matter, and hence a strong proof of the nebular hypothesis. Our popular astronomical writers were not slow to improve the occasion, but in fact the new star never coincided with the nucleus. The assumption of any intimate physical connection of the new star with the nebula has been given up by Vogel, of Potsdam, and Hasselburg, of Pulkowa, who have examined its spectrum. Within the limits of this nebula there can be counted from fifteen hundred to two thousand telescopic stars, and one of these has proved to belong to the class of temporary stars, so-called, of which we have records of from 20 to 30. What causes these stars suddenly to flame out, and then to fade gradually away we do not know; and so far as I know, there is hardly a plausible theory.

I first saw this new star on September 6, when its magnitude seemed to me $7\frac{1}{2}$, and the star had a decidedly ruddy tinge. This color lasted but a few weeks, and as the star grew fainter it became of a white color. My observations have been continued until February 7th of the present year, and probably the star will be visible in the 26-inch refractor after the present moon has passed. It is now very near the limit of visibility in our telescope, or of nearly the sixteenth magnitude. The passage from the seventh magnitude to the sixteenth corresponds to a very great change of brightness, since it is the passage from the limit of visibility to the naked eye to that in a 26-inch telescope. Several hypotheses were proposed

to account for this wonderful star, and one that seemed to me quite ingenious is that of Mr. Monck, of Ireland, who assumed that this star is one of the swiftly moving ones that in rushing through the nebula had been set on fire, like a meteor in our atmosphere. Led by some such suggestions, and also by that of Professor Peters that it would be interesting to test the parallax of such a star, on September 29th I began some measures of the new star by referring it by means of polar coördinates to a known star of the eleventh magnitude, distant from it a little less than 2'. These measures have been continued until the present time, although of course as the star became extremely faint the measures became difficult and less accurate. I do not think my measures show any proof of a parallax, though they indicate perhaps a diminution of the distance, and even this may be sufficiently accounted for by variations in the light and color of the new star, since such variations would be likely to affect the measures. My measures are given in the following table, and I have added the parallactic coefficients computed from the formulæ,

$$\begin{aligned} \text{Coefficient for Angle} &= [9.7932]. \cos(\theta - 172^\circ 21') \\ \text{Coefficient for Distance} &= [9.9810]. \cos(\theta - 284^\circ 46') \end{aligned}$$

where θ is the longitude of the sun; p denotes the observed angle of position, and s the observed distance.

Date.	p .	Coeff.	s .	Coeff.	Remarks.
1885, Sept. 29	82.32	+0.602	109.98	-0.132	9th mag., sky hazy.
Oct. 3	82.24	0.589	109.96	0.067	
6	82.30	0.578	109.75	-0.017	Less than 9th mag.
9	82.17	0.565	109.68	+0.032	10th mag.
15	82.34	0.534	109.84	0.131	
25	82.17	0.471	109.60	0.291	10.7 mag.
26	82.25	0.464	109.57	0.307	
31	82.36	0.426	109.80	0.384	
Nov. 24	82.21	0.205	109.37	0.702	On Nov. 12th, mag. same as star of comparison.
Dec. 2	82.21	0.122	109.27	0.783	
6	82.28	0.079	109.31	0.818	11.5 mag.
12	82.13	+0.014	109.27	0.862	
1886, Jan. 1	82.25	-0.199	110.18	0.940	Very faint, misty; 15th mag.
2	82.30	0.210	109.39	0.940	13th-14th mag.
7	81.37	0.262	109.66	0.940	Very faint.
30	82.27	0.460	108.67	0.846	Very faint, 16th mag.
Feb. 7	82.17	-0.513	109.50	+0.779	Very faint, 16th mag.

The observations have been corrected for differential refraction, but the small reduction to a common epoch has been omitted. A comparison of the observed quantities with the coefficients shows little evidence of parallax. The observation of January 7 was made by Lieut. W. H. Allen, U. S. N., and

he estimated the brightness of the new star on November 12 to be the same as that of the star of comparison. Such a relative estimate is good, but the absolute magnitudes are uncertain. The limit of visibility in a 26-inch telescope is 16.3 magnitudes, and the *nova* is now so near this limit that accurate measures can no longer be made.

The great nebula of Andromeda is easily visible to the naked eye, and doubtless it was known to the astronomers of very ancient times. Those astronomers watched the heavens with unaided vision much more carefully than do modern astronomers, and they were far better acquainted with the constellations. The old astronomers had a theory that this nebula was variable both in form and brightness. They had poor means of judging of its form, but it is possible that their estimates of brightness may be more trustworthy, and that our new star may be an old variable which has appeared before, causing the nebula apparently to vary in brightness. One of the best descriptions of this nebula is by an astronomer of the middle ages, Simon Marius in 1612, who says it resembles a candle shining through a horn. It has a bright nucleus, around which is the soft, fleecy-looking nebulous matter, shading off very gradually from the center. This nebula has an angular extent of two degrees. No parallax has yet been found for a nebula; but if we suppose them to be as distant as the brightest of the fixed stars, and to have a parallax of a quarter of a second of arc, we may get some idea of the enormous extent of such a nebula as the great one in Andromeda. Making the preceding assumptions, its diameter will be about a thousand times as great as the distance of Neptune from the sun. Probably this estimate is less than the real diameter. That changes go on in such vast bodies we cannot doubt, for we see motion and change everywhere, but the distances are so great that small changes would pass without notice by astronomers on our earth. For this reason and also from the difficulty of making accurate drawings of such indefinite objects, we have as yet hardly any proof of changes in the forms of *nebulæ*.

U. S. Naval Observatory, 1886, Feb'y 12th.