

PECULIARITY OF FOCAL OBSERVATIONS OF THE
PLANETARY NEBULÆ AND VISUAL OBSERVA-
TIONS OF *NOVA PERSEI* WITH THE FORTY-INCH
YERKES TELESCOPE.

By E. E. BARNARD.

As is well known, and as I have shown further in *Monthly Notices of the Royal Astronomical Society*, Vol. LX, January, 1900, pp. 255-557, the focus of a large refracting telescope for the planetary nebulæ is something like 0.25 inch farther away from the object-glass than for a fixed star. With a high power on the 40-inch Yerkes telescope this difference of focus for a star and a gaseous nebula is very striking. It is so decided that if one should first focus carefully on a star and then examine a planetary nebula with the same adjustment, he would see only the coarser details. A re-focusing on the nebula would reveal details he would not ordinarily suspect. This also holds in photographing these bodies, so that a focus which (with a color-screen) would give a perfect image for a star with the 40-inch would not clearly show the details of a planetary nebula. By setting the plate from a quarter to a third of an inch farther out than for the star the details of the nebula are beautifully shown while the stars are but ill-defined, and the fainter ones entirely lost.

This peculiarity of a refracting telescope is a natural consequence of the difference in the spectra of the stars and the planetary nebulæ, as has been pointed out to me by Professor Hale.

It may be interesting to copy here the table showing these differences of focus printed in *Monthly Notices*, Vol. LX, to which are added several other objects and more observations. These were all determined with the 40-inch.

TABLE OF FOCUS FOR THE PLANETARY NEBULÆ.

N. G. C.	α 1860.0	δ 1860.0	Neb.—Nucl.	Neb.—Star.	Nucl.—Star.
			in.	in.	in.
1535	4 ^h 7 ^m 44 ^s	-13° 6'	+0.23	+0.28	+0.05
2392	7 20 53	+21 12	+0.29	+0.32	+0.03
3242	10 18 2	-17 56	+0.12	+0.16	+0.04
6543	17 58 36	+66 38	+0.16	+0.21	+0.05
6720 (<i>M</i> 57)	18 48 23	+32 51	+0.20	+0.30	+0.10
6826	19 41 2	+50 11	+0.22	+0.21	-0.01
6905	20 16 9	+19 40	+0.19	+0.33	+0.15
7009	20 56 33	-11 55	+0.19	+0.23	+0.04
7662	23 19 11	+41 45	+0.06	+0.20	+0.14
			+0.18	+0.25	+0.06

No. 1535—Two nights' observations.

2392 Seven " "

3242 Five " "

6543 Two " "

6720 Two " "

6826 Two " " for nucl.—star, both the same.

6905 Two " "

7009 Two " " for neb.—star.

7662 Four " " " " "

The *Orion* nebula gave nebula — star = + 0.22 inch.

Nova Aurigae is a striking example of this peculiarity. Recent observations with the 40-inch show that it has declined in the past few years to the thirteenth magnitude. With as faint an object as this the difference of focus between it and a star is decided, the *Nova* being best seen with a focus about one-third inch farther out.

This is shown by the following observations for focus on Nov. 3, 1900:

Focus on <i>Nova Aurigae</i>	-	-	in.	2.43 (3 obs.)
Focus on star	-	-	-	2.16 (3 obs.)
<i>Nova</i> —star	-	-	-	+0.27

From the above table it would appear that if a planetary nebula were so minute as to present no appreciable disk in the telescope its nebulous character should still be recognizable without the spectroscope by this peculiarity in its focus.

No. 7662 has been observed quite a number of times with the micrometer for position of its nucleus. Sometimes the central star was very faint and difficult, while at other times, apparently as favorable, it has been an easy object. This has led me to suspect it of variation, but I have not yet been able to confirm the supposed variability.

In some respects No. 2392 is the most remarkable of these objects as seen with the great telescope, in which it is very beautiful. The following description, with some changes, is from *Monthly Notices*, LX, for January, 1900:

A bright star of the ninth magnitude in (but not exactly central) a brightish ring which is oval in form and almost incomplete in its southern part. This ring, which is well defined inside and out, is surrounded by a vacuity, and this in turn by a broad ring of light less intense than the inner ring, and with a distinct break in it north preceding. This ring breaks up into a clouded or unequal surface, and is very irregular on its inner edge but fairly uniformly circular on the outside. The inner ring is filled with nebulous light, which has a bright spot in it south preceding the nucleus. I have found another excessively difficult star within the inner ring north of the bright star; this minute object comes to a focus with the nebula and not with the central star. It is therefore, doubtless, a small condensation of the nebula not so far advanced in stellar condition as the bright central star. When the atmospheric conditions permit, this beautiful nebula is best seen with a very high power—it stands magnifying well. It must also be very carefully focused—on the nebulosity itself—before the details described are seen. With a low power it is quite different, for it then appears as a bright yellowish star in a circular disk of light, surrounding which is a perfectly circular vacuity, and surrounding this vacuity is a symmetrical circular ring not so bright as the central disk. This, I suppose, is the general impression it gives when examined casually. But with the higher powers it loses much of this symmetry and becomes more complex, as already described.

In the article referred to in *Monthly Notices*, LX, the faint additional star in the central ring is described as being south of the central star. It is north.

The focus determinations for this nebula are the best of any in the list, as they depend on seven nights' observations.

In No. 6905 the central star is faint, and there is not much detail to focus on. A note says: "there seems to be some detail in the nebula, possibly spiral in form, but mainly an inequality of its light."

This brings me to the purpose of this note, some peculiarities of *Nova Persei*. I was absent with the eclipse expedition to Sumatra when this star appeared, and did not see it during its great brilliancy. It had declined to the sixth or seventh magnitude when I first saw it in August. Like its predecessors, it shows, in the fading of its light, the nebular spectrum, and seems, therefore, to have become a gaseous nebula.

To test the nebulous character of this object visually I have carefully examined it with the 40-inch, both for nebulosity and for peculiarity of focus. I have not been able with certainty to see any nebulosity. A careful series of focus readings on two dates, comparing it with the white star *DM. + 43° 732* (7.5 magnitude; $1855.0: 3^h 18^m 45^s + 43^\circ 14'.6$), does not show any difference in focus between the star and the *Nova*.

Following are the measures for focus:

1901. August 12. <i>Nova</i> ,	2.25 in. (4 obs.)	}	power 700
	7.5 mag. star, <u>2.26</u> in. (4 obs.)			
	<i>Nova</i> - 7.5 mag. star = - 0.01			
1901. September 3. <i>Nova</i> ,	2.29 in. (5 obs.)	}	power 1300
	7.5 mag. star, <u>2.30</u> in. (5 obs.)			
	<i>Nova</i> - 7.5 mag. star = - 0.01			

This difference, though it is the same in the two sets of observations, doubtless does not mean anything. The readings are on a scale of inches engraved on the tube. The tube lengthens and shortens with changes of temperature, which causes the difference in the two sets of readings.

This, of course, does not necessarily imply the absence of nebulosity in the *Nova*. It may mean that the visual light is so predominant as to mask the usual effect produced by a nebula in its focus. Its action is therefore more like that of the nucleus of a planetary nebula. When the *Nova* has faded greatly it will be interesting to see if its focus becomes like that of the planetary nebulae.

On August 12 the seeing was unusually good. Examining the *Nova* with high powers, I was struck with its appearance. It was brighter than the star, but under the high magnifying powers its light was strikingly dull, having more the appearance of planetary light. This was so decided that had I been examining the stars in that region I should at once have singled out the *Nova* as different from any of the stars. The spurious disk appeared much duller and somewhat larger than that of a star, and of a slight yellowish color.

This peculiarity has been seen several times since.

On several occasions a faint companion has been visible north following *Nova Persei*. On September 16 and 23, 1901, its position was measured.

NOVA PERSEI AND *a*.

1901.709	63°5	Dist. 19'6
.729	66.8	19.2
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1901.719	65.1	19.4

It is about 15^m and very difficult to measure.

Five other stars of about the thirteenth magnitude were also measured.

NOVA PERSEI AND *b*.

1901.578	116°21	102'55	13 mag.
.693	116.14	102.57	
.709	116.33	102.50	
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1901.66	116.23	102.54	

NOVA PERSEI AND *c*.

1901.578	211°20	124'25	13 mag.
.693	211.34	124.20	
.709	211.28	124.18	
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1901.66	211.27	124.21	

NOVA PERSEI AND *d*.

1901.732	303°48	164'62	13 mag.
.749	303.67	165.03	
.751	303.62	165.25	
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1901.74	303.59	164.97	

NOVA PERSEI AND *e*.

1901.732	63°07	158'55	12.7 mag.
.749	63.10	158.76	
.751	63.07	158.51	
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1901.74	63.08	158.61	

NOVA PERSEI AND *f*.

1901.732	292°98	181'70	12.8 mag.
.749	293.07	181.82	
.751	293.02	181.78	
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1901.74	293.02	181.77	

All the observations, except for *a*, are double distances.

On September 16 at 14^h the *Nova* was carefully compared in brightness with the stars *DM.*+43°720, *DM.*+43°730, and *DM.*+43°732. The result for the *Nova* was 7.3 magnitude on the *DM.* scale of magnitudes.

Having seen the announcement by M. Flammarion and Dr Max Wolf of the discovery of a nebula about *Nova Persei* I carefully looked for it with the 12-inch refractor on the night of September 20. The following note was made:

Examined *Nova Persei* between 13^h and 14^h with the 12-inch, using a low power (about 90 diameters). I could not see with certainty anything of the nebula encompassing this star as described by Dr. Max Wolf in *A.N.*, 3736. The sky and seeing were good with the low power. The region of the *Nova* for some distance seemed to have more scattered light than that farther away, while the region of the 7.5 mag. star *DM.*+43°732, about 2½ minutes preceding and 10' south, by contrast was free of this peculiarity.

I have since that date examined the *Nova* with the 40-inch for the nebulosity after having seen Mr. Ritchey's excellent photograph of it. Knowing the exact positions of the various parts of the nebula, these were perhaps seen, but the night was not sufficiently pure to make certain of it. This nebulosity is,

of course, vastly better suited for the photographic plate than for visual observations with any telescope.

During the observations of *Nova Persei* a nebula was found which from its proximity to the new star is worthy of record. It lies one degree south of the *Nova*.

This nebula was measured with reference to a twelfth magnitude star.

TWELFTH MAGNITUDE STAR AND NEBULA.

1901.735 4°7 (3) 33'9 (2)

The twelfth magnitude star was measured with reference to the 7.8 mag. star *DM.*+42°776 whose place for 1855.0 is

$\alpha=3^{\text{h}} 22^{\text{m}} 25^{\text{s}}.5$ $\delta+42^{\circ} 15'2$

Twelfth mag. star precedes 7.8 mag. star $0^{\text{m}} 55^{\text{s}}.69$ (14)

“ “ “ north of 7.8 “ “ 1' 55'61 (2)

This gives for the position of the nebula

1860.0 $\alpha=3^{\text{h}} 21^{\text{m}} 50^{\text{s}}.5$ $\delta=+42^{\circ} 18'7$

It is about 13.5 mag., a half minute in diameter and somewhat brighter in the middle ; and is perhaps irregular in form.

YERKES OBSERVATORY,
September 13, 1901.

NOTE.—A photograph of the spectrum of *Nova Persei*, taken on September 24 by Mr. Walter S. Adams with a one prism spectrograph attached to the 24-inch reflector of the Yerkes Observatory, indicates that the continuous spectrum in the yellow and green is relatively stronger than in the case of the planetary nebulae. This may perhaps be sufficient to account for the peculiarities of focus observed by Professor Barnard.—ED.