facts with regard to the streak systems, we may look to see if we can find any reasonable explanation of their origin. We must still admit that they are utterly unlike anything found at present upon the Earth, and this adds materially to the difficulty of our task. Possibly, however, this difficulty may be in part removed if we suggest that the difference in the case of the two planets may be due not so much to any difference in the volcanic action itself, as to the great difference existing in the densities of their atmospheres. Thus if the craterlets on the rim of Tycho were constantly giving out large quantities of gas or steam, which in other regions was being constantly absorbed or condensed, we should have a wind uniformly blowing away from that summit in all directions. Should other summits in its vicinity occasionally give out gases mixed with any fine white powder such as pumice, this powder would be carried away from Tycho, forming streaks.

Looking at this matter from another standpoint, it is well known that the bright streaks can only be well seen after the Moon has passed the first quarter, and that they disappear when it has passed the last quarter. That is, they are only conspicuous when the shadows visible upon the Moon are small. Let us imagine a large number of small white particles lying in the center of a large, level,

and somewhat darker surface. If the Sun is low, these particles will each be nearly half in shade, — a shade which upon the Moon would be absolute blackness, — besides which they will cast shadows upon one another. Owing to this action, we may not at a distance, be able to distinguish them from the surrounding grey surface. If on the other hand the Sun is overhead, their white color would at once attract our notice. This effect may be readily observed by scattering powdered salt upon a piece of light grey paper. Indeed, I have noticed it upon a somewhat larger scale in this vicinity. As we are living in a volcanic region, the roads are in some places partially covered with a white pumice-like material. When the Sun is behind us, casting the shadows away from us, the white pumice is very noticeable where it is brought in contrast with the grey soil. When the Sun is in front of us however this contrast almost entirely disappears. Thus we find that while the general appearance of the streaks may perhaps be most readily explained by the hypothesis of a light colored powder extending away from the craterlets, that this very powder will also explain their most prominent characteristic, — that of being visible only when the Moon approaches the full.

Arequipa, Peru, 1892 July 4.

William H. Pickering.

On the Central Star of the Ring Nebula in Lyra.

By James E. Keeler.

Dr. Scheiner's interesting note in A. N. 3086, on the character of the central star in the Lyra nebula, leads me to mention some visual observations of my own which have a bearing on the same subject. The central star is beyond the reach of the Allegheny refractor, and all my observations were made in California, with the thirty-six inch telescope of the Lick Observatory. With this instrument the central star was always easily visible, although it was too faint for observation with the spectroscope.

Owing to the considerable chromatic aberration of so large a telescope, a gaseous nebula and its stellar nucleus cannot be seen distinctly at the same time; if the focus is adjusted on the star, the eyepiece must be drawn out a little to give a distinct view of the nebula. If the nebula presents any well-marked details, (like the beautiful planetary nebula G. C. 4373, in Draco), this peculiarity becomes very noticeable, and the difference of focus for the two objects may be easily measured. Professor Holden and Professor Schaeberle found the change of adjustment required in the case of the Draco nebula to be 0.44 inch. From a consideration of the color-curve of the objective, obtained by Vogel's spectroscopic method, the difference would appear to be somewhat less than this, perhaps from 0.35 to 0.40 inch, the exact value depending upon the position which the observer assigns to the focal plane for the three principal nebular lines, as the most satisfactory compromise. Thus the telescope itself roughly serves the purpose of a spectroscope, and in default of more accurate methods may

give indications of value. Applying this method to the Ring Nebula in Lyra, I found that the same difference of focus was required, as nearly as I could judge, as for G. C. 4373, the central star being sharply seen when the eyepiece was considerably inside the position required for the ring. Hence the maximum of light in the spectrum of the star is in the yellow or green, as it is in the nuclei of all the planetary nebulae which are sufficiently bright for examination with the spectroscope.

Dr. Scheiner's conclusions in regard to the character of the central star therefore require some modification. It can hardly be doubted that the central star is actually formed from the nebula by a process of condensation; but it is not merely a brighter portion of the nebula, omitting radiations of the same character as the rest. Increased radiation in the lower part of the spectrum has accompanied the process of condensation. The nucleus so nearly approaches the stellar character that the general distribution of light in its spectrum is that of an ordinary star.

It may very well be, however, that the photographic energy of the star is due to bright lines in the violet part of its spectrum (most probably the hydrogen lines), the presence of which would add greatly to the photographic effect without displacing the maximum general brightness from the yellow. The nuclei of some planetary nebulae which are within reach of the spectroscope are of this character.

It is possible to give another explanation, which

accounts for the observed phenomena without attributing unusual properties to the central star. The photographic energy of a gaseous nebula resides very largely in the fourth line in its spectrum, or the $H\gamma$ line of hydrogen, and in different nebulae various relations of brightness are found to exist between the hydrogen lines and the first and second nebular lines, while to these two last almost the whole visual effect is due. In the Orion nebula the hydrogen lines are relatively bright; in the intrinsically brilliant nebula NGC. 7027 they are relatively faint. Hence the brightness of a nebula is not a trustworthy indication of its photographic activity. Now the intrinsic brightness of the Ring Nebula is far below that of many smaller nebulae, and moreover the hydrogen lines are relatively faint. Hence it may be that the prominence of the central star in the photographs may be due not to strength of photographic action of the star, but to weakness of that of the nebula, which is taken as the term of comparison. Obviously the true test would be to compare the central star, not with the nebulous ring, but with other stars on the plate, of the same visual magnitude, which are outside the limits of the nebula. It is possible that such comparisons have been made, although I do not know of any

published results. In the only photographic representation of the Lyra nebula which I have, the plate in Pubblicazioni della Specola Vaticana, Fascicolo II, both the central star and the well known star following the ellipse are shown. The magnitudes of these stars have been variously estimated by different observers, and the former is sometimes regarded as variable. Mr. Burnham rates them as 15.4 and 12.4 respectively. In the plate mentioned, the larger star is about twice the diameter of the smaller. Whether two other stars of the same magnitudes would give similar discs I have no means of telling. The exposure of the photograph was one hour and fifty minutes.

It is quite possible that the photographic prominence of the central star is due to both causes, namely: partly to feeble action of the nebulous ring, and partly to strong action of the central star.

It should also be borne in mind that the relative prominence of these two features in the photograph is not determined solely by their natural difference of constitution, but in a large measure by the dimensions of the telescope employed. The brightness of the image of the nebula follows one law, that of the stellar image, another.

Allegheny Observatory, Allegheny, Pa., 1892 Juli 5.

James E. Keeler.

Beobachtungen der partiellen Mondfinsterniss 1892 Mai 11.

Auf der Grossherzoglichen Sternwarte in Jena.

Am Bamberg'schen Refractor beobachtete ich mit 40-facher Vergrößerung folgende Schattenantritte, wobei ich die dunkelste Stelle, d. h. den innersten Rand des verwaschenen Saumes als Schattengrenze ansah.

M. Z. Jena	Eintritte:
9 ^h 58 ^m 14 ^s	Mondrand (wahrscheinlich zu früh)
10 18 2	Copernicus I. Rand
20 0	» ungefähre Mitte
20 57	» II. Rand
35 11	Manilius I. Rand
35 47	» II. »
39 4	Menelaus I. Rand
40 14	» II. »
44 59	Dionysius I. Rand
45 20	» II. »
53 49	Mare Crisium I. Rand
54 18	Proclus
54 18	Tycho I. Rand
55 11	Censorinus I. Rand
55 48	» II. Rand
56 41	Tycho Mitte
10 59 6	» II. Rand

M. Z. Jena	Austritte:
12 ^h 8 ^m 27 ^s	Tycho I. (südlicher) Rand
9 10	» Mitte
9 49	» II. (nördlicher) Rand
14 43	Grimaldi I. Rand
15 48	» Mitte
16 38	» II. Rand
36 10	Aristarch
40 43	Copernicus I. Rand
40 58	» Mitte (schlecht)
41 56	» II. Rand
56 26	Dionysius
57 21	Manilius I. Rand
12 58 51	» II. Rand (weniger sicher)
13 1 2	Plato II. Rand
1 22	Menelaus I. Rand
2 20	» II. »
19 50	Mare Crisium II. Rand
13 23 18	Mondrand

Die auf die Zuverlässigkeit der Beobachtung sich beziehenden Bemerkungen sind dem Beobachtungsbuch entnommen.

Während der Finsterniss fand die wohl auch anderwärts beobachtete Bedeckung des Sterns BD. — 19° 40' 9" durch den Mond statt. Für Jena erfolgte die Bedeckung

meiner Beobachtung nach um 11^h 44^m 31^s M. Z. Jena unterm Positionswinkel von ungefähr 95°. Leider ist die Beobachtung wegen der Schwäche des Sterns (9^m.4) und der trotz der Verfinsternung nicht genügenden Dunkelheit des Mondrandes bis auf 3^s unsicher. Der Ort des Sterns ist für 1892.0:

15^h 17^m 39^s 87 — 19° 26' 42" 5; Anschluss mittels Kreismikrometers an AWe. 11870 8^m.2 15^h 18^m 18^s 27 — 19° 34' 44" 3.