the successive stages characteristic of Novae into one very strongly resembling that of planetary nebulae; and then, by the gradual elimination of the nebular lines and their replacement by Wolf-Rayet bands, into a spectrum identical with this characteristic type of stellar spectra. It appears very probable from the observations of Nova Aurigae and Nova Persei that this stage of development is to be considered as in the nature of a permanent one. It is of interest to note, however, that the period required to reach this condition may be quite variable for different stars, since the nebular lines λ 5007 and λ 4960 were still by far the most prominent feature of the spectrum of Nova Lacertae (1910) as recently as the autumn of 1913. It seems entirely possible that the nebular lines found in the case of Novae are extraneous to the stars themselves and due to material in which they are involved. Of especial importance in this connection is the recent discovery by Wright[4] that the central star in certain planetary nebulae has the Wolf-Rayet type of spectrum.

[1] *Stellar Movements and the Structure of the Universe*, p. 156.
[2] *Astr. Nachr. Kiel*, **177**, 113 (1908).
[3] *Contrib. Mt. Wilson Solar Obs.*, No. **87**; *Astrophys. J.*, **40**, 294 (1914).
[4] *Astrophys. J.*, **40**, 466 (1914).

A SINGULAR DARK MARKING ON THE SKY

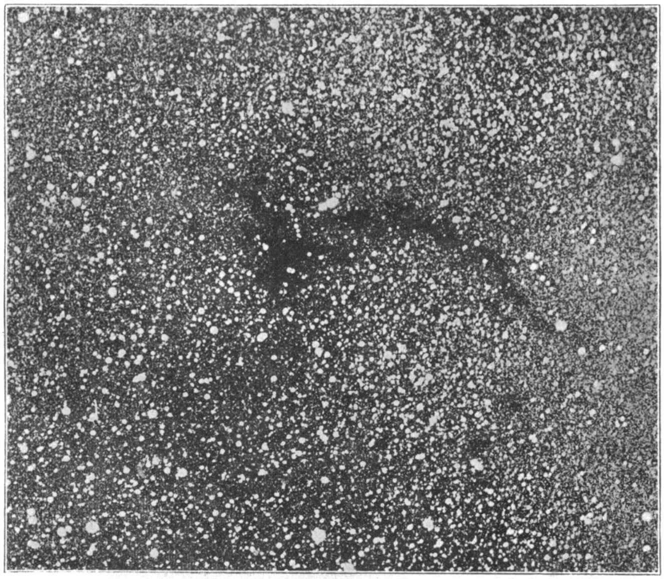
By E. E. Barnard
YERKES OBSERVATORY, UNIVERSITY OF CHICAGO
Read before the Academy, April 20, 1915. Received, June 4, 1915

In the search for dark or vacant regions in the sky I have photographed a number of very remarkable places, such as those near *ρ Ophiuchi* and *θ Ophiuchi*, and elsewhere.

These regions are generally connected with the presence of diffused nebulosity, but I have found several cases in which a well defined dark object seems superposed on the sky itself without any visible presence of ordinary nebulosity. One of these, and perhaps the most remarkable on account of its well defined character and singular form, is in the position: (1855.0)$\alpha = 20$ h. 48 m.; $\delta = +59°.6$, in Cepheus (see Plate). It resembles an irregular, roughly torn and curved opening through which a darker region is visible. It is one degree long and narrows down to something like 3′ across at its western end. It seems to be a part of the background of the sky independent of the starry stratum (there are no indications whatever of nebulosity immediately about it), and is apparently of a similar nature to the remarkable dark 'lanes' shown in my photographs of a region in *Taurus*. (See *Astrophys. J.*, **25**, 218, 1907). There are two very small dark spots near and south of the west end of the dark marking.

The accompanying plate is from a photograph which was taken by me on October 1, 1910, with the 10-inch Bruce telescope of the Yerkes Observatory, with an exposure of 6 h. 2 m. I had previously taken a photograph of this part of the sky on September 30, 1910, with an exposure of 5 h. 5 m. which verifies the above in all particulars.

NORTH



DARK OBJECT IN *CEPHEUS* ($\alpha = 20^h\ 48^m$, $\delta = +60°$)
Scale: 1°=41mm.

There are two possible explanations of this object:

(1) That it is an opening in a widely diffused nebulous stratum.

(2) That it is an opaque, non-luminous object projected against space, which is itself luminous.

From this object and those in *Taurus*, I get the impression that the interstellar spaces (or possibly the regions beyond the stars), perhaps covering the entire heavens, are suffused with a feeble nebulosity that, with very prolonged exposures, affects the photographic plate; and that such phenomena (as the present one) are due to the projection upon this background of nearer, dark, opaque objects. If not this, then they are rifts or openings in a luminous background which look out into the blackness of space beyond. From investigations elsewhere in the sky, I lean towards the idea that these are relatively non-luminous, opaque bodies, seen against a luminous background.

THE RULING AND PERFORMANCE OF A TEN-INCH DIFFRACTION GRATING

By A. A. Michelson

RYERSON PHYSICAL LABORATORY, UNIVERSITY OF CHICAGO

Presented to the Academy, May 13, 1915

The principal element in the efficiency of any spectroscopic appliance is its resolving power—that is, the power to separate spectral lines. The limit of resolution is the ratio of the smallest difference of wave-length just discernable to the mean wave-length of the pair or group. If a prism can just separate or resolve the double yellow line of sodium its limit of resolution will be (5896–5890)/5893 or approximately one one-thousandth, and the resolving power is called one thousand.

Until Fraunhofer (1821) showed that light could be analysed into its constituent colors by diffraction gratings these analyses were effected by prisms the resolving power of which has been gradually increased to about thirty thousand. This limit was equaled if not surpassed by the excellent gratings of Rutherford of New York, ruled by a diamond point on speculum metal, with something like 20,000 lines, with spacing of 500 to 1000 lines to the millimeter. These were superseded by the superb gratings of Rowland with something over one hundred thousand lines, and with a resolving power of 150,000.

The theoretical resolving power of a grating is given as was first shown by Lord Rayleigh by the formula $R = mn$, in which n is the total number of lines, and m the order of the spectrum. An equivalent expression is furnished by $R = \frac{l}{\lambda}(\sin i + \sin \theta)$, where l is the total length of the ruled surface, λ the wave-length of the light, i the angle of incidence, and θ the angle of diffraction; and the maximum resolving power which a grating can have is that corresponding to i and θ each equal to 90° which gives $R = 2\,l/\lambda$, that is twice the number of light waves in the entire length of the ruled surface.

This shows that neither the closeness of the rulings nor their total number determine this theoretical limit, and emphasizes the importance of a large ruled space.