

On an Error in Brünnow's Formulæ for Differential Refraction in Distance and Position-Angle. By W. H. Finlay, M.A.

My attention was recently drawn to the fact that the formulæ given by Brünnow and by Chauvenet for the differential effects of refraction on distance and position-angle do not agree, and on investigation I found that there is an error in Brünnow's formulæ.

After finding expressions for the differential refractions in right ascension and declination, he proceeds to deduce those in distance (Δ) and position-angle (π) by help of the formulæ

$$\left. \begin{aligned} \cos \delta(\alpha - \alpha') &= \Delta \sin \pi \\ \delta - \delta' &= \Delta \cos \pi \end{aligned} \right\}$$

but in differentiating the first equation he treats δ as a constant.

If these equations be differentiated, treating δ as a variable and substituting $\kappa \tan \zeta \cos \eta$ for $d\delta$, it will be found that the expressions for refraction in distance and position-angle agree exactly with Chauvenet's formulæ.

Royal Observatory, Cape of Good Hope:
1889, *March.*

Photographs of the Nebulæ M 81, 82, and a Nebulous Star in Ursa Major. By Isaac Roberts.

The photographs were taken on March 31, 1889, with an exposure of $3\frac{1}{2}$ hours. One is enlarged five times and the other fifteen times the negative, and they show that the nebula M 81 is of a spiral character, and so differs from the other nebulæ, which have been already photographed, and differs also from the written descriptions of it which have been published by Sir John Herschel and by the Earl of Rosse. Sir J. Herschel refers to it as a "remarkable object, extremely bright, extremely large, suddenly very much brighter in the middle, and with a bright nucleus." The Earl of Rosse confirms these statements, and adds that it extends about 8' from the nucleus to the north and does not extend beyond the first two stars.

The photograph shows it to extend far beyond the two stars presumably referred to, and the negative shows that the nucleus, which has not a well-defined boundary, is surrounded by rings of nebulous or meteoric matter, and that the outermost rings are discontinuous in the n.p. and s.f. directions.

It is very noticeable that there are numerous stars, or, more probably, star-like condensations of the nebular matter, arranged symmetrically, and apparently incorporated with the rings. It

requires little stretch of the imagination, and we feel strongly tempted, to account for these extraordinary appearances by referring them to Mr. Lockyer's theory of the collision of streams of meteorites. In this case one stream would be coming from the n.p. and the other from the s.f. directions, the collision between them causing the formation of the dense and undefined nucleus as well as the vortex, as shown in the photograph.

The other explanation of the vortex would be that it is an optical illusion, caused by the outermost rings appearing discontinuous, owing to insufficient photographic power, either physical or instrumental, to show that the faint rings are continuous round the nucleus; but the vortex hypothesis seems at present to explain most satisfactorily all the appearances as they are presented on the photograph.

M 82.

This nebula is described by Sir John Herschel as a "beautiful ray," very bright, very large, and very much extended. Lord Rosse states it is a "most extraordinary object, at least 10' in length and crossed by several dark bands."

The photograph, particularly the negative, shows it to be probably a nebula seen edgewise, with several nuclei of a nebulous character involved, and the rifts and attenuated places in it are the divisions of the rings, which would be visible as such if we could photograph the nebula from the direction perpendicular to its plane. We see it in section, and the upper and lower surfaces are very rugged, and suggest that the evolution of this stellar system has not proceeded so far as that of the *Andromeda* nebula; but I must refrain from pursuing further speculation, for we want fuller data.

Nebulous Star.

The star is in the s.f. quadrant, and is very bright. Shortly I shall be able to give to the Society the distances and triangulation of it and of the two nebulæ already described; but an important question has frequently arisen in my mind when examining this and several other nebulous stars that I have photographed in different parts of the sky. *Are they not the bright nuclei of nebulæ*, the rings around them being invisible to us by reason of either of the following conditions: 1st, condensation not having proceeded far enough to show the rings; 2nd, they may be too distant for us to see the rings; 3rd, greater optical power might show them, and we may hope that ere long the question may be satisfactorily answered by the means which are now available to us?

The photographs are placed in the Library.