

Note on Mr. Blakesley's paper, "A new Definition of Focal Length, &c."

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XVI. *Note on Mr. Blakesley's paper, "A new Definition of Focal Length, &c."* By Prof. A. GRAY*.

I HAVE read Mr. Blakesley's paper on "A new Definition of Focal Length, &c.," with much interest. It is true, as Mr. Blakesley states, that the treatment of lenses and combinations of lenses in ordinary text-books is frequently faulty, and that much advantage would be gained by a consideration of the question from other points of view than that generally adopted in treatises on geometrical optics. Something of this kind has been achieved by the admirable series of papers on points in physical optics which have appeared from time to time, during the last fifteen years, from the pen of Lord Rayleigh, and the lucid and elementary discussion of the propagation of waves through lenses, and their reflexion from mirrors, published by Dr. S. P. Thompson, in Oct. 1889.

I think further clearness in the presentment of the action of lens systems in important cases would be obtained if more use were made of the notion of the apparent distance of an object seen through a system of lenses. This idea, which is at least as old as Smith's 'Compleat System of Opticks' (Camb. 1738), seems to have been strangely neglected until attention was called to it again by Lord Rayleigh in the *Phil. Mag.* for June 1886. Yet the formula for the apparent distance of an object situated on or near the common axis of a system of lenses, and viewed along that line, yields at once from its mere form many most valuable theorems: for example, that the interchange of position of the image and object, without change of position of the lens-system, does not affect the magnification; that the magnification of an object, seen through such a lens-system, is equal to the ratio of the real distance of the object from the object-glass to the apparent distance of the object from the eye, or the ratio of the breadth of the pencil at the object-glass to the breadth of the pencil at the eye.

In this mode of discussion attention is, as in Mr. Blakesley's

* Read June 11, 1897.

paper, focussed on the magnification produced by the lens-system. Hence the method of determining the focal length of a combination by comparisons of the magnifications for (1) two positions of the object at a measured distance apart, or for (2) two positions of the image at a measured distance apart. If l denote the distance in either case, m , n the magnifications, the focal length is $l \frac{mn}{m-n}$ in (1), and $\frac{l}{m-n}$ in the other; or if, as Mr. Blakesley suggests, the two possible positions of the combination for fixed positions of the object and image be taken, and l be the distance through which the combination is moved, the focal length is $\frac{lm}{m^2-1}$.

But this method of determining focal lengths has already been used for several years by Abbe for his optical combinations, and apparatus for the purpose is to be found described by S. Czapski (*Zeitschrift für Instrumentenkunde*, vol. xii. 1892). A discussion of the method and some account of the apparatus will be found in the very valuable treatise on "Optik," by Czapski, lately published as part of the *Handbuch der Physik*, just completed under the editorship of Dr. A. Winkelmann (see vol. ii. pp. 289, 290, *et seq.*).

Though the experimental method of Mr. Blakesley's paper has thus been in the main anticipated, his paper is valuable as a fresh and instructive view of the subject, and as directing attention to methods of focometry as yet apparently not very generally known.

Bangor, June 17, 1897
