ER jointly. It is therefore as ER/CR · CR, that is, as ER. Draw any straight line Em, cutting RN in *s*, and any other ordi­nate FL in *x*R*s*. The whole light which illuminates the circumference described by I is to the whole light which illuminates the centre *b* as ER to EC, or as Rs to *Cm.* In like manner, the whole light which illuminates the circum­ference described by the point *f* in the circle of dispersion, is to the whole light which illuminates the centre *b* as F*x* to C*m*. The lines *Cm,* Rs, Far, are therefore proportional to the whole light which illuminates the corresponding cir­cumferences in the circle of dispersion. Therefore the whole light which falls on the circle whose radius is *b*I, will be represented by the trapezium in CR*s*; and the whole light which falls on the ring described by IA, will be represented by the triangle E*s*R ; and so of any other portions.

By considering the figure, we see that the distribution of the light is exceedingly unequal. Round the margin it has no sensible density ; while its density in the very centre is incomparably greater than in any other point, being ex­pressed by the asymptote of a hyperbola. Also the circle described with the radius contains 3/4ths of the whole light. No wonder, then, that the confusion caused by the mixture of these circles of dispersion is less than one should expect ; besides, it is evident that the most lively or im­pressive colours occupy the middle of the spectrum, and are there much denser than the rest. The margin is covered with an illumination of deep red and violet, neither of which colours is brilliant. The margin will be of a dark claret colour. The centre revives all the colours, but in a proportion of intensity greatly different from that in the common prismatic spectrum, because the radiant points L, *p, b, g,* &c*.* by which it is illuminated, are at such dif­ferent distances from it. It will be white ; but, we appre­hend, not a pure white, being greatly overcharged with the middle colours.

These considerations show that the coloured fringes which are observed to border very luminous objecte seen on a dark ground through optical instruments, do not pro­ceed from the object-glass of a telescope or microscope, but from an improper construction of the eye-glasses. The chromatic dispersions would produce fringes of a different colour when they produce any at all, and the colours would be differently disposed. But this dispersion by the object-glass can hardly produce any fringes : its effect is a general and almost uniform mixture of circles all over the field, which produces an uniform haziness, as if the object were viewed at an improper distance, or out of its focus, as we vulgarly express it.

We may at present form a good guess at the limit which this cause puts to the performance of a telescope. A point of a very distant object is represented, in the picture formed by the object-glass, by a little circle, whose diameter is at least 1/300th of the aperture of the object-glass, making a very full allowance for the superior brilliancy and density of the central light. We look at this picture with a mag­nifying eye-glass. This magnifies the picture of the point. If it amplify it to such a degree as to make it an object in­dividually distinguishable, the confusion is then sensible. Now this can be computed. An object subtending one minute of a degree is distinguished by the dullest eye, even although it be a dark object on a bright ground. Let us therefore suppose a telescope, the object-glass of which is of six feet focal distance, and one inch aperture. The dia­meter of the circle of chromatic dispersion will be 1/300th of an inch, which subtends at the centre of the object-glass an angle of about nine seconds and a half. This, when magnified six times by an eye-glass, would become a dis­tinguishable object ; and a telescope of this length would be indistinct if it magnified more than six times, if a point were thus spread out into a spot of uniform intensity. But the spot is much less intense about its margin. It is found experimentally that a piece of engraving, having fine cross hatches, is not sensibly indistinct till brought so far from the limits of perfectly distinct vision, that this indistinctness amounts to 6' or 5' in breadth. Therefore such a telescope will be sensibly distinct when it magnifies thirty-six times ; and this is very agreeable to experience.

We come, in the second place, to the more arduous task of ascertaining the error arising from the spherical figure of the surfaces employed in optical instruments. Suffice it to say, before we begin, that although geometers have ex­hibited other forms of lenses which are totally exempt from this error, they cannot be executed by the artist ; and we are therefore restricted to the employment of spherical surfaces. We shall set out with Dr Smith’s fundamental theorem.

1. *In Reflections.*

Let AVB (fig 3) be a concave spherical mirror, of which C is the centre, V the vertex, CV the axis, and F the focus of an infinitely slender pencil of parallel rays passing through the centre. Let the ray *a*A, paral­lel to the axis, be reflected in AG, crossing the central ray C V in *f.* Let AP be the sine of the semi-aperture AV, AD its tangent, and CD its secant.

The aberration *Pf* from the principal focus of central rays is equal to 1/2VD, the excess of the secant above the radius, or very nearly equal to 1/2 of VP, the versed sine of the semi-aperture.

For, because AD is perpendicular to CA, the points C, A, D, are in a circle, of which CD is the diameter ; and be­cause A*f* is equal to *Cf,* by reason of the equality of the angles *f*AC, *fCA,* and CA*a*, *f* is the centre of the circle through C, A, D, and *f* D is = 1/2 CD. But FC is = 1/2 CV. Therefore F*f* is 1/2 of VD.

But because D V : VP = DC : VC, and DC is very little greater than VC when the aperture AB is moderate, DV is very little greater than VP, and F*f* is very nearly equal to 1/2 of VP.

*Cor.* 1. The longitudinal aberration F*f* is = \*\*\*, for PV is very nearly = ÿcV"

**AV∙,**

*Cor.* 2. The lateral aberration FG is = ~~⅛[j~~v^∙' For FG : F*f* = AP : *Pf =* AV : 1/2 CV nearly, and therefore re - av\* 2 \_ avj

- 4CV ’ CV -2CVi'

2. *In Refractions.*

Let AVB (fig. 4 or 5) be a spherical surface separating