Let white or compounded light fall perpendicularly on the flat side PQ (fig. 1.) of a plano-convex lens PVQ, whoſe axis is CV and vertex V. The white ray pP falling on the extremity of the lens is diſperſed by refraction at the point P of the ſpherical ſurface, and the red ray goes to the point *r* of the axis, and the violet ray to the point *v.* In like manner the white ray qQ is diſperſed by refraction at Q, the red ray going to r, and the violet to *v.* The red ray Pr croſſes the violet ray Qv in a point D, and Qr croſſes Pv in a point E ; and the whole light refracted and diſperſed by the circumference, whoſe diameter is PQ, passes through the circular area, whoſe diameter is DE. Suppoſing that the lens is of ſuch a form that it would collect red rays, refracted by its whole ſurface in the point r, and violet in the point *v* ; then it is evident that the while light which occupies the ſurface of the lens will paſs through this little circle, whoſe diameter is DE. Therefore white light iſſuing from a point ſo diſtant that the rays may be conſidered as parallel, will not be collected in another point or focus, but will be diſperſed over the ſurface of that little circle ; which is therefore called the *circle of chromatic diſpersion* ; and the radiant point will be repreſented by this circle. The neighbouring points are in like manner repre­ſented by circles ; and theſe circles encroaching on and mixing with each other, muſt occaſion hazineſs or confuſion, and render the picture indiſtinct. This indiſtinctneſs will be greater in the proportion of the number of circles which are in this manner mixed together. This will be in the pro­portion of the room that is for them ; that is, in proportion to the area of the circle, or in the duplicate proportion of its diameter. Our firſt buſineſs therefore is, to obtain meaſures of this diameter, and to mark the connection between it and the aperture and focal diſtance of the lens.

Let *i* be to *r* as the sine of incidence in glaſs to the sine of refraction of the red rays ; and let *i* be to *v* as the line of incidence to the line of refraction of the violet rays. Then we say, that when the aperture PQ is moderate, *v—r : v + r* —2*i —* DE : PQ, very nearly. For let DE, which is evi­dently perpendicular to Vr, meet the parallel incident rays in K and L and the radii of the ſpherical ſurface in G and II. It is plain that GPK is equal to the angle of inci­dence on the poſterior or spherical ſurface of the lens ; and GPr and GPv are the angles of refraction of the red and the violet rays ; and that GK, GD, and GE, are very near­ly as the sines of thoſe angles, becauſe the angles are suppoſed to be ſmall. We may therefore inſtitute this propor­tion DE : KD = v*—r* : *r—i* ; then, by doubling the conſequents DE : 2KD = *v—r : 2r— 2i.* Alſo DE : 2KD + DE = v—*r : 2r — 2i + v — r, = v — r* : r + v — 2i. But 2KD + DE is equal to KL or PQ. Therefore we have DE : PQ = v *— r : r + v — 2i. E. D.*

*Cor.* I. Sir Isaac Newton, by moſt accurate obſervation, found, that in common glaſs the sines of refraction of the red and violet rays were 77 and 78 where the sine of inci­dence was 50. Hence it follows, that *v — r* is to *v + r — 2i* as 1 to 55 ; and that the diameter of the ſmalleſt circle of diſperſion is 1/55th part of that of the lens.

2. In like manner may be determined the circle of diſperſion that will comprehend the rays of any particular colour or let of colours. Thus all the orange and yellow will paſs through a circle whoſe diameter is 1/260th of that of the lens.

3. In different ſurſaces, or plano-convex lenſes, the angles of aberration rPv are as the breadth PQ directly, and as the focal diſtance VF inverſely ; becauſe any angle DPE is as its ſubtenſe DE directly and radius DP inverſely. *N. B.* we call VF the focal diſtance, becauſe at this diſtance, or at the point F, the light is moſt of all conſtipated. If we examine the focal diſtance by holding the lens to the ſun, we judge it to be where the light is drawn into the ſmalleſt spot.

When we reflect that a lens of 51/2 inches in diameter has a circle of diſperſion 1/10th of an inch in diameter, we are ſurpriſed that it produces any picture of an object that can be diſtinguished. We ſhould not expect greater diſtinctneſs from ſuch a lens than would be produced in a camera obſcura without a lens, by simply admitting the light through a hole of 1/10 th of an inch in diameter. This, we know, would be very hazy and confuſed. But when we remark the ſuperior vivacity of the yellow and orange light in compariſon with the rest, we may believe that the effect produced by the confuſion of the other colours will be much leſs ſenſible. But a ſtronger reaſon is, that the light is much denser in the middle of the circle of disperſion, and is exceedingly faint towards the margin. This, however, muſt not be taken for granted ; and we muſt know diſtinctly the man­ner in which the light of different colours is diſtributed over the circle of chromatic diſperſion, before we pretend to pro­nounce on the immenſe difference between the indiſtinct­neſs ariſing from colour and that ariſing from the ſpherical figure. We think this the more necessary, becauſe the illuſtrious diſcoverer of the chromatic aberration has made a great miſtake in the companion, becauſe he did not conſider the diſtribution of the light in the circle of ſpherical diſper­ſion. It is therefore proper to inveſtigate the chromatic diſtribution of the light with the ſame care that we beſtowed on the ſpherical diſperſion in Optics, n⁰ 251. &c. ; and we ſhall then see that the ſuperiority of the reflecting teleſcope is incomparably leſs than Newton imagined it to be.

Therefore let EB (fig. 2.) repreſent a plano convex lens, of which C is the centre and Cr the axis. Let us ſuppoſe it to have no ſpherical aberration, but to collect rays occu­pying its whole ſurface to single points in the axis. Let a beam of white or compounded light fall perpendicularly on its plane ſurface. The rays will be so refracted by its cur­ved ſurface, that the extreme red rays will be collected at r*,* the extreme violet rays at w, and thoſe of intermediate refrangibility at intermediate points, *ο, y, g, b, p, v,* oſ the line *rw,* which is nearly 1/28th of rC. The extreme red and violet rays will croſs each other at A and D ; and AD will be a section or diameter of the circle of chromatic diſperſion, and will be about 1/55th of EB. We may ſuppoſe *vor* to be biſected in b, becauſe *ιυb* is to *br* very nearly in the ratio of equality (for *rb* : rC = *b*A : cE, z = *b*A : cB, = *vob* : wC). The line *rvo* will be a kind of priſmatic ſpectrum, red from *r* to o, orange-coloured from *o* to *y,* yellow from *y* to *g,* green from *g* to *b,* blue from *b* to *ρ,* purple from *p* to *v,* and violet from *v* to *vυ.*

The light in its compound ſtate muſt be ſuppoſed uni­formly denſe as it falls upon the lens ; and the same muſt be ſaid of the rays of any particular colour. Newton ſuppoſes alſo, that when a white ray, ſuch as e E, is diſperſed into its component coloured rays by refraction at E, it is uniformly ſpread over the angle DEA. This ſuppoſition is indeed gratuitous ; but we have no argument to the con­trary, and may therefore conſider it as juſt. The conſequence is, that each point w, *v, p, b, &c.* of the ſpectrum is not only equally luminous, but alſo illuminates uniformly its correſponding portion of AD : that is to ſay, the coating (ſo to term it) of any particular colour, ſuch as purple, from the point p*,* is uniformly denſe in every part of AD on which it falls. In like manner, the colouring of yellow, intercepted by a part of AD in its passage to the point *y,* is uniformly denſe in all its parts. But the denſity of the different colours in AD is extremely different : for since the radiation in w is equally dense with that in *p,* the density of the violet colouring, which radiates from w, and is