Of Colours

Isaac Newton

Newton Project Logo

SOURCE: Cambridge University Library Add Ms. 3975, pp. 1-22: 'Of Colours'

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HAND: Holograph

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REVISION HISTORY
Transcribed and tagged by Linda Cross September 2003.
Checked against microfilm by Rob Iliffe October 2003.

<1>
Of Colours.

1. The rays reflected from Leafe Gold are yellow but then transmitted are blew, as appears by holding a leafe of Gold twixt your eye & a candle.

2. Lignum Nephriticum sliced & about a handfull infused in 3 or 4 pints of faire water for a night the liquor (looked on in a cleare violl) reflects blew rays & transmits yellow ones. And if the liquor being too much impregnated appeares (when looked through) of a darke red it may be diluted with faire water till it appeare of a Golden Colour.

3 The flat peices of some kinds of Glase will exhibit the same Phænomena with Lignum Nephritcum And these Phænomena of Gold & Lignum Nephriticum are represented by the Prisme in the 37th experiment as also in the 22d & 24th Experiment.

4 But Generally bodys which appeare of any colour to the eye, appeare of the same colour in all positions; Nay Gold if it bee not soe very thin as to bee transparent appeares onely yellow & perhaps the yellow colour of Lignum Nephriticum would vanish if the tincture bee strong & the liquor of a greate thicknesse. And perhaps there are many coloured bodys which if made so thin as to bee transparent would appeare of one colour when looked upon & of another colour when looked through. Perhaps Motes in theSun doe so for they appeare coloured. And

5 The tincture of Lignum Nephriticum may bee deprived of its blew colour without any alteration made in the yellow. by putting a little of any acid salt into it (as spirit of Salt of vinegar, of Lemon juice, oyle of Vitrioll, Aqau fortis &c). Sulphureous Salts (whither Vrinous (i.e. Volatile salts of Animal substances) as Spirit of hartshorne of Vrin; of blood, of Sal Armoniack; Or Lixiviate Vnctuous Alcalizate & fixed salts made by incineration as the Solution of Salt of potashes, of common wood ashes, of lime water, Oyle of Tartar &c) doe restore the blew colour without making any change in the yellow.

<2>
Experiments with the Prisme

On a black peice of paper I drew a line opq, whereof one halfe op was a good blew the other pq a good deepe red (chosen by Prob. of Colours). And looking on it through thePrisme adf, it appeared broken in two twixt the colours, as at rst, theblew parte rs being nearer the vertex ab of the Prisme

than the red parte st. Soe that blew rays suffer a greater refraction than red ones. Note [I call those blew or red rays &c, which make the Phantome of such colours.

The same Experiment may bee tryed with a thred of two colours held against the darke.

7 Taking a Prisme, (whose angle fbd was about 60dr into a darke roome into which the sun shone only at one little round hole k. And laying it close to the hole k in such manner that the rays, being equally refracted at (n & h) their going in & out of it, cast colours rstv on the opposite wall. The colours should have beene in a round circle were all the rays alike refracted, but their forme was oblong terminated at theire sides r & s with streight lines; theire bredth rs being 21/3 inches, theire length to about 7 or eight inches, & the centers of the red & blew (q & p) being distant about 23/4 or 3 inches. The distance of the wall trsv from the Prisme being 260 inches

8 Setting the Prisme in the midst twixt the hole k & the opposite wall, in the same posture, & laying a boarde xy betwixt the hole k & the Prisme close to the Prisme, in which board there was a small hole as big as the hole k (viz: 1/8 of an inch in Diameter) so that the rays passing through both those holes to the Prisme might all bee almost parallel (wanting lesse than 7 minutes, whereas in the former experiment some rays were inclined 31min). Then was the length & breadth of the colours on the wall every way lesse than halfe the former by about 2 inches viz rs = 3/8inch, tv = 23/4inch . & pq = 11/4inch Soe that the Red & blew rays which were parallel before refraction may bee esteemed to be <3> generally inclined one to another after refraction some more some lesse than) 34min. And that some of them are inclined more than a degree, in this case. And therefore if theire sines of incidence (out of glasse into aire) be of the same, theire sines of refraction will generally bee in the proportion of 285 to 286 & for the most extreamly red & blew rays, they will bee as 130 to 131 +, : ffor by experiment if their angle of incidence out of the glasse into the aire bee 30d. The angle refraction of the red rays being 48gr 35': the angle of refraction of the blew rays will bee 48gr, 52', generally but if the rays bee extreamly red & blew the angle of refraction of the blew rays may bee more than 49gr, 5'.

9 In the 7th Experiment the colours appeared in this order. but in the 8th exper: when the rays were more distinct & unmixed

10 Painting a good blew or red colour on a peice of paper neither of which was much more luminous than the other (for carrying them gadually into the darke, both grew faint alike almost & disappeared together) if the Prismaticall blew fell upon the colours thay both appeared perfectly blew but the red paint afforded much the fainter & darker blew, but if the Prismaticall red fell on the colours then both appeared perfectly red but the painted blew afforded much the fainter Red. The Prisme was ordered as in the 8th experiment. Note that the purer the Blew | Red is the lesse tis visible with blew | Red rays.

<4>

11 If the plate abcdsr bee painted with any two colours & abcd bee the lighter colour, the partition edge of the Colours, cd will appeare through the prisme txy of a red colour, but if cres bee the lighter colour, their common edge cd 12 will through a prisme looke blew. 12 And this will happen though the colours differ not in species but only in degrees, as if acdb bee black & cdsr darkness or blacker than abdc the edge dc will bee red & much more conspicuous than the black, which is strange.

13 But if in a darke roome (as in Experiment 10) the prismaticall blew or redd fall on a paper abdc the edges of the paper will not appeare otherwise coloured through another Prisme than to the naked eye, viz: of the same colour with the rest of the paper. [ffor the first Prisme perfectly seperats the blew & red rays whereas I beleive all the colours proper to bodys are a little mixed.]

14 Prismaticall colours appeare in the eye in a contrary order to that in which they fall on the paper.

15 If a foursquare vessell abcd bee made with two parallel sides of well pollished glasse AC BD, & bee filled with water; And if the sunns rays passing into a darke roome through the hole k doe fall very obliquely on the glasse sides of the vessell the rays at their egresse shall paint colours on the paper EF on which they fall. [The blew & red rays being seperated by the first refraction.]

16 The colours are not made broader (as they would be were the prisme triangular) by removing the paper farther from the vessell. [becaus the blew & red rays become parallell againe after the second refraction] if the rays pass through two holes near or close to the vessell on either side the colours

<5>

17 The window k being opened that the Sun or other terminated light might shine freely, If I limited the rays by an opace body held twixt the wall & the vessel the edge of the bodys shaddow would not appeare coloured. But if the said body were on that side the vessel towards the sun its shaddow would be coloured on its edge

18. But in the Triangular Prisme whither the said body bee held on the one side or on the other the edges of its shaddow appeares coloured.

19. If you looke upon some uniformely luminous body (as on the cleare sky or a sheet of white paper &c) through a triangular prisme. & hold the said opace body on the farther side of the Prisme soe as to obscure parte of the said luminous body; the farther the said opace body is held from the Prisme, the more its edges will bee coloured; & the nearer, the lesse; untill the colours almost vanish when the said body is held close close to the Prisme.

20 But if instead of the triangular Prisme you use the said 4square vessell ABDC, held obliquely that the rays may bee much refracted in passing through it to the eye when the opake body is placed as neare to the vessell as you can distinctly see it, your eye being close to the vessell, the edges of thesaid body will appeare coloured which colours are diminished by removing the body farther from the vessell, & quite vanish when the distance of the said body is very greate. Thus the Sun, by reason of his distance, appeares not coloured on his edges when looked on through the said vessell, & yet in the 15th experiment hee trajects colours on a peice of paper.

21 The colours made by this vessel appeare imediatly to the eye in the same order in which they fall on paper but by the Prisme that order is divers.

Note, That the more the glasse sides of the vessell ABCD are distant, the better it is; that distance should not bee lesse than 6 or 8 inches to make the Pænomena conspicuous. Some of the Pænomena may bee tryed by tying two Prismes thus together: But the distance of theire sides is two little to exhibit them

<6>

22. If the sun S shine upon the Prism def, some of his rays being transmitted through the base ef will make colour on the wall cb at b, others will bee reflected to the wall at c making only a white without colours; Now if the Prisme bee soe inclined as that the rays ab bee refracted more & more obliquely, the blew colour will at last vanish from b; soe that the red alone being refracted to b, the blew will bee reflected to c & make the white colour there to appeare a litttle blewish. But if the Prisme bee yet more inclined, the red colour at b will vanish too & being reflected to c will make the blewish colour turne white againe.

23. If in the open aire you looke at the Image of the Sky reflected from the bases of the Prism ef, holding your eye O almost perpendicular to the basis you will see one part of the sky ep (being as it were shaded with a thin curtaine) to appeare darker than the other qf. [ffor all the rays which can come to the eye from qf, fall soe obliquely on the basis as to bee all reflected to the eye. Whereas those which can come to the eye from ep are so direct to the basis as to bee most of them transmitted to g]: & the partition of those two parts of the Sky, pq, appeares blew; [ffor the rays , which can come to the eye from pq, are so inclined to the basis that all the blew rays are reflected to the eye whilst most of the red rays are transmitted through to g as in Eperimnt 22]

24 Tying two Prismes basis to basis def & bef together I so held them in the sun beames transmitted through a hole into a darke roome, that they <7> falling pretty directly upon the base ef

(in fig 1) were most of them transmitted to B on the paper CB; though some of them were reflected to C by the filme of aire ef betwixt the Prismes.But both C & D were white Then I inclined the Basis (ef) of the Prismes more & more to the rays untill B changed from white to Red, & the white at C became blewish; & inclining the Prisme a little more the Red at B vanished, & the blewish colour at C became white againe. As in the 22th Experiment.

25 If I held the said Prismes in the open air as in the 23d experiment, holding my eye at O (in the 2d fig) to see the reflected sky the Phænomena were the same as in that 23d experiment; ep appearing darker than qf, & pq being blew. But if I held my eye at N to see the sky through the base of the Prismes ef (or rather through the plate of aire betwixt those bases) there appeared the contrary Phænomena but much more plaine ep being very light, qf very darke, & pq very red. [The reason was given in the 23d experiment

Note, That the 22th & 24th (& all such like experiments that require that the rays coming from a luminous body be all wholly or almost parallell) would bee more conspicuous were the suns Diameter lesse, & therefore for such like experiments his rays may bee straitned through two small holes at a good distance assunder, as was done in the 8th Experiment.

Also the 23th & 25t Experiment (most other such like in which the rays passe immediatly from the prisme to the eye) would bee more conspicuous were the Pupill lesse than it is, And therefore it would bee convenient to looke through a small hole at the Prisme.

26 The colours in the portion pq appeared to the eye O in this order

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27 The two Prismes being tyed together then in trying the 24th experiement, there appeared a white spot in the midst of the red colour B, & a darke spot in the blewish colour C. And after the base ef of the Prismes was more inclined to the rays , so that the red colour vanished & that (by the laws of Refraction) noe light could penetrate the filme of aire ef, yet the white spot remained at B & the darke one in the midst of the light at C.

28 Holding my eye at O or N (in trying the 25t Exper:) very obliquely to the basis ef; To my eye at O appeared a black spot (R) in the midst of the white basis (or filme of aire) ef, & to my eye at N appeared a white spot (R) in the midst of the black basis (or plate of aire) ef; though which spot (as through a hole in the midst of a black body) I could distinctly see any object, but could discerne nothing though any other parts of the appearingly blak basis ef.

29 By variously pressing the Prismes together at one end more than at another I could make the said spot R run from one place to another; & the harder I pressd the prismes together, the greater the spot would appeare. to bee. [Soe that I conceive the Prismes (their sides being a little convex & not perfectly plaine) pressed away the interjacent aire at R & becoming contiguous in that spot, transmitted the Rays in that place as if they had beene one continuous peice of glasse; whereas the plate of aire ef is a very reflecting body: soe that the spot R may bee called a hole made in the plate of aire (ef)].

32 The colours of the circles (in the 30th & 31th experiment) appeared more distinct at C than at B, & to the Eye O than to the Eye N. There being I conceive some colourlesse light reflected with the coloured light to O, & C but much more colourlesse light transmitted to N & B; which must needs whiten & blend the colours.

<9>

30 In the 27th Experiment when the colour white or red was trajected on B, there would apeare severall circles of colours about. the white spot at B & also about the darke one at C. But these colours vanished together with the red colour at B: Growing greater & distincter untill they vanished.

31 Likewise in the 28th exper: when the spot was in that side the partition pq next the eye, it appeared to my eye both at O & N, encompassed with divers circles of colours. Which circles would

grow greater & distincter by how much the coloured partition pq came nearer & nearer to them (that is by how much the base ef was more & more oblique to the rays) & soe vanished by degrees as the said limb pq came to them. Before they began to vanish they appeared round or Ellipticall thus But in their vanishing (especially if looked on through a hole much smaller then my pupill) they appeared incurved thus. But I could see the most circles when I looked on them through a long slender slit, held parallel to the coloured limb pq, when the circles halfe disappeared: for then I have numbered 25 circles esteeming each consecution of red & blew to bee one circle & could perceive ther were many more so close together that I could not number them; whereas with my naked eye I could not discern above nine or ten .

33 The circles are the broadest nearest to the center & so beeing narrower & narrower doe (I conceive by the exactest measure I could make) increase in number as the interjacent aire doth in thicknesse. (Sit cd = radio curvitatis vitri; efghik circuli colorum; & $el = fm/2 = gn/3 = hp/4 = iq/5 = kr/6$ = crassitiei æris). And this I observed by a sphericall object-glasse of a Prospective tyed fast to a plaine glasse, so as to make the said spot with the circles of colours appeare

<10>

34 By the forenamed Prospective glasse I observed (though not very exactly) that the more obliquely the ray tc was incident to the filme of aire ef twixt the glasses, the greater the coloured circles are in this proportion:

35 When the rays were perpendicular to the aire ef, the diameter of 5 of the circles was one parte, whereof 400 was the raduis dC of the glasses curvity. the said raius being 25inches Soe that (el) the thicknesse of the aire for one circle was 1/64000inch or 0,000015625. [which is the space of the pulse of the vibrating medium.] by measuring it since more exactly I find 1/83000 = to the said thicknesse.

36 Accordingly as the glasses are pressed more or lesse together the coloured circles doe become greater or lesse. & as they are pressed more & more together new circles doe arrive in the midst untill at last the said pellucid spot R doth appeare.

37 The circles of colour appeare in this order from the center to the eye O Or on the paper at C viz Darke (or pellucid), white, yellow, greene, blew, purple, Red, yellow, greene, blew purple, Red, yellow, Greene, blew &c. But to the eye N or on the Paper at B they appeare in this order Light (or pellucid) black, blew, Greene, yellow, Red, purple, blew, greene soe that those circles which appeare Red to the eye O, appeare blew to the eye N, & thos which appeare blew to the eye O appeare of the contrary colour red to the Eye N

<11>

38 Those circles which appeare Red to the eye O, & blew to the eye N are almost as broade againe as those which appeare blew to the eye O & Red to the eye N.

39 Holding the said circles in a darke roome in the blew rays made by a Prisme (as the 10th Experiment) all the said circles appeared blew but those which in the discoloured light appeared red appeared of a blew much more diluted than the others. And if the Red Prismaticall rays fell upon those circles all the circles appeared red but those circles which in the clear light appeared blew, in the Prismaticall red rays appeared of a much darker & obscurer red than the others.

40 Whither these circles were held in the Prismaticall blew or red rays they still appeared of the same bignesse.

41 Putting water betwixt the two Prismes instead of the filme of aire; There appeared all the Phænomena of the said circles, & also of the 22, 23, 24, & 25t Experiments &c. Onely somewhat more obscurely becaus there is lesse refraction made out of glasse into water than into aire; & yet

42 The coloured circles appeared as big when there was a filme of water as when there was a filme of aire betwixt the Prismes.

43 If you make the pellucid spot R nimbly to run to & fro. There will appeare another spot S to follow it, which spot S exhibits such Phænomena as it ought to doe were it a Spot of aire, viz: To the eye O it appeares white next the Spot R & then Red &c, But to the eye N it appeares black next the Spot R & then blew &c: which colours it ought to have were it a filme of aire (by exper 37). But it is not a filme of aire because if the Spot R rests a little, the water creepes into the said spot S & makes it vanish. It seemes therefore that the water cannot nimbly enough follow the spot R, but leaves <12> the space S empty to bee possessed by Æther alone, untill the water have time to creepe into it.

44 Refracting the Rays through a Prisme into a darke rome (as in the 7th Experiment) And holding another Prisme about 5 or 6 yards from the former to refract the rays againe I found ffirst that the blew rays did suffer a greater Refraction by the second Prisme then the Red ones.

45 And secondly that the purely Red rays refracted by the second Prisme made noe other colours but Red & the purely blew ones noe other colours but blew ones.

46 If three or more Prismes A, B, C, bee held in the sun soe that the Red colour of the Prisme B falls upon the Greene or yellow colour of the Prisme A & the Red colour of the Prisme C falls on the Greene or yellow colour of the Prisme B; the said colours falling upon the Paper DE at P, Q, R, S. There will appeare a Red colour at P & a blew one at S but betwixt Q & R where the Reds, yellows, Greenes, blews, & Purples of the severall Prismes are blended together there appeares a white.

47 Or if you clean a peice of <13> Paper on one side of the Prisme with severall slits a, b, c, d, in it parallel to the edges of the Prisme soe that the light passing through those slits make colours on the Paper DE; If the said paper be held neare to the Prisme there will appeare for each slit a, b, c, d, a coloured line r, s, t, v. The paper being held farther of untill the said coloured lines bee blended together, there will appeare white twixt p & q where those colours are blended; at m there appeares Reds & at n blews. But if the paper bee still held farther of the white colour (pq) will appeare narrower & narrower untill it vanish. & then gh on one side appeares Red & gf on the other side is blew.

49 A single superficies of Glasse reflects many rays whither they passe out of glasse into aire or out of aire into Glasse & yet two surfaces of Glasse when contiguous (by the 27th 28th & 29th Experiment) reflect the Rays noe more then if the glasses had beene one entire peice without such a superficies betwixt them.

48 As white was made by a mixture of all sorts of colours (in the 46th & 47th Experiment) Greene is made by a mixture of blew & yellow, purple by a mixture of red & yellow, &c

50 Thin fflakes of Muscovy Glasse, Bubbles which children make of sope & water, the thin skums of molten leade, of cooling iron, water wiped very thin on glasse, glasse blowne very thin, &c represent the Phænomena of the coloured circles in the 30th and 31st Exper &c. To which may bee referred coloured motes in the Sun or in liquors, or pouders, or sollid bodys; the slender coloured threds of some cobwebbs, of silke wormes, & of flax finely dressed (though the flax in spining loseth its glosse, because the flat thredds cleave together againe into two greate a thicknesse see Exper 49)

<14>

51 If the Sun S shine upon a large glasse Globe abd filled with water And if you hold your eye very neare to the globe, the rays bp will appeare coloured redd & the farther you hold your eye from the glasse the lesse they appeares coloured, untill the colour vanish. But the Rays rd & fq appeare coloured at what distance so ever your eye bee placed from the Globe. The like you may observe by letting the colours fall on a peice of paper.

52 Though one termination of light trajected through the Prisme will not make both blews & reds; yet in this globe it doth (see Cartesij Meteora cap 8 sec 9) ffor the rays rd & fq make all sorts of blews & reds; indeed by the rays bp the red is very distinct but the blew is scarce discernable.

53 The colours of the Rainbow must bee explicated by the rays rd & fq (vide Cartesij Meteor Cap 8

sec 1, 2, 3, 9, 10, 11, 12, 15) ffor the bow may bee mad by drops of water forcibly cast up into the aire.

54 The spot R (mentioned in Experiment the 52d) grows lesse or lesse by how much the rays fall more & more obliquely on the intermediate filme of aire ef. [which seemes to intimate that the thinness of the intermediate filme of aire (or rather Æther) augments its refraction, untill (when the glasses become contiguous) it bee equall to that of glasse]

55 The surfaces of Glasse doe not reflect soe much light when the glasse is in water as when it is in aire & the lesse any two mediums differ in refraction the lesse their intermediate surface reflects light [which intimates that tis not the superficies of Glasse or any smoth pellucid body that reflects light but rather the cause is the diversity of Æther in Glasse & aire or in any contiguous bodys though the parts of the Glasse must necessarily reflect some rays.

<15>

56 The pouders of Pelluced bodys is white soe is a cluster of small bubles of aire, the scrapings of black or cleare horne, &c: [because of the multitude of reflecting surface soe are bodys which are full of flaws, or those whose parts lye not very close together (as Metalls, Marble, the Oculus Mundi Stone &c) whose pores betwixt their parts admit a grosser Æther into them than the pores in their parts]. hence

57 Most Bodys (viz: those into which water will soake as paper, wood, Marble, the Oculus Mundi Stone, &c) become more darke & transparent by being soaked in water [for the water fills up the reflecting pores]

58 I tooke a bodkin gh & put it betwixt my eye & the bone as neare to the Backside of my eye as I could: & pressing my eye with the end of it (soe as to make the curvature a, bcdef in my eye) there appeared severall white darke & coloured circles r, s, t, &c. Which circles were plainest when I continued to rub my eye with the point of the bodkin, but if I held my eye & the bodkin still, though I continued to presse my eye with it yet the circles would grow faint & often disappeare untill I renewed them by moving my eye or the bodkin.

59 If the experiment were done in a light roome so that though my eyes were shut some light would get through their lidds There appeared a greate broade blewish darke circle outmost (as ts), & within that another light spot srs whose colour was much like that in the rest of the eye as at k. Within which spot appeared still another blew spot r, <16> especially if I pressed my eye hard & with a small pointed bodkin. & outmost at vt appeared a verge of light

60 But on the contrary if I tryed the experiment in very darke roome the circle ts apeared of a Reddish light sr of a darkish blew & the middle spot r appeared lighter againe; & there seemed to be a circle of darke blew tv without the circle ts the outmost of all [I conceive (in the 60th experiment) where the curvature of the Retina at ma & fn began & was but little the blew colour tv was caused; at ab & ef where the Retina was most concave, the bright circle ts was caused: at bc. & de where the Retina was not much incurved nor strained the darke blew circle sr was caused & at cd where the Retina was stretched & made convex the light spot r was caused. In the 59th Experiment the spirits were perhaps strained out of the Retina at ab, ef, & cd or otherways made incapable of being acted upon by light & soe made a lesse appearance of light than the rest of the Retina]

61 That the same circle ts which appeared light in the darke, appeared darke in the light I found by suddenly letting in light into a darke darke roome for then the bright circles would imediatly turne into darke ones & darke ones into bright ones.

62 I could sometimes perceive vivid colours of blew & red, made by the said pressure & perhaps a criticall eye might have discerned this order of colours. in the 60th experiment viz from the center greene, blew, purple, darke purple, blew, greene, yellow, red like flame, yellow, greene, blew, broade purple, darke.

63 Looking on a very light object as the Sun or his image reflected; for a while after there would

remaine an impression of colours in my eye: viz: white objects looked red & soe did all objects in the light but if I went into a dark roome the Phantasma was blew.

64 That vision is made in the retina appeares because colours are made by pressing the bakside of the eye; but when the eye turns towards the pressure, soe that it is pressed before the colours cease.

<17>

The Tunica Retina grows not from the sides of the optick nerv (as the other two which rise one one from the dura, the other from the Pia mater) but it grows from the middle of the nerve sticking to it all over the extremitys of its marrow. Which Marrow if the nerve bee any where cut cross wise twixt the eye & the union of the nerves, appeares full of small spots or pimples, which are a little prominent, especially if the nerve be pressed or warmed at a candle. And these shoot into the very eye & may bee seene with in side where the retina grows to the nerve: and they also continue to the very juncture EFGH. But at this juncture they end on a suddein into a more tender white pap like the interior part of the braine & soe the nerve continues after the juncture into the braine filled with a white tender pap in which can bee seene noe distinction of parts as betwixt the said juncture & the eye.

Now I conceive that every point in the retina of one eye hath its correspondent point in the other, from which two very slender pipes filled with a most lympid liquor doe without either interuption or any other uneavenesse or irregularity in their processe, goe along the optick nerves to the juncture EFGH where they meete either twixt GF or FH, & there unite into one pipe as big as bothe of them, & so continue in one passing either twixt IL or MK into the braine where they are terminated perhaps at the next meeting of the nerves twixt the Cerebrum & cerebellum, in the same order that they extemities were scituate in the Retinals. And so there are a vast multitud of these slender pipes which flow from the braine the one halfe through the right side nerve IL till they come of the juncture GF where they are each divided into two branches the one passing by G & T to the right side of the right eye AB, the other halfe shooting through the juncture EF & soe passing by X to the right side of the left eye αβ. And in like manner the other halfe shooting through the left side nerve MK divide themselves at FH & their branches passing by EV to the right ey & by HY to the left, compose that 1/2 of the Retina <18> in both eyes which is towards the left side, CD, & γδ.

Hence it appears i why the two images of both eyes make but one image abcd in the braine. 2 Why when one eye is distorted objects appear double, ffor if the image of any object bee made upon α in the one ey & β in the other, that object shall have two images in the brain at a & b. Therefore the pictures of any object ought to bee made upon the corresponding points of the two Retinas if upon A in the right ey then upon α in the left. If upon B then also upon β. And soe shall the motions concurr after they have past the juncture GH & make one image at a or b more vivid then one ey alone could doe. 3 Why though one thing may appeare in two places by distorting the eye yet two things cannot appear in one place. If the picture of one thing fall upon A & of another upon α, they may both proceed to p but noe farther, they cannot both be carried on the same pipes pa into the braine, that which is strongest or most helped by fantasy will there prevaile & blot out the other. 4 Why a blew seene by one eye & a yellow by the other at the same time produces a greene unlesse the fantasy make one colour prædominant. 5tly Why if one of the branches of the nerve beyond the juncture as at GF or FH should bee cut: That halfe of both eys toward the wounded nerve would bee blind, the other halfe remaing perfect. 6tly Why the juncture is almost as broad again twixt G & H then twixt E & F, becaus all the tubuli of both eys pass twixt G & H & but 1/2 of them twixt E & F. It is not quite so broad again because the tubuli crossing in G are joining &c: also the thicknes of the quicks &c.7tly why the nerve GILF buts not directly upon the nerve XEHY but deviates a little towards TV because its Tubuli are to passe only into that side of the nerve EHYX towards EX. The like of FMKH 8thly why the marrow of the nerve TVEG grows soft on a suddein when it comes at the juncture EF & more suddenly on that side towards G then towards E. And the like of the nerve EXYH. For it being necesary that the nerve TVEG should bee stretcht & bended severall ways by the motion of the eye: Therefore the tubuli are involved or wrought up with in the substances of severall tough skins which being foulded up together compose the marrow of the nerve, pretty sollid & flexible least the tubuli should be prejuced by the severall motions of the nerve. And those small pimples or prominences which appeare in the nerve cut crosse wise I conceive to bee made by the foldings of these crasser skins. But the nerve at the juncture EGFH being well guarded from all violence &c. <19> motion by the bones into which it is closely adapted: tis not necessary the said membranes substance should be continued any further then EG therefore the tubuli there on a suddein unsheath themselves there on the inner side of the nerves towards VE & XE may severally crosse twixt EF & bee united with their correspondents on the other sides YH & TG. Now because the inner tubuli must first crosse before they can convene with the outmost tubuli of the opposite nerve hence it is that the nerves grow soft sooner on the inner side at E then on the outer side at G & H.

9thly why the two nerves meet a second time in the braine, because the two half images caried along IL & MK may bee united into one complete image in the sensory. Note that the nerves at their contact | meeting are round about disjoyned from the rest of the braine, nor are they soe thick theire as a little before their meeting. But by their externall figure they seeme as if the capillamenta concentered like the radii of a hemisphere to a point in the lower part of the juncture. And tis probable that the visive faculty is there for else why doe the nerves swell there to so great a bulke as it were preparing for their last office, why doe they run directly crosse from eitherside the braine to meet there if the designe was to have the motions coveyed by the short cut from the eye to the sensorium before they grew too weak. If they were to proceed further , they might have gone a shorter cut & in a lesse channell. There is indeed a marrow shoots from under them toward the cerebellum to which they are united but the greatest part of their substance if not all of it lys above this marrow & also shoots cross beyond it to the center of the brain where they meet. Lastly the substance here is most pure, the scituation in the midst of the brain, constituting the upper part of that small passage twixt all the ventricles. where all superfluous humors have the greatest advantages to slide away that they may not incumber that prerous organ

Light seldom striks upon the parts of grosse bodys (as may bee seen in its passing through them), its reflection & refraction is made by the diversity of æthers, & therefore it effectes on the Retina can only bee to make this vibrate which motion then must bee either carried in the optick nerve to the sensorium or produce other motions that are carried thither. Not the latter for water is too grosse for such subtile impressions & as for animall spirits <20> though I tyed a peice of the optick nerve at one end & warmed it in the middle so see if any aery substance by that meanes would disclose it selfe in bubbles at the other end, I could not spy the least bubble; a little moisture only & the marrow it selfe squeezed out. And indeed they that know how difficultly aire enters small pores of bodys, have reason to suspect that an aery body though much finer then aire can pervade easily & without violence (as it ought to doe) the small pores of the braine & nerves, I should say of water, because those pores are filled with water, & if it could it would bee too subtil to bee imprissoned by the dura mater & Skull, & might passe for æther. However, what need of such spirits much Motion is ever lost by communication especially twixt bodys of different constitutions. and therefore it can noe way bee conveyed to the sensorium so entirely as by the æther it selfe Nay granting mee but that ther are pipes filld with a pure tranparent liquor passing from the ey to the sensorium & the vibrating motion of the æther will of necessity run along thither. ffor nothing interrupts that motion but reflecting surfaces, & therefore also that motion cannot stray through the reflecting surfaces of the pipe but must rush along (like a sound in a trunk) intire to the sensorium. And that vision bee thus made is very conformable to the sense of hearing which is made by like vibrations.

ffrom the whitenes of the brain & nerves the thicknesse of its vessells may be determined & their cavitys guessed at. And its pretty to consider how these agree with the utmost distinctnesse in vision. As als with the intent of nature in conveying distinctly the motions of the Aether.

<22>

If rays be incident out of glasse upon a film of air terminated twixt two glasses, the thicknesse of a vibration is 1/81000, or 1/80000 part of an inch

If water was put twixt the glasses the thickness of a vibration was 1/1000000inch, of 3/4 of its former dimensions. viz as the densitys of the interjected mediums.

If the rays were incident obliquely, the circles increase so that their diameters are as the secants of the rays obliquity within the film of air, or reciprocally as their celerity within the said film.

And the thicknesse belonging to each vibration is as the squares of those secants of celeritys, And the lengths of the rays belonging to each vibration as their cubes.

The first pulse ends at the first dark circle

The thicknesse of a pulse of extream rubiform rays to that of purpuriform ones perpendicularly incident is greater then 3 to 2 & lesse then 5 to 3. viz as 9 to 14 or 13 to 20. And the thicknesse belonging to each coulour is 13, 14 141/2, 151/2 161/2. 171/2. 181/2. 19. for extreame purple, intense purple, Indico, blew, green, the terminus of green & yellow, yellow, orange, red, extream red.

Mr Boyle mentions one that by sickness became so tender sighted as in the dark night to see & distinguish plainly the colours of ribband (& other objects) on purpose pinned on the inside of his curtains against he awaked. Of the determinate nature of Effluviums p 26, And of another that by a feaver became of so tender hearing as to hear plainly soft whispers at a distance which others could not at all perceive, but when he grew well his hearing became but like that of other men. Ibid.

Stipic vegetables, as gall, oaken bark, red roses, Log-wood, Sumach &c turn vitriol to a black precipitate.