

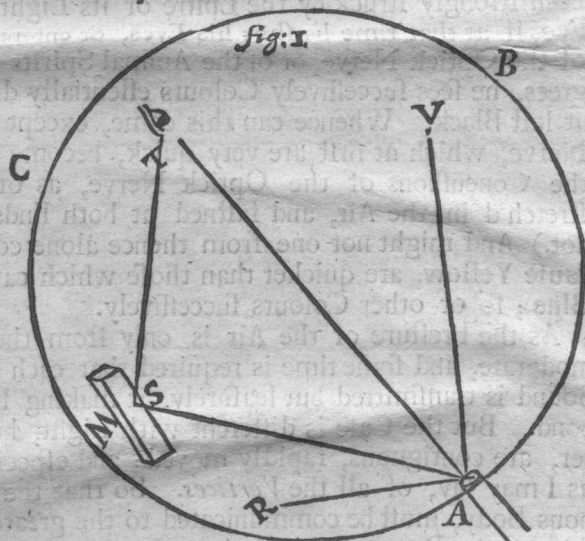
F. MALEBRANCHE'S TREATISE
 CONCERNING
Light and Colours.
 BEING AN
ILLUSTRATION
 OF THE
 Fourth CHAPTER of his Sixth BOOK.

Never before Printed.

IN order to explain my Thoughts concerning the Natural Causes of Light and Colours, let us conceive a great Foot-ball externally press'd by a Force, in a manner infinite; and that the fluid Matter contain'd in it, has so rapid a Motion, as not only to turn all, after one and the same Fashion, with a mighty Swiftneſs; but that each Part of it, to imploy all its Motion, (that is, to move it ſelf equally to its Force,) is ſtill oblig'd either to turn upon the Centre of an infinite Number of little *Vortices*, or elſe to glide between them, and all this with a prodigious Celerity; inſomuch that the Force of the Matter contain'd in the Foot-ball, ſhall make an equal Poize with that external Force which compreſſes it. In a word, let us conceive the Matter contain'd in the Foot-ball to be like that with which M. *Des Cartes* furniſhes our *Vortex*, excepting only that the little Bowls of his ſecond Element, which he ſuppoſes hard, be nothing but little *Vortices* themſelves; or at leaſt, that they have no Hardneſs but what is occaſion'd by the Preſſure of thoſe which ſurround them: For if theſe little Bowls were hard by their own Nature, (as I think I have demonſtrated the contrary,) it were impoſſible for them to tranſmit Light and Colours, as we ſhall ſee by and by. But if this Suppoſition be difficultly conceived, let us only ſuppoſe a Foot-ball fill'd with Water, or rather with a Matter infinitely more fluid, and receiving an external Preſſure from without. The Circle *A B C* is the Section through the Centre of the Foot-ball.

In the laſt Chapter of the Search, where I treat of the Hardneſs of Bodies.

This being ſuppos'd, let there be imagin'd a ſmall Hole to be made at the Point *A*; I ſay, that all the Parts of the Water, as *R S T V*, contain'd therein, will tend towards the Point *A* by the right Lines, *R A*, *S A*, &c. For all the Parts which were equally preſs'd before, ceaſe to be ſo on that ſide which answers to the Hole. They muſt therefore tend towards it, ſince every Body that is preſs'd, muſt tend to move it ſelf that way where it finds the leaſt Reſiſtance.



But if a Stopple be put in the Orifice *A*, and it be haſtily thruſt inwards, the ſame Parts, *R S T V*, &c. will all tend to remove themſelves from the Hole, directly by the ſame Lines, *A R*, *A S*, &c. Becauſe, upon the advancing in of the Stopple, they are more preſs'd on the Side wherein it enters.

Laſtly, If we conceive the Stopple moved haſtily backwards and forwards, all the Parts of the ſubtile Matter (which exactly fills the Foot-ball, whoſe Elatiſcity is very great, and which difficultly contracts or extends it ſelf) will receive infinite Vibrations from the Preſſure.

Let us now ſuppoſe an Eye at *T*, or elſewhere, directed towards a Torch at *A*; the Parts of the Torch being in continual Motion, will conſtantly preſs the ſubtile Matter on all ſides, and conſequently quite from *A* to the Fund of the Eye: And the Optick Nerve, being vehemently preſs'd and ſhaken by very quick Vibrations, will excite in the Soul the Senſation of Light, or of a lively and glittering Whiteness.

If we ſuppoſe at *S* a dark Body *M*, the ſubtile Matter being not reflected towards the Eye that way directed, nor vibrating the Optick Nerve, the Body will appear black; as when we look into the Mouth of a Cave, or the Hole of the Pupil of the Eye.

If the Body *M* be ſuch, as that the ſubtile Matter vibrated by the Torch, be reflected towards the Eye, without any Diminution of the Quickneſs of the Vibrations, the Body *M* will appear

White, and so much the more White as there shall be more Rays reflected. It will likewise appear Luminous, as Flame, if the Body *M* being polish'd shall reflect all, or almost all the Rays in the same order.

But if the Body *M* be such, as that the subtile Matter reflected has its Vibrations less quick, in certain Degrees that cannot be exactly determin'd, the Result will be one of the primitive Colours, Yellow, Red, Blue, provided all the Parts of the Body *M* diminish equally the Vibrations caused by the Flame in the subtile Matter, and all the rest of the Colours made up of a Mixture of the primitive, will arise according as the Parts of the Body *M* shall unequally diminish the Quickness of the said Vibrations. This is what I meant, when I advanc'd in some Places of my Book, that Light and Colours consisted only in the Vibrations of Pressure, as they were more or less quick, produced by the subtile Matter on the *Retina*.

This simple Exposition of my Opinion will, perhaps, make it seem probable enough, to those at least who are acquainted with *M. Des Cartes's* Philosophy, and who are not satisfied with the Explication which that Learned Man gives of Colours: But that a more solid Judgment may be made on my Opinion, it is not enough to have barely propos'd it; it is requisite to produce some Arguments to confirm it.

To that End, it is necessary to observe, First, That Sound is rendred Sensible only by the Vibrations of the Air, which shake the Ear; for upon the Air's being drawn out of the Air-Pump, Sound is no longer heard.

Secondly, That the Difference of Tones proceeds not from the Strength of these Vibrations of the Air, but from their Quickness, as it is more or less.

Thirdly, That though the Impressions which Objects make upon the Organs of our Senses, differ sometimes, but according to more or less, the Sensations which the Soul receives from them differ essentially. There are no Sensations more opposite than Pleasure and Pain; and yet a Man that scratches himself with Pleasure, feels Pain, if he scratches a little harder than ordinary. There is great probability that Bitter and Sweet, which cause Sensations essentially different, differ only by *more* and *less*: For there are those who taste that Bitter which others taste Sweet. There are Fruits which to Day are Sweet, and to Morrow Bitter. A little Difference in Bodies makes them capable of causing very opposite Sensations; a sign that the Laws of Union of the Soul and Body are arbitrary, and an undoubted Proof that we receive not from Objects the Sensations we have of them.

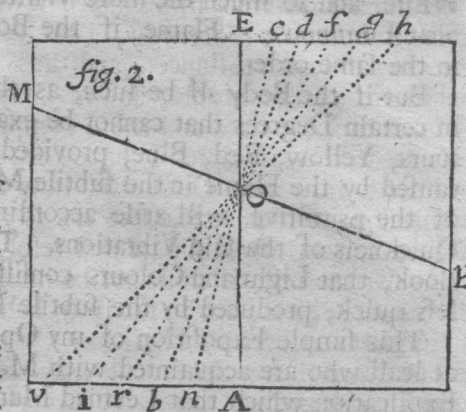
Fourthly, If the Vibrations of the Air, as they are quicker or slower, produce very different Tones, we should not admire that the Vibrations of the subtile Matter, which presses perpetually the Optick Nerve, should cause us to see Colours altogether different, though the Celerity of these Vibrations differ only by more or less. When a Man has beheld the Sun, and his Optick Nerve has been strongly struck by the Lustre of its Light, because that Nerve is situate in the *Focus* of the Eye, if at that time he shut his Eyes, or enters with them open into a dark Place, the Concussion of the Optick Nerve, or of the Animal Spirits contain'd in the Nerve, diminishing by unequal Degrees, he sees successively Colours essentially different, first White, then Yellow, Red, Blue, and at last Black. Whence can this come, except that the Vibrations or Concussions of the Optick Nerve, which at first are very quick, become by Degrees more slow? (For we must not judge of the Concussions of the Optick Nerve, as of those of the Strings of Instruments, which are stretch'd in the Air, and fastned at both Ends, and the Celerity of whose Vibrations diminish not.) And might not one from thence alone conclude, that the Vibrations of the *Retina*, which cause Yellow, are quicker than those which cause Red; and those of Red, quicker than those of Blue; so of other Colours successively.

As the Pressure of the Air is only from the Weight of the Atmosphere, its Elasticity is but moderate, and some time is required that each part of Air may impell its Neighbour: And thus Sound is transmitted but leisurely, it making but about an Hundred and eighty Fathom in a Second. But the Case is different with Light, because all the Parts of the other, or subtile Matter, are contiguous, rapidly moved; and especially because they are compress'd with the Weight, as I may say, of all the *Vortices*. So that the Vibrations of Pressure, or the Action of a luminous Body, must be communicated to the greatest Distance in the shortest Time; and if the Pressure of the Parts constituting our *Vortex*, were actually infinite, the Vibrations of Pressure must undoubtedly be made in an Instant. Monsieur *Hugens*, in his *Treatise of Light*, pretends, from Observations made on the Eclipses of *Jupiter's Satellites*, that Light is transmitted about Six hundred thousand times faster than Sound. The Weight therefore of all the other, or the Compression of its Parts, is much greater than that of the Atmosphere. I think I have sufficiently proved, that the Hardness of Bodies can proceed only from the Pressure caused by this Weight; and if so, it must needs be extraordinary great, since there are Bodies so hard, as demand a very great Force to separate the least part of them.

Let us suppose then that all the Parts of the other, or of the subtile and invisible Matter of our *Vortex*, are compress'd with a kind of infinite Force, and that each of these Parts is very fluid, having its Hardness only from the Motion of those which encompass and compress it on all sides; and let us see how it's possible for the Impressions of infinite different Colours to be communicated without Confusion; how Ten thousand Rays which cut one another, in one physical or sensible Point, transmit, through the same Point, all their different Impulsions: For, probably, the System which can explain that great Difficulty, will be consonant to the Truth.

Search after
Truth,
Ch. ult.

Let *APEM* be a Chamber painted with a great Variety of Colours, and let them be as opposite as may be; that is, let there be White at *A* next to Black at *n*, Blue at *b* next to Red at *r*, Yellow at *i* next to Purple at *v*. From all these Points, *Anbriv*, let right Lines be drawn, all cutting in one common Point *O*, and let an Eye be placed beyond it, as in *Ecdfgh*, all these different Colours will be seen through the same Point of Interfection *O*. And since this Figure represents only one row of Colours, whereas we must imagine as many as there are visible Points in a Sphere, the Point of Interfection *O*, must receive and transmit an infinite Number of different Impressions, without destroying one another.



I say then, that if the Physical Point, or the Globule *O*, be an hard Body, as *M. Des Cartes* supposes it, it is impossible that an Eye at *E* should see White at *A*, and that another Eye at *c* should see Black at *n*. For a Body being hard, if any part of it tends directly from *A*, for Example, towards *E*, (that is, if it proceeds any whit to compress the Optick Nerve) all the other parts must necessarily tend thither also: and therefore Black and White cannot be seen at the same time, by the Interposition of the Globule *O*. *M. Des Cartes* pretends farther, that Red is made by the turning of the little Globules, which is communicated from one to another quite along the whole Ray, from the Object to the Eye. That Opinion is indefensible for many Reasons: but there needs no more to ruin it, than to consider that if the Globule *O* turn upon the axis *PM* from *r*, where there is Red, towards *f* where the Eye is placed, it cannot at the same time turn upon the axis *rf* from *M*, where I likewise suppose Red, towards *P* where I suppose another Eye. For the rest: When I say that the Rays cut themselves in the Globule *O*, I do not assert that the visual Rays have no greater density than that of a Globule of the second Element. I do not determine what thickness of these Rays is sufficient so to strike the Optick Nerve, as to cause it to see Colours. But what I have said of a single Globule, must be understood of an Hundred or a Thousand, if so many be required to make a Ray sensible.

It is not therefore possible that the little Globule *O*, or its fellows, should transmit the Action of infinite different Colours, if these Globules are hard: But if they be conceived infinitely soft, as the simple Idea of Matter represents them (since Rest has no Force, and it is indifferent to each part to be or not to be near another,) I say, if these Globules be conceived very soft, or rather as exquisitely little *Vortices* composed of an infinitely fluid Matter, they will be susceptible of infinite different Impressions, which they can communicate to others upon which they lean, and with which they are as it were infinitely compressed. I will endeavour to explain and prove this.

In order to which, it is necessary well to understand, that Re-action is here necessarily equal to Action, for these Reasons, That naturally Force is never destroy'd, that our *Vortex* is as it were infinitely compress'd, and that there is no *Vacuum*; and lastly, because the Ethereal Matter is in vehement Motion. If, for Example, a Man thrust his Cane against an immovable Wall, it will be repelled with the same Force that it is pushed. The Re-action will be equal to the Action. Now though the Rays are not hard like Sticks, yet very near the same thing will happen in regard of Re-action, because of the compression and plenitude of our *Vortex*.

For if we suppose a Cask exactly full of Water, and a Pipe being fitted to it, a Stopple be thrust into this Pipe, it will meet with a Resistance within, equal to the driving Force without. And if a little Hole be made in the middle of the Stopple, through which the Water may pass from the Vessel; and then the Stopple be thrust in, all the Water which shall be compressed by it, will tend at the same time, by reason of its fluidity, both to recede from every point of the Stopple, and also to approach the Hole in the middle of it. For if the Stopple be forced in with violence enough, the Vessel will burst in the weakest part of it, let it be where it will; a certain sign that the Water presses the Vessel every where; and if the Stopple be push'd in, the Water will immediately thereupon fly out by the little Orifice. All this, because Re-action is equal to Action in a *plenum*, and that Water, or the subtile Matter, is soft or fluid enough for every part of it, so to figure it self as to suffice for all sorts of Impressions. It must also be observed, That the more violently the Stopple is forc'd into the Vessel, the more forcibly the Water, whilst 'tis driven toward the Concave Surface of the Vessel, returns towards the Stopple, and leaps through the Hole.

Hence 'tis easie to perceive that a Black Point on White Paper must be more visible than upon Blue; because White repelling the light stronger than any other Colour, it must by its Re-action tend more forcibly towards the Black Point. But if the Ethereal Matter were not infinitely soft and fluid, it is plain that the little Globules which transmit the impression of White, being hard, would hinder that of Black, because these Globules supporting one another, could not tend towards the Black Point: And if that Ethereal Matter were not pressed, there would be no Re-action.

What I have been saying of White and Black, ought to be applied to other Colours, though it would be difficult to do it in particular, and to answer the Objections which many would make upon that Subject: For it is easie to raise Objections, in matters that are obscure. But all those who are able to make Objections, are not always capable of comprehending the Principles on which the Resolution of them depend. To me it seems easie enough, to conceive how it is possible for a sensible

a sensible point of Matter, infinitely fluid, and compressed on all sides, to receive at the same time infinite different Impressions, if we attend to these two things: *First*, That Matter is divisible *in infinitum*: *Secondly*, That each part necessarily tends and advances that way where it meets with least resistance; and thus, that every soft and unequally press'd Body, receives all the Sculptures of the Mould, as I may say, that surrounds it, and receives them so much more readily as it is more fluid and more compress'd. I omit the enumeration of Consequences which follow from the Principles I have been explaining; by which Consequences, I think, may be removed that surprizing Difficulty, how the Rays of different Colours may cross each other without Confusion; which appears to me so great a Difficulty, as that none but the true System of the World can entirely dissipate and resolve it.

As for the rest, it must not be imagined that what I have said of the Globules of the second Element (which I am so far from believing hard, as that I consider them as little *Vortices*) can injure M. *Des Cartes's* Physicks: On the contrary, my Opinion, if true, perfects his System in General. For if my Sentiment may be useful to the Explication of Light and Colours, it seems much more proper to resolve other General Questions of Natural Philosophy; as for Example, how to explain the surprizing Effects of Fire.

As Bodies cannot naturally acquire any Motion, unless it be communicated to them, it is manifest that Fire cannot be made but by the Communication of the Motion of the subtle Matter. M. *Des Cartes*, as is known, pretends that 'tis only the first Element which communicates its Motion to the third, of which gross Bodies are compos'd, and which sets it on fire. According to him, when one strikes fire, one forcibly dissevers a little part of the Flint: (I rather should believe it to be a part broke off from the Steel, which is kindled: For when we behold with a Microscope the Sparks of Fire which are collected, it appears to be the Iron which has been melted and reduced into Globules, or little long and round Figures. I have not observ'd any Change to have happen'd in the little parts broken from the Flint, but that makes nothing at the bottom.) That little part broken off from the Iron, spinning then round with force, drives the little Globules, or the second Element, and consequently causes that first to flow towards the Particle of Steel, which surrounding it on all sides, communicates its Motion to it, and sets it on fire. This is pretty nearly the Opinion of M. *Des Cartes*. It may be seen more at large in the Fourth Part of his *Principles*, in the 80th, and following Numbers. But if these Globules are hard, and all contiguous, it is difficult to conceive how the first Element could flow towards the separated part of the Iron, and that with a sufficient Quantity to encompass and set it on fire, not only that, but all the Powder of a Cannon or a Mine, since the first Element is but a very small Portion of the Ethereal Matter, as fitting only the little triangular or concave Spaces, which the contiguous Globules leave between them. This then is the Way that I explain Fire, upon Supposition that the little Globules of the second Element are only little *Vortices* of a violently agitated Matter.

Though the Air be not absolutely necessary to excite some Spark of Fire, yet for want of Air, Fire immediately goes out, and cannot so much as communicate it self to Gun-powder, though very easie to be inflamed. Experience shews, that if a Pistol well primed have its Cock struck down in an Air-Pump, when the Air is exhausted, the Priming never takes fire, and it is very difficult to observe the Sparks. Lastly, Every Body knows that Fire goes out for want of Air, and that it is kindled by blowing: This being supposed, see how I explain the Production of Fire.

When a Man strikes Fire in a *Vacuum*, he breaks off, by the force of the Blow, a little part of the Steel, or of the Flint; this little part whirling about, and striking rudely upon some little *Vortices*, breaks them; and consequently determines their Parts to follow its Determination, and to surround it in an Instant, and set it on fire. But the Matter of these little *Vortices*, after having made abundance of irregular Motions, re-places it self partly in new *Vortices*, and partly escapes between the Intervals of the surrounding *Vortices*, which approach the dissever'd part of Iron. And these new *Vortices* are not easily broken, because they follow pretty exactly the Motion of the part of Iron; which being perhaps either circular or cylindrous, and turning nearly, either upon its Centre, or its *Axis*, strikes no more the *Vortices* in a manner capable of breaking them. All this is perform'd as in an Instant, when the Flint strikes the Steel in a Place void of Air, and the Spark then is hardly visible.

But when the Steel is stricken in full Air, the part broken off from it, as it whirls, meets and vibrates a good deal of Air, whose Parts, probably branchy, meet with it, and break many more of the *Vortices* than the Iron alone. So that the subtle Matter of these *Vortices*, coming to surround the Iron and the Air, affords them plenty enough of different Motions, strongly to repel the other *Vortices*. Thus the Sparks must be much more glittering in the Air than in a *Vacuum*, they must remain much longer, and have sufficient force to fire Gun-powder; which cannot want subtle Matter to set it on fire, whatever Quantity of Powder there is; since it is not only the first Element, but much more the second, which produces its extraordinary Motion. If one make Reflexion on what happens to Fire, when 'tis clear, that is, when a great deal of Air is driven against it, we shall not doubt but that the Parts of the Air are very proper to determine the subtle Matter, to communicate a part of its Motion to the Fire since 'tis only from this Matter that the Fire can derive its Motion; no Body being capable of moving it self, but by the Action of those which environ it, or which strike against it.