

OPTICKS

OR A TREATISE OF THE
REFLECTIONS, REFRACTIONS, IN-
FLECTIONS & COLOURS OF LIGHT

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the Rock, and is not yet found in other Bodies. I do not say that this Virtue is magnetical: It seems to be of another kind. I only say, that whatever it be, it's difficult to conceive how the Rays of Light, unless they be Bodies, can have a permanent Virtue in two of their Sides which is not in their other Sides, and this without any regard to their Position to the Space or Medium through which they pass.

What I mean in this Question by a *Vacuum*, and by the Attractions of the Rays of Light towards Glass or Crystal, may be understood by what was said in the 18th, 19th, and 20th Questions.

Quest. 30. Are not gross Bodies and 'Light convertible into one another, and may not Bodies receive much of their Activity from the Particles of Light which enter their Composition? For all fix'd Bodies being heated emit Light so long as they continue sufficiently hot, and Light mutually stops in Bodies as often as its Rays strike upon their Parts, as we shew'd above. I know no Body less apt to shine than Water; and yet Water by frequent Distillations changes into fix'd Earth, as Mr. *Boyle* has try'd; and then this Earth being enabled to endure a sufficient Heat, shines by Heat like other Bodies.

The changing of Bodies into Light, and Light into Bodies, is very conformable to the Course of Nature, which seems delighted with Transmutations. Water, which is a very fluid tasteless Salt, she changes by Heat into Vapour, which is a sort of Air, and by Cold into Ice, which is a hard, pellucid, brittle, fusible Stone; and this Stone returns into Water by Heat,

and Vapour returns into Water by Cold. Earth by Heat becomes Fire, and by Cold returns into Earth. Dense Bodies by Fermentation rarify into several sorts of Air, and this Air by Fermentation, and sometimes without it, returns into dense Bodies. Mercury appears sometimes in the form of a fluid Metal, sometimes in the form of a hard brittle Metal, sometimes in the form of a corrosive pellucid Salt call'd Sublimate, sometimes in the form of a tasteless, pellucid, volatile white Earth, call'd *Mercurius Dulcis*; or in that of a red opake volatile Earth, call'd Cinnaber; or in that of a red or white Precipitate, or in that of a fluid Salt; and in Distillation it turns into Vapour, and being agitated *in Vacuo*, it shines like Fire. And after all these Changes it returns again into its first form of Mercury. Eggs grow from insensible Magnitudes, and change into Animals; Tadpoles into Frogs; and Worms into Flies. All Birds, Beasts and Fishes, Insects, Trees, and other Vegetables, with their several Parts, grow out of Water and watry Tinctures and Salts, and by Putrefaction return again into watry Substances. And Water standing a few Days in the open Air, yields a Tincture, which (like that of Malt) by standing longer yields a Sediment and a Spirit, but before Putrefaction is fit Nourishment for Animals and Vegetables. And among such various and strange Transmutations, why may not Nature change Bodies into Light, and Light into Bodies?

Quest. 31. Have not the small Particles of Bodies certain Powers, Virtues, or Forces, by which they

act at a distance, not only upon the Rays of Light for reflecting, refracting, and inflecting them, but also upon one another for producing a great Part of the Phænomena of Nature? For it's well known, that Bodies act one upon another by the Attractions of Gravity, Magnetism, and Electricity; and these Instances shew the Tenor and Course of Nature, and make it not improbable but that there may be more attractive Powers than these. For Nature is very consonant and conformable to her self. How these Attractions may be perform'd, I do not here consider. What I call Attraction may be perform'd by impulse, or by some other means unknown to me. I use that Word here to signify only in general any Force by which Bodies tend towards one another, whatsoever be the Cause. For we must learn from the Phænomena of Nature what Bodies attract one another, and what are the Laws and Properties of the Attraction, before we enquire the Cause by which the Attraction is perform'd. The Attractions of Gravity, Magnetism, and Electricity, reach to very sensible distances, and so have been observed by vulgar Eyes, and there may be others which reach to so small distances as hitherto escape Observation; and perhaps electrical Attraction may reach to such small distances, even without being excited by Friction.

For when Salt of Tartar runs *per Deliquium*, is not this done by an Attraction between the Particles of the Salt of Tartar, and the Particles of the Water which float in the Air in the form of Vapours? And why does not common Salt, or Salt-petre, or Vitriol,

run *per Deliquium*, but for want of such an Attraction? Or why does not Salt of Tartar draw more Water out of the Air than in a certain Proportion to its quantity, but for want of an attractive Force after it is satiated with Water? And whence is it but from this attractive Power that Water which alone distils with a gentle luke-warm Heat, will not distil from Salt of Tartar without a great Heat? And is it not from the like attractive Power between the Particles of Oil of Vitriol and the Particles of Water, that Oil of Vitriol draws to it a good quantity of Water out of the Air, and after it is satiated draws no more, and in Distillation lets go the Water very difficultly? And when Water and Oil of Vitriol poured successively into the same Vessel grow very hot in the mixing, does not this Heat argue a great Motion in the Parts of the Liquors? And does not this Motion argue, that the Parts of the two Liquors in mixing coalesce with Violence, and by consequence rush towards one another with an accelerated Motion? And when *Aqua fortis*, or Spirit of Vitriol poured upon Filings of Iron dissolves the Filings with a great Heat and Ebullition, is not this Heat and Ebullition effected by a violent Motion of the Parts, and does not that Motion argue that the acid Parts of the Liquor rush towards the Parts of the Metal with violence, and run forcibly into its Pores till they get between its outmost Particles, and the main Mass of the Metal, and surrounding those Particles loosen them from the main Mass, and set them at liberty to float off into the Water? And when the acid Particles, which alone

would distil with an easy Heat, will not separate from the Particles of the Metal without a very violent Heat, does not this confirm the Attraction between them?

When Spirit of Vitriol poured upon common Salt or Salt-petre makes an Ebullition with the Salt, and unites with it, and in Distillation the Spirit of the common Salt or Salt-petre comes over much easier than it would do before, and the acid part of the Spirit of Vitriol stays behind; does not this argue that the fix'd Alcaly of the Salt attracts the acid Spirit of the Vitriol more strongly than its own Spirit, and not being able to hold them both, lets go its own? And when Oil of Vitriol is drawn off from its weight of Nitre, and from both the Ingredients a compound Spirit of Nitre is distilled, and two parts of this Spirit are poured on one part of Oil of Cloves or Carraway Seeds, or of any ponderous Oil of vegetable or animal Substances, or Oil of Turpentine thicken'd with a little Balsam of Sulphur, and the Liquors grow so very hot in mixing, as presently to send up a burning Flame; does not this very great and sudden Heat argue that the two Liquors mix with violence, and that their Parts in mixing run towards one another with an accelerated Motion, and clash with the greatest Force? And is it not for the same reason that well rectified Spirit of Wine poured on the same compound Spirit flashes; and that the *Pulvis fulminans*, composed of Sulphur, Nitre, and Salt of Tartar, goes off with a more sudden and violent Explosion than Gun-powder, the acid Spirits of the

Sulphur and Nitre rushing towards one another, and towards the Salt of Tartar, with so great a violence, as by the shock to turn the whole at once into Vapour and Flame? Where the Dissolution is slow, it makes a slow Ebullition and a gentle Heat; and where it is quicker, it makes a greater Ebullition with more heat; and where it is done at once, the Ebullition is contracted into a sudden Blast or violent Explosion, with a heat equal to that of Fire and Flame. So when a Drachm of the above-mention'd compound Spirit of Nitre was poured upon half a Drachm of Oil of Carraway Seeds *in vacuo*, the Mixture immediately made a flash like Gun-powder, and burst the exhausted Receiver, which was a Glass six Inches wide, and eight Inches deep. And even the gross Body of Sulphur powder'd, and with an equal weight of Iron Filings and a little Water made into Paste, acts upon the Iron, and in five or six hours grows too hot to be touch'd, and emits a Flame. And by these Experiments compared with the great quantity of Sulphur with which the Earth abounds, and the warmth of the interior Parts of the Earth, and hot Springs, and burning Mountains, and with Damps, mineral Coruscations, Earthquakes, hot suffocating Exhalations, Hurricanes, and Spouts; we may learn that sulphureous Steams abound in the Bowels of the Earth and ferment with Minerals, and sometimes take fire with a sudden Coruscation and Explosion; and if pent up in subterraneous Caverns, burst the Caverns with a great shaking of the Earth, as in springing of a Mine. And then the Vapour

than they do one another? For as all things ascend in Water which are less attracted than Water, by the gravitating Power of the Earth; so all the Particles of Salt which float in Water, and are less attracted than Water by any one Particle of Salt, must recede from that Particle, and give way to the more attracted Water.

When any saline Liquor is evaporated to a Cuticle and let cool, the Salt concretes in regular Figures; which argues, that the Particles of the Salt before they concreted, floated in the Liquor at equal distances in rank and file, and by consequence that they acted upon one another by some Power which at equal distances is equal, at unequal distances unequal. For by such a Power they will range themselves uniformly, and without it they will float irregularly, and come together as irregularly. And since the Particles of Island-Crystal act all the same way upon the Rays of Light for causing the unusual Refraction, may it not be supposed that in the Formation of this Crystal, the Particles not only ranged themselves in rank and file for concreting in regular Figures, but also by some kind of polar Virtue turned their homogeneal Sides the same way.

The Parts of all homogeneal hard Bodies which fully touch one another, stick together very strongly. And for explaining how this may be, some have invented hooked Atoms, which is begging the Question; and others tell us that Bodies are glued together by rest, that is, by an occult Quality, or rather by nothing; and others, that they stick together by con-

spiring Motions, that is, by relative rest amongst themselves. I had rather infer from their Cohesion, that their Particles attract one another by some Force, which in immediate Contact is exceeding strong, at small distances performs the chymical Operations above-mention'd, and reaches not far from the Particles with any sensible Effect.

All Bodies seem to be composed of hard Particles: For otherwise Fluids would not congeal; as Water, Oils, Vinegar, and Spirit or Oil of Vitriol do by freezing; Mercury by Fumes of Lead; Spirit of Nitre and Mercury, by dissolving the Mercury and evaporating the Flegm; Spirit of Wine and Spirit of Urine, by deflegming and mixing them; and Spirit of Urine and Spirit of Salt, by subliming them together to make Sal-armoniac. Even the Rays of Light seem to be hard Bodies; for otherwise they would not retain different Properties in their different Sides. And therefore Hardness may be reckon'd the Property of all un-compounded Matter. At least, this seems to be as evident as the universal Impenetrability of Matter. For all Bodies, so far as Experience reaches, are either hard, or may be harden'd; and we have no other Evidence of universal Impenetrability, besides a large Experience without an experimental Exception. Now if compound Bodies are so very hard as we find some of them to be, and yet are very porous, and consist of Parts which are only laid together; the simple Particles which are void of Pores, and were never yet divided, must be much harder. For such hard Particles being heaped up together, can scarce

touch one another in more than a few Points, and therefore must be separable by much less Force than is requisite to break a solid Particle, whose Parts touch in all the Space between them, without any Pores or Interstices to weaken their Cohesion. And how such very hard Particles which are only laid together and touch only in a few Points, can stick together, and that so firmly as they do, without the assistance of something which causes them to be attracted or press'd towards one another, is very difficult to conceive.

The same thing I infer also from the cohering of two polish'd Marbles *in vacuo*, and from the standing of Quick-silver in the Barometer at the height of 50, 60 or 70 Inches, or above, when ever it is well-purged of Air and carefully poured in, so that its Parts be every where contiguous both to one another and to the Glass. The Atmosphere by its weight presses the Quick-silver into the Glass, to the height of 29 or 30 Inches. And some other Agent raises it higher, not by pressing it into the Glass, but by making its Parts stick to the Glass, and to one another. For upon any discontinuation of Parts, made either by Bubbles or by shaking the Glass, the whole Mercury falls down to the height of 29 or 30 Inches.

And of the same kind with these Experiments are those that follow. If two plane polish'd Plates of Glass (suppose two pieces of a polish'd Looking-glass) be laid together, so that their sides be parallel and at a very small distance from one another, and then their lower edges be dipped into Water, the

Water will rise up between them. And the less the distance of the Glasses is, the greater will be the height to which the Water will rise. If the distance be about the hundredth part of an Inch, the Water will rise to the height of about an Inch; and if the distance be greater or less in any Proportion, the height will be reciprocally proportional to the distance very nearly. For the attractive Force of the Glasses is the same, whether the distance between them be greater or less; and the weight of the Water drawn up is the same, if the height of it be reciprocally proportional to the distance of the Glasses. And in like manner, Water ascends between two Marbles polish'd plane, when their polish'd sides are parallel, and at a very little distance from one another, And if slender Pipes of Glass be dipped at one end into stagnating Water, the Water will rise up within the Pipe, and the height to which it rises will be reciprocally proportional to the Diameter of the Cavity of the Pipe, and will equal the height to which it rises between two Planes of Glass, if the Semi-diameter of the Cavity of the Pipe be equal to the distance between the Planes, or thereabouts. And these Experiments succeed after the same manner *in vacuo* as in the open Air, (as hath been tried before the Royal Society,) and therefore are not influenced by the Weight or Pressure of the Atmosphere.

And if a large Pipe of Glass be filled with sifted Ashes well pressed together in the Glass, and one end of the Pipe be dipped into stagnating Water, the Water will rise up slowly in the Ashes, so as in