

An attempt to demonstrate, that all the phenomena [sic] in nature may be explained by two simple active principles, attraction and repulsion : wherein the attractions of cohesion, gravity, and magnetism, are shewn to be one and the same, and the phenomena of the latter are more particularly explained / by Gowin Knight.

Contributors

Knight, Gowin, 1713-1772.

Publication/Creation

[London] : [publisher not identified], [1748]

Persistent URL

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A N
A T T E M P T

To demonstrate, That all the

Phænomena in Nature

May be explained by

Two Simple Active Principles,

ATTRACTION *and* REPULSION:

WHEREIN

The ATTRACTIONS of COHESION, GRAVITY, and
MAGNETISM, are shewn to be one and the same; and
the *Phænomena* of the latter are more particularly
explained.

By GOWIN KNIGHT, M. B. F.R.S.

*Remember, Man, "The Universal Cause
"Acts not by partial, but by general Laws." POPE.*

L O N D O N :

Printed in the Year M.DCC.XLVIII.

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THE INTRODUCTION.

THE slow Progress that has been made in the Improvement of Natural Philosophy in former Ages, is rather to be attributed to the wrong Methods they employed in making their Inquiries, than either to their Want of natural Abilities, or sufficient Application. Some Centuries were spent by the Industrious Schoolmen in Searching for that Knowledge in their own Brains, which was only to be found by a diligent Inquiry into the Works of Nature, careful Observation, and accurate Experiments. *Des Cartes* was sensible of the Fallibility of human Reason, and imputing to that the Errours of preceeding Philosophers, was resolved to be upon his guard himself. Yet in spite of all his Precaution, the Strength of his Imagination hurried him into many Errours. Nevertheless, his Writings were so far of Service to the World, as their Ingenuity recommended them to the Perusal of Men of Parts, and improved their Relish for Philosophical Learning; whilst their Errours taught others how little we ought to rely upon mere *Hypothesis*, and put them upon a more diligent Application to those rigid Tests of Truth, Experience and Mathematicks. From this Source we may fairly deduce the many and surprising Discoveries of the last and present Age. Yet even those seem capable of making but little Progress, unless rightly applied to the Investigation of the general Laws of Nature; from which (if once known and explained) all the several Effects that depend on them may be readily deduced. A greater Progress has been made in Physicks by Sir *Iaac Newton* alone, than by all the Philosophers before or since him put together. Not that he had tried more Experiments than them all; but because from those, which he had tried, he was able to explain the Laws of Motion and Attraction, and the Properties of Light and

B

Colours,

Colours, from whence an infinite Variety of other Truths were easily deduceable to his penetrating Genius.

When we consider the vast Variety of Effects, that are explicable from Attraction alone; it will appear more than probable, that a few other Principles, as extensive, and as clearly explained, may open a Door to the most secret Mysteries of Nature. In pursuing this Thought I was gradually led to examine whether Repulsion was not a Principle of this Kind; and whether that and Attraction might not alone be sufficient to account for all the *Phænomena* with which we are acquainted.

There are few Persons, even among those that are well acquainted with Nature's Simplicity, to whom this Thought will not at the first View appear too bold, if not wild and extravagant.

But who can determine how much may be effected by two such Principles, when directed by a Being of Infinite Wisdom? Even human Invention affords us an Instance of a Thing, which (if it be of mere human Invention) is scarce less surprising, I mean the Use of Letters. The Art being common and familiar to us, we seldom reflect upon the wonderful Contrivance. But an entire Stranger to it would never comprehend how it was possible to express all the various Sounds, not only in this, but every other Language, by twenty-four Characters, especially if he was told that five of them alone gave the others all their Force. The Language of Nature, though more copious, is far more simple than ours; and a few Characters once decyphered will help us to discover the rest. If Reason and Experience shall appear to countenance this Supposition (however extraordinary it should seem at first) it may very well deserve to be seriously examined. As far as I have hitherto gone, I have endeavour'd at the Simplicity and Clearness of a Mathematical Demonstration: First laying down such Truths as are plain to common Sense; and from them, by necessary Conclusions, deducing others less obvious.

PROPOSITION I.

SINCE all natural Knowledge takes its Rise from observing the various *Phænomena* of Nature, and searching out the Causes of them; the shortest Way to arrive at it, is to find out those general Laws, by which a few simple Causes are enabled to produce a great Variety of Effects.

For if the infinite Variety of Effects required a distinct Cause to be assigned to each, it would be an endless Undertaking.

PROP. II.

A Knowledge of the general Laws of Nature can no ways be acquired, but by taking a View of the several Works of the Creation, and observing what general Truths we can discover.

For general Conclusions can be inferred only from a View of Particulars.

PROP. III.

The most general Truth that occurs to us, in contemplating the Works of the Creation, is, that there is a Being of infinite Wisdom, and Goodness, and Power, the first Cause of all Things.

This is a Proposition to which (one would imagine) no Man who had ever cast an Eye on the Works of Nature, could deny his Assent. But if any such there are, the best Advice I can give them, is, To look again.

AXIOM I.

If we admit that *GOD*, the Supreme Being, is the first Cause of all things; all other Causes must be either immediately, or mediately derived from Him.

DEFINITION I.

Immediate Causes are the Acts of *GOD* himself; depending only upon His Will for their Existence and Continuance.

PROP. IV.

No more Immediate Causes can exist in Nature, than are absolutely necessary.

For *GOD* never Acts but for some wise Purpose. Whence it has been receiv'd as an Axiom in Physicks, that Nature does nothing in vain. And Sir *Isaac Newton* has laid it down

as a Rule, That no more Causes ought to be admitted, than are really found in Nature, and are necessary towards explaining the several *Phænomena*: And also, that Effects of the same kind proceed from the same Cause.

D E F. II.

Mediate Causes are such as arise from Immediate ones.

P R O P. V.

More Mediate Causes, than one, must depend upon every Immediate Cause.

For it would be inconsistent with Divine Wisdom to create one Cause merely for the Sake of producing a second; which doubtless he might as well have produced immediately.

C O R O L L A R Y.

Every Mediate Cause is less general, than the Immediate one from which it proceeds.

P R O P. VI.

Every Cause is the Effect of some prior Cause, and that of some other, and so on, in a continued Chain; 'till we arrive at *GOD*, the First Cause.

For there is no self-existent Cause, but *GOD*.

P R O P. VII.

All those Properties, that belong to all Matter in general, can only be ascribed to the immediate Will of *GOD*.

For there is no other Cause to be found, more general, than themselves, to which they can be ascribed. *Coroll. Prop. 5.* Such are usually called the essential Properties of Matter.

C O R O L L. I.

Wherefore the Existence, Extension, Impenetrability, Mobility, and *Vis Inertiæ* of Matter, are apparently the immediate Effects of *GOD*'s Will.

C O R O L L. II.

All immediate Causes, being the Effects of *GOD*'s Will, must necessarily be constant, immutable, and irresistible by any finite Force. From hence appears the Truth of Sir *Isaac Newton*'s third Rule, *viz.* " Those Qualities of Bodies, which
" can

“ can neither be increased, nor diminished, and are common
 “ to all Bodies, that come under our Examination, ought to
 “ be admitted as general Qualities of all Bodies.

P R O P. VIII.

Besides the general Properties of Matter abovemention'd, there is in Nature some Active Principle or Principles capable of producing and continuing Motion in the Universe.

For those Properties being perfectly inactive, are of themselves incapable of producing any one Effect. And Motion is itself no essential Property of Matter: because it may be either produced, increased, diminished, or destroyed in any Body whatsoever.

D E F. III.

Attraction is that Cause which makes Bodies tend mutually to approach each other with different Forces at different Distances.

D E F. IV.

Gravity is that Species of Attraction which makes the Moon and all Sublunary Bodies tend towards the Centre of the Earth: and all the Heavenly Bodies, within the Solar System, towards the Sun.

D E F. V.

Cohesion is that Species of Attraction which makes the Particles of Matter, when almost in Point of Contact, tend to unite and adhere together.

P R O P. IX.

Attraction does really exist, and is an universal Cause that acts upon all the Bodies in Nature, of which we have any Knowledge; and this it does in two Shapes, that of Gravity, and that of Cohesion.

For Experience shews us, that all Bodies do gravitate; and also that their constituent Parts adhere together with a greater or less Degree of Cohesion.

P R O P. X.

The Attraction, both of Gravity and Cohesion, can only be ascribed to the immediate Will of GOD. For

For there is no other Cause more general than themselves.
Corol. Prop. 5, and Prop. 7.

P R O P. XI.

If two Particles indefinitely small, at a given Distance, attract each other with any given Force, how small soever; and that Force increases, as the Distances or the Squares of the Distances decrease; or in an higher Ratio: such Particles, in Point of Contact, will adhere with indefinite Force.

First, Suppose the Force increases simply as the Distances of the Surfaces decrease; then at half the given Distance they will attract with double the Force, at half that Distance with four times the Force, at the next half with eight times, and so on; for any given Distance may be divided *ad infinitum*: so that in Point of Contact their attracting Force will have undergone an infinite Increase, and consequently be infinite. Now this will be the Increase, if the Force of Attraction is computed from the Surfaces; but since the Force is always to be computed from the Centers of the attracting Bodies, which in this Case are at an indefinitely small Distance from each other, the Force in Point of Contact, though not infinite, will be greater than any that can be assigned. And if this holds good in the simple reciprocal Ratio of the Distances, it is easy to perceive that it will much more do so, if the Force be supposed to increase in an higher Ratio.

C O R O L L A R Y.

The larger any two Bodies are, the less will be their attracting Force, in Proportion to their Quantities of Matter, in Point of Contact; their Centers being proportionably at a greater Distance from each other.

P R O P. XII.

There must be some other active Principle in Nature besides that of Attraction.

For Attraction and the general Properties of Matter will serve to explain very few *Phænomena*, when considered alone.
 Amongst

Amongst the Heavenly Bodies, indeed, their Rotations and Revolutions might go on to Eternity very well, while their gravitating Force was counterballanced by their *Vis Centrifuga*. But on each particular Globe a perpetual Darkneſs would every where prevail, an inſuperable Bond of Attraction would deſtroy both Fluidity and Motion, and all Nature wou'd be at a ſtand.

Some faint Idea may be form'd of ſuch a State, from the Relation of ſuch Travellers as have wintered near the *North-Pole*: Where, during the Abſence of the Sun, the Principle of Attraction becomes ſo predominant, that nothing but a large Fire, and a cloſe Room, can preſerve either Animals, or Plants, or Fluids, from growing hard as a Rock.

D E F. VI.

Repulſion is that Cauſe which makes Bodies mutually endeavour to recede from each other, with different Forces at different Diſtances.

P R O P. XIII.

The Effects of Repulſion are directly contrary to thoſe of Attraction. *Def. 3 and 6.*

P R O P. XIV.

There is really exiſting in Nature ſuch a Cauſe as Repulſion.

In order to reconcile what is demonſtrated in *Prop. 11 and 12.* with the real *Phænomena* of Nature, we muſt neceſſarily admit of ſome contrary Cauſe, that may be able to counter-aſt and limit the Force of Attraction; which otherwiſe would every where too much prevail. That Repulſion is ſuch a Cauſe is evident from the laſt *Prop.* And we have likewiſe ſufficient Evidence of its Exiſtence, from Facts and Experience. For all Bodies are electrical, or capable of being made ſo: and electrical Bodies both attract and repel. *Secondly*, Both Attraction and Repulſion are very conſpicuous in all magnetical Bodies. *Thirdly*, Sir *Iſaac Newton* has ſhewn from Experiment, that the Surfaces of two convex Glaſſes repel each other. *Fourthly*,

Fourthly, The same great Philosopher has explain'd the Elasticity of the Air by supposing its Particles mutually to repel. *Fifthly*, The Particles of Light are, in Part at least, repelled from the Surface of all Bodies. *Lastly*, It seems highly probable that the Particles of Light mutually repel each other. The Air is always rarified by Heat; and that in a greater Proportion, as the Heat is more intense. What then must that Rarefaction be in the Focus of *Villette's Speculum*? Perhaps a more perfect Vacuum would not be produced by the best Air-Pumps. But suppose half the Air still remaining, its expansive Force will be equal to a Column of Mercury of fifteen Inches in height; whose Basis will be equal to an imaginary Surface surrounding the whole focal Space. But the Atmosphere will press with a Force equal to a Column of the same Base, and thirty Inches in height. What is it that supports this extraordinary Weight? A *Cartesian* will tell us, perhaps, that there is no Vacuum at all: But that the Air is drove out of its Place by the Subtile Matter; which being moved with great Rapidity by the Matter of the first Element, *i. e.* Light, and whirl'd round in a Vortex; by its Centrifugal Force is determined every way to fly off; and so counter-acts the Pressure of the Air. But how can Light, which moves, in this case, all of it in one Direction, communicate a Motion to the Subtile Matter so, that it shall act in all Directions? Another Difficulty arises from a Defect in the Momentum of Light: which being supposed the *Primum Mobile*, ought to act with a Force equal to several Pounds of Mercury. Now as all these Difficulties vanish; if we only admit a Repulsion betwixt the Particles of Light themselves, and betwixt them and Air, we can have no Reason to doubt of the Fact, especially since it is plain, from the Arguments above, that there is such a Cause as Repulsion in Nature. "For no Cause ought to be admitted, but what is really found in Nature, and no more" than are necessary towards explaining the several *Phænomena*.
Prop. 4.

P R O P. XV.

Repulsion is a general Cause, the immediate Effect of
 GOD's Will. It

It has, I think, been sufficiently proved in the last Proposition, that Repulsion is either found, or capable of being produced in all the Bodies that come under our Examination. And it seems also probable, that the Particles of Light mutually repel each other; and if so, it is not only universal in all Parts of the Earth, but throughout the immense Space of the whole visible World: Since there is not a Point of that Space, in which the Light of some of the Heavenly Bodies is not perceivable to the naked Eye. Wherefore Repulsion is the most general secondary Cause yet discover'd in Nature; excepting Attraction, and the other essential Properties of Matter, which can produce no Effect by themselves; and the Effects of Attraction are directly opposite to those of Repulsion. It is therefore the immediate Effect of GOD's Will. *Corol. Prop. 5.*

PROP. XVI.

If two Particles indefinitely small, at a given Distance repel each other with any given Force, how small soever; and that Force increases as the Distances decrease, or as the Squares of the Distances, or in an higher Ratio: Such Particles will in Point of Contact repel with an indefinite Force.

The Demonstration of this *Prop.* is exactly the same with that of *Prop. 11. mutatis mutandis*: It is therefore needless to repeat it. But it may not be amiss to observe, that the Truth of this is less repugnant to the common Appearances of Nature. The Increase of repulsive Force in the Particles of the Air, by their mutual Approach in a condensing Engine, corresponds very well, as far as we can or dare prosecute the Experiment. In the Explosion of Gun-Powder, the Air, or some other expansive Vapour, newly generated from the Nitre and other Ingredients, instantly expands itself with a Force that seems irresistible, and if not infinite, may very well pass for indefinite, till we can assign a Force that it is not able to overcome; and yet there are some Chemical Preparations, that appear much more violent in their Effects, than Gun-Powder itself.

PROP. XVII.

Repulsion alone, without Attraction, would not be sufficient to explain the *Phænomena* of Nature.

For a mutual Repulsion among all the Parts of Matter would reduce it to Atoms, and disperse it equably through every Part of Space. If it was peculiar to some Part of Matter, that Part would undergo the same Fate, and the rest would remain unactive and indifferent.

PROP. XVIII.

Both Repulsion and Attraction are constant, immutable, and irresistible by any finite Force. *Corol. 2. Prop. 7. Prop. 10, & 15.* And that their Force is irresistible in Point of Contact (in which Case only they act with their whole Force) is already demonstrated. *Prop. 11, 16.*

PROP. XIX.

Attraction and Repulsion cannot both, at the same Time, belong to the same individual Substance, being Contraries. *Prop. 13.*

The same Body cannot have a Tendency to move two Ways at once.

Note, It must not be inferred from the last Proposition, that Attraction and Repulsion are not Immediate Causes: For tho' they cannot both be the Properties of all Matter, it will be sufficient if they be more general than any other Cause; excepting those essential Properties of Matter, which are altogether unactive alone.

COROL.

Therefore we must conclude, that there are in Nature two Kinds of Matter, one attracting, the other repelling.

PROP. XX.

Those Particles of Matter, that mutually repel each other, seem in respect of other Matter also subject to the general Law of Attraction.

This Proposition includes in it no Contradiction: And Experience tells us, that Light, falling obliquely towards the Surface of transparent Bodies, is either repelled before it arrives

arrives at it, or determined towards the Perpendicular, and then transmitted. Moreover, Air always adheres to the Surfaces of Bodies; and it is intimately united throughout the whole Substance of some in great Quantities. See *Hales's Analysis of the Air*.

PROP. XXI.

If the essential Properties of Matter, in Conjunction with the two active Principles of Attraction and Repulsion, will alone explain all the *Phænomena* of Nature; no other Immediate Cause ought to be admitted.

For these do really exist. *Prop.* 9, 14. And no more can exist than are absolutely necessary. *Prop.* 4.

COROL.

Wherefore it would be unphilosophical to seek after any other Cause, till we are certain that these few are not sufficient.

PROP. XXII.

The primary Particles of Matter must necessarily have both Bulk and Figure of some Kind or other.

This is a necessary Consequence of Extension, one of the essential Properties of Matter.

PROP. XXIII.

All the Operations in Nature are performed with the greatest Simplicity that is possible.

For Nature does nothing in vain.

COROL.

As our Intention is to reduce the several Kinds of Attraction and Repulsion to two only, this Proposition will assist us in determining the Ratio in which their Forces act at different Distances. I think the simplest that we find in Nature, is the reciprocal Ratio of the Distances; and if so, this Proposition determines us to pitch upon that, if we can find any Way of reconciling all the others to it. The Magnetical Attraction is in some Cases found in this Ratio; and the Repulsion betwixt the Particles of the Air is always so, as far as we can judge: So that we have evidently some Founda-

dation in Nature for the Supposition ; since this Ratio does really exist in both Principles.

PROP. XXIV.

All the primary Particles of Matter are originally of the same Size, and all round.

This is more simple, than if we were to suppose them of different Sizes and Shapes, or of any other Shape beside this. So that unless different Sizes and other Shapes were necessary, which as yet we have no Reason to suppose, the Truth of this Proposition is an evident Consequence of the last.

COROL.

If the primary Particles of Matter are all of the same Size, they may be considered as indefinitely small, till we see some Reason to infer the contrary from some of the *Phænomena* of Nature. Experience tells us, that the primary Particles of Matter must be extremely minute ; and Reason demonstrates, that whatever is extended is likewise divisible *ad infinitum*. So that there is no Degree of Minuteness, that may not reasonably be ascribed to them.

PROP. XXV.

Matter was not created all in one Mass, but disposed throughout the whole Space of the Universe in such a Manner, that when the Principle of Attraction was impressed upon it, it might run together into such Forms, and acquire such Motions, as the All-wise *CREATOR* foresaw would be necessary in producing the System of the World, and were possible to be produced from such a Disposition.

GOD Almighty could, doubtless, with the same Facility create Matter in any Part of Space, by one single Act of his Will. It is therefore absurd to suppose, that he created it all in one Mass, and then exerted a second Act, to distribute it into different Masses, and different Parts of Space. Infinite Wisdom could certainly discern the Effects that Attraction would produce in the Whole, and in every Particle of Matter ; and without Doubt disposed it in that Manner, which would be most conducive towards effecting the Formation of the Universe.

PROP. XXVI.

Matter being thus constituted at the first Creation of it, and then a Principle of Attraction impressed upon it ; the Consequence must be, that those primary Particles, according to their Disposition, would mutually attract each other with different Forces, would immediately run together, and adhere in Point of Contact with indefinite Force. And according to the Number of Particles at that Time in the Neighbourhood of each other, there would be formed Corpuscles of different Bulks. Those Corpuscles, according to their Distances from each other, would run together in like Manner, and form larger ; and so on.

Note 1. It might be more methodical to prosecute here the first Formation of all the Heavenly Bodies, and explain the Origin of their Forms, their Magnitudes, Situations, and Motions ; but as all that can be done in this respect would be to prove, that they might be the Effects of an artful Distribution of Matter, at the first Production of it, and of the general Principle of Attraction, governed by the Laws of Motion ; it could not be necessarily inferred from thence, that those Effects were actually produced in that Manner : I shall therefore postpone this Part of my Undertaking, till I have considered the more minute Parts of Nature.

Note 2. It is easy to perceive from the last Proposition, that although the primary Particles of Matter were originally formed all of the same Magnitude, and indefinitely small ; yet by impressing on them a Principle of Attraction, they might be made to form themselves into Corpuscles of different Orders of Magnitude : But if any one thinks it more reasonable to suppose them created of different Sizes at first, I have no Objection at present, except that it does not appear to me so simple, as if we suppose them created all alike.

PROP. XXVII.

If a Number of Particles, of equal Magnitudes, and perfectly round, mutually attract each other with any Degree of Force at any given Distance, how small soever, upon their
mutual

mutual Conflux they will form themselves into a Figure as nearly spherical as possible.

For Bodies that mutually attract each other will endeavour to approach as near as possible to their common Center of Gravity; consequently they must endeavour to put on a spherical Figure as near as possible, there being no Figure that has all its Parts so near one common Center as a Sphere. And tho' at their first Conflux they should have any other Shape, and adhere in Point of Contact with indefinite Force, yet they would immediately assume a spherical one; for being perfectly round and equal, they might either roll or slide one amongst another, without any Hindrance from their Force of Cohesion.

PROP. XXVIII.

Those primary Particles of Matter, which mutually repel each other, would, if left to themselves, disperse equably throughout the whole Infinity of Space.

For if there were fewer of them in one Part of Space than another, their expansive Force would necessarily determine them to that Quarter, where there was least repellent Force to resist them; so that they would never be at rest, till all were *in equilibrio*: And altho' a Distance could be assigned, at which they might cease to repel, yet the Motion already acquired would still continue *ad infinitum*.

PROP. XXIX.

Either the World is infinite, or there is some Cause that prevents the Progress of Light beyond the Limits of the Universe.

For as Light disperses itself on all Sides from all the Heavenly Bodies, it will be continually flowing into the empty Space, and there continue its Motion *ad infinitum*; much more if its Particles mutually repel each other. *Prop. 28.*

PROP. XXX.

The more grand our Conceptions are of the Works of the Creation, the more likely they are to be just.

For

For if we reflect with ourselves who is the Author of them, we may clearly discern, that our finite Comprehensions will always fall short of the Truth.

COROL. I.

Wherefore if the Supreme Being might with equal Facility create the World infinite as finite, and no Argument can be brought from Reason or Experience, that He has not done it; we ought to determine our Assent that Way which appears most suitable to the Nature of the first Cause.

COROL. II.

Admitting the World to be infinite, we have no need of a Cause to limit the Expansion of repelling Matter, or to prevent the universal Conflux of the attracting. The first will disperse itself as equally as possible through every Part of Space: The latter may be disposed in such a Manner, that each System of the Heavenly Bodies may be *in equilibrio* with those that surround it.

PROP. XXXI.

If a cubical Inch of Matter should be divided into Parts indefinitely small, and those Parts were all placed at any given Distance from each other, how small soever, they would be diffused through a Space that would be greater than any we can assign. This is an evident Consequence of the infinite Divisibility of Matter.

COROL. I.

If the whole Space of the solar System was so full of repellent Particles, that in the Compass of every Cubic Inch there should be an indefinite Number, yet the Whole of them might not weigh one Grain.

COROL. II.

The whole Infinity of Space may be so full of repellent Particles, that no Part of it can be assigned so small, as not to contain many Thousands of them, and yet their Resistance to the Motions of the Heavenly Bodies may be indefinitely little.

Note 1. When

Note 1. When I speak of Space being full of repellent Particles, I suppose a Vacuum every where interspersed.

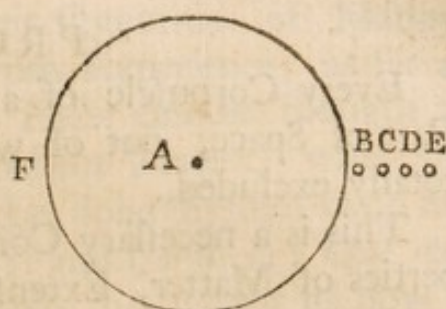
Note 2. This Reasoning may probably appear extravagant to those who have not sufficiently considered the inexpressible Minuteness of some of the Works of Nature. Yet it is not only evident from Mathematical Demonstration, that it may be true; but undoubted Facts and Experience convince us, that it is so. The Light of the Heavenly Bodies is at all Times visible to the naked Eye, in every Part of the Universe, unless where some opaque Body is interposed; and is every where so dense, that the Number of Particles, which each Moment strike upon the *Retina*, is at least as great as the Number of the visible Parts of all the Objects that can possibly be taken in at one View. If we look through the smallest Pin-hole, we may distinctly see all the Objects that are before us in a Room, and consequently there must pass through the Pin-hole, at the same Time, as many Rays of Light as there are visible Parts in those Objects; and that without Confusion, or any ways interfering with each other. Nevertheless, as dense as the Particles of Light appear to be in every Part of Space, such is their Minuteness, and so small their Quantity of Matter, that it gives no sensible Resistance to the Motion of the Heavenly Bodies.

PROP. XXXII.

If the whole Infinity of Space was filled with a Fluid, whose Particles were indefinitely small, and mutually repelled each other in the reciprocal Ratio of their Distances, and this Fluid should by any Cause whatsoever be either totally, or in Part excluded from any Part of Space, the Density of the Fluid immediately surrounding the said Part of Space, would be increased in Proportion to the Number of Particles excluded.

Let

Let the Sphere A represent a Part of Space furrounded with such an elastick Fluid, but itself quite void of repellent Particles; and let B C D E represent a Series of such Particles continued *ad infinitum*.



The Particle at B being furrounded with repellent Particles on one Side, but having a Space void of them on the other, will be determined towards the Center A, and pressed upon the resisting Surface of the Sphere. *Prop. 28.* For the same Reason the Particle C will be determined towards the same Center, and press upon B till it has approached so near, that the repulsive Force of B, added to the repulsive Force of all the distant Particles beyond the empty Space about F, shall be equal to the repulsive Force of the infinite Series of Particles D E, &c. For the same Reason the Particle D will press upon C, and E upon D.

In like Manner, if the Space A contained fewer repellent Particles than the circumambient Space, the Particles B C D E, &c. will be determined towards A, with a Force proportionable to the Want of Resistance on that Side, *i. e.* in Proportion to the Want of repellent Particles.

COROL.

The larger the Space is, that is devoid of repellent Particles, the greater will be the Condensation of the like Particles round it.

PROP. XXXIII.

The Forces with which these Particles will be determined towards the Center of this empty Space, will be in the reciprocal Ratio of their Distances from that Center.

For two or more Particles, at different Distances from this Center, will be determined towards it with Forces exactly equal to those with which they would be repelled, if the Space was filled with its due Share of repellent Particles; which Repulsion is supposed to be in the reciprocal Ratio of the Distances.

D

PROP.

PROP. XXXIV.

Every Corpuscle of attracting Matter must occupy some Part of Space, out of which the repellent Matter will be totally excluded.

This is a necessary Consequence of the two essential Properties of Matter, Extension and Impenetrability.

COROL. I.

Wherefore the repellent Particles of our elastick Fluid will be condensed round every Corpuscle of attracting Matter, more or less, in Proportion to the Size of such Corpuscles. *Prop.* 32. and the *Corol.* And the Forces with which these Particles will be determined towards the Center of each Corpuscle, will be in the reciprocal Ratio of their Distances from that Center. *Prop.* 33.

COROL. II.

This Determination of the repellent Particles towards the Center of a Corpuscle of attracting Matter, will be just the same in Effect, as if they were attracted towards that Center with a Force increasing in the reciprocal Ratio of their Distances from it.

Note, On Account of this Resemblance of an Attraction betwixt the attracting and repelling Matter, it is not easy to demonstrate from Facts, that there is any real Attraction betwixt them; for those seeming Appearances of Attraction, mentioned in *Prop.* 20. and others of the like Nature, may possibly be accounted for, from what is demonstrated in the last Proposition and the last Corollaries. However, till Reason or Experience shall appear to evince the contrary, I think I have a Right to assume that Side of the Question, which shall be most likely to serve my Purpose; especially as the Question relates not to the introducing any new Property of Matter, but regards only the settling the due Extent of those already demonstrated. The great Founder of our modern Philosophy has made the Attraction of Gravity universal to all Matter in general; whether the several Parts are in a State of Attraction or Repulsion in respect of each other, they still

Will gravitate in Proportion to their Quantities of Matter. The Truth of this is evident from Experience, as far as Experience can reach. But what Facts can be brought to prove the Gravitation of our repellent Matter, when the Whole that is contained within the Solar System may not equal a Grain in Weight? *Prop.* 31. and *Corol.* 1. Our excellent Philosopher, in his *third* Rule, has taught us how to reason in Cases of this Nature: For by that Rule, since Gravity is common to all Bodies that come under our Examination, it ought to be admitted as a general Quality, extending also to those Bodies which it is not in our Power to examine. Now if we admit that repellent Matter gravitates, we must grant that it is attracted by the attracting Matter.

PROP. XXXV.

Admitting that the repellent Matter is subject to the general Law of Attraction, in Contact it will adhere with indefinite Force. *Prop.* 11.

Note, As these two Causes conspire in producing one Effect, namely, a mutual Approach betwixt the attracting and repelling Matter (for Brevity's Sake) I shall include both under one Name, *viz.* the Attraction of repellent Matter; except where there is a Necessity to distinguish them.

PROP. XXXVI.

Every Corpuscle of attracting Matter will have round it, (either adhering to its Surface, or condensed in Form of Atmosphere) as many repellent Particles as will just ballance its attracting Force.

For the Surface will have as many adhering to it, as can come in Contact with it: But when that is so full, that their repulsive Force will permit no more to come in Contact, they can only be condensed round in Form of Atmosphere, which will grow less and less dense all the Way from the Surface, till the Repulsion of all the Particles collected round the Corpuscle is sufficient to ballance the condensing Force, *Prop.* 32 and 34. *Corol.* 1. and then the next Series of repellent Particles, being repelled with as much Force one Way

as they will have to attract them in the contrary Direction, will remain quiescent. For equal contrary Forces must mutually destroy each other.

PROP. XXXVII.

The Quantity of repellent Matter which will be collected round Corpuscles of different Sizes will be in Proportion to their Magnitudes.

Since the Corpuscles of attracting Matter are all compounded of Particles of equal Sizes, and perfectly round, *Prop.* 24. they will be all of equal Densities; consequently the Quantities of Matter in Corpuscles of different Sizes will be in Proportion to their Magnitudes. Their attracting Force being as their Quantities of Matter, that must also be in Proportion to their Magnitudes. But the Quantity of repellent Particles collected round each Corpuscle will be in Proportion to its attracting Force. *Prop.* 36. Wherefore the Quantity will be in Proportion to their Magnitudes.

Note, These two last Propositions are universally true, supposing the repellent Matter always quiescent; otherwise not, as appears from the two next Propositions and their Corollaries.

PROP. XXXVIII.

The Quantity of repellent Particles, that will come in Contact with the Surfaces of the attracting Corpuscles, will be nearly proportionable to the Largeness of those Surfaces.

If the Attraction of the repellent Particles was the only Cause that acted, in bringing them in Contact with the attracting Corpuscles, the larger Corpuscles would have them ranged closer upon their Surfaces, than those that are less. But this Consideration would only take Place, whilst the repellent Matter was in a quiescent State; that is, so far quiescent, as only to be actuated by the Repulsion of its own Particles amongst themselves, and the Attraction of the attracting Matter. But if we should consider these Particles vibrating backwards and forwards with great Force and Rapidity, in various Directions, and continually striking upon the Surfaces of the attracting Corpuscles, a very
different

different Effect will be produced. In this Case, the larger Corpuscles, in Proportion to their greater Quantity of repellent Particles already surrounding them, will have a greater Force to repel back again the Particles that impinge against them. So that most of the impinging Particles will be reflected, before they can come in Contact with the Surface. On the other hand, the smaller Corpuscles, having fewer repellent Particles as yet united to their Surfaces, if others impinge with Force against them, will not have that Power to repel them, and hinder their coming in Contact. But all that do come in Contact will adhere with indefinite Force, *Prop. 11.* and never be again separated. Thus the smaller Corpuscles will soon have their Surfaces covered as thick with repellent Particles as the large. That this Motion of the repellent Matter is not merely hypothetical, but has a real Existence in Nature, will be clearer, when we come to make a more particular Inquiry into the Cause of Light and Fire. It will be enough for the present to shew, that Light agrees perfectly well with the Description given of our repellent Particles in Motion: *First*, Light consists of Particles indefinitely small. *Secondly*, They move with incredible Velocity. *Thirdly*, They are found in every Part of Space: For Light is sensible to our Eyes in most Parts of Space, and always produceable; and where it appears quite dark to us, many other Animals can see very distinctly. *Fourthly*, Its Particles seem mutually to repel each other. *Prop. 14.* *Fifthly*, It is repelled from the Surfaces of attracting Matter, and that before it touches those Surfaces. Till these Surfaces are sufficiently guarded with repellent Particles, ought not Light to force its Way till it comes in Contact? I think the Agreement is so apparent, that it deserves not to be further insisted on.

C O R O L.

Therefore in a decreasing Series of attracting Corpuscles, the Quantity of repellent Matter adhering to their Surfaces will decrease nearly in Proportion as their Surfaces decrease.

P R O P.

PROP. XXXIX.

The smaller a Corpuscle of attracting Matter is, the larger will be the Quantity of repelling Matter united to its Surface, in Proportion to the Magnitude of the Corpuscle.

For the Magnitudes of the Corpuscles decrease as the Cubes of their Diameters, the Surfaces only as the Squares ; wherefore the Surfaces, and consequently the Quantities of repellent Matter united to them, *Prop. 38.* do not decrease so fast as the Magnitudes of the said Corpuscles.

COROL. I.

But if the Quantity of repellent Matter united be proportionably greater as the Corpuscles diminish, the Quantity condensed round must be proportionably less ; since both together are in Proportion to the Magnitudes of the Corpuscles. *Prop. 37.*

COROL. II.

If we conceive the attracting Corpuscles so small, that their Surfaces will be able to contain as much repellent Matter as is sufficient to ballance their attracting Force, such Corpuscles will have none at all condensed round them in Form of Atmosphere. *Prop. 36.* And if we conceive them still less, such Corpuscles will contain more repellent Particles upon their Surfaces, than merely what are necessary to ballance their attracting Force. *Prop. 38.*

COROL. III.

Those Corpuscles that have not Surface enough to hold all the repellent Matter necessary to ballance their attracting Force, will have the Overplus condensed round in Form of Atmosphere. And the larger they are, the greater will be the Extent of that Atmosphere. *Corol. I.*

PROP. XL.

Those Corpuscles that have more repellent Matter united to their Surfaces, than what is necessary to ballance their Force of Attraction, will mutually repel each other, with a Force proportionable to the Excess of their repellent Matter.

For

For a Body that is impelled by two contrary unequal Forces, will move in the Direction of the strongest with a Force equal to its Excess.

P R O P. XLI.

The smaller such repellent Corpuscles are, the greater will be their repulsive Force, in Proportion to the Quantities of Matter.

For the smaller the Corpuscle, the larger the Quantity of repellent Matter in Proportion to the attracting. *Prop. 39.* And the Corpuscles repel with a Force proportionable to the Excess of their repellent Matter. *Prop. 40.*

P R O P. XLII.

Neutral Corpuscles (or such as have as much repellent Matter united to their Surfaces as will just ballance their attracting Force) will neither attract nor repel each other, except when they approach very near.

At any considerable Distance, the two Forces being equal, and contrary, will mutually destroy each other; but when such Corpuscles approach very near, the repellent Particles being external to the attracting ones, their Distances will decrease much faster, than the Distances of the attracting Matter, and consequently their Forces will increase faster likewise: Since they are supposed to increase in the reciprocal Ratio of their Distances, and since the repellent Particles surrounding the Corpuscles would in Point of Contact repel with indefinite Force (*Prop. 16.*) it is evident they can never be brought to touch by any finite Force.

C O R O L. I.

This Repulsion of the Surfaces, whilst the neutral Corpuscles are at any considerable Distance, will be indefinitely small: For the absolute Forces of the attracting and repellent Matter being equal, their Difference can only arise from the Difference of the Distances at which they act: Wherefore the Difference of the Forces will be in Proportion to the Difference of those Distances. The Distances only differ, in as much as the repellent Matter is external to the attracting. So that

that the Difference of Distances will, at most, be only equal to twice the Diameter of a repellent Particle. Therefore at any considerable Distance of the Corpuscles, this Difference must be indefinitely small; and consequently the Difference of the Forces must be so likewise.

COROL. II.

Since, when neutral Corpuscles are brought very near, the Distances of their Surfaces will decrease much faster than the Distances of their Centers, this Repulsion of the Surfaces will increase much faster than in the reciprocal Ratio of the Distances of their Centers.

COROL. III.

The Repulsion of the Surfaces takes place also in the attracting and repelling Corpuscles, if they are made to approach near enough, and for the very same Reasons.

PROP. XLIII.

Those Corpuscles which, on Account of their Size, have Part of their repellent Matter surrounding them in Form of Atmosphere, whilst at a certain Distance, will neither attract nor repel; yet if they are brought so near together, that their Atmospheres begin to coincide, they will then begin to attract.

It is easy to conceive, that upon the mutual Approach of two such Corpuscles, the repellent Particles that compose their Atmospheres will recede backwards behind each Corpuscle: So that when the Corpuscles come to a certain Distance from each other, there will not be so many repellent Particles betwixt them, as will be sufficient to ballance their Force of Attraction; on which Account they will run together, and their Atmospheres will coincide, so as to make up but one Atmosphere to the whole.

PROP. XLIV.

The larger these attracting Corpuscles are, the greater will be the Distance at which they will begin to attract, and the greater the Force with which they will run together; and *vice versâ*.

Because

Because the larger they are, the greater will be the Extent of their Atmospheres. *Corol. 3. Prop. 39.* Wherefore their Atmospheres will begin to coincide at a greater Distance, and they will begin to attract at a greater Distance. Also their attracting Force being, all the Way as they approach nearer, increased, and being likewise greater in Proportion to the Quantity of attracting Matter, the largest Corpuscles must run together with the greatest Force.

PROP. XLV.

Although the attracting Corpuscles can no more come in actual Contact than the neutral ones, their Surfaces being surrounded with repellent Particles which adhere with indefinite Force (*Prop. 35, and 42.*) yet they will approach nearer and nearer in Proportion to their Size. Those of them which are largest will approach nearest.

The Force of Attraction will make them approach, till that Force is overcome by the Repulsion of their Surfaces. Wherefore the less that Force is, the sooner it will be overcome: Consequently the smallest Corpuscles, having least attracting Force, will be soonest stopped in their Approach, and the largest will approach nearest.

COROL. I.

Since all the Corpuscles of attracting Matter are surrounded with repellent Particles, there can never be any real Contact, either betwixt those Corpuscles, or Bodies compounded of them.

Note, Wherefore when we speak of the Contact of Corpuscles or Bodies, no more is meant than that they are brought as near as the Repulsion of their Surfaces will admit.

COROL. II.

After the attracting Corpuscles are brought so near by the Excess of their attracting Force, as to have that Force balanced by the Repulsion of their Surfaces, it will hardly be in the Power of human Art to compress them still nearer, in any Degree great enough to be sensible: For the repellent Particles on the Surfaces are already compressed with a Force

E

equal

equal to the Excess of Attraction. This Force must be exceeding strong in such a Number of Corpuscles, as are necessary to compose a Body of sufficient Bulk to be examined by a mechanical Compression. So extremely minute are even the largest of these Corpuscles, that an indefinite Number of them must be contained in every cubic Inch of Matter. Wherefore, if we express the Excess of Attraction in any single Corpuscle, by any finite Quantity, how small soever; the Sum of that Excess in all the Corpuscles of a cubic Inch will be indefinitely great. The Sum of the Repulsions of all the Surfaces ballances this extraordinary Force of Attraction, and is consequently as great. Compress them still further by an external Force, and this Repulsion will be vastly increased upon every little Diminution of the containing Space; because it increases much faster, than in the reciprocal Ratio of the Distances of the Centers of the Corpuscles. *Prop. 42. Corol. 3.* Hence we may conclude, that a very strong Force must be required to make a very small Compression. And after all it will be next to impossible to demonstrate, whether such Compression is real or not: For whatever Machinery we make use of in trying the Experiment, the Materials of which it is composed will give way, more or less, and leave us still in Doubt.

PROP. XLVI.

Neutral Corpuscles will be repelled by repellent Corpuscles, and attracted by the attracting ones.

In both Cases their Tendency to recede from each other will be as the Quantities of repelling Matter; and their Tendency to approach will be as the Quantities of attracting Matter: But the Sum of the repellent Matter is the greatest in the first Case; and that of the attracting in the second: Therefore in the first Case they will repel, and in the second attract.

PROP. XLVII.

Attracting and repelling Corpuscles will either attract or repel, or be neutral in regard to each other, according as the
Sizes

Sizes of each are greater or less; and according to their Distances from each other.

First, In Point of Contact: If both the attracting and repelling Corpuscles are the smallest of their Kinds, they will repel each other.

For in that Case the Excess of repellent Matter would be very great in the repelling Corpuscles; and the Defect of it very little in the attracting ones. *Prop. 41, and 44.* So that the Sum of it in both would exceed the Sum of the attracting Matter.

Secondly, If the Corpuscles were the largest of their Kinds, the repelling ones would exceed very little in repelling Matter; and the attracting ones would have little united to them. On which Account, the attracting Principle would prevail.

Thirdly, For the same Reasons it must follow, that in some of the intermediate Sizes the Excess of Repulsion in the repellent Corpuscles will just ballance the Defect of it in the attracting ones. In which Case they will be neutral in respect of each other.

Fourthly, If the attracting and repelling Corpuscles are not in Contact, but at any considerable Distance, their mutual Action upon each other will produce a weaker Kind of Repulsion.

For an attracting Corpuscle will have the Defect of repellent Matter on its Surface made up by an Atmosphere condensed round it. *Prop. 39. Corol. 3.* So that the Corpuscle and its Atmosphere together will contain an equal Quantity of attracting and repelling Matter; and a repelling Corpuscle placed without the Limits of its Atmosphere will be repelled, for the same Reason as in the Case of neutral Corpuscles. *Prop. 46.* But this Repulsion will be of a weaker Kind than if the repellent Matter was fixed; because that Part of it, which is in Form of Atmosphere, will recede in Part backwards, in Proportion as the Corpuscles are brought nearer.

Fifthly, If the attracting Corpuscle, on Account of its Largeness, has a very extensive Atmosphere, and a repelling

Corpuscle be brought so near as to enter within the Limits of that Atmosphere, it will then begin to be attracted.

Because the further it penetrates within the Atmosphere, the fewer repellent Particles will be betwixt the two Corpuscles; and even those that are united to the repellent Corpuscle will begin to be determined towards the Center of the attracting one, with a Force increasing in the reciprocal Ratio of the Distances, *Prop.* 33. and in Contact they will cohere together with a Force proportionable to the Excess of their attracting Matter directly, and the Distances of their Centers reciprocally.

PROP. XLVIII.

All the various Degrees of Cohesion, that are found amongst Bodies, will naturally arise from the different Sizes of their constituent Corpuscles; and one simple, uniform Kind of Attraction and Repulsion, such as hath been already explained.

§. 1. All the primary Corpuscles of Bodies are compounded of attracting and repelling Matter. *Prop.* 36. The smallest Corpuscles in Nature are such as mutually repel each other. *Prop.* 39. *Corol.* 2. and *Prop.* 40. A sufficient Number of such repellent Corpuscles, collected together, will compose a Fluid in all Respects resembling pure elementary Air, at least as far as we are able to judge from the known Properties of that Element. The common Air, indeed, of our Atmosphere is a Fluid far less simple and homogeneous than what is here supposed: It is rather a Chaos of all the Substances in Nature, and is on that Account capable of producing a great Variety of *Phænomena*, that can in no wise be ascribed to so simple a Cause. If therefore we would make a just Comparison betwixt the common Air and our repellent Corpuscles, we must suppose them also mixed with the same Variety of other Substances. Our repellent Fluid will be compressible and perfectly elastic, the Distance of its Particles will render it extremely rare and pellucid, and their Distance and Smallness together will make it exceed all other Fluids in Levity. If the Air is really more elastic at different Heights of the Atmosphere, we need only conceive its Particles of different
Sizes,

Sizes, to account for it. The smallest, and consequently the lightest, will have most Elasticity, *Prop.* 41. Those by the Laws of Hydrostaticks will rise highest, and *vice versâ* the grossest and least elastic will occupy the lowest Part of the Atmosphere.

§. 2. The neutral Corpuscles are the next in Magnitude : These will neither attract nor repel, except in Point of Contact. Such Corpuscles would compose a Fluid of much greater Density than the Air, void of Tenacity, and compressible. *Prop.* 42. We do not find in Nature any Fluid exactly corresponding with this in all its Properties : So that if such a one does really exist, it must be disguised by some other Circumstances. Water is a Fluid that seems most likely to wear this Mask. Pure elementary Water may be both compressible, and void of Tenacity : But all that we are acquainted with is far from being pure, and the Mixture of other Substances may very well account both for its Tenacity and Incompressibility. If neutral Corpuscles are mixed with attracting ones, the Composition thence arising will be a Fluid, in which the attracting Principle will be more prevalent than that of Repulsion. In this Case the neutral Corpuscles will be attracted by the attracting Corpuscles, *Prop.* 46. and taking the Place of their Atmospheres, be condensed round them, with a Force proportionable to the Excess of their Attraction. The several Aggregates, thus produced, containing more attracting than repelling Matter, will be determined towards each other, with a Force likewise proportionable to the Excess of Attraction : Whence a Fluid will be formed, the Attraction of whose Parts among themselves will cause a moderate Degree of Tenacity, like that of Water. It will also be incompressible, for the same Reasons that are given in the second *Corollary* to *Prop.* 45. For its Parts are in Contact, and are already compressed by their own Force of Attraction. Oils, Salts, Earths and Minerals of all Kinds are composed, in Part at least, of attracting Corpuscles ; some of which make always a Part of Water, even in its purest State. The Air, indeed, insinuates itself into it, but does not make any necessary

fary Part of its Composition. When Water is purged of Air by the Air-Pump, or Boiling, its Properties continue the same. The chief Reason of its mixing with Water seems to be this: The superincumbent Atmosphere presses with its whole Weight upon its Surface; the Particles of Air contiguous to the Surface are more repelled by those of their own Kind than by the Particles of Water, and therefore enter the Substance of it, to recede from the greater Repulsion. After this Entrance they will remove to as great a Distance as possible from each other, and disperse themselves equably throughout the containing Fluid. Take off the Pressure of the Atmosphere, and they emerge again, which shews that they are not united to the Particles of Water by any Bond of Cohesion: Therefore the Repulsion that would be between the Corpuscles of Air and Water, *Prop.* 46. would not prevent the Air from insinuating itself into the Body of that Fluid. Hence we see the Reason of the great Transparency and Fluidity of Water, and why its specific Gravity so much exceeds that of the Air. The aqueous Corpuscles are never in real Contact with each other; but leave a sufficient Space interspersed for the easy Transmission of the Rays of Light. They roll over one another without any Impediment to their Motion, but a small Degree of Tenacity, and their *Vis Inertiæ*. Being both larger, and closer together than the Corpuscles of the Air, they must necessarily produce a Fluid of greater specific Gravity.

§. 3. The attracting Corpuscles remain only now to be examined; and it will not be difficult to find what Name to class them under. Let the Size of those Corpuscles be greater or less, they will mutually attract each other; and (unless they be intermixed with repelling or neutral Corpuscles) their Adhesion in Point of Contact will give them the Properties of a solid Body. Indeed the smaller these Corpuscles are, the less will their Force of Cohesion be; but the smallest will cohere in some Degree, and that small Cohesion will produce but a less Degree of Hardness. It will be very different from what has been shewn to constitute Fluidity in Water;

ter: In that, the attracting Corpuscles are each surrounded with others, which do not at all attract, but are only condensed round them by their Attraction, and serve the same Purpose as a Multiplicity of Wheels in a Machine; which by their bearing one upon another diminish the Friction almost *ad infinitum*. But here, each Corpuscle adheres with some Degree of Force to all those that are in Contact with it; and however small that Force may be in one single Corpuscle, yet in such a Number as must be contained in a Body of a sensible Magnitude, it will amount to something considerable. Wherefore since all attracting Corpuscles, of whatever Size, agree in this Property of Solidity, I think they may properly enough be all included under the general Name of Earth. Attracting Corpuscles of different Magnitudes will produce Bodies of as different Degrees of Hardness and Density; and if the constituent Corpuscles of Bodies were homogeneous, the various Kinds of Bodies would not be more in Number than the various Magnitudes of attracting Corpuscles. And even in this Case, there might be produced almost an infinite Variety. But these Corpuscles are never found in Nature unmixed with Air, or Water, or both. What an endless Diversity of Substances must necessarily arise from such a Combination! If the Elements of Air and Earth both contain an indefinite Series of Corpuscles of different Sizes, the various Mixtures that may be made of those two alone, will be much more indefinite. Join to these the Element of Water, and this Variety will be immensely increased.

§. 4. If the smallest of the attracting Corpuscles are united to a small Quantity of neutral ones, just enough to surround and cover their Surfaces, a Fluid will be thence produced of much greater Tenacity than Water, and of greater specific Gravity. For these Corpuscles being supposed the smallest of their Kind, their Force of Attraction will not much exceed their repulsive Force: Wherefore, if they are combined with as many neutral Corpuscles as will cover their Surfaces, their Contact and Cohesion will be sufficiently prevented to leave them in a fluid State; and the Excess of their Attraction

tion will suffice to produce a considerable Degree of Tenacity, and to bring the Parts of this Fluid closer together than those of Water. On which Account, and also because of the greater Size of its Corpuscles, it will exceed Water in specific Gravity. This Fluid will imbibe a much greater Quantity of Air than will be admitted by pure Water, because it contains more attracting than repelling Matter. In Water, the compound Corpuscles being neutral, the Corpuscles of Air contiguous to its Surface will be repelled by them, tho' with less Force than by those of their own Kind. *Prop. 46.* Wherefore those which penetrate that Fluid, in so doing, are only determined to that Quarter where there is least Repulsion, and consequently least Resistance: But the Fluid under our present Consideration has less Repulsion than Water, and will therefore give less Resistance to the Air in penetrating its Substance. Its greater Tenacity will, indeed, be rather an Impediment to the Air's Admission, but when admitted will retain it so much the stronger. It will imbibe Air, till such time as the Repulsion of that which is already entered, and the Fluid's Tenacity together, are sufficient to resist the Effort made by the Air's Weight and Spring to introduce itself. After which, the Air will be condensed upon its Surface; the Repulsion on the Side of the Fluid being still less than that of the Particles of Air amongst themselves: So that the latter will still press in some Degree towards the former, though not with Force sufficient to enter. The Excess of Attraction in the Fluid will also conspire in condensing the Air on its Surface. The Quantity of Air imbibed by this Fluid will very much increase its Volume: For as it consists of attracting Corpuscles, surrounded by neutral ones, a Quantity of repellent Corpuscles being interspersed amongst them, must very much dilate them; because neutral and repellent Corpuscles repel each other. On this Account its specific Gravity will be generally less than that of Water; though if it were to be found unmixed with Air it would be greater. Its less specific Gravity will make it swim upon Water; for which and some other Reasons it will

will not easily mix with that Element. Water, indeed, is already supposed one Part of its Composition; notwithstanding which, it will be difficult for more to insinuate itself among its component Parts. The Air that is plentifully mixed with it, and also spread over its Surface, will not only hinder those Fluids from attracting, but even make them repel each other: For Air repels Water, *Prop.* 46. The Tenacity likewise of this Fluid will hinder its mixing with Water; which cannot be effected without a Separation of its Parts. These Properties very well agree with the known Properties of Oils. If in some Circumstances they are found to differ, that Difference may be very well accounted for by the Mixture of various other Substances. Oils are never found in the common Course of Nature unmixed with a greater or less Proportion of Salts, and a grosser Kind of Earth. This is probably the Reason why some are specifically heavier than Water; as doubtless it is the Cause of a great Diversity in the Consistency, Taste, Smell, Colour and other Properties of that Fluid. These smallest attracting Corpuscles, when not surrounded by neutral ones, will form a Substance vastly different from Oil: It will appear, when we come to treat of Fire, to be what *Stahl* and other Chemists have called the *Phlogiston*, the most subtle Earth in Nature.

§. 5. If we consider the Size of attracting Corpuscles as still larger, we shall have an Idea of the universal Acid, the Basis of all Salts; to which this Acid bears the same Relation, as the *Phlogiston* does to Oils: For they have as much Analogy as can be expected in Things essentially different. They are both of them very fixed in the Fire, provided they be contained in close Vessels, and have neither Air nor Water joined with them to make them volatile. When not united to grosser Earth, and exposed to the open Air, they are the most volatile Substances yet known, except Water and Air itself; and such Compounds as contain one or both of them, and are made volatile by them. Surround their Corpuscles with Water, the one becomes Oil, the other the Acid of Vitriol: Join to this Oil different Proportions of

Salts and Earths, you will have generated Oils various in Smell, Taste, Colour, Spissitude, Weight, &c. Likewise Balsams, Gums, and Refines. For Corpuscles of a larger Size than those that constitute Oils, will have a greater Proportion of attracting Matter, *Prop. 44.* and therefore when mixed with them, the Proportion of attracting Matter will be greater in the Compound, than it was in Oils singly; and by how much the attracting Principle in any Compound prevails more than the repellent, by so much the stronger will the Cohesion among the several constituent Parts be, *cæteris paribus*; the Effect being always proportionable to the Cause. A like Increase of Cohesion, but in a greater Degree, will happen to the vitriolic Acid from a Mixture of earthly Corpuscles, of a larger Size, and consequently more attracting. The acid and earthy Particles will run together with Violence; and after they have separated themselves from the superfluous Air and Water before united with them, they will form one Concrete; whose Parts will adhere so strongly, as to constitute a Solid. Hence Salts will be generated in a solid Form of various Kinds, according to the Nature of the Earth with which they are combined.

§. 6. Corpuscles of a greater Magnitude than those last mentioned, to constitute the universal Acid, will have a still greater Force of Attraction. *Prop. 44.* And by considering the Sizes, in a regular Series, one exceeding another, there can be no Degree of Cohesion amongst the constituent Parts of Bodies that may not be thence produced, whether they be Earths, Stones, Metals, or other Minerals. And this Cohesion will be differently modified by the different Combination of Air, Water, Oils, Salts, Earths, and Metals, in an infinite Variety: So that, I think, I have clearly proved, that all the various Degrees of Cohesion that are found amongst Bodies, will naturally arise from the different Sizes of their constituent Corpuscles, and one simple, uniform Kind of Attraction and Repulsion.

Note, The Doctrine I have interspersed through the whole Course of this Demonstration, for the Sake of illustrating the

the Force of it by an Application to Facts, may, in some Cases, be erroneous, without lessening the Truth of the Proposition; the Evidence of which is sufficiently clear, without any Reference to Facts, provided the Propositions referred to in the Demonstration be true. Even supposing the Principles I go upon to be out of Doubt, it would be the highest Presumption in me to think myself capable of making a right Application of them to all the *Phænomena* in Nature. The same Principles in the Hands of a Person of greater Capacity, and more extensive Knowledge than myself, would doubtless be much better applied; and even then come infinitely short of the Truth. They would still be in the Hands of a finite Being, that sees as through a Glass, darkly: Whereas the real Application of these Principles in Nature is conducted by a Being of infinite Wisdom and Power.

COROL. I.

It follows, from what hath been said of the Nature of Cohesion, that all Bodies, whether solid or fluid, are a Compound of attracting and repelling Matter.

COROL. II.

Bodies in which the attracting and repelling Matter are equal, will neither attract nor repel.

COROL. III.

Such Bodies as contain more attracting than repelling Matter in their Composition, will attract with a Force proportionable to the Excess of attracting Matter; and *vice versâ*.

COROL. IV.

The attracting Force of Bodies will increase in Proportion as their repulsive Force decreases; and *vice versâ*.

PROP. XLIX.

If two or more attracting Bodies cohere together, and a Force be applied to separate them, the Resistance to the separating Force will increase, the farther they are separated from each other, till they come to a certain Distance; after which it will decrease.

Attracting Corpuscles approach each other with an increasing Force, till they come so near, that the Repulsion at their Surfaces begins to counter-act their Force of Attraction; after which their Attraction becomes weaker and weaker, the nearer they approach, being more and more destroyed by the contrary Force of Repulsion; and at a certain Distance the Repulsion at their Surfaces becomes so strong, as to equal and quite destroy the attracting Force: For equal and contrary Forces mutually destroy each other. In this Point therefore the attracting Corpuscles are at rest; *Prop.* 42. and *Corol.* 3. and are in physical Contact with each other. Now 'tis evident, that if in their Approach the Force of Attraction increased, till they came to a certain Distance from each other, and then gradually decreased, till in Contact it was nothing; in removing them back again to the same Point, the Attraction will be gradually restored, or increase, and beyond that Point it will decrease again: But the Resistance to a separating Force at different Distances will be as the Force of Attraction at those Distances; therefore the Resistance will increase, the further they are removed from each other, till they come to a certain Distance; after which it will decrease.

COROL.

This Law of Cohesion very well explains the Cause of Elasticity in Bodies. Every Kind of Elasticity depends either upon the Spring, with which Bodies restore themselves when their Parts are pressed together; or when stretched or drawn out to a greater Distance from each other; or when some Parts are stretched, whilst others are pressed. When the Parts of Bodies are pressed together, the Repulsion at the Surfaces of each component Corpuscle will re-act as a Spring. When they are drawn out to a greater Distance from each other, they will contract and restore themselves again by this Law, with a Force proportionable to the Degree of Tension. But if the distending Force be so great as to draw them beyond the Distance at which the Repulsion of Surfaces begins to take place, their greatest Force of Attraction will

will be then overcome, and an entire Separation must ensue: As is the Case when the Strings of musical Instruments are broke, by being over-stretched. Both Causes seem to take place in common Springs; for when they are bent, the Parts on the concave Side are compressed, and those on the convex Side are distended.

PROP. L.

All Bodies whatsoever, whether solid or fluid, must contain more Pores than solid Parts.

The Truth of this Proposition has been sufficiently proved by most of the Philosophers of this and the last Century, from Facts and Experience: Yet it was not so easy to conceive, how it could be true in all Cases; whilst they supposed the constituent Parts of Bodies in actual Contact. But since it is evident from *Prop. 45. Corol. 1.* that the Corpuscles, of which Bodies are compounded, never come in actual Contact at all, I think all those Difficulties are removed, and the Truth too clear to require any further Demonstration.

COROL. I.

Therefore all Bodies, how dense soever, will be capable of containing betwixt their component Corpuscles more or less of the repellent Fluid, in Proportion to the Number and Size of their Pores.

COROL. II.

There will be always more Pores to admit, than solid Parts to resist the free Ingress and Regress of the repellent Fluid.

PROP. LI.

The repellent Matter will be condensed partly in the Pores of solid Bodies, and partly upon their Superficies in Form of Atmosphere.

It must be condensed either in the Pores, or on the Superficies, or both. *Prop. 32. and 34. Corol. 1.* It cannot be condensed in the Pores only; because it would then be denser in the Pores than in the Space immediately surrounding them,
and

and not being confined by an equal Pressure from without, they must be determined outwards, to the Part where there is least Pressure. For the same Reason, if the Condensation was only on the Superficies, they would be determined into the Pores: Therefore the Condensation must be both in the Pores and on the Superficies.

COROL.

The repellent Matter will be always denser in the Pores and on the Superficies of solid Bodies, than in other Parts of Space.

PROP. LII.

In solid Bodies of equal Dimensions the Space occupied by the Pores will be greater, *cæteris paribus*, in Proportion as the component Corpuscles are less; and *vice versâ*, where the component Corpuscles are largest, the Space occupied by the Pores will be least.

In Bodies of equal Dimensions the whole containing Spaces must be equal; and the less the component Corpuscles are, the less Space they will occupy themselves, *cæteris paribus*: The rest will be Pores; and *vice versâ*.

COROL. I.

This will be the Case, supposing the Number of Corpuscles the same in each Body: But since the Number of Corpuscles are always greater in Bodies where they are larger, and consequently much denser, *Prop. 45.* the Space occupied by the Pores will, on that Account, also be greater where the Corpuscles are small, than where they are large; and *vice versâ*.

PROP. LIII.

In Bodies of equal Dimensions, those whose Corpuscles are largest and densest, will have the greatest Quantity of repellent Matter condensed upon their Surfaces, in Form of Atmosphere.

The larger the Corpuscles are, the more repellent Matter will be attracted by them; which will all be either condensed in the Pores, or upon the Superficies in Form of Atmosphere.

sphere. *Prop.* 51. The Capacity of the Pores is least, where the Corpuscles are largest and densest. *Prop.* 52. and *Corol.* and the less the Pores can contain, the more must be condensed upon the Superficies in Form of Atmosphere.

Note 1. In my Reasoning on Bodies in general, I consider them as quite homogeneous and uniform, both in their Pores and solid Parts; free from those Cavities and Depressions, and other Inequalities usually found in the Texture of natural Bodies. A proportionable Allowance must therefore be always made in the Application of these Truths to Facts.

Note 2. The repellent Fluid condensed on the Surfaces of solid Bodies in Form of Atmosphere, I call their repellent Atmosphere, to distinguish it from their true Atmosphere; which is Air in like Manner condensed.

PROP. LIV.

If the Pores of a Body are large enough to admit the Air, or a denser Fluid, the repellent Matter in the Pores, and on the Surface, will give place to the denser Fluid.

All other Fluids besides the repellent one, consist of Corpuscles, that are partly repellent, and partly attracting Matter: The repellent Matter of these Corpuscles will be equally determined towards the Surfaces, and into the Pores, with as much Force as the Particles of the repellent Fluid, being in all Respects the same. The attracting Matter of the same Corpuscles will be attracted in Proportion to the Quantity of it. Therefore the repelling Matter of the Corpuscles being determined towards the Surfaces and into the Pores, with a Force equal to that of the repellent Fluid, and the Force of the attracting Matter conspiring, the Corpuscles must be determined towards the Surfaces and into the Pores with more Force than the Particles of the repellent Fluid; which must consequently give place to the stronger Force.

PROP. LV.

Water will be attracted by the Surfaces and Pores of solid Bodies with more Force than Air; and, provided the Pores are large enough, will enter them, and drive out the Air.

Water

Water has a greater Force of Attraction than Air, having more attracting Matter; and will therefore be stronger attracted both by the Surfaces, and into the Pores, provided the Pores are large enough to admit the Corpuscles of Water, and the Attraction strong enough to overcome its Tenacity: Which will always be the Case in solid Bodies, because their component Corpuscles are larger and more attracting than those of Water: It will therefore enter the Pores, and drive out the Air.

COROL.

For the same Reasons, such Fluids as contain more attracting Matter than Water, will be stronger attracted by the Surfaces and into the Pores, provided their Tenacity is not greater than that of Water, and the Pores be large enough to receive them.

PROP. LVI.

If the Pores are wholly or in Part void of Air, and large enough to admit Water, the Water will rush in with more Violence, in Proportion as there is a less Quantity of Air to be removed.

For if the Pores be already filled with Air, the Water cannot drive it out without acting upon it; and since Action and Re-action are mutual, the Air will act upon the Water, and retard its Motion: But when the Pores are void of Air, it enters without any Impediment, and is likewise assisted by the Weight of the Atmosphere.

COROL.

The Cavities of capillary Tubes cannot contain so much Air as would have been condensed upon the same Quantity of Surface on the external Parts of the Glafs; and the smaller the Cavities are, the less will be the Quantity contained in Proportion to the Surface: So that Water, in entering the Cavities of capillary Tubes, will have a less Proportion of Air to remove in those of a small Diameter; and will consequently rush in with more Violence. The Force of Attraction will be, *cæteris paribus*, as the attracting Surfaces; which

which will be as the Diameters of the Tubes. But the Cavities of the Tubes will be as the Squares of the Diameters, *cæteris paribus*; therefore the Quantity of contained Air will decrease in the duplicate Ratio of the Diameters: But the Force that is to drive it out will only decrease in the simple Ratio of the Diameters.

PROP. LVII.

The Density of the repellent Atmospheres, at different Distances from the Center of the Bodies they surround, will be reciprocally as those Distances.

The repellent Matter will be determined towards the Space occupied by the Body, with a Force decreasing in the reciprocal Ratio of the Distances. *Prop. 33.* And since the Densities will be as the condensing Force, they will likewise be in the reciprocal Ratio of the Distances. If the repellent Matter be attracted by the attracting Matter, the Density of the repellent Atmosphere will not be altered thereby; for the Attraction will be as the Quantities of Matter multiplied by the Distances reciprocally; and the Quantity of Matter that composes the repellent Atmosphere will be very small, and some of it at a very great Distance from the Center of the attracting Body; consequently the Attraction of it must there be quite inconsiderable, and the Condensation arising from thence will be very little: But if it were more than can reasonably be supposed, the absolute Density would be still the same; because in Proportion to the Condensation arising from Attraction, the other would be diminished, since the Principle on which the other takes place is the Defect of repellent Matter towards the Space occupied by the Body; which Defect will be lessened in Proportion to the Quantity drawn thither by the Body's Attraction. Wherefore the absolute Density must still remain exactly in the reciprocal Ratio of the Distances from the Center of the Body.

PROP. LVIII.

If the whole Infinity of Space was filled with a repellent
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Fluid,

Fluid, and only one solid Body existed in it, the repellent Atmosphere of that Body would extend to a greater Distance than can be assigned.

The Density of the repellent Atmosphere would increase in the simple Ratio of the Distances reciprocally, by the last: Therefore at double the Distance from the Center of the Body, the Density will be $\frac{1}{2}$, at triple the Distance $\frac{1}{3}$, at quadruple the Distance $\frac{1}{4}$, and so on *ad infinitum*. Wherefore at any assignable Distance the Density will be something more than at a Distance still greater; and consequently the repellent Atmosphere will extend to a greater Distance than can be assigned.

PROP. LIX.

If two or more Bodies be supposed to exist, and be placed at a Distance, their repellent Atmospheres will mutually put Bounds to each other on those Sides which mutually respect each other.

The repellent Fluid cannot both increase and decrease in Density at the same Time, and in the same Place; therefore on those Sides which mutually respect each other, there must be a certain Distance, at which the repellent Atmosphere of one Body will cease to decrease in Density, and that of the other begin to increase; that is, one will end where the other begins. Therefore they will mutually put Bounds to each other, on the Sides which mutually respect each other.

PROP. LX.

Within the repellent Atmosphere of a Body the Force of Repulsion decreases directly as the Distances decrease from the Center.

The Quantities of repellent Matter at different Distances will be in the compound Ratio of the Spaces it takes up, and of the Densities. The Spaces occupied by the repellent Matter, at different Distances from the Center of the Body, are in the direct Ratio of the Cubes of those Distances, and the Densities are as the Distances reciprocally, *Prop. 57.* which two Ratio's compounded are equal to the direct Ratio

Ratio of the Squares of the Distances. Therefore the Quantities of repellent Matter at different Distances within the repellent Atmosphere, will be as the Squares of those Distances directly: But the Force of Repulsion, at different Distances, will be in a Ratio compounded of the direct Ratio of the Quantities of repellent Matter, and the reciprocal Ratio of the Distances; that is, a Ratio compounded of the direct Ratio of the Squares of the Distances, and the reciprocal Ratio of the Distances, equal to the direct Ratio of the Distances: Consequently the Force of Repulsion, at different Distances within the repellent Atmosphere, must be in the direct Ratio of those Distances, and decrease directly as the Distances decrease.

PROP. LXI.

At different Distances within the repellent Atmosphere of a Body, the Force of Attraction will be in the reciprocal Ratio of the Squares of those Distances from its Center.

If the Repulsion was the same at all Distances, the Force of Attraction would be simply in the reciprocal Ratio of the Distances: But the attracting Force of Bodies increases in Proportion as the repulsive decreases, *Prop. 48. Corol. 4.* and the repulsive Force decreases as the Distances decrease, by the last: Wherefore the attractive Force will increase as the Distances decrease, on Account of the diminished Repulsion, as well as on Account of the Decrease of Distance. But the two Ratio's compounded produce the reciprocal Ratio of the Squares of the Distances; *e. g.* At half the Distance the Force of Attraction is equal to 2, from the Decrease of Distance, the Repulsion remaining the same: But if at half the Distance the Repulsion will be but $\frac{1}{2}$, the Attraction will have double the Force that it would have if the Repulsion was the same. The whole Force therefore will be $2 \times 2 = 4$. In like Manner, at $\frac{1}{3}$ of the Distance, the Force of Attraction is $3 \times 3 = 9$; and so on.

COROL. I.

The Attraction betwixt the Sun and each of the heavenly
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Bodies

Bodies revolving round it, will be in the reciprocal Ratio of the Squares of their Distances from its Center: For the repellent Atmosphere of the Sun is bounded by those of the Fixed Stars surrounding it. *Prop. 59.* Therefore its Extent will be sufficient to contain not only the whole Sphere of *Saturn*, but the utmost Bounds to which any of the Comets may be supposed to go. And all the Planets and Comets, surrounded with their repellent Atmospheres, are within the Limits of the Sun's repellent Atmosphere; and consequently are attracted towards its Center, with a Force increasing as the Squares of the Distances decrease.

C O R O L. II.

For the same Reason, all the secondary Planets, revolving within the repellent Atmosphere of their Primaries, must gravitate towards its Center. The Moon and all other Bodies within the Earth's repellent Atmosphere, towards the Center of the Earth; and universally everyBody, within the repellent Atmosphere of another, will gravitate towards the Center of that Body.

C O R O L. III.

Therefore the Attraction of Gravity, as well as that of Cohesion, decreases in Reality as the Distances increase, tho' it seems to act in the reciprocal Ratio of the Squares of the Distances, on Account of having the repulsive Principle compounded with it. So that these two Attractions decreasing in different Ratio's, is no Hindrance to their being essentially the same.

P R O P. LXII.

Besides the repellent Atmospheres surrounding solid Bodies, they will likewise have an Atmosphere of Air. This I shall call their true Atmosphere, or simply their Atmosphere.

The Earth has evidently a very extensive Atmosphere, and Experiments seem to shew, that all solid Bodies upon the Earth have Air condensed round them, more or less, and likewise adhering to their Surfaces. It is not necessary to enumerate the several Facts that have been referred to in
Confirmation

Confirmation of this Doctrine, since they are sufficiently known. It will be more to our Purpose to shew, from what has been already demonstrated, the Cause of this Condensation, and to prove the Necessity of its being universal. It follows, from *Prop. 51.* that all solid Bodies must have a repellent Atmosphere. The Air presses upon the Surfaces of all Bodies, and is contiguous with them; it therefore enters within the repellent Atmospheres of Bodies, and must consequently be attracted towards their Centers, with a Force decreasing in the reciprocal Ratio of the Squares of the Distances. *Prop. 61.* Those Particles of Air that are nearest the Surface will be united in Contact with it; and cohere with a Force, that will be in a Ratio compounded of the direct Ratio of the Excess of attracting Matter in the Body, and of the reciprocal Ratio of the Distances from its Center. *Prop. 47. §. 5.* Wherefore the Air will be united to the Surfaces of all solid Bodies, and as far as the repellent Atmosphere reaches, form an Atmosphere round them, till the Excess of repellent Matter in the Air, added to the repellent Atmosphere interspersed among its Particles, is sufficient to ballance the Force of Attraction in the Body. Now if the Earth, and all the solid Bodies upon it, have their respective Atmospheres, it is reasonable to conclude, that the Planets and other heavenly Bodies are not without them: The Sun has, apparently, a very large Atmosphere, and the Comets can hardly be supposed to be without, when we consider the Appearance they make. The Existence of the Moon's Atmosphere is rendered more than probable, from many astronomical Observations; nor do I know any conclusive Argument that can be brought to prove, that any of the Planets are without: So that we ought to conclude this Proposition universally true, till Reasons can be found to evince the contrary.

COROL.

The Surfaces of all solid Bodies have Air in Contact with them, and cohering to them; and that even *in vacuo*: For the Pressure of the external Air may very much increase the Cohesion.

Cohesion of Air to the Surfaces of solid Bodies; yet as it is not the whole Cause of that Union, the Absence of it will not produce a Separation.

PROP. LXIII.

The repellent Atmospheres of solid Bodies upon the Surface of the Earth, will have their Places supplied by the Presence of their true Atmospheres; and no more of them will remain, than what is condensed in the Interstices betwixt the Particles of Air.

The Particles of Air consist of a greater Proportion of repellent than attracting Matter, *Prop.* 48. and therefore, the more of them are condensed upon the Surfaces of Bodies, and united to them, the more will the Excess of Attraction in each Body be ballanced by the Excess of Repulsion in its Atmosphere. The Air will be condensed till the Increase of Repulsion arising from that Condensation is equal to the Excess of Attraction, and the Body, together with its Atmosphere, contains an equal Proportion of attracting and repelling Matter. Beyond the Limits of the true Atmosphere, the attracting and repelling Forces will be *in equilibrio* with each other; and consequently neither the Air, nor repellent Fluid, will have any Tendency there towards the Body. The repellent Atmosphere therefore cannot extend beyond the Limits of the true one: But in the Interstices betwixt the Corpuscles, that compose the true Atmosphere, it will be condensed; and may be still considered as a repellent Atmosphere.

COROL. I.

For this Reason there can be no Attraction of Cohesion betwixt solid Bodies, whilst the Air is united to, and condensed upon their Surfaces: But the Air being removed by the Application of a denser Fluid, and the Bodies brought in Contact, they will cohere together.

COROL. II.

The Air being united to the Surfaces of Bodies, those Surfaces will repel each other when brought very near together.

COROL.

COROL. III.

Where a sufficient Quantity of Air or repellent Fluid cannot have Access to the Surface of a Body to ballance the Force of Attraction, that Surface will be in an attracting State. The Surfaces of the internal Pores of all Bodies are in this State; and all Cavities whatsoever, whose Sides are so near as not to admit the Whole of their Atmospheres betwixt them. For Instance: The Cavities of capillary Tubes not having a sufficient Capacity to contain all the Air or repellent Fluid that would be necessary to ballance the Attraction of their internal Surfaces, the Whole of those Surfaces are in a State of Attraction. The smaller their Cavities are, the stronger will that Attraction be. Water will rise to the greatest Heights in Tubes of the smallest Diameter, though their Lengths be the same; which is owing to the attracting Surfaces acting upon the Water at a less Distance in narrower Tubes: For the Attraction will be in the reciprocal Ratio of the Distances at which the Surfaces act. The Distances of the Surfaces in Tubes of different Diameters, will be as the Diameters: Therefore the Force of Attraction will be in the reciprocal Ratio of the Diameters, *cæteris paribus*. But in Tubes of equal Diameters, and different Lengths, the longest will raise the Water to the greatest Height, because the Whole of the internal Surfaces are in a State of Attraction, and the longest Tubes have the most internal Surface, *cæteris paribus*.

PROP. LXIV.

The true Atmospheres of the heavenly Bodies will no ways alter the general Laws of Gravitation.

The Earth and its Atmosphere together can only be considered as one Body, in regard to Gravitation; because the attracting and repelling Forces of both will act as from one common Center, and the Quantities of attracting and repelling Matter in both will continue the same at all Distances from the Sun. The same Reasoning is equally true, when applied to the rest of the heavenly Bodies: This however deserves

serves Consideration, that the larger and denser the Atmospheres are that surround the heavenly Bodies, in Proportion to their Magnitudes, the less will be the Force of their Attraction at all Distances; because the more Air there is in the Compound, the more there will be of repellent Matter; and the more there is of repellent Matter, the less will be the Force of Attraction. From whence we may deduce the following Corollaries:

COROL. I.

The Density of the heavenly Bodies may even increase in Proportion as their Magnitudes increase, provided their Atmospheres increase in a much greater Proportion; and yet their Force of Attraction may increase in a much less Proportion than that of their Magnitudes: So that we must not necessarily conclude the larger of the heavenly Bodies to be rarer than the less, because they are specifically lighter; unless we were sure, that the smaller had as large Atmospheres as they, in Proportion to their Size. Certainly it is more consistent with that beautiful Simplicity and Uniformity which is every where conspicuous in the Works of the Creation, to suppose those vast Bodies, the Sun, *Jupiter* and *Saturn*, to be much more dense than either the Earth or Moon; and that their Atmospheres are proportionable to their Magnitudes in Extent. In which Case, the Quantity of Air contained in them will be much greater in Proportion to the Magnitude of their Bodies, than the Quantity contained in our Atmosphere is, in Proportion to the Body of the Earth; because their Atmospheres will be exceedingly more dense than ours, both on account of their Heights, and the greater Force of Attraction that must belong to Globes of their Magnitudes.

COROL. II.

The Density of the Moon may be less than that of the Earth, or any of the other Planets, notwithstanding its Force of Attraction is proportionably greater, provided
its

its Atmosphere is proportionably less than theirs, in respect to the Quantity of Air contained in it.

Quære. May not this be one Reason why the Moon's Atmosphere is so little visible to us at this Distance?

PROP. LXV.

If a Body, surrounded by its Atmosphere, revolves round a larger, surrounded by another Atmosphere, the two Atmospheres will mutually repel each other, with a Force increasing as the Distances decrease.

The component Corpuscles of both Atmospheres consist of more repelling than attracting Matter, *Prop.* 48. §. 1. and consequently the Force of Repulsion in both will exceed the Force of Attraction: Wherefore they will mutually repel each other, with a Force proportionable to that Excess; which Force will increase as the Distances decrease, by the general Law of Repulsion.

COROL. I.

In Proportion to the Degree of this repulsive Force, the Atmosphere of the revolving Body will recede from the Center of the other, and retreat more or less behind its own Globe.

Quære. May not the Atmosphere of the Moon be in Part repelled by that of the Earth, towards that Side which is always turned from us? And may not this be another Reason why it is less visible to us?

COROL. II.

This Repulsion will be very considerable in the Atmospheres of the Comets: For it will become greater and greater, in Proportion to their nearer Approach to the Sun; because it increases as the Distances decrease. Therefore at every Decrease of Distance, the Comet's Atmosphere will more and more retreat to that Side of the Comet which is farthest distant from the Sun's Center. And since this Force will act in a Direction almost contrary to that of the projectile Motion of the Comet, the projectile Motion of its At-
H atmosphere

mosphere will be more and more retarded thereby; and that Part of it which is most remote from the Comet, will least conspire with the Direction of the projectile Force, and also be left a great Way behind the Comet, on Account of the Retardation of its Motion. This seems to explain all those remarkable *Phænomena* that appear in the Tails of Comets. The Length of their Tails increases very considerably in their nearer Approach to the Sun: But as soon as they begin to recede from the Sun, their Extent is vastly more augmented; because then the projectile Force, and that of Repulsion, conspire together, and act almost in the same Direction: So that the Tail moves with the whole projectile Force of the Comet, increased by its own repulsive Force, and must consequently move with much greater Velocity than the Comet; and would leave it far behind, was it not for the Comet's Attraction, which all the while acts upon it with a Force decreasing, as the Squares of the Distances increase. The Direction of the Tails will neither conspire with that of the repulsive Force nor that of the projectile, but each of their component Corpuscles will move in the Diagonal of both Forces. Those Corpuscles which are nearest the Body of the Comet will have most of the projectile Force, and move most in its Direction: Therefore those which are farthest from it will be least influenced by the projectile Force, and move most in the Direction of the other, especially if the repellent Corpuscles decrease in Size at greater Heights of the Atmosphere; because then their repulsive Force will be proportionably greater. *Prop. 41.* Now if the component Corpuscles of the Tails move in different Directions at different Heights from the Comet, the Tails themselves will be in different Directions at different Heights, and consequently be curved. That Part of them which is nearest the Comet, will be most in the Direction of the Comet's Motion; and that Part which is farthest distant, will be most in the Direction of the repulsive Force.

PROP.

PROP. LXVI.

If a Number of equal and perfectly elastic Bodies are ranged in a direct Line, so as to be contiguous to each other, and a Motion be communicated to the first in the Direction of that Line, the last Body in the Series will receive the Momentum of the first, by the Intervention of the intermediate Bodies, and no Motion will be communicated to the intermediate Series, besides a Tremor continued from one to the other: After which they will be all at rest, except the last.

This is a direct Consequence of the known Laws of elastic Bodies; for all the Bodies being equal and perfectly elastic, the whole Momentum of the first Body will be received by the second, and the first will remain at rest; the second will communicate its whole Momentum to the third, and then be at rest also; and so on till you come to the last.

COROL.

This Law will perfectly take place in a continued Series of elastic Particles, such as compose our repellent Fluid; because they are of all Bodies the most perfectly elastic.

PROP. LXVII.

By how much these elastic Bodies are smaller, and more compressed together, by so much the less will they be moved from their Places, in communicating their Motion from one to the other, *cæteris paribus*.

The greater the Compression is already, the greater will be the Resistance to a further Compression; and the greater that Resistance, the less Space will be moved through by the Body in Motion, before its Motion is destroyed: Likewise the less the Momentum of the moving Body, the less Space it will move through before that Momentum is destroyed. But the less the Body is, the less will be its Momentum, *cæteris paribus*.

COROL.

Wherefore when elastic Bodies are indefinitely small, and the Degree of Compression indefinitely great, their Re-

moval from their Places will be indefinitely small, in communicating any Degree of Motion whose Velocity is finite.

PROP. LXVIII.

If a strait Line be supposed to pass in any Direction whatsoever through a Part of Space occupied by the repellent Fluid, all the repellent Particles that are in the Direction of that Line, may be considered as a Series of elastic Bodies: And if the first Particle strikes the second with a certain Degree of Velocity, the same Velocity will be communicated to the last; and if all the intermediate Particles are contiguous, their Motion from their Places will be indefinitely little.

If all the intermediate Particles are not contiguous, yet the Motion will be continued from one to the other; only with this Difference, that where the Series is any where interrupted, the repellent Particles will have to move further from their Places: But since it appears, from *Prop.* 31. that the Number of repellent Particles in any assignable Part of Space, how small soever, may be indefinitely great, no Series of them in any Direction can be a great Way interrupted; especially when we consider, that their equally repellent Forces will naturally range them in a regular Manner: So that in most Cases, the Particles of one Series will be opposed to the intermediate Spaces betwixt the Particles of the next, in the Manner of a *Quincunx*. When all the Particles of a Series are contiguous, the Removal of the intermediate ones from their Places will be indefinitely small, by the last *Corol.* For the Particles themselves are indefinitely small, *Prop.* 24. & *Corol.* and their Degree of Compression may be also indefinite. The Degree of Compression will be equal to the expansive Force of the repellent Fluid, which will be in Proportion to the Number of repellent Particles contained in any given Space; but the Number of repellent Particles contained in any given Space, how small soever, may be indefinite. *Prop.* 41. *Corol.* 1, 2.

PROP.

PROP. LXIX.

All the *Phænomena* of Light and Colours will be the same, whether we suppose the Propagation of Light performed by a progressive Motion of its Particles, or by the Vibrations of our repellent Fluid.

It makes no Difference, in respect to the Action of a Body impinging upon another, whether the impinging Body has moved already through a great Space, or is only just put in Motion, provided the Velocity and Direction be exactly the same in both Cases. Therefore a Particle of Light will strike upon the *Retina* of the Eye with the very same Effect, when it receives its Motion from the next contiguous Particle, as when it has moved all the Way from the Sun, with the same Direction and Velocity. And it is much easier to comprehend how a Tremor may be propagated from one End of a Series of elastic Bodies to the other, in the same Time that Light takes up in coming from the Sun to us, than to conceive how a Particle of Light can continue its Motion and Direction unaltered, through so vast a Space; and with so great a Velocity; whilst innumerable other Particles are every where moving in different and often contrary Directions. Is it possible that it can move so far, and not frequently impinge upon other Particles, when every minute Part of Space must contain Thousands of them? What Confusion must necessarily arise in the Direction of its Motion from such a Variety of Percussions! But supposing the Motion propagated through our repellent Fluid, these Difficulties immediately vanish. In that Case, the Motion may be conveyed in all Directions at once, without Danger of Confusion; because by the last Proposition the Motion of the intermediate Particles from their Places will be inconsiderable; and from the Nature of Percussion, amongst equal elastic Bodies, one Particle is no sooner removed from its Place, but the Particle which removed it, takes Possession of the same, and remains there at rest. The most obvious Objection to this Doctrine is, that in a repellent Fluid a Particle in Motion will not only act upon the next that lays
exactly

exactly in the Direction of that Motion, but also upon all those that are placed but a very little Way out of that Direction; and by this Means several other Vibrations will commence, which will be communicated in such Directions as correspond with the Degrees of Obliquity with which the Particles act: Whereby Light will not only be propagated from one Body to another, in right Lines, but will at the same Time be communicated side-ways, in almost all Directions. And this will not only create Confusion in regard to Vision, but also make it impossible that there should be any Darkeness in the Night. To this I answer, that even granting a Particle of the repellent Fluid will act upon such Particles as lay but a little Way out of the Direction of its own Motion, yet it will not act on them with the same Force as it does on those directly in its Way; therefore these lateral Vibrations will be much weaker than the direct ones, which give us the Sensation of Light: However, though these Vibrations may be too weak for our Organs, yet they may be well enough suited to the delicate Structure of the Eyes of many Insects and Animalcula, and even of some larger Animals; for doubtless what is Darkeness to us, is not so to many of them. The same Thing happens in regard to Sounds: For if all the Vibrations of the Air were capable of affecting our Organs of Hearing, there could be no such Thing as Stillness or Silence; because the Particles of Air must be put in continual Vibrations in all Directions, by every little Percussion that happens among Bodies. All Nature is perpetually in motion; and every Motion, in such an elastic Fluid as the Air, must be attended with a greater or less Vibration of that Fluid. As to the Objections that may be drawn from the Analogy betwixt the Waves in Water, and the Undulations of an elastic Fluid, they will be answered all at once, by denying the Existence of these Undulations; at least with regard to the Propagation of Sound or Light. I will not say, that the Air is never made to undulate: The Winds themselves have often a Wave like Motion; but this is not Sound: A large Body in Motion through the Air may make

Undulations

Undulations in it. The Oscillations of a Pendulum, or the String of an Instrument, may do the same. But none of these are the immediate Cause of Sound. The moving Body, Pendulum and String are all silent. Only it generally happens in the last Case, that whilst the String performs its Oscillations, its component Corpuscles, being elastic, are put into a tremulous Motion, which Motion they communicate to the circumambient Air. Touch the String with a soft unelastic Body, and the tremulous Motion of the Parts ceases. But the String continues to oscillate for a long Time after with as much Silence as a Pendulum.

From the whole of what has been said, I think it is sufficiently evident, that the Effect of Light will in all Cases be the same, when its Motion is propagated through a repellent Fluid, as when it is progressive, in the Manner that Sir *Isaac Newton* has supposed. So that the whole Theory of Opticks, demonstrated by that excellent Philosopher, continues the same as before. Only one Thing, that is of any Consequence, remains to be reconciled, I mean his Doctrine of Colours. He shews the Diversity of Colours to be owing to the different Momenta of the Particles of Light, and supposes their Momenta to differ on account of their different Magnitudes. I have supposed all the Particles of Light to be of the same Size. This was done for the sake of Simplicity, which must always take place, as far as the Nature of Things will admit. And the Momenta of the Particles of Light will differ, though their Sizes are the same, if Light be propagated by Vibrations. For in the same Manner as the Tones in Musick make a Difference in Sound, according as those Vibrations are quicker or slower; so the Momenta of the Particles of Light will differ, according as they vibrate with more or less Force. A great many will be ready to object; that if the Particles of Light are equal, and yet their Momenta different, they must move with different Velocities: And consequently that the red Rays will come from Jupiter to us, in less Time than the blue. I grant the Premises, but deny the Consequence: For Sound moves with equal Velocities,

cities, let the Tone be what it will. What I advance may at first Sight appear a very great Paradox. But it seems evident to me, that in two different Series of equal and elastic Bodies, those of one Series may move with greater Velocity than those of another, and yet the Propagation of Motion from one to the other be performed in equal Times. Instead of a Mathematical Figure, I'll explain the Case by a familiar Instance. Suppose two Men were to strive which could give the quickest Intelligence at an hundred Miles Distance, and the Method they both pitched upon was to place a Man and Horse at the Distance of every ten Miles; and give orders that the first Man should make what speed he could towards the second, till he came to a certain distance, and that then he should fire a Gun; upon hearing of which, the second should start, and at a like Distance also fire his Gun; and then the third start, and so on to the last: Let one Man's Horses be all able to go nine Miles whilst those of the other could only go eight: And let the Riders of the first fire their Guns when they had rode nine Miles. And those of the second at eight Miles from their Place of Starting, it is plain that the Intelligence would arrive at the same Time in both Cases, because the Riders of both would fire their Pieces at the same Time. The Case is exactly similar in two Series of repellent Particles placed at equal Distances. If those of one Series move all swifter than those in the other, yet nothing can be gained thereby if each Particle moves proportionably farther before the next starts, which must necessarily be the Case; for it will move on till its Motion is destroyed by the Re-action of the next: And the greater its Momentum, the farther it must move before that Momentum is destroyed.

From all these Considerations we may safely conclude, that all the *Phænomena* of Light and Colours will be the same, when produced by Vibrations in a repellent Fluid, as when produced by a progressive Motion of the Particles. When we come to apply these Principles to Opticks in particular, a great many beautiful Truths will arise from them, and add not a little to the Improvement of that Science.

PROP.

PROP. LXX.

If the Atmospheres of the Sun and Stars are proportionable to their Magnitudes, and consist of repellent Corpuscles of different Sizes, decreasing gradually from the largest that will repel, to the smallest that can be supposed, all the Vibrations that happen in the lower Parts of their Atmospheres, and are propagated upwards, will be communicated to the repellent Fluid above, and cause Light.

If the repellent Corpuscles composing the Sun's Atmosphere are of unequal Sizes, they will naturally dispose themselves at different Heights, according to their different specific Gravities : So that from the Bottom to the Top of the Atmosphere, they will make a decreasing Series of Bodies; and the smallest of all at the Top may consist of only two or three attracting Particles, surrounded with repellent ones. The vast Weight of the Sun's Atmosphere must make the Density of the Air so great near the Sun's Surface, that what would create a Sound scarce audible with us, would there produce a very loud Noise. The Velocity of Sounds in so dense an Air must likewise be very great. Those Vibrations that are propagated upwards will pass through a decreasing Series of perfectly elastic Bodies; and therefore according to what has been demonstrated by that great Mathematician Mr. *Huygens*, the Velocity of the last Body in the Series will be prodigious; for the Velocity of the first Body was very great. What then must it be, when increased through so long a Series! Can there be any Doubt of its being equal to that of Light? And if so, will not the last and least Corpuscles of the Sun's Atmosphere be capable of producing the same Vibrations in the repellent Fluid, every where surrounding it, and strongly condensed upon it? And will not those Vibrations be continued in right Lines from the Sun, through the whole Immensity of Space occupied by the repellent Fluid? Hence we see why the Sun and Fixed Stars are the grand Fountains of Light and Heat; and why they shine with Light of their own, whilst the rest of the heavenly Bodies reflect it only from them. Hence the

Reason why their Light is of no Service to us in discovering any thing upon their Surfaces; the Proportion of what is reflected from thence being very little, in Comparison to what is generated by the Vibrations of their Atmospheres. Their Globes are no longer frightful Gulphs of Fire, but inhabitable Worlds: Those Philosophers who thought them too hot for the Habitation of Salamanders, and those sublimer Genii, who thought them to be Hells, will now perhaps be in Pain, lest the Inhabitants should freeze with Cold. But let us be under no Concern; all-wise Providence has taken care of all Things for the Good of his Creatures.

P R O P. LXXI.

If Light in a sufficient Quantity enters the Pores of a solid or fluid Body, the Quantity of repellent Matter will be thereby increased, the Body expanded, and the common Effects of Heat produced.

Light is nothing but the repellent Fluid put into very violent Vibrations, *Prop. 69*. When these Vibrations are continued in a right Line, till they arrive near the Surface of a Body, they will begin to be acted upon by the repellent and true Atmosphere surrounding that Surface, and either be repelled thereby, or have Force sufficient to penetrate within those Atmospheres: If the latter, the same Vibrations will be continued through the repellent Atmosphere, only the Direction will be changed towards the Perpendicular; because the repellent Particles will be acted upon by two Forces, in different Directions; (except when the Light falls perpendicular to the Surface) for within the Atmospheres of Bodies the repellent Matter is attracted towards the Surface, *Prop. 31*. Light will therefore move within the Atmosphere of Bodies, in the Diagonal of the projectile and attracting Force; and by the Continuation and Increase of that attracting Force, will be made to describe a Curve, and come nearer the Direction of a Line drawn perpendicular to the Surface; where, when it arrives, it will either fall upon a Pore or solid Part: If the former, it will enter among the component Corpuscles
of

of the Body, and increase the repulsive Force betwixt those Corpuscles, which must make them recede farther from each other, and consequently the Body will be dilated. The greater the Quantity of Light that thus enters amongst the component Corpuscles of Bodies, the greater will be their Expansion: Heat therefore will be most produced, where the greatest Number of repellent Particles are in a vibratory Motion without the Body. Nor is it necessary that those Vibrations should be always so violent as to excite in us the Sensation of Light. A very small Vibration will be sufficient, when the Direction of it is perpendicular to the Surface. Hence we see the Difference betwixt Light and Heat: The first may be produced by a few vibrating Rays, provided those Vibrations are brisk enough; the latter may be produced by much weaker Vibrations, provided the Rays are sufficiently numerous.

PROP. LXXII.

The denser Bodies are, the longer they will be in receiving Heat, but will retain it more strongly when received.

The Truth of this Proposition is founded upon Experience, but the Reasons are not so obvious. If Heat was excited by the repellent Fluid's entering the Pores of a Body in a Stream, it would flow out as fast as it came in, and little or no Expansion would be produced: But since it is propagated by Vibrations, those Vibrations will be continued within the Pores, either in an uniform or irregular Direction, according to the regular or irregular Disposition of the Pores. The denser the Bodies are, the greater will be the Density of their Atmospheres; and in Proportion to the Density of their Atmospheres, more of the Vibrations will be reflected back from the Surface; and consequently fewer will enter. In like Manner, when the Vibrations which have entered arrive again at the outward Surface, and would make their Egress, they will be more or less reflected back into the Pores, in Proportion to the Density of repellent Matter on the Surface; therefore the Density of their Atmospheres

will make the Ingress and Egress of the Vibrations equally difficult, and consequently the denser the Bodies are, the longer they will be in receiving Heat; but retain it so much the more strongly when received.

COROL.

The Densities of Bodies and their Atmospheres will be exceeding great upon the Surfaces of the Sun and Stars, and larger Planets; and therefore, if they have a constant Supply of Heat, though it be in a less Quantity, yet their retaining it so much longer will make Amends for the Defect.

PROP. LXXIII.

The Air and repellent Fluid will mutually supply the Place of each other in ballancing the Force of Attraction; and where the Air can have Access, the other will give Place: But the Air being expelled, will be again restored.

The Air contains more repellent than attracting Matter, and must therefore increase the Force of Repulsion in all Bodies, to which it is any Way united: For which Reason, the more Air is united to Bodies, the less, *cæteris paribus*, will be the Quantity of the repellent Fluid condensed upon their Surfaces, and in their Pores, because less is wanted to ballance the Force of Attraction. Where the Air can have Access, its Determination towards Bodies will be greater than that of the repellent Fluid, *Prop. 54.* but where it cannot, or is by any Cause removed, then the repellent Fluid will be condensed in Proportion to the Defect of repellent Matter. *Prop. 32.*

COROL. I.

The Air will endeavour to unite itself to all Bodies where it can have Access, in Proportion to the Defect of repellent Matter in those Bodies; and if the Pores are large enough, it will enter with considerable Force, and in Part expel the repellent Fluid. The *Nisus* of the Air to penetrate into the Pores of Bodies will be much increased by the Weight of the Atmosphere. Very small Pores will not easily admit the Air, because the solid Parts surrounding the Entrance will
be

be covered with Particles of Air, which will repel those that endeavour to enter. For this Reason the Particles of many denser Fluids will enter where the Air cannot, though they be really larger than the Particles of Air.

COROL. II.

By this Means the Air will be intimately incorporated with most Substances, and will become a component Part of even the most solid Bodies; and when solid Bodies are reduced to Powder, the Air having then free Access to every minute Particle, unites itself thereto; and where the Particles are very small, the Quantity of Air united to their Surfaces is sufficient to make them light enough to float in the Atmosphere. In like Manner when solid or fluid Bodies have their Parts so much expanded by Heat, that the Air is able to insinuate itself amongst them, they are soon carried up in Form of Fumes or Vapour. Fluids indeed of most Kinds do not so much want the Air's Assistance to make them volatile, because a moderate Heat will expand them to such a Degree, that their component Corpuscles will be carried out of the Sphere of each other's Attraction, and then they will begin to repel each other: For as soon as two Corpuscles have got so much repellent Matter round them, that their attracting and repelling Forces are *in equilibrio*, a small Addition of Heat must increase their repulsive Force, and make them repel. Sir *Isaac Newton* has observed, that where the Sphere of Attraction ends, that of Repulsion begins; and that Bodies which attract strongest whilst within the Sphere of each other's Attraction, will have the strongest Repulsion when out of it. He discovered this Law from Facts and Observation: But it is not difficult to deduce it from the Principles already explained. The stronger the Attraction is betwixt the Parts of a Body united, the more repellent Matter will be collected round them when separate.

PROP. LXXIV.

The repellent Fluid contained in the Pores of Bodies, but not in Contact with their component Corpuscles, will seldom exceed

exceed the Quantity which the Space occupied by the Pores ought to have upon an equal Distribution.

The Air, that is intimately incorporated with the component Parts of most Bodies, will be one Cause of diminishing the Quantities of the repellent Fluid within the Pores, *Prop. 73. Corol. 2.* and the Repulsion betwixt the Surfaces of the component Corpuscles will be another very powerful one. For the component Corpuscles being strongly compressed together by the Force of Attraction, the repellent Matter united to their Surfaces will be condensed by the same Force, and its repellent Force will be proportionable to that Condensation. Therefore this Force will strongly resist the repellent Fluid that endeavours to enter the Pores. So that these two Causes conspiring, will make the Quantities of the repellent Fluid contained in the Pores, very seldom exceed what the Pores ought to have upon an equal Distribution, independent of the solid Parts.

COROL. I.

Therefore in most Bodies the repellent Matter contained in the Pores, but not united to the component Corpuscles, cannot be considered as a Part of what belongs to the Body: Because the Space occupied by the Pores ought to contain it independent of the solid Parts.

COROL. II.

If a very dense Body has nevertheless here and there very large Pores interspersed, and those Pores be either wholly, or in a great Measure devoid of Air; there may be contained in such Pores more of the repellent Fluid than would belong to the Space occupied by them.

PROP. LXXV.

If the Air is suddenly removed from the Surface of a solid Body, the repellent Fluid will as suddenly rush upon it to supply its Place.

This is evident from *Prop. 73*, for the repellent Fluid will be instantly restored to its Place, when the Air which had taken Possession of it is removed, being always ready at hand.

COROL.

COROL. I.

The more sudden the Removal of the Air, the more violently will the repellent Fluid rush in to supply its Place.

COROL. II.

The repellent Fluid, in rushing upon the Surface of a solid Body, will partly enter its Pores and expand the Body, and partly be reflected.

For what falls upon the Pores will enter, and the solid Parts being covered with repellent Matter, will reflect what falls upon them. Hence we see the Reason why two solid Bodies, violently rubbed together, produce Heat, Light and Fire : For the Air, condensed upon and united to their Surfaces, is alternately removed and restored; and consequently the repellent Fluid is continually making fresh Impulses upon these Surfaces; more and more continually enters the Pores of the Bodies, and expands them. The component Corpuscles of each Body are put into a brisk oscillatory Motion, and their Pores thereby alternately contracted and dilated; alternately drawing in and pressing out the repellent Fluid : The Air all the while is put into strong Vibrations, which create a harsh Sound, and by the Continuation and Violence of the Attrition, the Vibrations in the repellent Fluid become at length strong enough to produce Light and Fire.

COROL. III.

As long as the component Corpuscles continue their Oscillations, some Degree of Heat will continue, though the first productive Cause ceases to act; because those Oscillations must alternately contract and dilate the Pores of the Body: By which Means the repellent Fluid will be alternately drawn in and pressed out of the Pores.

PROP. LXXVI.

If those Substances, which contain many of the smallest attracting Corpuscles united with neutral ones, have once a sufficient Degree of Heat communicated to them to produce
Flame,

Flame, they will be able to continue or even increase that Heat, provided the Air have free Access.

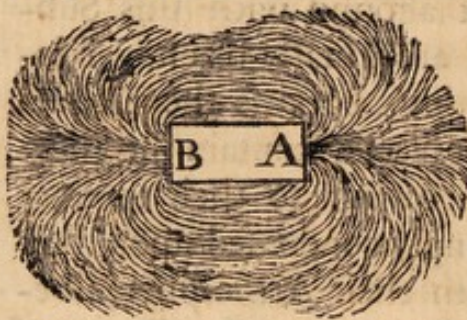
The Air will be repelled by the smallest attracting Corpuscles, *Prop.* 47. §. 1. & 4. therefore the Air cannot supply the Place of their repellent Atmospheres by uniting itself to them. Whether they be surrounded with neutral Corpuscles, or united to others more attracting than themselves, their Separation will be effected by a less Degree of Heat than that of any other attracting Corpuscles, because they have the least Spheres of Attraction; and upon their Separation the repellent Matter will throw itself round them in Form of Atmosphere. So that they may be considered as the *primum Mobile* in agitating the repellent Fluid. Neutral Corpuscles are not fit for this Purpose, because they do not attract the repellent Fluid; and the larger attracting Corpuscles require a considerable Degree of Heat to separate them, and the Air readily unites itself to them when separate. But the Presence of the Air is absolutely necessary for the Continuance of Fire and Flame; for by its Presence it confines the more volatile and active Parts from flying away, before they are heated enough to separate their ultimate component Corpuscles; and by the Elasticity of its Corpuscles it reflects back upon the Body the Vibrations of the repellent Fluid, and also those of the expansive Vapour arising from the Body. Nor is it of less Service by its continual Succession in carrying away with it the unelastic Fumes that are continually separated from the burning Substance, and which would, if continued, more and more weaken the Vibrations of the repellent Particles, so necessary to the Continuance of Heat and Fire. What I mean by unelastic Fumes is nothing but the *Phlogiston*, or smallest attracting Corpuscles, which having performed their Office in making a Conflux of repellent Matter, and being surrounded with their repellent Atmospheres, are now no longer of use in promoting the Vibrations of the repellent Fluid, but rather destroy or weaken the Motion of every repellent Particle that impinges against them; for which Reason I call them

them unelastic. That these Corpuscles will, in a great Measure, be unelastic in respect to the Particles of the repellent Fluid, I conclude from hence: Each Corpuscle is surrounded with a little Atmosphere of repellent Matter; wherefore a Vibration will not be reflected from that Atmosphere, but be continued to the repellent Surface of the Corpuscle before it will be reflected. In its Descent, the repellent Particles of the Atmosphere will act contrary to its Motion, and retard it; for the Accession of a new Particle in the Atmosphere must make all those that were there before recede farther from the Corpuscle; and since Action and Re-action are equal, the acceding Particle will be retarded by the same Force with which the others are made to recede by it: Wherefore the Vibrations will be weaker when they arrive at the Surface of the Corpuscle, than when they first entered its repellent Atmosphere. They will also be retarded after their Reflection, in coming out of the said Atmosphere; because the Attraction of the Corpuscle acts contrary to the Motion of each vibrating Particle, as far as the repellent Atmosphere reaches. It is for this Reason that the Corpuscles of the *Phlogiston* are of all others the least capable of reflecting Light; whence Bodies that abound with this Substance pure and superficially united, are usually black. Metals are in some Respects an Exception, because they reflect more Light than other Bodies, though they contain the *Phlogiston* in great Plenty. But this is owing to their greater Density; whereby the Air is so strongly condensed upon their Surfaces, that Light is reflected from their Atmospheres before it arrives at their Surfaces. But when the Parts of Metals are very minutely divided by Attrition, or any other Means, so that they become too small to condense a sufficient Quantity of Air, they then appear black. All the Light that passes the outward Atmosphere of Metals, is little or not at all reflected, or transmitted, being immediately suffocated in the Pores by the *Phlogiston*. Hence we may derive the Cause of their Opacity.

Quære, Is not this the Cause why all Bodies, which contain the *Phlogiston*, attract Light stronger than others, as Sir *Isaac Newton* has observed?

PROP. LXXVII.

If the Parts of a very dense Body be so constituted, that more repellent Matter may be contained in its Pores than what would belong to the Space occupied by them, and that repellent Matter by any Cause whatsoever be put in Motion, so as to move in a continued Stream in one Direction within the Pores, those Pores from whence the Stream moves will be supplied by a Conflux of the same Matter from without; and the Stream of repellent Matter, coming out of the Body at the opposite Side, will be carried round to the Side where it first began, to supply the Place of what enters the Body there: By which Means, a Circulation of the repellent Fluid may be continued through the Body, going in at one Side and coming out at the opposite, and then moving back without to the Place where it first entered, to be again admitted: And this Motion will be perpetual.



Suppose A B to represent a Body, and that the repellent Matter contained in its Pores be put in Motion, so as to move from B to A: As soon as that Motion begins, the Pores at B will be emptied of the repellent Matter which they contained, by its Removal towards A:

And since the external repellent Fluid expands itself on all Sides, it must enter to supply its Place: But at the same Time that the Motion begins, the repellent Matter will flow out at A into a Part of Space, which has already its due Proportion: It will therefore be accumulated, and be ready to diffuse itself every Way; and if there be less Resistance one Way than another, it will be determined towards that Quarter: It will therefore be determined towards B,
because

because the repellent Matter that has entered there, has lessened the Quantity in that Part. Now it is evident, that this Circulation will continue for ever, unless interrupted by some external Cause: For the repellent Fluid will enter at B, with a Velocity equal to that with which it moves from B to A: It will come out at A with the same Velocity; and it will be carried back from A to B with the same Velocity as that with which it enters at B; for the Flux from A to B must be proportionable to the Want of it at B, which will be in Proportion to the Velocity with which it enters at B: Therefore if the Velocity continues always the same, the Motion will be perpetual.

Note, The Reason why the Stream must be always supplied at the Place where it first entered, will appear afterwards in *Prop.* 85.

COROL. I.

This Circulation of the repellent Fluid perfectly agrees with that of the magnetic Virtue of a Loadstone, if we suppose B the North Pole, and A the South: For the Manner in which Steel-Filings dispose themselves round a Loadstone expresses very exactly the Direction of the magnetic Virtue, and very well corresponds with the Circulation here described. So that if all the *Phænomena* of the Loadstone can be explained by such a Circulation of the repellent Fluid, and a Reason can be given why this Circulation produces the Effects of Magnetism in no Bodies but such as contain Iron, I think the whole Mystery of Magnetism will be accounted for.

DEF.

The Quantity of repellent Matter that circulates through a Loadstone, or other magnetical Body, I call the Quantity of absolute Magnetism.

COROL. II.

This Motion of the repellent Fluid has no Connection with that vibratory Motion which is the Cause of Light, and can no more produce Light than a gentle Breeze can

produce a Sound. The Wind indeed produces Sound in a Storm, by striking violently upon Bodies opposed to it; but then, by the same Analogy, we must not expect Light from a Loadstone, till we can produce a Storm of Magnetism.

PROP. LXXVIII.

If two Loadstones, that have the repellent Fluid circulating as explained above, be situated so, that the South Pole of one be applied to the North of the other, they will mutually attract each other.

I call that Part the North Pole where the repellent Fluid enters, and that the South, where it comes out: Therefore when the South of one is applied to the North of the other, the Stream of repellent Matter will be carried from one to the other; so that it will not circulate back again, till it has passed through both Loadstones. Now it was supposed in the last Proposition, that the circulating Fluid was more than what belonged to the Space occupied by the Pores of the Body, and consequently some Part of it must be what belongs to the Space occupied by the solid Parts; that is, it must be a Part of the repellent Matter belonging to the Body itself, and should serve to counter-act the attracting Force of the Body: So that when the Loadstones are thus applied to each other, a Part of the repellent Matter, which should ballance their Force of Attraction, is moving directly through them both; and consequently can have no Effect in hindering the two Bodies from being attracted towards each other: For, whether they be placed at a greater or less Distance, the repellent Matter that passes out of one into the other will all the while have the same relative Distance in regard to its own Parts; and therefore can no more be instrumental in making the two Bodies recede from each other, than a String or Wire passing through them. Hence we may conclude, that the repellent Force betwixt the two Loadstones will be diminished in Proportion to the Quantity of repellent Matter passing from one to the other; and that the attracting Principle will prevail in the same Proportion.

Prop. 48. Corol. 4. DEF.

D E F.

The Quantity of repellent Matter that passes from one magnetical Body to another, I call their Quantity of relative Magnetism.

C O R O L. I.

Therefore the Force of Attraction betwixt two Loadstones will be, *cæteris paribus*, in Proportion to their Quantity of relative Magnetism.

C O R O L. II.

Two Loadstones of equal Magnitudes will attract at different Distances with a Force that will be in a Ratio compounded of the direct Ratio of their Quantities of relative Magnetism, and of the reciprocal Ratio of their Distances; because the Attraction will increase as the Distances decrease, by the general Law of Attraction.

C O R O L. III.

Therefore if the Quantity of relative Magnetism be the same in two Loadstones at different Distances, the Force of Attraction at those Distances will be simply in the reciprocal Ratio of their Distances; but if that Quantity increase as the Distances decrease, then the Force will be in the reciprocal Ratio of the Squares of the Distances: If the Quantity increases as the Squares of the Distances decrease, then the Forces will be inversely as the Cubes; and so on. Now on the other hand, if in any Case the Quantity should increase in some direct Ratio of the Distances, then the Force may happen to be in a less Ratio than that of the Distances reciprocally; or even increase as the Distances directly.

C O R O L. IV.

From the last it is evident, that if in different Pairs of Loadstones the Quantities of relative Magnetism may be different at different Distances, and that in very different Ratio's of those Distances, then there can be no certain Law of Attraction peculiar to Magnetism; and that the universal
Law

Law of Attraction is here only variously modified by the Irregularity of the repellent Principle.

COROL. V.

Since almost all Loadstones are more or less heterogeneous, and some of them very much so, the Force of magnetic Attraction will not act always in Lines drawn from the Center of the Stone; and the Distances must not be computed from thence, but from the Center of those Parts that are magnetical.

COROL. VI.

The smaller Loadstones are, the greater will be their Force, *cæteris paribus*, in Proportion to their Magnitudes. This will follow from the general Law of Attraction. *Prop. 11. & Corol.*

PROP. LXXIX.

The Quantities of relative Magnetism may be very different at different Distances, and that in different Ratio's of the Distances.

§. 1. The Quantities of relative Magnetism are as the Quantities of repellent Matter, that pass from one Loadstone to another, by the *Def.* Therefore we are to prove, that at different Distances the Quantities of repellent Matter that will pass from one Loadstone to another may be different, and that in different Ratio's of the Distances.

§. 2. If a Loadstone be by itself, the Stream of repellent Matter, that comes out at the South Pole, will move round and enter again at the North. *Prop. 77.* The Direction of its Motion in passing through the Stone is in the Direction of the Axis of the Stone, which may be called the Direction of its projectile Motion: As soon as it comes out of the South Pole, it disperses on all Sides; and in so doing is acted upon by a new Force in a different Direction: Therefore, by the known Laws of Motion, it will move in the Diagonal of the two Forces; and, by the continued Action of the latter, will be made to move in curve Lines, more and more diverging from the Direction of the Axis:

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At the same Time it begins to be impelled by a third Force, acting in a Direction towards the North Pole: By this it will be made to diverge from the Axis much faster; and those Particles which come out of the Polar Surface at the greatest Distance from the Axis, will be most acted upon by this last Force; and consequently be made to diverge faster, be sooner made to move in a Direction contrary to the projectile Force, and be carried back to the North Pole. It is for this Reason that the magnetic Virtue that comes out at the Edges of the Polar Surface, is immediately acted upon by the opposite Pole, and carried back in almost right Lines just above the intermediate Surface: But this is most remarkable when the Axis of the Stone is very short; because the two Poles being in that Case very near, the Action of the North upon the repellent Matter coming out of the South, is proportionably stronger: The repellent Matter which comes out a little Way within the Edges of the Polar Surface, will not be drawn back to the opposite Pole with so much Force; and therefore will move in a larger Curve, that will be exterior to the other. In like Manner, in Proportion as the magnetic Virtue comes out at a less Distance from the Axis, it will be carried back in curve Lines, that will be larger and larger, and farther distant from the Stone. At or very near the Axis of a large Stone the magnetic Virtue diverges so little, that it appears to move for a great Way in the Direction of the Axis. If we lay a Piece of Paper upon a Loadstone, whose Axis is parallel with the Horizon, and sprinkle it over with Steel Filings, they will readily dispose themselves in the Direction of the magnetic Virtue; and express the curve Lines in which it moves from one Pole to the other: And I think any one acquainted with the Laws of Motion will easily comprehend, that the several Forces, acting as above described, must necessarily make the repellent Matter move, in the same Manner as the magnetic Virtue appears to do; and the Whole of my Reasoning will be too plain to require any further Illustration. One Thing will be observable in most Loadstones, which is, that
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the magnetic Virtue generally comes out of the Sides, as well as at the Polar Surfaces; and that what comes out of the Sides of one Pole, enters in at the Sides of the other, at the same Distance from the Middle betwixt the Poles.

§. 3. After we understand the Manner how the repellent Matter moves, when a Loadstone is alone, it will not be difficult to determine what will happen when the South Pole of one is brought near to the North of another: But since the most powerful Conviction, in regard to Facts, is from what we see with our Eyes, let us examine the Matter by the same Experiment with a Paper and Filings. Let two Loadstones be laid at some Distance from each other; let the South of one be opposed to the North of the other; lay over them a Piece of Paper, and sprinkle it with Filings; and strike the Table to make them all range themselves in the Direction of the magnetic Virtue. Now let us reason on what appears: The Filings which lay directly betwixt the two Polar Surfaces, near their common Axis, are disposed in right Lines, running from the South Pole of one to the North of the other; from whence I conclude, that about the Axis the magnetic Stream runs directly out of the South of one into the North of the other. At different Distances from the Axis, the Filings describe regular curve Lines, which run from one Pole to the other, and diverge from each other in moving from the South Pole, till they come half Way; and then converge more and more through all the other Half of the intermediate Space, till they arrive at the North. From hence I conclude, that the repellent Matter, which comes diverging from the South Pole of the one, is made to converge again by the Action of the North Pole of the other, and is drawn into it. At the same Time, if we observe the Disposition of the Filings, which lay on the Sides of the two Loadstones, we may observe that those which lay near the two Poles form Arches of Circles, which reach from one Loadstone to the other; but those which lay farther from the opposed Poles, and nearer their opposite Poles, form Arches of Circles which are bent
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towards those opposite Poles. From whence I conclude, that all the repellent Matter which comes out of one Loadstone is not carried into the other, but that some of it, which is farthest out of the Sphere of Action of the other, is carried back in curve Lines towards the contrary Pole of the same Loadstone; as it would have been, in case the other was not there. These Things being observed, if you bring the two Poles nearer than before, and sprinkle the Filings a-fresh, you will see the Arrangement of them nearly similar to the former; but with this Difference, that there will be fewer Arches passing from one Pole to the other of the same Loadstone, and more of them passing from one Loadstone to the other: Also the internal Arches that are formed near the common Axis of the two Loadstones, and reach from one Polar Surface to the other, will now approach nearer to strait Lines. From whence it may be concluded, that the nearer the two Loadstones are brought together, the more repellent Matter may pass from one to the other, and less be carried back to the contrary Poles; and therefore the relative Quantity of Magnetism may be different at different Distances. The Alteration of the curved Lines betwixt the two Polar Surfaces shews, that as the Poles are brought nearer, the repellent Matter runs more directly out of one into the other. If the two Loadstones are brought so near as to be almost in Contact, the Disposition of the Filings shew, that all the Virtue of one enters into the other; unless where the Loadstones are long, and have Part of their Virtue coming out of their Sides. It may not be amiss to observe, that the Motion of the magnetic Virtue is more regular, when we make use of Steel rendered magnetical, instead of real Loadstones; because the latter are seldom uniform in the Distribution of their Parts.

§. 4. But though it appears from what has been said, that the Quantity of relative Magnetism may be very different at different Distances, and that it can never be the same at all Distances; yet we must not infer from thence, that it always changes, upon every Change of Distance: For if

two equal Loadstones that are both very long, and have all their Virtue coming out and going in at their Polar Surfaces, have their two friendly Poles brought near each other, all the magnetic Stream of the one will be carried into the North of the other: And this will happen at a certain Distance; betwixt which and the Point of Contact an infinite Number of less Distances may be taken, in all which the Quantity of relative Magnetism must be the same; because there is no Doubt, but that if the whole Stream passes from one to the other at a greater distance, it will also do it at a less. Therefore at all Distances where the whole Stream of repellent Matter passes from one to the other, the Quantity of relative Magnetism will be the same, and the Force of Attraction in the reciprocal Ratio of those Distances, *Corol. 3.* The Force will continue in this Ratio till they are separated to a certain Distance, at which the Stream of repellent Matter ceases to be all carried on from one loadstone to the other, Part of it being carried back to the opposite Poles, and then the Force will diminish in an higher Ratio.

§.5. If a small Loadstone be applied to the Axis of a very large one, and the Quantity of absolute Magnetism in the small one be greater than that of the large one, in Proportion to its Size; the Force of Attraction will be in a less Ratio than that of the Distances reciprocally, till you come to a certain Distance, and then it will begin to be reciprocally as the Distances; but at Distances still greater, it will decrease in Ratio's still higher. First, Let us suppose the North Pole of the small one in Contact with the South of the large one, in a Part about the Axis; then because the large one has a less Quantity of Magnetism in Proportion to its Size than the small one, the Stream coming out of the Part where the small one is applied, will not be sufficient to supply it with so dense a Stream as its own, the small one must therefore be, in Part, supplied by a lateral Conflux of repellent Matter brought round from its opposite Pole, which moving in a contrary Direction to the Stream coming from the great one, will

will produce a repulsive Force that will act contrary to that of the magnetic Attraction, and will be stronger in Proportion to the Nearness of the Loadstones ; because the Stream coming from the larger, by diverging, becomes rarer at greater Distances ; and if we suppose that at greater Distances more of it should be made to converge towards the small one to supply its Stream, it will amount to the same thing ; for the more repellent Matter is supplied to the small one out of the Stream of the large one, the less will be brought back from the opposite Pole of the small one ; and consequently the Repulsion will be diminished on that Account, and the Quantity of relative Magnetism rather increased : Therefore since there will be a repulsive Force decreasing at greater Distances, and counter-acting the Force of Attraction, that Force will not decrease so fast as in the reciprocal Ratio of the Distances ; unless the Distance be so large, that the Quantity of repellent Matter passing from the greater to the smaller be very much decreased ; in which Case the Quantity of relative Magnetism being much less than at nearer Distances, and the Repulsion too small to be taken into Consideration, the Force may begin to decrease in the reciprocal Ratio of the Distances, or even in an higher Ratio.

§. 6. This Repulsion will take place, not only where the Loadstones are of different Magnitudes, but where the Magnitudes are the same, provided the Quantities of absolute Magnetism are different ; for if one Loadstone has not a Stream sufficient to supply the other, the other will be supplied by the Return of its own Stream ; which moving contrary to that of the first, must produce a Repulsion. The Case will be much the same, if we suppose the South Pole of the stronger opposed to the North of the weaker ; for then all the Stream of the stronger will not be able to enter the North of the weaker, but be reflected back, and thereby produce a repulsive Force, acting contrary to that of Attraction : The nearer they approach, the more will the repellent Matter be accumulated betwixt them, and the Repulsion the more increased : But probably the Repulsion will

not take place at so great a Distance, as in the last Case; which may make some Difference in the Degree of Attraction at different Distances. I cannot but admire the Sagacity of the learned Professor *Musschenbroek*, who from a Number of accurate Experiments, tried with a View to discover the Law of magnetic Attraction, arrived at the Knowledge of this repulsive Force, and applied it, as I do, without knowing any thing of the Cause on which it depended.

§. 7. An infinite Variety of Irregularities will arise in the Attraction of Magnetism from the unequal Distribution of magnetical Particles in the Composition of most Loadstones: In large ones particularly, this Inequality is very observable. If you dip one of the Poles of a large Loadstone in Steel-Filings, and observe in what Manner they adhere to it, you seldom find them uniformly distributed, but disposed in little Tufts here and there; in some Places very thickly placed, whilst others are quite bare: Generally the Edges of the Polar Surfaces have the most, though not always, for sometimes they have less than other Parts. Consider what Effect this must have in regard to the Attraction at different Distances. For Instance, suppose two Loadstones equal and similar; and let the South of the one be in Contact with the North of the other: Let the Disposition of their magnetical Parts be such, that one Half of each Polar Surface shall have a great Share of Magnetism, and the other Halves little or none; and let the weak Half of one Surface be opposed to the strong Half of the other; is there Reason to expect any great Degree of Attraction betwixt them whilst thus in Contact? Remove them a little from each other, will the Attraction be lessened by the Increase of Distance? It seems more probable that it would be increased; for when they are separated, there is Room for the Stream, coming out of the strong Side of the one, to be drawn across the intermediate Space to the strong Side of the other. I should not therefore be surprised, if any one should tell me they had two Loadstones, both possessed of a large Quantity of Magnetism; and yet that when the South Pole of the one was

was in Contact with the North of the other, their Attraction was very little, but became stronger and stronger as they were removed from each other, till at a certain Distance their Force began to decrease again.

§. 8. The Dimensions, Length and Shape of Loadstones will also make a Difference in the Ratio of their Forces at different Distances: But it would be tiresome both to myself and the Reader to examine all the Causes of Irregularity in the magnetic Attraction. I think I have already said enough to convince any one, that all these Varieties may arise from the different Manner in which the magnetical Streams are made to move and act; and that the magnetical Attraction is really in itself no ways different from that of Cohesion and Gravity: And the Truth of the Proposition is also clear, that the Quantities of relative Magnetism may be different at different Distances, and in different Ratios of those Distances: From whence, and from what has been proved above, I beg leave to draw the following Corollaries.

COROL. I.

The Force of magnetic Attraction is never at all Distances in the same Ratio of the Distances.

COROL. II.

The Force of magnetic Attraction betwixt the same Loadstones, and at the same Distances, may be very different, if the two Poles that are opposed to each other be only turned round a little Way upon their Axis, so as to make different Parts of the Polar Surfaces respect each other differently, §. 7.

COROL. III.

If a generous Loadstone be applied to a weaker, there will be a Kind of Repulsion even betwixt their friendly Poles, but its Force will be overpowered by the stronger Force of Attraction.

COROL. IV.

Large Loadstones will be able to act at a greater Distance
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than small ones, though the Quantities of absolute Magnetism be even less in them than in the small ones ; because the Axis of a large Loadstone being longer, and the Poles at a greater Distance, the repellent Matter will not be drawn from one Pole to the other with so much Strength, but be carried more in the Direction of its projectile Force, and move round from one Pole to the other in larger Curves : Its Sphere of Action will therefore be more extensive.

COROL. V.

If Loadstones are long and slender, their Spheres of Activity will be proportionably greater ; for the same Reasons.

COROL. VI.

Thicker Armour will be required, when the Poles are at a greater Distance, *cæteris paribus*, and *vice versâ* ; because the Use of the Armour is to stop the Flux of magnetic Virtue ; and by carrying it down into the Feet, to convey it all from one Pole to the other through them. Now the nearer the Poles are, the sooner the projectile Force of the magnetic Virtue is overcome, § 2. and consequently thinner Armour will be required to conduce to that Effect ; and *vice versâ*.

COROL. VII.

Since small Loadstones will have the least Spheres of Activity, they will act at a less Distance ; but then at small Distances they ought to be more vigorous, because their Streams of repellent Matter, moving in a less Compass, must be denser.

PROP. LXXX.

If the two South Poles or two North Poles be applied to each other, they will mutually repel each other.

It is easy to conceive, that when the two Poles that have both a Stream of repellent Matter coming out of them, are opposed to each other, they will be mutually repelled by the Conflux of the two Streams, and the Accumulation of repellent Matter thereby produced : But the Reason of the Repulsion of the North Poles is not quite so obvious,

vious, though the Cause be much the same in both Cases; for there must be a Conflux of repellent Matter towards both Poles to supply their Streams, which must make a double Flux of it towards the intermediate Space; and because both the North Poles are supplied by Streams coming from their contrary South Poles, the Stream coming to the one will be opposite to that coming to the other.

PROP. LXXXI.

If the two unfriendly Poles be brought in Contact, they will in some Cases continue to repel; but in others, they will begin to attract at a little Distance before they come in Contact.

When the repellent Forces of both are equally vigorous, they will continue to the very Point of Contact; but if one Loadstone is much stronger than the other, it will be able to invert the Polarity of the weaker about the Part with which it is nearly in Contact. From hence we may understand an odd Fact, oddly related by some of the old Writers upon Loadstones: They say, that if two Loadstones, a stronger and a weaker, have their repellent Poles brought together, the weaker will have its Virtue put in Confusion, and be as it were inebriated, and will not come to itself for some Days. The Case, in short, seems to be this: The Polarity of the Part which was in Contact becomes inverted by the Force of the stronger Stone; but that Inversion not reaching far beyond the Polar Surface, and the Virtue of the greater Part of the Stone remaining still unaltered, it is able by its contrary Force to restore the confused Part to itself again in a few Days. But what Mr. *Boyle* relates from his own Experience deserves much better our Attention: He says, that taking a very small Fragment of a Loadstone, and applying sometimes one Pole, and sometimes the other, to the Poles of a very vigorous one, he could change the Poles of the little Fragment, though by applying a larger Piece he was not able, in many more Hours than he employed Minutes before, to make any sensible Change of the Poles.

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PROP. LXXXII.

The Attraction of Magnetism may be peculiar to one Kind of Bodies, without ever acting upon others, or being interrupted by them.

If only one Kind of Bodies have their Parts so constituted, as to admit within their Pores more repellent Matter, than what belongs to the Space occupied by the Pores, then will the Attraction of Magnetism be peculiar to one kind of Bodies, *Prop. 77*, and it will not act upon other Bodies, or be interrupted by them: For the repellent Fluid can readily pass through the Pores without Interruption, when it moves in a Stream; because they much exceed the solid Parts, and are always open, *Prop. 50. Corol. 2.* The Case is much different, when the Motion of repellent Matter is propagated by Vibrations, from what it will be, when moving in a Stream like that of Magnetism; for in Proportion as the Stream of repellent Matter meets with Resistance from the solid Parts, it will crowd in so much the faster at the Pores: for Example, suppose a Stream is passing through a Piece of Gold, and is in Part stop'd at the first Surface by the solid Parts, then the repellent Matter will be there accumulated and condensed; and to restore the *Equilibrium*, it will crowd in at the Pores with greater Velocity and in greater Quantities, in Proportion to the Degree of Condensation. As long as the Stream continues to be impeded, so long will it continue to be accumulated, condensed, and accelerated in its Passage; till at length it is carried through as fast as it arrives, without any Impediment. Now if the repellent Matter in the Pores is no more than what belongs to the Space occupied by them, independent of the solid Parts, it is no Part of that which belongs to the Body, nor any way contributes towards ballancing its Force of Attraction: Its being put in Motion, therefore, will not make the Body in whose Pores it moves, magnetical. That the repellent Matter contained in the Pores of most Bodies is no more than what belongs to the Space occupied by them, appears from *Prop. 74.* Therefore Magnetism may be peculiar to one Kind of Bodies, without ever acting upon others, or being interrupted by them.

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The Reason why no other Bodies but Iron, and such as contain Iron, are magnetical, is plainly this: No other Bodies contain more repellent Matter in their Pores than what belongs to the Space occupied by the Pores; for it follows from *Prop. 77*, that they would be magnetical if they did.

PROP. LXXXIII.

The Reason why Iron contains more repellent Matter in its Pores, than what belongs to the Space occupied by them, may be explained from the peculiar Construction of the Pores of Iron.

Mr. *De Reaumur*, in his *Treatise upon Steel* (a Work deservedly admired) has explained the Structure of a little Grain of Steel, as it appears in a Microscope: It consists of a great Number of *Moleculæ*, adhering together, without any Order or Regularity: each of these *Moleculæ* are compounded of others, no less irregular and confused; and probably even those may be a Compound of others still less: But suppose the Gradation goes no further, and these last visible *Moleculæ* are compounded of the primary constituent Corpuscles of Steel, it is evident from this Kind of Structure, that there must be a Gradation of Pores as well as solid Parts; and that the largest Class of Pores, when compared with the smallest, are very wide Cavities, whose Sides are at too great a Distance to admit of a Repulsion of their Surfaces; for that Kind of Repulsion can act but at a very small Distance, as appears from *Prop. 42. Corol. 1.* The repellent Matter may therefore be condensed in those, and many of the inferior Classes of Pores, perhaps in all except the smallest, that are formed betwixt the primary Corpuscles; by which Means more repellent Matter will be contained in the Pores of Steel, than merely what belongs to the Space occupied by them. The larger Pores of Iron are differently constructed from those of Steel; but there is no Reason to doubt, but that there are the same Gradations of Pores. There is no Substance, that I know of, so unlikely to have Air incorporated with it, as solid Iron or Steel: For they are, whilst separated from the Ore, exposed to the intensest Degree of Heat; and most of the Changes, undergone afterwards,

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are effected in a red hot State at least: So that if they contain any Air, it cannot be much, and that only in their largest Pores. From what has been said it appears, that neither of the two Causes mentioned, *Prop.* 74, exist in Iron or Steel, in any Degree sufficient to prevent the repellent Matter from being condensed in their Pores.

PROP. LXXXIV.

The Attraction between Loadstones and Iron is owing to the very same Cause, as that betwixt Loadstone and Loadstone.

For though Iron has no fixed Magnetism itself, yet as soon as it is brought within the Action of a Loadstone, it becomes magnetical, and has all the Properties of the Loadstone as long as it continues there.

COROL. I.

The Difference betwixt the Magnetism of Loadstones and Iron consists in the magnetical Streams being permanent in the first, but not in the latter.

COROL. II.

If there be found two Bodies, which only differ in the Arrangement of their Parts; one of which has a fixed Magnetism, and the other not, the different Arrangement of their Parts will be the Cause of their different Magnetism.

COROL. III.

Since Steel that is hardened will receive a permanent Magnetism, and soft Steel will not; if we can find out the Difference betwixt the Arrangement of the Parts in soft and hardened Steel, that will lead us to the Cause of the Fixedness of Magnetism: For I think it cannot be reasonably supposed that soft Steel differs from hard in any Thing but the Arrangement of the Parts.

PROP. LXXXV.

The Difference of soft and hardened Steel consists in this: The first contains its *Phlogiston* chiefly in its largest Pores; the latter contains it in the smaller.

§. 1. The Facts on which I shall found the Demonstration of this Proposition, are to be met with in that excellent Treatise of M'. *De Reaumur*, already mentioned. That there
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is in Steel a very large Quantity of the *Phlogiston*, is beyond Doubt: It was observed in *Prop.* 76, that Blackness, when it appeared in Metals, was owing to the *Phlogiston*, which does not reflect Light like other Bodies. Accordingly soft Steel has a dusky Appearance; so that we see the *Phlogiston* in its Pores with the naked Eye. When it is very hard, the Appearance is quite otherwise: It is then white; and the little Grains are not only white, but reflect so much Light as to be quite brilliant, and sparkle like little Diamonds. Where now is the *Phlogiston*? Is it fled away, or is it only retired behind the Scenes? It is certainly no longer visible. If it remains, it must have penetrated deeper into the Substance of the Steel, and have hid itself in the invisible Pores. Take the hardened Steel, and lay it upon Charcoal, or any thing that is red-hot, that it may gradually return to its former Softness, and you will perceive that it is not fled away: It comes out again into the visible Pores, as the Steel grows hot; and even spreads itself all over the outward Surface. What comes out at first is not sufficient to suffocate the Vibrations of Light so much, but that it is reflected in Colours: First it becomes paler; then has a yellowish Cast, or Straw-colour; then a stronger Yellow; then a Gold-colour; after that, a Gold-colour mixed with Purple; then a Purple; then deeper and deeper, till it becomes a Violet: This changes at length to a deep Blue; which at last degenerates to a dusky Water-colour. Thus we see the *Phlogiston* come out of the invisible Pores again, into the larger; which therefore reflect the Vibrations of Light weaker and weaker, till at last the large Pores being again filled with it, appear black, as before. And what plainly shews that the *Phlogiston* comes out from betwixt the very component Corpuscles, is this: It not only makes its Appearance in the large Pores, but all over the outward Surface of the Steel, which is the same with the outward Surface of the external Corpuscles that compose it. If the Steel be quenched when it comes to a deep Blue, the *Phlogiston* remains fixed upon the Surface, which continues blue: If you rub it off, or continue the Heat till it

flies away, the Surface then has the common Colour of Steel; that is, a dusky Brightness: The solid Parts reflect Light, whilst the Pores are black. Let us now inquire the Reasons why the *Phlogiston* retires into the smallest Pores of Steel heated to a violent Degree, and why it is fixed there by quenching it in Water. It appears from our general Account of the component Corpuscles of Bodies, that those of Steel must be some of the largest in Nature: The Weight, Density, and Hardness of Steel are all Proofs of that Truth. The component Corpuscles must therefore have singly among themselves a very great Force of Attraction; and if we suppose a Number of them collected together in a Body, so as to form one of the smallest Grains of Steel, such a Grain will be vastly dense: The Force of Attraction betwixt each Corpuscle will bring them very near each other; and consequently the Pores will be very small, considering the Size of the Corpuscles: Each Grain will also have a great Force of Attraction. A Number of these Grains brought in Contact make larger; those, larger still; and so on. Suppose the Pores filled with the *Phlogiston*, and we have an Idea of soft Steel; the Particles of *Phlogiston* are but one Size bigger than those of Water, and their small Attraction amongst themselves will remove them but one Degree from Fluidity: Therefore when the Pores of Steel are filled with them, the Attraction between the little Grains will be lessened, by the Introduction of a Substance amongst them that has very little Cohesion in itself. The little Corpuscles of the *Phlogiston* will be strongly attracted by the minutest Grains, cover over their Surfaces, insinuate themselves betwixt them, and serve as Rollers to enable them to slide with less Friction one upon another. Hence the Cause of Ductility and Flexibility, hence the Blackness of Steel, as well as all other Metals, when their Parts are separated, and they reduced to an impalpable Powder, by continual Attrition: But the *Phlogiston* cannot enter into the small Pores betwixt the component Corpuscles of the smallest Grains: The Minuteness of those Pores will not readily admit them; and the strong Cohesion of the Cor-

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puscles themselves will not allow the Pores to dilate for their Reception. When the Steel is made intensely hot, all its Parts are dilated; the very component Corpuscles are removed to a great Distance from each other, in Comparison to what they were before. The *Phlogiston* may now enter; and though it be violently dilated itself, yet the Attraction being so much stronger in the Pores betwixt the component Corpuscles, than it is in the larger Vacuities betwixt the Grains, it will be all drawn in betwixt the component Corpuscles. If now you quench the Steel in cold Water, the sudden Removal of the Heat makes all the Parts run into Contact, before the *Phlogiston* has Time to escape out of the Pores betwixt the component Corpuscles: They are therefore shut up there, and the Vacuities betwixt the Grains are left empty. The smallest Grains are no longer disunited by the *Phlogiston*; they adhere together with all their Force of Attraction: The larger Grains that are compounded of them adhere to each other in like Manner; but as they touch but in few Points, their Force of Cohesion is less than before: The *Phlogiston*, which before filled up the Vacuities betwixt them, and increased the Points of Contact, being now removed, the sudden Cold, and the Want of the *Phlogiston* to interpose itself betwixt the smaller Grains, makes them run together into larger *Moleculæ*, whence the largest Grains exceed those of soft Steel. This likewise diminishes the Number of Points of Contact. The Want of the *Phlogiston* betwixt the Grains takes away the former Ductility. The Parts are hard and brittle; and will sooner separate than slide upon each other. The outward Surface has the Air strongly condensed upon it, on Account of its powerful Attraction. All the Light that falls upon it is reflected from the large Grains: Hence their sparkling Appearance. If the Steel be quenched with a less Degree of Heat, the Grains are less, because fewer small ones have run together to make one large one: They have also dusky Parts interspersed amongst them, which is owing to the *Phlogiston*; some of which yet remains in the large Pores, the Heat not
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being sufficient to dilate the Pores betwixt the component Corpuscles, enough for them to receive it all. When Steel is quite hard, it takes up more Space than when soft, because its least component Grains are swelled by the Admission of the *Phlogiston* into their Pores.

§. 2. Now let us consider how Magnetism will be affected by this different Arrangement of the Pores. In soft Steel the Pores of the least Grains can have nothing to do with Magnetism, because of their Smallness, and the strong Repulsion of the Surfaces of their component Corpuscles: These will not contain more repellent Matter than what belongs to the Space occupied by them: We must therefore look for it in the Pores betwixt the Grains. These are filled with the *Phlogiston*, which is not only loose in those Cavities, but adheres strongly to the Surfaces of the Grains that compose them: The Condensation therefore of repellent Matter will be removed from those Surfaces, by the Repulsion betwixt them, and the Surfaces of the Corpuscles of *Phlogiston*, which adhere to, and are condensed upon them. It will therefore be chiefly found in the Centers of these Vacuities; where it will be free, and ready to be put in Motion in any Direction. This repellent Matter may be plentifully condensed in the Centers of these Cavities, and yet have little Attachment to any of the solid Parts; only the Corpuscles of the *Phlogiston* may detain it a little by their weak Attraction. Suppose this repellent Matter is made to move in a Stream, by the Presence of a Loadstone; it is put in Motion with the greatest Facility; it passes without any Impediment from Pore to Pore; only the smallest Grains do not transmit it so freely through them: Now remove the Loadstone that first produced the Stream in this Piece of Steel, and see if the Stream will continue: In Fact it does not. But why? The repellent Matter that moves out at the South Pole is not supplied by fresh at the opposite Side. It can be supplied near at hand: Nothing hinders it from flowing from all Quarters, since it is every where free.

§. 3. In

§. 3. In hardened Steel the Case is very different; there the large Pores are quite empty of *Phlogiston*, contain nothing but repellent Matter, and that strongly condensed upon the internal Surfaces of the Pores, and tied down there as it were by Attraction, not easily to be put in Motion. For this Reason it is difficult to make a Stream of repellent Matter in hardened Steel; but when once it is produced, it is as difficult to stop it. A Stream in one Part cannot be supplied from any of the neighbouring Parts indifferently: It must be supplied from those behind; where the repellent Matter is in Motion in its own Direction. That in the adjacent Pores is either moving itself in a parallel Stream, or at Rest, and not easily to be put in Motion: It is for this Reason that a Loadstone will but very little attract Steel, when well hardened; its Virtue not easily penetrating the Pores of it strongly enough to commence a magnetical Stream.

COROL. I.

Therefore the Difference between fixed and unfixed Magnetism depends on the greater or less Force, required to put the repellent Matter in Motion; according as it is more or less fixed in the Pores.

COROL. II.

Since in Loadstones their Magnetism is no less fixed and unchangeable than in hardened Steel; and we have no Reason to conclude, that the Structure of the Pores in Loadstones is not as capable of fixing the repellent Matter, we ought to suppose it analogous to that of hardened Steel; that we may not multiply Causes without Necessity. It may be sufficient to observe, in respect to the Texture of Loadstones, that generally they are very hard, and brittle; and, *cæteris paribus*, more vigorous in Proportion to their Degree of Hardness: That Emery, and some other Iron Ores made use of for polishing, on Account of their containing very hard Particles, have a great Number that are vigorously attracted by the Loadstone.

PROP.

PROP. LXXXVI.

All Causes, that are capable of making the repellent Fluid move in a Stream, are capable of producing Magnetism in Bodies duly qualified to receive it.

This is evident from our Explication of Magnetism in general; and is further confirmed by a Variety of Facts. When Iron or Steel undergo a violent Attrition in any one particular Part, the Air, that is strongly united and condensed upon the Part, being removed by the Attrition, the repellent Matter rushes in to supply its Place: It stops not at the Surface, but in Part enters the Pores with the *Impetus* that it has acquired. In its Conflux it dilates the Part, and produces Heat; and at the same Time a Stream of Magnetism. The Part where it enters becomes a North Pole. If it be hardened Steel, as in the Case of Drills, it acquires a fixed Magnetism: If it be soft Iron, the Magnetism remains no longer than whilst the Heat continues; because Iron takes no fixed Magnetism: The Stream ceases with the Heat, as Mr. Boyle has observed. Lightning is the strongest Power, yet known, in producing a Stream of Magnetism: It is able in an Instant to render hardened Steel strongly magnetical; or to invert the Polarity of a Mariner's Compass: Like Magnetism, it frequently passes through other Bodies, without Resistance; and yet acts so violently upon Steel, as to melt it. So that probably if we could produce by Art the same violent Stream, we might instantly render Steel magnetical to a surprising Degree, strengthen Loadstones, and invert their Poles instantaneously, or place them how we please, and that even when they are surrounded by other Substances. The late surprising Discoveries in Electricity have furnished us with something very like Lightning. The great Professor *Muschenbroek*, and many others since him, have felt the Violence of its Effects: What may be done by it in regard to Magnetism must be the Work of future Discoveries.

The common Methods of producing Magnetism are founded upon the same Principles as that of touching a Needle,

Needle, and depend upon nothing more than placing the Body that is not magnetical in the Stream of one that is so already; and contriving Matters so, that the magnetical Stream shall enter the Body with as much Force as possible, and be carried through it in one Direction, so as to go in at one Part, and come out at the Part directly opposite. This Method does very well for touching Needles, and other slender Pieces of Steel; but does not answer so well when the Piece is thick, because the Stream is chiefly applied to the outward Surface, and has not Force enough to penetrate to any considerable Depth of the Steel, especially if it be very hard, as it ought to be to make the Magnetism fixed. Rubbing with Iron Bars placed in the magnetical Line, produces the same Effect, in the same Manner. Large Loadstones frequently give a very good Touch, though their Virtue be less dense than that of smaller; because their Virtue moves more in right Lines, acts at a greater Distance, and is easier made to converge towards the Point of Contact. Sometimes small Loadstones are so vigorous as to give a very strong Touch to a slender Needle, by communicating a very dense Stream.

COROL.

Since when a Body is red hot the repellent Fluid is made to move in all Directions, the Stream of Magnetism must be confused thereby, and its Direction be destroyed: Hence the Reason why Fire destroys Magnetism.

PROP. LXXXVII.

The Earth may be considered as a great Loadstone, whose magnetical Parts are disposed in a very irregular Manner.

All the *Phænomena* attending the Direction of the Needle in different Parts of the Earth, in a great Measure correspond with what happens to a Needle when placed upon a large *Terrella*; if we make an Allowance for the different Disposition of the magnetical Parts in respect to each other, and consider the South Pole of the Earth to be a North Pole in respect to Magnetism. When the Needle is placed upon

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the *Terrella* at an equal Distance betwixt the South and North Pole, the South Pole of the Needle points towards the North of the *Terrella*, the Needle is equally attracted by both (if both Poles are equally strong) and disposes itself in a Line parallel to the Axis: Move it towards the South Pole, and the North End of the Needle dips downwards, and that more and more, the farther it is moved towards the South: On the other Side of the Equator, the South End will dip in like Manner. This is the Case, if the *Terrella* has its Virtue coming out of its Poles in an uniform Manner; but if it comes out in Spots here and there, at different Distances from the Axis, the Needle will in many Places vary from the Direction of the Axis, both horizontally and vertically, even when placed upon the Equator, but more so at some Distance from it: For Example, suppose a large Quantity of magnetic Virtue comes out at the Distance of 20 Degrees from the South Pole (this I call a false Pole) and let the Needle be placed upon the Equator at such a Part, that a Line drawn from thence through the false Pole, may pass also through the true one; the Needle in this Place cannot point towards the false Pole, but it must likewise point towards the true one: There will be no Variation here, nor in any Part of the intermediate Space laying directly betwixt this Point of the Equator and the false Pole: Therefore a Line drawn from hence to the false Pole will be a Line of no Variation; only the dipping Force will increase much faster in moving the Needle along this Line from the Equator towards the false Pole, than it would do in case there was none, and it was moved in the same Line towards the true Pole. Now if the Needle be moved upon the Equator from the former Point on either Side, it must then vary more and more, the farther it is removed from it: for then a Line drawn from the Needle to the false Pole will not pass through the true one; and both Poles being supposed to act upon it at the same Time, it must point in the Direction of the Diagonal of the two Forces; which Direction will vary more and more from that of the true Pole,

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in Proportion as the Needle is moved farther from the Line of no Variation, and also in Proportion as it is brought nearer the false Pole, in moving it from the Equator. If there be several false Poles, there will be more Causes of Variation; and the Forces will be more compounded, and the Theory of the Variation be thereby rendered more complex. Now considering the Earth as a great Loadstone, very heterogeneous in its Parts, there may be a great Number of these false Poles both to the South and North of the Equator, to which the Irregularity of the Variation may be reasonably ascribed. Here is no Occasion for the least Hypothesis: The Needle is acted upon by the Earth in the same Manner as by a Loadstone that is heterogeneous in its Parts; and if the Earth produces the same Effects as a Loadstone, is it not a Loadstone? That the Earth has its magnetical Parts disposed in an irregular Manner, is no less evident: Wherever there is Magnetism there is Iron, and where there is no Iron there is no Magnetism. But is Iron equally disposed over all Parts of the Earth? No certainly: Some Countries abound with it much more than others. Why then may not some Countries have more Magnetism than others? But it may be answered, that all Iron Ores are not magnetical, and that therefore a Country may abound with them, without having any Magnetism. I grant it; but though most Iron Ores are without Magnetism, yet they are all capable of having it, and those that have it are capable of losing it. The curious Experiments of Dr. *Muschenbroek* will make it appear, that when Iron has an Acid united with it, it is incapable of becoming magnetical: When you separate the Acid and restore the *Phlogiston*, it becomes as readily magnetical as ever. An Iron Ore that has the vitriolic Acid united to it, can never become magnetical, unless the Acid be first separated: But have we any Reason to imagine, that Ores remain always in the same State in the Mines? The Miners tell us quite the contrary: They say that they find by long Experience, that Ores are continually approaching nearer and nearer to a State of Perfection, and then

degenerate again. What is then the most perfect State of a Metal? Is it not that State in which it puts on a true metalline Form; *e. g.* Is not Virgin Copper in its most perfect State? Wherein does it differ from its more imperfect Ores, but by being freed from the universal Acid, and being united to the *Phlogiston*? If it was again corroded by the same Acid, it would more and more degenerate from its State of Perfection. Iron is never found in a Virgin State more than in a Loadstone: It is then free from the vitriolic Acid, and united to the *Phlogiston*; and some Loadstones have even a metallic Appearance. We grant therefore, that the common Iron Ores are unmagnetical; but allowing them capable of coming to a greater Perfection in a long Course of Years, it will follow, that Iron Mines are pregnant with Loadstones not yet come to Maturity, and may in Time become Mines of good Loadstones: In a like Course of Years the vague Acid may return again, corrode them, and destroy their Magnetism. Thus the false Poles may decrease in Force every Year, and even new ones be generated where there were none before. From hence we see not only the Cause of the Variation, but why it does not always remain the same in the same Place.

It follows from hence, that the Variation will not alter according to any regular Law: And, that the only Way to come at a Certainty in Regard to it, is to register the Observations of Mariners from Year to Year; to form new Tables from such Journals as are found best to agree together, and publish them as oft as possible, or as oft as shall be found necessary. Mess. *Mountaine* and *Dodson* were lately engaged in this laudable Attempt at *London*; and from the best Collection of Facts, they were able to come at, have corrected the Chart formerly published by Dr. *Halley*; and with it have given a short Account of what they have done, and shewn the Necessity there is of forming new Tables or Charts, from Time to Time, as often as we can be supplied with Observations. It appears by the Alterations since the Time of Dr. *Halley*, that the Variation does not alter according to any regular Law,

Law, as those Gentlemen have observed: so that we must not look for regular Causes where the Effects are irregular.

PROP. LXXXVIII.

There must be some Cause that first gave Magnetism to the Earth, and continues to renew it.

If the Parts of our Globe had been never so well disposed to receive Magnetism at the first Creation, it might have yet remained unmagnetical, unless there was some Cause existing, capable of making the repellent Matter move in a Stream through it: and if the magnetical Parts are continually becoming unfit for receiving the magnetical Stream, whilst others become susceptible of it, there seems a Necessity that the same Cause should continue to act; that the new magnetical Parts may be actually impregnated with Magnetism.

PROP. LXXXIX.

This Cause must be a very extensive one.

Otherwise it could not produce so extensive an Effect, as to make the whole Earth magnetical.

PROP. XC.

This Cause must act in such a Manner, as to make the magnetical Stream enter at the South Pole of the Earth.

Because the South Pole of the Earth is the North Pole in respect to Magnetism.

PROP. XCI.

If the Earth revolves round the Sun in an Ellipsis, and the South Pole of the Earth is directed towards the Sun at the Time of its Descent towards it, a Stream of repellent Matter will thereby be made to enter at the South Pole, and come out at the North.

All the Time that the Earth is descending towards the Sun, it meets with a greater Density in the repellent Fluid that composes the Sun's repellent Atmosphere; therefore the South Pole, moving first, will have the repellent Fluid continually entering into its Pores, otherwise the Density within the Pores would be continually less and less, in Proportion to the Density without; and to make the Density propor-

proportionable throughout the Pores of the whole Globe, it must pass successively from Pore to Pore quite through the Globe. By this Means a Stream will be commenced, that enters at the South Pole, and comes out at the North: This Stream, once begun, will continue whilst the Earth is returning from the Sun; for before the Equinox the South Pole is still in a denser Part of the repellent Fluid than the North, being nearer the Sun; and therefore the Stream will not be carried back again through the Pores of the Earth from North to South, but as soon as it escapes out at the North Pole, coming into a rarer Medium, will disperse every Way; and as the South Pole moves now into a rarer Medium continually, the Stream of Magnetism will be supplied by repellent Matter brought round from the North Pole. After the Equinox the North Pole being turned towards the Sun, the Stream will be made stronger by the Earth's receding into a Part where the repellent Fluid is rarer; for then the repellent Matter will be denser in the Pores about the North Pole than in the Space surrounding it, and will come out the faster: But the Stream will be most accelerated in Winter, when the Earth is descending near its *Perihelion*; because its Motion is then quickest. This may be one Reason why Magnetism is stronger in Winter than in Summer. It is probable, on this Principle, that the Earth's magnetical North Poles lie at a considerable Distance on this Side the antarctick Circle; for the Stream ought to enter in the Parts about the Southern Tropick; which is a Circumstance, that I think is confirmed by such Observations as have been made in regard to the Magnetism on the South Side of the Line; and it shews us a new Reason for the Variation, very consistent with the preceding Explication of it. Thus, I think, we have found out a Cause that will account for the Production of Magnetism in the Earth, and continue, or perhaps improve it perpetually, from Year to Year: Probably it has been improving ever since the Creation; which may be one Reason why the Use of the Compass was not discovered sooner.

The CONCLUSION.

I have now gone through most of the grand *Phænomena* of Nature, except Electricity ; but that is too great a Task at present: I therefore must beg Leave to defer it ; and shall only add this Observation, that it will not be difficult to foresee, that these simple Principles will be able to do much in explaining such *Phænomena* as are generally attended with various Attractions and Repulsions, and Sparks of Fire. When we rub the Surfaces of Bodies, and put the repellent Matter on them in Motion, what are we to expect but new Streams of repellent Matter, different from those of Magnetism, but capable of producing as extraordinary Appearances?

F I N I S.



THE CONCLUSION

I have now gone through most of the grand arguments of Nature, except Electricity; but that is too great a task at present; I therefore must beg leave to defer it, and shall only add this Observation, that it will not be difficult to shew, that these simple Principles will be able to do much in explaining both the phenomena as are generally attended with these Attractions and Repulsions, and several of the other we find the Success of Bodies, and put the repellent Matter on their in Motion, what we so often find in the Success of repellent Matter, distinct from those of Magnetism, has capable of producing a extraordinary Appearance.

THE END