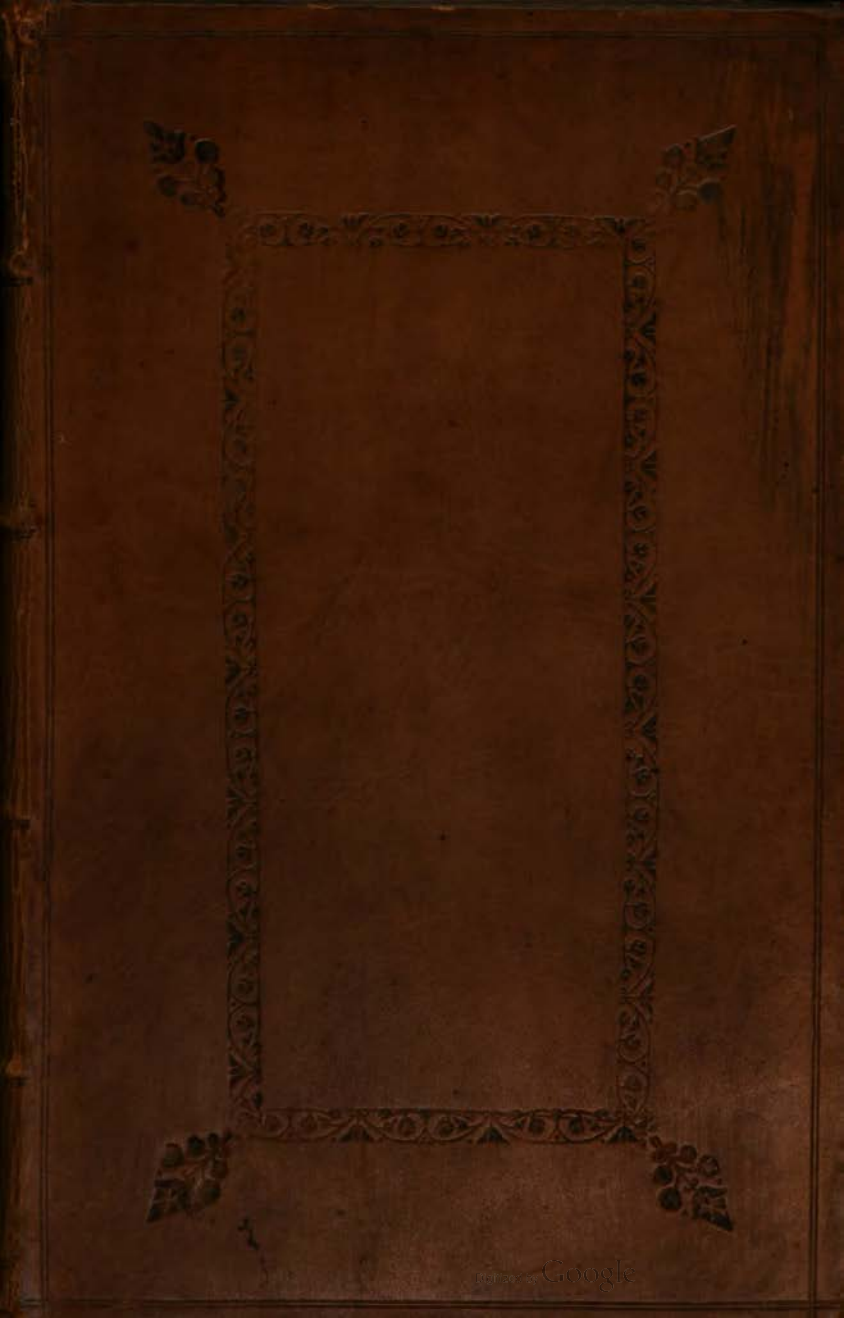

THE Celestial Worlds DISCOVER'D:

OR,

CONJECTURES

Concerning the

INHABITANTS,

PLANTS and PRODUCTIONS

OF THE

Worlds in the Planets.

Written in Latin by

CHRISTIANUS HUYGENS,

And inscrib'd to his Brother

CONSTANTINE HUYGENS

Late Secretary to his Majesty King *William.*

The Second Edition, Corrected and Enlarged.

LONDON:

Printed for JAMES KNAPTON, at the *Crown* in St. *Paul's* Church-Yard. MDCCXXII.

TO THE READER.

THIS Book was juſt finiſhed, and deſigned for the Preſs, when the Author, to the great loſs of the Learned World, was ſeized by a Diſeaſe that brought him to his Death. However he took care in his laſt Will of its Publication, deſiring his Brother, to whom it was writ, to take that Trouble upon him. But he was ſo taken up with Buſineſs and Removals, (as being Secretary in *Holland* to the King of *Great Britain*) that he could find no time for it till a Year after the Death of the Author: When it ſo fell out, that the Printers being ſomewhat tardy, and this Gentleman dying, the Book was left without either Father or Guardian. Yet it

now ventures into the Publick, in the ſame Method that it was writ by the Author, and with the ſame Inſcription to his Brother, tho' dead; in confidence that this laſt Piece of his will meet with as kind a Reception from the World as all the other Works of that Author have. 'Tis true there are not every where Mathematical Demonſtrations; but where they are wanting, you have probable and ingenious Conjectures, which is the moſt that can be reaſonably expected in ſuch matters. What belongs to, or has any thing to do with Aſtronomy, you will ſee demonſtrated, and the reſt ingeniouſly and ſhrewdly gueſs'd at, from the Affinity and Relation of the heavenly Bodies to the Earth. For your farther Satisfaction read on, and farewel.

THE

THE PUBLISHER TO THE READER.

I *Doubt not but I ſhall incur the Cenſures of learned Men for putting this Book into* Engliſh, *becauſe, they'll ſay, it renders Philoſophy cheap and vulgar, and, which is worſe, furniſhes a ſort of injudicious People with a ſmattering of Notions, which being not able to make a proper uſe of, they pervert to the Injury of Religion and Science. I confeſs the Allegation is too true: but after Biſhop* Wilkins, *Dr.* Burnet, *Mr.* Whiſton *and others, to ſay nothing of the ancient Philoſophers, who wrote in their own*

Tongues; *I ſay, after theſe great Authors have treated on as learned and abſtruſe Subjects in the ſame Language, I hope their Example will be allowed a ſufficient excuſe for printing this Book in* Engliſh.

Concerning this Edition I can ſay, that I have taken care to have the Cutts exactly done, and have placed each Figure at the Page of the Book that refers to it, which I take to be more convenient to the Reader than putting them all at the End.

I have been careful to procure the beſt Paper; that I might in ſome meaſure come up to the Beauty of the Latin Edition, though this bear but half the Price of it.

And I hope the Tranſlator has expreſſed the Author's Senſe aright, and has not committed Faults beyond what an ingenuous Reader can pardon.

NEW

NEW CONJECTURES Concerning the Planetary Worlds, THEIR INHABITANTS AND PRODUCTIONS.

Written by CHRISTIANUS HUYGENS, and inscribed to his Brother CONSTANTINE HUYGENS.

BOOK the First.

A Man that is of *Copernicus*'s Opinion, that this Earth of ours is a Planet, carry'd round and enlighten'd by the Sun, like the rest of the Planets, cannot but sometimes think, that it's

Book 1. not improbable that the reſt of the Planets have their Dreſs and Furniture, and perhaps their Inhabitants too as well as this Earth of ours: Eſpecially if he conſiders the later Diſcoveries made in the Heavens ſince *Copernicus*'s time, *viz.* the Attendants of *Jupiter* and *Saturn*, and the champaign and hilly Countries in the Moon, which are a ſtrong Argument of a Relation and Kin between our Earth and them, as well as a Proof of the Truth of that Syſtem. This has often been our Talk, I remember, good Brother, over a large Teleſcope, when we have been viewing thoſe Bodies, a Study that your continual Buſineſs and Abſence have interrupted for many Years. But we were always apt to conclude, that 'twas in vain to enquire after what Nature is doing there, ſeeing there was no likelihood of ever coming to any Certainty of the Enquiry. Nor could I ever find that any Philoſophers, either antient or modern, have attempted any thing upon this Subject. At the very Birth of

of Aſtronomy, when the Earth was first aſſerted to be Spherical, and to be ſurrounded with Air, even then there were ſome Men ſo bold as to affirm, there were an innumerable Company of Worlds in the Stars. But later Authors, ſuch as Cardinal *Cuſanus*, *Brunus*, *Kepler*, (and if we may believe him, *Tycho* was of that opinion too) have furniſhed the Planets with Inhabitants. Nay, *Cuſanus* and *Brunus* have allowed the Sun and fixed Stars theirs too. But this was the utmoſt of their Boldneſs; nor has the ingenious *French* Author of the Dialogues about *the Plurality of Worlds* carried this Matter any farther. Only ſome of them have coined ſome Stories of the Men in the Moon, juſt as probable as *Lucian*'s true Hiſtory; among which I muſt count *Kepler*'s, which he has diverted us with in his Aſtronomical Dream. But a while ago thinking ſomewhat ſeriouſly of this matter (not that I count my ſelf quicker-ſighted than thoſe great Men, but that I had the Happineſs to live after moſt

Book I.

Some have already talk'd of the Inhabitants of the Planets, but went no farther.

Book I. moſt of them) the Enquiry appeared not ſo impracticable, nor the Way ſo ſtopt up with Difficulties, but that there was very good room left for probable Conjectures. As they came into my Head, I put them down into common Places, and ſhall now try to digeſt them into ſome Method for your better Conception of them, and add ſomewhat of the Sun and fix'd Stars, and the Extent of that Univerſe of which our Earth is but an inconſiderable Point. I know you have ſuch an Eſteem and Reverence for any thing that belongs to the Heavens, that I perſwade my ſelf you will read what I have written with ſome Pleaſure: I'm ſure I writ it with a great deal; but as often before, ſo now, I find the Saying of *Archytas* true, even to the Letter, *That tho' a Man were admitted into Heaven to view the wonderful Fabrick of the World, and the Beauty of the Stars, yet what would otherwiſe be Rapture and Extaſie, would be but a melancholy Amazement if he had not a Friend to communicate*

cate it to. I could wiſh indeed that all the World might not be my Judges, but that I might chuſe my Readers, Men like you, not ignorant in Aſtronomy and true Philoſophy; for with ſuch I might promiſe my ſelf a favourable hearing, and not need to make an Apology for daring to vent any thing new to the World. But becauſe I am aware what weak Hands it's likely to fall into, and what a ſevere Sentence I may expect from thoſe whoſe Ignorance or Zeal is too great; it may be worth the while to guard my ſelf beforehand againſt the Aſſaults of thoſe ſort of People. Book I.

The Objections of ignorant Cavillers prevented.

There's one ſort who knowing nothing of Geometry or Mathematicks, will laugh at it as a whimſical and ridiculous Undertaking. It's an incredible Thing to them to talk of meaſuring the Diſtance and Magnitude of the Stars: And for the Motion of the Earth, they count it, if not a falſe, at leaſt a precarious Opinion; and no wonder then if they take what's built upon ſuch a ſlippery Foundation

Book I. dation for the Dreams of a fanciful Head and a diſtemper'd Brain. What ſhould we anſwer to theſe Men, but that their Ignorance is the Cauſe of their Diſlike, and that if they had ſtudied theſe things more, and viewed the Works of Nature nicely, they would have fewer Scruples? But few People having had an opportunity of proſecuting theſe Studies, either for want of Parts, Learning or Leiſure, we cannot blame their Ignorance; and if they reſolve to find fault with us for ſpending time in ſuch Matters, becauſe they do not underſtand the Uſe of them, we muſt appeal to properer Judges.

Theſe Conjectures do not contradict the holy Scriptures.

The other ſort, when they hear us talk of new Lands, and Animals, and Creatures endued with as much Reaſon as themſelves, will be ready to cry out, that we ſet up our Conjectures againſt the Word of God, and broach Opinions directly oppoſite to Holy Writ. For we do not there read any thing of the Production of ſuch Creatures, no not ſo much as that they exiſt; nay rather we read

read the quite contrary. For, That Book I. only mentions this Earth with its Animals and Plants, and Man the Lord of them: To ſuch Perſons I anſwer, what has been often urged by others before me: That it's evident, God had no deſign to make a particular Enumeration in the Holy Scriptures, of all the Works of his Creation. When therefore it is plain that under the general Name of *Stars* or *Earth* at the Creation, are comprehended all the Heavenly Bodies, even the Attendants upon *Jupiter* and *Saturn*, why muſt all that Multitude of Beings which the Almighty Creator has been pleaſed to place upon them, be excluded the Privilege, and not ſuffered to have a Share in the Expreſſion? And theſe Men themſelves can't but know in what Senſe it is that all things are ſaid to be made for the Uſe of Man, not certainly for us to look at through a Teleſcope, for that's very abſurd. Since then the greateſt part of God's Creation, that innumerable multitude of Stars, is placed out of the reach

Book I. reach of any Man's Eye; and many of them it's likely, of the beſt Glaſſes, ſo that they don't ſeem to belong to us; is it ſuch an unreaſonable Opinion to think, that there are ſome reaſonable Creatures who ſee and admire thoſe glorious Bodies at a nearer diſtance?

This Enquiry not over curious.

But perhaps they'll ſay, it does not become us to be ſo curious and inquiſitive in theſe Things which the Supreme Creator ſeems to have kept for his own Knowledge: For ſince he has not been pleaſed to make any farther Diſcovery or Revelation of them, it ſeems little better than preſumption to make any inquiry into that which he has thought fit to hide. But theſe Gentlemen muſt be told, that they take too much upon themſelves when they pretend to appoint how far and no farther Men ſhall go in their Searches, and to ſet bounds to other Mens Induſtry; as if they knew the Marks that God has placed to Knowledge: or as if Men were able to paſs thoſe Marks. If our Forefathers had been at this rate ſcrupulous, we might have

have been ignorant ſtill of the Mag- Book I.
nitude and Figure of the Earth, or
that there was ſuch a Place as *America*:
We ſhould not have known that the
Moon is inlightned by the Sun's Rays,
nor what the Cauſes of the Eclipſes
of each of them are, nor a multitude
of other Things brought to light by
the late Diſcoveries in Aſtronomy.
For what can a Man imagine more
abſtruſe, or leſs likely to be known,
than what is now as clear as the Sun?
Whence it follows, that vigorous In-
duſtry, and piercing Wit were given
Men to make Advances in the Search
of Nature, and there's no Reaſon to
put any Stop to ſuch Enquiries. I
muſt acknowledge that what I here
intend to treat of is not of that Na-
ture as to admit of a certain Know-
ledge; I can't pretend to aſſert any
thing as poſitively true (for how is it
poſſible) but only to advance a pro-
bable Gueſs, the Truth of which eve-
ry one is at his own liberty to exa-
mine. If any one therefore ſhall
gravely tell me, that I have ſpent my
Time idly in a vain and fruitleſs En-
quiry

Book I. quiry after what by my own acknowledgment I can never come to be ſure of; The Anſwer is, that at this rate he would put down all Natural Philoſophy as far as it concerns it ſelf in ſearching into the Nature of Things: In ſuch noble and ſublime Studies as theſe, 'tis a Glory to arrive at Probability, and the Search it ſelf rewards the Pains. But there are many degrees of Probable, ſome nearer Truth than others, in the determining of which lies the chief exerciſe of our Judgment. But beſides the Nobleneſs and Pleaſure of the Studies, may not we be ſo bold as to ſay, they are no ſmall help to the Advancement of Wiſdom and Morality? ſo far are they from being of no uſe at all. For here we may mount from this dull Earth, and viewing it from on high, conſider whether Nature has laid out all her Coſt and Finery upon this ſmall Speck of Dirt. So, like Travellers into other diſtant Countries, we ſhall be better able to judge of what's done at home, know how to make a true Eſtimate of, and ſet its

Conjectures not uſeleſs, becauſe not certain.

Theſe Studies uſeful to Religion.

its own Value upon every Thing. We shall be less apt to admire what this World calls Great, shall nobly despise those Trifles the generality of Men set their Affections on, when we know that there are a multitude of such Earths inhabited and adorned as well as our own. And we shall worship and reverence that God the Maker of all these things; we shall admire and adore his Providence and wonderful Wisdom which is displayed and manifested all over the Universe, to the Confusion of those who would have the Earth and all things formed by the shuffling Concourse of Atoms, or to be without beginning. But to come to our Purpose. Book I.

Copernicus's System explained.

And now because the chief Argument for the Proof of what we intend will be taken from the Disposition of the Planets, among which without doubt, the Earth must be counted in the Copernican System, I shall here first of all draw two Figures. The first is a Description of

Book 1. the Orbs the Planets move in, in that order that they are placed round the Sun, drawn as near as can be in their true Proportions, like what you have seen in my Clock at home. The second shows the Proportions of their Magnitudes in respect of one another and of the Sun, which you know is upon that same Clock of mine too. In the first the middle Point or Center is the Place of the Sun, round which, in an order that every one knows, are the Orbits of *Mercury*, *Venus*, the Earth with that of the Moon about it; then those of *Mars*, *Jupiter* and *Saturn*: and about the two last the small Circles that their Attendants move in: about *Jupiter* four, and about *Saturn* five. Which Circles as well as that of the Moon are drawn larger than their true Proportion would admit, otherwise they could not have been seen. You may easily apprehend the Vastness of these Orbits by this, that the distance of the Earth from the Sun is ten or twelve thousand of the Earth's Diameters. Almost all these Circles are in the same Plane, declining very little

little from that in which the Earth moves, call'd *The Plane of the Ecliptick.* This Plane is cut obliquely by the Axis upon which the Earth turns it self round with respect to the Sun in 24 Hours, whence arise the Successions of Day and Night: The Axis of the Earth always keeping the same Inclination to the Ecliptick (except a small Change best known to Astronomers) while the Earth itself is carried in its yearly Course round the Sun, causes the regular Order of the Seasons of the Year: as you may see in all Astronomers Books. Out of which I shall transcribe hither the Periods of the Revolutions of the Planets, *viz. Saturn* moves round the Sun in 29 Years, 174 Days, and 5 Hours: *Jupiter* finishes his Course in 11 Years, 317 Days, and 15 Hours: *Mars* his in about 687 Days. Our Year is 365 Days 6 Hours: *Venus*'s 224 Days 18 Hours: and *Mercury*'s 88 Days. This is the now commonly received System, invented by *Copernicus*, and very agreeable to that frugal Simplicity Nature shows in all

Book 1. her Works. If any one is resolved to find fault with it, let him first be sure he understands it. Let him first see in the Books of Astronomers with how much greater Ease and Plainness all the Motions of the Stars, and Appearances in the Heavens are explained and demonstrated in this than either in that of *Ptolomy* or *Tycho*. Let him consider that Discovery of *Kepler*, that the Distances of the Planets from the Sun, as well of the Earth as the rest, are in a fix'd certain proportion to the Times they spend in their Revolutions. Which Proportion it's since observed that their Satellites keep round *Jupiter* and *Saturn*. Let him examine what a contradictory Motion they are fain to invent for the Solution of the Polar Star's changing its Distance from the Pole. For that Star in the end of the little Bear's Tail which now describes so small a Circle round the Pole, that it is not above two Degrees and twenty Minutes, was observed about 1820 Years ago, in the Time of *Hipparchus*, to be above 12: and

Arguments for the Truth on't.

B
As
m
th
on

and will within a few Ages more be 45 Degrees distant from it: and after 25000 Years more will return to the same Place it is now in. Now if with them we allow the Heavens to be turned upon their own Axis, at this rate they must have a new Axis every Day: a Thing most absurd, and repugnant to the Nature of all Motion. Whereas nothing is easier with *Copernicus* than to give us Satisfaction in this Matter. Then he may impartially weigh those Answers that *Galilæus*, *Gassendus*, *Kepler*, and others have given to all Objections proposed, which have so satisfied all Scruples, that generally all Astronomers now-a-days are brought over to our Side, and allow the Earth its Motion and Place among the Planets. If he cannot be satisfied with all this, he is either one whose Dulness can't comprehend it, or who has his Belief at another Man's Disposal. Book I.

In the other Figure you have the Globes of the Planets, and of the Sun, represented to your Eyes as placed near one another. Where

Book 1. I have observed the same Proportion, of their Diameters to that of the Sun, that I published to the World in my Book of *The Appearances of Saturn*: namely, the Diameter of the Ring round *Saturn* is to that of the Sun as 11 is to 37; that of *Saturn* himself about as 5 to 37; that of *Jupiter* as 2 to 11; that of *Mars* as 1 to 166; of the Earth as 1 to 111; and of *Venus* as 1 to 84: to which I shall now add that of *Mercury* observed by *Hevelius* in the Year 1661, but calculated by my self, and found to be as 1 to 290.

The Proportion of the Magnitude of the Planets, in respect of one another, and the Sun.

If you would know the way that we came to this Knowledge of their Magnitudes, by knowing the Proportion of their Distances from the Sun, and the Measures of their Diameters, you may find it in the Book beforementioned: And I cannot yet see any Reason to make an Alteration in those I then settled, altho' I will not say they are without their Faults. For I can't yet be of their Mind, who think the Use of Micrometers, as they call them, is beyond that of our

The Lamellæ more convenient than Micrometers.

our Plates, but must still think that those thin Plates or Rods of which I there taught the Use, not to detract from the due Praises of so useful an Invention, are more convenient than the Micrometers. Book 1.

In this proportion of the Planets it is worth while to take notice of the prodigious Magnitude of the Sun in comparison with the four innermost, which are far less than *Jupiter* and *Saturn*. And 'tis remarkable, that the Bodies of the Planets do not increase together with their Distances from the Sun, but that *Venus* is much bigger than *Mars*.

The Earth justly likened to the Planets, and the Planets to it.

Having thus explained the two Schemes, there's no Body I suppose but sees, that in the first the Earth is made to be of the same sort with the rest of the Planets. For the very Position of the Circles shows it. And that the other Planets are round like it, and like it receive all the Light they have from the Sun, there's no room (since the Discoveries made by Telescopes) to doubt. Another Thing they are like it in is, that they are moved

Book I. ved round their own Axis; for since 'tis certain that *Jupiter* and *Saturn* are, who can doubt it of the others? Again, as the Earth has its Moon moving round it, so *Jupiter* and *Saturn* have theirs. Now since in so many Things they thus agree, what can be more probable than that in others they agree too; and that the other Planets are as beautiful and as well stock'd with Inhabitants as the Earth? Or what shadow of Reason can there be why they should not?

If any one should be at the Dissection of a Dog, and be there shewn the Intrails, the Heart, Stomach, Liver, Lungs and Guts, all the Veins, Arteries and Nerves; could such a Man reasonably doubt whether there were the same Contexture and Variety of Parts in a Bullock, Hog, or any other Beast, tho' he had never chanc'd to see the like opening of them? I don't believe he would. Or were we thoroughly satisfy'd in the Nature of one of the Moons round *Jupiter*, should not we straight conclude the same of the rest of them? So if we could be assur'd

aſſur'd in but one Comet, what it was that is the Cauſe of that ſtrange Appearance, ſhould we not make that a Standard to judge of all others by? 'Tis therefore an Argument of no ſmall Weight that is fetch'd from Relation and Likeneſs; and to reaſon from what we ſee and are ſure of, to what we cannot, is no falſe Logick. This muſt be our Method in this Treatiſe, wherein from the Nature and Circumſtances of that Planet which we ſee before our Eyes, we may gueſs at thoſe that are farther diſtant from us. Book I.

Arguments from their Similitude, of no ſmall weight.

And, Firſt, 'tis more than probable that the Bodies of the Planets are ſolid like that of our Earth, and that they don't want what we call Gravity, that Virtue, which like a Loadſtone attracts whatſoever is near the Body to its Center. And that they have ſuch a Quality, their very Figure is a Proof; for their Roundneſs proceeds only from an equal preſſure of all their Parts tending to the ſame Center. Nay more, we are ſo skilful now-a-days, as to be able to tell how much

The Planets are ſolid, and not without Gravity.

Book I. much more or leſs the Gravitation *in* *Jupiter* or *Saturn* is than here; of which Diſcovery and its Author you may read my *Eſſay of the Cauſes of Gravitation.*

But now to carry the Search farther, let us ſee by what Steps we muſt riſe to the attaining ſome knowledge in the deeper Secrets concerning the State and Furniture of theſe new Earths. And, firſt, how likely is it that they may be ſtock'd with Plants and Animals as well as we? I ſuppoſe no Body will deny but that there's ſomewhat more of Contrivance, ſomewhat more wonderful in the Production and Growth of Plants and Animals, than in Lifeleſs Heaps of inanimate Bodies, be they never ſo much larger; as Mountains, Rocks, or Seas are. For the Finger of God, and the Wiſdom of Divine Providence, is in them much more clearly manifeſted than in the other. One of *Democritus*'s or *Carte*'s Scholars may venture perhaps to give ſome tolerable Explication of the Appearances in Heaven and Earth, allow him but his Atoms

Have Animals and Plants.

and

and Motion; but when he comes to Book I.
Plants and Animals, he'll find himself
non-plus'd, and give you no likely account of their Production. For every Thing in them is so exactly adapted to some Design, every part of them so fitted to its proper Use, that they manifest an Infinite Wisdom, and exquisite Knowledge in the Laws of Nature and Geometry, as, to omit those Wonders in Generation, we shall by and by show; and make it an Absurdity even to think of their being thus happily jumbled together by a chance Motion of I don't know what little Particles. Now should we allow the Planets nothing but vast Deserts, lifeless and inanimate Stocks and Stones, and deprive them of all those Creatures that more plainly speak their Divine Architect, we should sink them below the Earth in Beauty and Dignity; a Thing very unreasonable, as I said before.

Well then, we have gain'd the Point thus far, and the Planets may be allowed some Creatures capable of moving themselves, not at all inferior

to

Book I. to ours; and these are Animals. And if this be allowed, it almost necessarily follows, that there must be Herbs for Food for them. And as for the Growth and Nourishment of all these, 'tis no doubt the same with ours, seeing they have the same Sun to warm and enliven them as ours have.

Not to be imagin'd too unlike ours.

But perhaps some Body may say, we conclude too fast. They will not deny indeed but that there may be Plants and Animals on the Surface of the Planets, that deserve as well to be provided for by their Creator as ours do: but why must they be of the same Kind with ours: Nature seems to love variety in her Works, and may have made them widely different from ours either in their matter or manner of Growth, in their outward Shape, or their inward Contexture; she may have made them such as neither our Understanding nor Imagination can conceive. That's the Thing we shall now examine, and whether it be not more likely that she has not observ'd such a Variety as they talk of. Nature seems

ſeems moſt commonly, and in moſt of her Works, to affect Variety, 'tis true; But they ſhould conſider 'tis not the Buſineſs of Men to pretend to ſettle how great this Difference and Variety muſt be. Nor does it follow, becauſe it may be Infinite, and out of our Comprehenſion and Reach, that therefore Things in reality are ſo. For ſuppoſe God ſhould have pleaſed to have made all Things in the reſt of the Planets juſt as he has here, the Inhabitants of thoſe Places (if there are any ſuch) would admire his Wiſdom and Contrivance no leſs than if they were widely different; ſeeing they can't come to know what's done in the other Planets. Who doubts but that God, if he had pleaſed, might have made the Animals in *America* and other diſtant Countries nothing like ours? yet we ſee he has not done it. They have indeed ſome difference in their Shape, and 'tis fit they ſhould, to diſtinguiſh the Plants and Animals of thoſe Countries from ours, who live on this ſide the Earth; but even in this Variety there is an Agreement, an

an exact Correſpondence in Figure and Shape, the ſame ways of Growth, and new Productions, and of continuing their own Kind. Their Animals have Feet and Wings like ours, and like ours have Hearts, Lungs, Guts, and the Parts ſerving to Generation; whereas all theſe Things, as well with them as us, might, if it had pleaſed Infinite Wiſdom, have been order'd a very different Way. 'Tis plain then that Nature has not exhibited that Variety in her Works that ſhe could, and therefore we muſt not allow that Weight to this Argument, as upon the Account of it to make every Thing in the Planets quite different from what is here. 'Tis more probable that all the Difference there is between us and them, ſprings from the greater or leſs diſtance and influence from that Fountain of Heat and Life the Sun; which will cauſe a Difference not ſo much in their Form and Shape, as in their Matter and Contexture.

Planets have Water. And as for the Matter whereof the Plants and Animals there conſiſt, tho' it

it is impoſſible ever to come to the Knowledge of its Nature, yet this we may venture to aſſert (there being ſcarce any Doubt of it) that their Growth and Nouriſhment proceeds from ſome liquid Principle. For all Philoſophers argee that there can be no other way of Nutrition; ſome of the Chief among them having made Water to be the Original of all Things: For whatſoever's dry and without Moiſture, is without Motion too; and without Motion, it's impoſſible there ſhould be any Increaſe. But the Parts of a Liquid being in continual Motion one with another, and inſinuating and twiſting themſelves into the ſmalleſt Places, are thereby very proper and apt to add not themſelves only, but whatſoever elſe they may bring along with them, to the Increaſe and Growth of Bodies. Thus we ſee that by the Means of Water the Plants grow, bloſſom, and bear Fruit; and by the Addition of that only, Stones grow together out of Sand. And there's no doubt but that Metals, Cryſtals, and Jewels, have

Book 1. have the same Method of Production: Tho' in them there has been no opportunity to make the same Observation, as well by reason of their slow Advances, as that they are commonly found far from the Places of their Generation; thrown up I suppose by some Earthquakes or Convulsions. That the Planets are not without Water, is made not improbable by the late Observations: For about *Jupiter* are observed some Spots of a darker Colour than the rest of his Body, which by their continual change show themselves to be Clouds: For the Spots of *Jupiter* which belong to him, and never remove from him, are quite different from these, being sometimes for a long time not to be seen for these Clouds; and again, when these disappear, showing themselves. And at the going off of these Clouds, some Spots have been taken notice of in him, much brighter than the rest of his Body, which remained but a little while, and then were hid from our Sight. These Monsieur *Cassini* thinks are only the Reflecti-

Reflection from the Snow that covers the Tops of the Hills in *Jupiter*: But I ſhould rather think that it is only the Colour of the Earth, which happens to be free from thoſe Clouds that commonly darken it. Book 1.

Mars too is found not to be without his dark Spots, by means of which he has been obſerved to turn round his own Axis in 24 Hours and 40 Minutes; the Length of his Day: but whether he has Clouds or no, we have not had the ſame opportunity of obſerving as in *Jupiter*, as well becauſe even when he is neareſt the Earth, he appears to us much leſs than *Jupiter*; as that his Light not coming ſo far, is ſo briſk as to be an Impediment to exact Obſervations: And this Reaſon is as much ſtronger in *Venus* as its Light is. But ſince 'tis certain that the Earth and *Jupiter* have their Water and Clouds, there is no Reaſon why the other Planets ſhould be without them. I can't ſay that they are exactly of the ſame nature with our Water; but that they ſhould be liquid their Uſe requires, as their Beauty does that they ſhould be clear. *But not juſt like ours.*

Book 1. clear. For this Water of ours, in *Jupiter* or *Saturn*, would be frozen up instantly by reason of the vast distance of the Sun. Every Planet therefore must have its Waters of such a temper, as to be proportioned to its Heat: *Jupiter*'s and *Saturn*'s must be of such a Nature as not to be liable to Frost; and *Venus*'s and *Mercury*'s of such, as not to be easily evaporated by the Sun. But in all of them, for a continual supply of Moisture, whatever Water is drawn up by the Heat of the Sun into Vapours, must necessarily return back again thither. And this it cannot do but in Drops, which are caused as well there as with us, by their ascending into a higher and colder Region of the Air, out of that which, by reason of the Reflection of the Rays of the Sun from the Earth, is warmer and more temperate.

Here then we have found in these new Worlds Fields warm'd by the kindly Heat of the Sun, and water'd with fruitful Dews and Showers: That there must be Plants in them as well for Ornament as Use, we have shewn just

juſt now. And what Nouriſhment, what manner of Growth ſhall we allow them? Probably, there can be no better, nay no other, than what we here experience; by having their Roots faſtned into the Earth, and imbibing its nouriſhing Juices by their tender Fibres. And that they may not be only like ſo many bare Heaths, with nothing but creeping Shrubs and Buſhes, we may allow them ſome nobler and loftier Plants, Trees, or ſomewhat like them: Theſe being the greateſt, and, except Waters, the only Ornament that Nature has beſtowed upon the Earth. For not to ſpeak of thoſe many uſes that are made of their Wood, there's no one that is ignorant either of their Beauty or Pleaſantneſs. Now what way can any one imagine for a continual Production and Succeſſion of theſe Plants, but their bearing Seed? A Method ſo excellent, that it's the only one that Nature has here made uſe of, and ſo wonderful, that it ſeems to be deſigned not for this Earth alone. In fine, there's the ſame reaſon to think that this Method is obſerved in thoſe

Plants grow and are nouriſhed there as they are here.

Book I.

Book I. distant Countries, as there was of its being followed in the remote Quarters of this same Earth.

The same true of their Animals.

'Tis much the same in Animals as 'tis in Plants, as to their manner of Nourishment, and Propagation of their Kind. For since all the living Creatures of this Earth, whether Beasts, Birds, Fishes, Worms, or Insects, universally and inviolably follow the same constant and fix'd Institution of Nature; all feed on Herbs, or Fruits, or the Flesh of other Animals that fed on them: since all Generation is performed by the impregnating of the Eggs, and the Copulation of Male and Female: Why may not the same Rule be observed in the Planetary Worlds? For *'tis certain that the Herbs and Animals that are there would be lost, their whole Species destroyed without some daily new Productions:* except there be no such thing there as Misfortune or Accident: except the Plants are not like other humid Bodies, but can bear Heat, Frost, and Age, without being dry'd up, kill'd or decay'd: except the Animals have Bodies as hard and

and durable as Marble; which I think are groſs Abſurdities. If we ſhould invent ſome new Way for their coming into the World, and make them drop like Soland Geeſe from Trees, how ridiculous would this be to any one that conſiders the vaſt Difference between Wood and Fleſh? Or ſuppoſe we ſhould have new ones made every Day out of ſome ſuch fruitful Mud as that of *Nile*, who does not ſee how contrary this is to all that's reaſonable? And that 'tis much more agreeable to the Wiſdom of God, once for all to create of all ſorts of Animals, and diſtribute them all over the Earth in ſuch a wonderful and inconceivable way as he has, than to be continually obliged to new Productions out of the Earth? And what miſerable, what helpleſs Creatures muſt theſe be, when there's no one that by his Duty will be obliged, or by that ſtrange natural fondneſs, which God has wiſely made a neceſſary Argument for all Animals to take care of their own, will be moved to aſſiſt, nurſe or educate them? Book I.

Book I. As for what I have ſaid concerning their Propagation, I cannot be ſo poſitive; but the other Thing, namely, that they have Plants and Animals, I think I have fully proved, *viz.* from hence, that otherwiſe they would be inferiour to our Earth. And by the ſame Argument, they muſt have as great a Variety of both as we have. What this is, will be beſt known to him that conſiders the different Ways our Animals make uſe of in moving from one Place to another. Which may be reduc'd, I think, to theſe; either that they walk upon two Feet or Four; or like Inſects, upon Six, nay ſometimes Hundreds; or that they fly in the Air bearing up, and wonderfully ſteering themſelves with their Wings; or creep upon the Ground without Feet; or by a violent Spring in their Bodies, or paddling with their Feet, cut themſelves a Way in the Waters. I don't believe, nor can I conceive, that there ſhould be any other Way than theſe mentioned. The Animals then in the Planets muſt make uſe of one or more of theſe, like our amphibious Birds, which

which can ſwim in Water as well as walk on Land, or fly in the Air; or like our Crocodiles and Sea-Horſes, muſt be Mongrels, between Land and Water. There can no other Method be imagined but one of theſe. For where is it poſſible for Animals to live, except upon ſuch a ſolid Body as our Earth, or a fluid one like the Water, or ſtill a more fluid one than that, ſuch as our Air is? The Air I confeſs may be much thicker and heavier than ours, and ſo, without any Diſadvantage to its Tranſparency, be fitter for the volatile Animals. There may alſo be many ſorts of Fluids ranged over one another in Rows as it were. The Sea perhaps may have ſuch a fluid lying on it, which tho' ten times lighter than Water, may be a hundred Times heavier than Air; whoſe utmoſt Extent may not be ſo large as to cover the higher Places of their Earth. But there's no Reaſon to ſuſpect or allow them this, ſince we have no ſuch Thing; and if we did, it would be of no Advantage to them, for that the former Ways of moving would not be hereby at all in-

Book 1. creas'd: But when we come to meddle with the Shape of these Creatures, and consider the incredible Variety that is even in those of the different parts of this Earth, and that *America* has some which are no where else to be found, I must then confess that I think it beyond the Force of Imagination to arrive at any knowledge in the Matter, or reach to Probability concerning the Figures of these Planetary Animals. Altho' considering these Ways of Motion we e'en now recounted, they may perhaps be no more different from ours than ours (those of ours I mean that are most unlike) are from one another.

If a Man were admitted to a Survey of *Jupiter* or *Venus*, he would no doubt find as great a Number and Variety as he had at home. Let us then, that we may make as near a Guess at, and as reasonable a Judgment of the Matter as we can, consider the many Sorts, and the admirable Difference in the Shapes of our own Animals; running over some of the Chief of them (for 'twould be tedious to set about a general Catalogue) that are notoriously

Great Variety of Animals in this Earth.

ouſly different from one another, either in the Figure or ſome peculiar Property belonging to them; as they belong to the Land, or the Water, or the Air. Among the Beaſts we may take notice of the great Diſtance between the Horſe, the Elephant, the Lion, the Stag, the Camel, the Hog, the Ape, the Porcupine, the Tortoiſe, the Cameleon: in the Water, of that between the Whale, and the Sea-Calf, the Skait, the Pike, the Eel, the Ink-Fiſh, the Pourcontrel, the Crocodile, the Flying-fiſh, the Cramp-fiſh, the Crab, the Oiſter, and the Purple-Fiſh: and among Birds, of that between the Eagle, the Oſtrich, the Peacock, the Swan, the Owl, and the Bat: and in Inſects, of that between the Ants, the Spider, the Fly, and the Butterfly; and of that Prodigy in their wonderful change from Worms. In this Roll I have paſs'd by the creeping Kind as one Sort, and skip'd over that vaſt Multitude of leſs different Animals that fill the intermediate Spaces. But be they never ſo many, there is no reaſon to think that the Planets cannot match them. For tho' we in vain gueſs at

Book 1.

And no leſs in the Planets.

Book I. at the Figures of thoſe Creatures, yet we have diſcover'd ſomewhat of their manner of Life in general; and of their Senſes we ſhall ſpeak more by and by.

The ſame in Plants. The more conſiderable Differences in our Plants ought to be thought on, as well as the other. As in Trees, that between the Fir and the Oak, the Palm, the Vine, the Fig, and the Co-co-Nut Tree, and that in the *Indies*, from whoſe Boughs new Roots ſpring, and grow downwards into the Earth. In Herbs, the Difference is notable between Graſs, Poppy, Colewort, Ivy, Pompions, and the Indian Fig with thick Leaves growing up without any Stalk, and Aloe. Between every one of which again there are many leſs differing Plants not taken notice of. Then the different Ways of raiſing them are remarkable, whether from Seeds, or Kernels, or Roots, or by grafting or inoculating them. And yet in all theſe, whether we conſider the Things themſelves, or the Ways of their Production, I make no doubt but that the Planetary Worlds have as wonderful a Variety as we.

But

Rational Animals in the Planets.

But ſtill the main and moſt agreeable Point of the Enquiry is behind, which is the placing ſome Spectators in theſe new Diſcoveries, to enjoy theſe Creatures we have planted them with, and to admire their Beauty and Variety. And among all, that have never ſo ſlightly meddled with theſe Matters, I don't find any that have ſcrupled to allow them their Inhabitants: not Men perhaps like ours, but ſome Creatures or other endued with Reaſon. For all this Furniture and Beauty the Planets are ſtock'd with ſeem to have been made in vain, without any Deſign or End, unleſs there were ſome in them that might at the ſame time enjoy the Fruits, and adore the wiſe Creator of them. But this alone would be no prevaling Argument with me to allow them ſuch Creatures. For what if we ſhould ſay, that God made them for no other Deſign, but that he himſelf might ſee (not as we do 'tis true; but that he that made the Eye ſees, who can doubt?) and delight himſelf in the Contemplation of them? For was not Man

Book I. Man himſelf, and all that the whole World contains, made upon this very account? That which makes me of this Opinion, that thoſe Worlds are not without ſuch a Creature endued with Reaſon, is, that otherwiſe our Earth would have too much the Advantage of them, in being the only part of the Univerſe that could boaſt of ſuch a Creature ſo far above, not only Plants and Trees, but all Animals whatſoever: a Creature that has ſomething Divine in him, that knows, and underſtands, and remembers ſuch an innumerable number of Things; that deliberates, weighs and judges of the Truth: A Creature upon whoſe Account, and for whoſe Uſe, whatſoever the Earth brings forth ſeems to be provided. For every Thing here he converts to his own Ends. With the Trees, Stones, and Metals, he builds himſelf Houſes: the Birds and Fiſhes he ſuſtains himſelf with: and the Water and Winds he makes ſubſervient to his Navigation; as he doth the ſweet Smell and glorious Colours of the Flowers to his Delight. What can there be

in

in the Planets that can make up for its Defects in the want of so noble an Animal? If we should allow *Jupiter* a greater Variety of other Creatures, more Trees, Herbs and Metals, all these would not advantage or dignify that Planet so much as that one Animal doth ours by the admirable Productions of his penetrating Wit. If I am mistaken in this, I do not know when to trust my Reason, and must allow my self to be but a poor Judge in the true Estimate of Things. Book 1.

Vices of Men no hindrance to their being the Glory of the Planet they inhabit.

Nor let any one say here, that there's so much Villany and Wickedness in Man that we have thus magnified, that it's a reasonable Doubt, whether he would not be so far from being the Glory and Ornament of the Planet that enjoys his Company, that he would be rather its Shame and Disgrace. For first, the Vices that most Men are tainted with, are no hindrance, but that those that follow the Dictates of true Reason, and obey the Rules of a rigid Virtue, are still a Beauty and Ornament to the Place that has the Happiness to harbour them.

Besides,

Book 1. Beſides, the Vices of Men themſelves are of excellent Uſe, and are not permitted and allowed in the World without wiſe Deſign. For ſince it has ſo pleaſed God to order the Earth, and every Thing in it as we ſee it is (for it's abſurd to ſay it happen'd againſt his Will or Knowledge) we muſt not think that ſo great a Diverſity of Minds were placed in different Men to no End or Purpoſe: but that this mixture of bad Men with Good, and the Conſequents of ſuch a Mixture, as Misfortunes, Wars, Afflictions, Poverty, and the like, were permitted for this very good End, *viz.* the exerciſing our Wits, and ſharpening our Inventions; by forcing us to provide for our own neceſſary Defence againſt our Enemies. 'Tis to the Fear of Poverty and Miſery that we are beholden for all our Arts, and for that natural Knowledge which was the Product of laborious Induſtry; and which makes us that we cannot but admire the Power and Wiſdom of the Creator, which otherwiſe we might have paſſed by with the ſame indifference as Beaſts. And if Men were

were to lead their whole Lives in an undisturbed continual Peace, in no fear of Poverty, no danger of War, I doubt they would live little better than Brutes, without all knowledge or enjoyment of those Advantages that make our Lives pass on with Pleasure and Profit. We should want the wonderful Art of Writing, if its great Use and necessity in Commerce and War had not forced out the Invention. 'Tis to these we owe our Art of Sailing, our Art of Sowing, and most of those Discoveries of which we are Masters; and almost all the Secrets in experimental Knowledge. So that those very Things on account of which the Faculty of Reason seems to have been accused, are no small helps to its Advancement and Perfection. For those Virtues themselves, Fortitude and Constancy, would be of no use if there were no Dangers, no Adversity, no Afflictions for their Exercise and Trial. Book I.

If we should therefore imagine in the Planets some such reasonable Creature as Man is, adorn'd with the same Vir-

Book I. Virtues, and liable to the ſame Vices, it would be ſo far from degrading or vilifying them, that while they want ſuch a one, I muſt think them inferior to our Earth.

Reaſon there not different from what 'tis here.

But if we allow theſe Planetary Inhabitants ſome ſort of Reaſon, muſt it needs, may ſome ſay, be the ſame with ours? Certainly it muſt; whether we conſider it as applied to Juſtice and Morality, or exerciſed in the Principles and Foundations of Science. For Reaſon with us is that which gives us a true Senſe of Juſtice and Honeſty, Praiſe, Kindneſs and Gratitude: 'tis That that teaches us to diſtinguiſh univerſally between Good and Bad; and renders us capable of Knowledge and Experience in it. And can there be any where any other Sort of Reaſon than this? or can what we call juſt and generous, in *Jupiter* or *Mars* be thought unjuſt Villany? This is not at all, I don't ſay probable, but poſſible. For the Aim and Deſign of the Creator is every where the Preſervation and Safety of his Creatures. Now when ſuch Reaſon as we are Maſters of,

of, is neceſſary for the preſervation of Life, and promoting of Society (a thing that they are not without, as we ſhall ſhow) would it not be ſtrange that the Planetary Inhabitants ſhould have ſuch a perverſe Sort of Reaſon given them, as would neceſſarily deſtroy and confound what it was deſign'd to maintain and defend? But allowing Morality and Paſſions with thoſe diſtant Inhabitants to be ſomewhat different from ours, and ſuppoſing they may act by other Principles in what belongs to Friendſhip and Anger, Hatred, Honeſty, Modeſty, and Comelineſs, yet ſtill there would be no doubt, but that in the Search after Truth, in judging of the Conſequences of Things, in Reaſoning, particularly in that Sort which belongs to Magnitude or Quantity, about which their Geometry (if they have ſuch a Thing) is employ'd, there would be no doubt, I ſay, but that their Reaſon here muſt be exactly the ſame, and go the ſame way to work with ours, and that what's true in one part will hold true over the whole Univerſe; ſo that all the diffe- Book I.

Book I. rence must lie in the Degrees of Knowledge, which will be proportional to the Genius and Capacity of the Inhabitants.

They have Senses. But I perceive I am got somewhat too far: Let us first enquire a little concerning the bodily Senses of these Planetary Persons; for without such, neither will Life be any Pleasure to them, nor Reason of any Use. And I think it very probable, that all their Animals, as well their Beasts as rational Creatures, are like ours in all that relates to the Senses: For without the Power of Seeing we should find it impossible for Animals to provide Food for themselves, or be fore-warn'd of any approaching Danger, so as to guard themselves from it. So that where-ever we plant any Animals, except we wou'd have them lead the Life of Worms or Moles, we must allow them Sight; than which nothing can conduce more either to the Preservation or Pleasure of their Lives. Then if we consider the wonderful Nature of Light, and the *Sight.* amazing Artifice in the fit framing the Eye for the Reception of it, we cannot but

but see that Bodies so vastly remote could not be perceived by us in their proper Figures and just Distances, any other way than by Sight. For this Sense, and all others that we know of, must proceed from an external Motion. Which in the sense of Seeing must come either from the Sun, the fix'd Stars, or Fire: whose Particles being put into a very quick Motion, communicate it to the Celestial Matter about, whence 'tis convey'd in a very short time to the most distant parts, just like Sound through the Air. If it were not for this Motion of the intermediate Æthe-rial Matter, we should be all in Dark-ness, and have Sight neither of Sun nor Stars, nor any thing else, for all other Light must come to us by Reflection from them. This Motion perceived by the Eyes is called Light. And the nice Curiosity of this Perception is admirable, in that it is caused by the smallest Particles of the luminous Body brought to us by that fine Matter, which at the same time determine the Coast from whence the Motion comes; and in that all these different Roads of Book 1.

Book I. Motion, these Waves crossing and interfering with one another, are yet no hindrance to every one's free Passage. All these Things are so wisely, so wonderfully contrived, that it's above the Power of humane Wit, to invent or frame any thing like them; nay, it is very difficult so much as to imagine and comprehend them. For what can be more amazing, than that one small Part of the Body should be so devised and framed, as by its means to shew us the Shape, the Position, the Distance, and all the Motions, nay, and all the Colours, of a Body that is far remote from us, that it may appear the more distinct? And then the artful Composition of the Eye, drawing an exact Picture of the Objects without it, upon the concave Side of the Choroides, is even above all Admiration, nor is there any Thing in which God has more plainly manifested his excellent Geometry. And these Things are not only contriv'd and fram'd with so great Wisdom and Skill, as not to admit of better, but to any one that considers them attentively, they seem to be of such a Nature

ture as not to allow any other Method. For it's impoſſible that Light ſhould repreſent Objects to us at ſo vaſt a diſtance, except by ſuch an intervening Motion; and it's as impoſſible that any other Compoſition of the Eye ſhould be equally fitted to the Reception of ſuch Impreſſions. So that I cannot but think them greatly miſtaken, that maintain theſe Things might have been contrived many other Ways. It's likely then, and credible, that in theſe Things the Planets have an exact correſpondence with us, and that their Animals have the ſame Organs, and uſe the ſame way of Sight that we do. They muſt have Eyes therefore, and two at leaſt we muſt grant them, otherwiſe they would not perceive thoſe Things cloſe to them, nor hardly be able to walk about with Safety. And if we muſt allow them to all Animals for the Preſervation of their Life, how much more muſt they that make more, and more noble Uſes of them, not be deprived of the Bleſſing of ſo advantageous Members? For by them we view the various Flowers, and the elegant Features of Beauty: with

Book I.

Book I. them we read, we write, we contemplate the Heavens and Stars, and measure their Distances, Magnitudes, and Journeys: which how far they are common to the Inhabitants of those Worlds with us, I shall presently examine. But first I shall enquire whether now we have given them one, we ought also to give them the other four Senses. And indeed as to Hearing many Arguments perswade me to give it a Share in the Animals of those new Worlds. For 'tis of great consequence in defending us from sudden Accidents; and, especially when Seeing is of no use to us, it supplies its Place, and gives us seasonable warning of any imminent Danger. Besides, we see many Animals call their Fellow to them with their Voice, which Language may have more in it than we are aware of, tho' we don't understand it. But if we do but consider the vast Uses and necessary Occasions of Speaking on the one side, and Hearing on the other, among those Creatures that make use of their Reason, it will scarce seem credible that two such useful, such

Hearing.

ex-

excellent Things were deſigned only for us. For how is it poſſible but that they that are without theſe, muſt be without many other Neceſſaries and Conveniencies of Life? Or what can they have to recompenſe this Want? Then, if we go ſtill farther, and do but meditate upon the neat and frugal Contrivance of Nature in making the ſame Air, by the drawing in of which we live, by whoſe Motion we ſail, and by whoſe Means Birds fly, for a Conveyance of Sound to our Ears; and this Sound for the Conveyance of another Man's Thoughts to our Minds: Can we ever imagine that ſhe has left thoſe other Worlds deſtitute of ſo vaſt Advantages? That they don't want the Means of them is certain, for their having Clouds in *Jupiter* puts it paſt doubt that they have Air too; that being moſtly formed of the Particles of Water flying about, as the Clouds are of them gathered into ſmall Drops. And another Proof of it is, the neceſſity of breathing for the preſervation of Life, a Thing that ſeems to be as univerſal a Dictate of Nature, as feeding upon the Fruits of the Earth. Book 1.

A Medium to convey Sound to the Ears.

Book I. As for Feeling, it ſeems to be given upon neceſſity to all Creatures that are cover'd with a fine and ſenſible Skin, as a Caution againſt coming too near thoſe Things that may injure or incommode them: and without it they would be liable to continual Wounds, Blows and Bruiſes. Nature ſeems to have been ſo ſenſible of this, that ſhe has not left the leaſt place free from ſuch a Perception. Therefore it's probable that the Inhabitants of thoſe Worlds are not without ſo neceſſary a Defence, and ſo fit a Preſervative againſt Dangers and Miſhaps.

Touch.

Smell and Taſte.

And who is there that doth not ſee the inevitable neceſſity for all Creatures that live by feeding to have both Taſte and Smell, that they may diſtinguiſh thoſe Things that are good and nouriſhing, from thoſe that are miſchievous and harmful? If therefore we allow the Planetary Creatures to feed upon Herbs, Seeds, or Fleſh, we muſt allow them Taſte and Smell, that they may chuſe or refuſe any Thing according as they find it likely to be advantageous or noxious to them.

I know

I know that it hath been a Queſtion Book 1.
with many, whether there might not have been more Senſes than theſe five. If we ſhould allow this, it might nevertheleſs be reaſonably doubted, whether the Senſes of the Planetary Inhabitants are much different from ours. *Their Senſes not very different from ours.*

I muſt confeſs, I cannot deny but there might poſſibly have been more Senſes; but when I conſider the Uſes of thoſe we have, I cannot think but they would have been ſuperfluous. The Eye was made to diſcern near and remote Objects, the Ear to give us notice of what our Eyes could not, either in the Dark or behind our Back: Then what neither the Eye nor the Ear could, the Noſe was made (which in Dogs is wonderfully nice) to warn us of. And if any thing eſcapes the notice of the other four Senſes, we have Feeling to inform us of the too near Approaches of it before it can do us any miſchief. Thus has Nature ſo plentifully, ſo perfectly provided for the neceſſary preſervation of her Creatures here, that I think ſhe can give nothing more to thoſe there, but what will

Book I. will be needleſs and ſuperfluous. Yet the Senſes were not wholly deſigned for uſe: but Men from all, and all other Animals from ſome of them, reap Pleaſure as well as Profit, as from the Taſte in delicious Meats; from the Smell in Flowers and Perfumes; from the Sight in the Contemplation of beauteous Shapes and Colours; from the Hearing in the Sweetneſs and Harmony of Sounds; from the Feeling in Copulation, unleſs you pleaſe to count that for a particular Senſe by it ſelf. Since it is thus, I think 'tis but reaſonable to allow the Inhabitants of the Planets theſe ſame Advantages that we have from them. For upon this Conſideration only, how much happier and eaſier a Man's Life is rendred by the enjoyment of them, we muſt be obliged to grant them theſe Bleſſings, except we would engroſs every thing that is good to our ſelves, as if we were worthier and more deſerving than any elſe. But moreover, that Pleaſure which we perceive in Eating or in Copulation, ſeems to be a neceſſary and provident Command of Nature,

They have Pleaſure ariſing from the Senſes.

ture, whereby it tacitly compels us to the preſervation and continuance of our Life and Kind. It is the ſame in Beaſts. So that both for their Happineſs and Preſervation it's very probable the reſt of the Planets are not without it. Certainly when I conſider all theſe Things, how great, noble, and uſeful they are; when I conſider what an admirable Providence it is that there's ſuch a Thing as Pleaſure in the World, I can't but think that our Earth, the ſmalleſt part almoſt of the Univerſe, was never deſign'd to monopolize ſo great a Bleſſing. And thus much for thoſe Pleaſures which affect our bodily Senſes, but have little or no relation to our Reaſon and Mind. But there are other Pleaſures which Men enjoy, which their Soul only and Reaſon can reliſh: Some airy and brisk, others grave and ſolid, and yet nevertheleſs Pleaſures, as ariſing from the Satisfaction which we feel in Knowledge and Inventions, and Searches after Truth, of which whether the Planetary Inhabitants are not partakers, we ſhall have an opportunity of enquiring by and by. There

Book I. There are ſome other things to be conſider'd firſt, in which it's probable they have ſome relation to us. That the Planets have thoſe Elements of Earth, Air and Water, as well as we, I have already made not unlikely. Let us now ſee whether they may not have Fire alſo: which is not ſo properly call'd an Element, as a very quick Motion of the Particles in the inflamable Body. But be it what it will, there are many Arguments for their not being without it. For this Earth is not ſo truly call'd the Place of Fire as the Sun: and as by the Heat of that all Plants and Animals here thrive and live; ſo, no doubt, it is in the other Planets. Since then Fire is cauſed by a moſt intenſe and vigorous Heat, it follows that the Planets, eſpecially thoſe nearer the Fountain of it, have their proportionate degrees of Heat and Fire. And ſince there are ſo many ways of its Production, as by the collection of the Rays of the Sun, by the reflection of Mirrors, by the ſtriking of Flint and Steel, by the rubbing of Wood, by the cloſe loading of moiſt

All the Planets have Fire.

moiſt Graſs, by Lightning, by the eruptions of Mountains and Volcanos, it's ſtrange if neither Art ſhould have produced it, nor Nature effected it there by one of theſe many means. Then how uſeful and neceſſary is it to us? By it we drive away Cold, and ſupply the want of the Sun in thoſe Countries where his oblique Rays make a leſs vigorous Impreſſion, and ſo keep a great part of the Earth from being an uninhabited Deſart: which is equally neceſſary in all the Planets, whether we allow them Succeſſion of Seaſons, or a perpetual Spring and Æquinox: for even then the Countries near the Pole would receive but little Advantage from the Heat of the Sun. By the help of this we turn the Night into Day, and thereby make a conſiderable addition to the ſhortneſs of our Lives. Upon all theſe Accounts we ought not to think this Earth of ours enjoy it all alone, and exclude all the other Planets from ſo advantageous and ſo profitable a Gift. Book I.

But perhaps it may be asked as well concerning Brutes as rational Creatures,

Book 1. tures, and of their Plants and Trees too, whether they are proportionably larger or less than ours. For if the Magnitude of the Planets was to be the Standard of their measure, there would be Animals in *Jupiter* ten or fifteen times larger than Elephants, and as much longer than our Whales, and then their Men must be all Giants in respect to us. Now tho' I don't see any so great Absurdity in this as to make it impossible, yet there is no reason to think it is really so, seeing Nature has not always ty'd her self to those Rules which we have thought more convenient for her: For example, the Magnitude of the Planets is not answerable to their distances from the Sun; but *Mars*, tho' more remote, is far less than *Venus*: and *Jupiter* turns round his Axis in ten Hours, when the Earth which is much less than him, spends 24. But since Nature, perhaps some will say, has not observed such a Regularity in the proportion of Things, for ought we know there may be only a Race of Pygmies about the Bigness of Frogs and Mice, pos-

The bigness of their Creatures not rightly guest at by the bigness of the Planets.

seſs'd of the Planets. But I ſhall ſhow that this is very improbable by and by. Book I.

There may ariſe another Queſtion, whether there be in the Planets but one ſort of rational Creatures, or if there be not ſeveral ſorts poſſeſſed of different degrees of Reaſon and Senſe. There is ſomething not unlike this to be obſerved among us. For to paſs by thoſe who have human Shape (altho' ſome of them would very well bear that Enquiry too) if we do but conſider ſome ſorts of Beaſts, as the Dog, the Ape, the Beaver, the Elephant, nay ſome Birds and Bees, what Senſe and Underſtanding they are maſters of, we ſhall be forced to allow, that Man is not the only rational Animal. For we diſcover ſomewhat in them of Reaſon independent on, and prior to all Teaching and Practice. *In the Planets are many ſorts of rational Creatures as well as here.*

But ſtill no Body can doubt, but that the Underſtanding and Reaſon of Man is to be preferr'd to theirs, as being comprehenſive of innumerable Things, indued with an infinite memory of what's paſt, and capable of providing

Book I. viding againſt what's to come. That there is ſome ſuch Species of rational Creatures in the other Planets, which is the Head and Sovereign of the reſt, is very reaſonable to believe: for otherwiſe, were many Species endued with the ſame Wiſdom and Cunning, we ſhould have them always doing Miſchief, always quarrelling and fighting one with another for Empire and Sovereignty, a Thing that we feel too much of where we have but one ſuch Species. But to let that paſs, our next Enquiry ſhall be concerning thoſe Animals in the Planets which are furniſhed with the greateſt Reaſon, whether it's poſſible to know wherein they employ it, and whether they have made as great Advances in Arts and Knowledge as we in our Planet. Which deſerves moſt to be conſidered and examined of any thing belonging to their Nature; and for the better Performance of it we muſt take our Riſe ſomewhat higher, and nicely view the Lives and Studies of Men.

And in thoſe things wherein Men provide and take care only of what's ab-

absolutely necessary for the preservation of their Life; in defending themselves from the Injuries of the Air; in securing themselves against the Incursions of Enemies by Walls; and against Fraud and Disturbances by Laws; in educating their Children, and providing for themselves and them: In all these I can see no great reason that Man has to boast of the Pre-eminency of his Reason above Beasts and other Animals. For most of these Things they perform with greater Ease and Art than we, and some of them they have no need of. For that Sense of Virtue and Justice in which Man excels, of Friendship, Gratitude and Honesty, of what use are they, but either to put a stop to the Wickedness of Man, or to secure us from mutual Assaults and Injuries, Things wherein the Beasts want no Guide but Nature and Inclination? Then if we set before our Eyes the manifold Cares, the Disturbances of Mind, the restless Desires, the dread of Death, that are the result of this our Reason; and compare them with Book I.

Book I. that eaſy, quiet, and harmleſs Life which other Animals enjoy, we ſhould be apt to wiſh a Change, and conclude that they, eſpecially Birds, lived with more Pleaſure and Happineſs than Man could with all his Wiſdom. For they have as great a Reliſh of bodily Pleaſures as we, let the new Philoſophers ſay what they will, who would have them to be nothing but Clocks and Engines of Fleſh; a Thing which Beaſts ſo plainly confute by crying and running away from a Stick, and all other Actions, that I wonder how any one could ſubſcribe to ſo abſurd and cruel an Opinion. Nay, I can ſcarce doubt but that Birds feel no ſmall Pleaſure in their eaſy, ſmooth ſailing through the Air; and would much more if they but knew the Advantages it hath above our ſlow and laborious Progreſſion. What is it then after all that ſets human Reaſon above all other, and makes us preferable to the reſt of the Animal World? Nothing in my Mind ſo much as the Contemplation of the Works of God, and the Study of Nature, and the improving

Men chiefly differ from Beaſts in the Study of Nature.

proving thoſe Sciences which may bring us to ſome knowledge in their Beauty and Variety. For without Knowledge what would be Contemplation? And what difference is there between a Man, who with a careleſs ſupine Negligence views the Beauty and Uſe of the Sun, and the fine golden Furniture of the Heaven, and one who with a learned Niceneſs ſearches into their Courſes; who underſtands wherein the Fix'd Stars, as they are call'd, differ from the Planets, and what is the Reaſon of the regular Viciſſitude of the Seaſons; who by ſound Reaſoning can meaſure the Magnitude and Diſtance of the Sun and Planets? Or between ſuch a one as admires perhaps the nimble Activity and ſtrange Motions of ſome Animals, and one that knows their whole Structure, underſtands the whole Fabrick and Architecture of their Compoſition? If therefore the Principle we before laid down be true, that the other Planets are not inferiour in Dignity to ours, what follows but that they have Creatures not to ſtare and wonder at the

They have Aſtronomy.

Book 1. Works of Nature only, but who employ their Reaſon in the Examination and Knowledge of them, and have made as great Advances therein as we have? They do not only view the Stars, but they improve the Science of Aſtronomy: nor is there any thing can make us think this improbable, but that fond Conceitedneſs of every Thing that we call our own, and that Pride that is too natural to us to be eaſily laid down. But I know ſome will ſay, we are a little too bold in theſe Aſſertions of the Planets, and that we mounted hither by many Probabilities, one of which, if it chance to be falſe, and contrary to our Suppoſition, would, like a bad Foundation, ruin the whole Building, and make it fall to the Ground. But I would have them to know, that all I have ſaid of their Knowledge in Aſtronomy, has Proofs enough, antecedent to thoſe we now produced. For ſuppoſing the Earth, as we did, one of the Planets of equal Dignity and Honour with the reſt, who would venture to ſay, that no where elſe were to be found any that en-

enjoy'd the glorious Sight of Nature's Theatre? Or if there were any Fellow-Spectators, yet we were the only ones that had dived deep into the Secrets and Knowledge of it? So that here's a Proof not so far fetch'd for the Astronomy of the Planets, the same which we used for their having rational Creatures, and enjoying the other Advantages we before talk'd of, which serves at the same time for the Confirmation of our former Conjectures. But if Amazement and Fear at the Eclipses of the Moon and Sun gave the first occasion to the Study of Astronomy, as probably they did, then it's almost impossible that *Jupiter* and *Saturn* should be without it; the Argument being of much greater force in them, by reason of the daily Eclipses of their Moons, and the frequent ones of the Sun to their Inhabitants. So that if a Person disinterested in his Judgment, and equally ignorant of the Affairs of all the Planets, were to give his Opinion in this Matter, I don't doubt he would give the Cause for Astronomy to those two Planets rather than us. Book 1.

Book 1. This Suppoſition of their Knowledge and Uſe of Aſtronomy in the Planetary Worlds, will afford us many new Conjectures about their manner of Life, and their State as to other things.

And all its ſubſervient Arts. For, Firſt: No Obſervations of the Stars that are neceſſary to the Knowledge of their Motions, can be made without Inſtruments; nor can theſe be made without Metal, Wood, or ſome ſuch ſolid Body. Here's a neceſſity of allowing them the Carpenters Tools, the Saw, the Ax, the Plane, the Mallet, the File: and the making of theſe requires the Uſe of Iron, or ſome equally hard Metal.

Geometry and Arithmetick: Again, theſe Inſtruments can't be without a Circle divided into equal Parts, or a ſtrait Line into unequal. Here's a neceſſity for introducing Geometry and Arithmetick.

And Writing. Then the Neceſſity in ſuch Obſervations of marking down the Epochas or Accounts of Time, and of tranſmitting them to Poſterity, will force us to grant them the Art of Writing; perhaps very different from ours which is commonly uſed, but I dare affirm not more ingenious

nious or eaſy. For how much more ready and expeditious is our Way, than by that multitude of Characters uſed in *China*; and how vaſtly preferable to Knots tied in Cords, or the Pictures in uſe among the barbarous People of *Mexico* and *Peru*? There's no Nation in the World but has ſome way or other of writing or marking down their Thoughts: So that it's no wonder if the Planetary Inhabitants have been taught it by that great Schoolmiſtreſs Neceſſity, and apply it to the Study of Aſtronomy and other Sciences. In Aſtronomical Matters the Neceſſity of it is moreover apparent from hence, that the Motion of the Stars is as 'twere to be fancied and gueſs'd at in different Syſtems, and theſe Syſtems to be continually improved and corrected, as later and more exact Obſervations ſhall convince the old ones of Faults: all which can never be deliver'd down to ſucceeding Generations, unleſs we make uſe of Letters and Figures. Book 1.

But after all theſe large and liberal Allowances to Them, they will ſtill

Book 1. *And Opticks.*

be behind-hand with us. For we have ſo certain a Knowledge of the true Syſtem and Frame of the Univerſe; we have ſo admirable an Invention of Teleſcopes to help our failing Eye-ſight in the view of the Bigneſs and different Forms of the Planetary Bodies, in the diſcovery of the Mountains, and the Shadows of them on the Surface of the Moon, in the bringing to light an innumerable multitude of Stars otherwiſe inviſible, that we muſt neceſſarily be far their Maſters in that Knowledge. Hence it is almoſt neceſſary (except we have a Mind to flatter and complement our ſelves as the only People that have the Advantage of ſuch excellent Inventions) either to allow the Planetary Inhabitants ſuch ſharp Eyes as not to need them, or elſe the uſe of Glaſſes to help the Deficiency of their Sight. And yet I dare not aſſert this, leſt any one ſhould be ſo diſturbed at the Extravagancy of ſuch an Opinion, as to take the meaſure of my other Conjectures by it, and hiſs them all off, upon the account of this alone.

But

But ſome Body may perhaps object, and that not without reaſon at firſt ſight, that the Planetary Inhabitants it's likely are deſtitute of all refined Knowledge, juſt as the *Americans* were before they had Commerce with the *Europeans*. For if one conſiders the Ignorance of thoſe Nations, and of others in *Aſia* and *Africa* equally barbarous, it will appear as if the main Deſign of the Creator in placing Men upon the Earth was that they might live, and, in a juſt ſenſe of all the Bleſſings and Pleaſure they enjoy, worſhip the Fountain of their Happineſs; but that ſome few went beyond the Bounds of Nature in their Enquiries after Knowledge. There does not want an Anſwer to theſe Men. For God could not but foreſee the Advances Men would make, in their enquiring into the Heavenly Bodies: that they would diſcover Arts uſeful and advantageous to Life: that they would croſs the Seas, and dig up the Bowels of the Earth. Nothing of all this could happen contrary to the Mind and Knowledge of the Infinite Author of all Things. And if he

Book 1.

Theſe Sciences not contrary to Nature.

Book 1. he foreſaw theſe Things would be, he ſo appointed and deſtin'd them to humane kind. And the Studies of Arts and Sciences cannot be ſaid to be contrary to Nature, ſince in the ſearch thereof they are employ'd: eſpecially if we conſider how great the natural deſire and love of Knowledge, rooted in all Men is. For it's impoſſible this ſhould have been given them upon no Deſign or Account. But they will urge, that if ſuch a Knowledge is natural, if we were born for it, why are there ſo very few, eſpecially in Aſtronomy, that proſecute theſe Studies? For *Europe* is the only Quarter of the Earth in which there have been any Advancements made in Aſtronomy. And as for the Judicial Aſtrology, which pretends to foretel what is to come, it is ſuch a wretched and oftentimes miſchievous piece of Madneſs, that I do not think it ought to be ſo much as named here. And even in *Europe*, not one in a hundred Thouſand meddles with theſe Studies. Beſides, its Original and Riſe is ſo late, that many Ages were paſt before the

the very first Rudiments of Astronomy or Geometry (which is necessary to the learning of it) were known. For every Body is acquainted almost with its first Beginnings in *Egypt* and *Greece*. Add to this, that 'tis not yet above fourscore Years since the bungling Epicycles were discarded, and the true and easy plain Motion of the Planets was discovered. For the Satisfaction of these Scruples, to what we said before, concerning the Fore-knowledge of God, may be added this; That God never designed we should come into the World Astronomers or Philosophers; these Arts are not infused into us at our Birth, but were ordered, in long Tracts of Time, by degrees to be the Rewards and Result of laborious Diligence; especially those Sciences which are now in debate, are so much the more difficult and abstruse, that their late Invention and slow Progress are so far from being a Wonder, that it is rather strange they were ever discover'd at all. There are but few, I acknowledge one or two perhaps in an Age, that pursue them, or

Book I. or think them their Buſineſs: but their Number will be very conſiderable if we take in thoſe that have lived in all the Ages in which Aſtronomy hath flouriſhed: and no Body can deny them that Happineſs and Contentment which they have pretended to above all others. In fine, it was ſufficient that ſo ſmall a Number ſhould make it their Study, ſo that the Profit and Advantage of their Inventions might but ſpread it ſelf over all the World. Since then the Inhabitants of this Earth, let them be never ſo few, have had Parts and Genius ſufficient for the Attainment of this Knowledge; and there's no reaſon to think the Planetary Inhabitants leſs ingenious or happy than our ſelves; we have gain'd our Point, and 'tis probable that they are as skilful Aſtronomers as we can pretend to be. So that now we may venture to deduce ſome Conſequences from ſuch a Suppoſition.

We have before ſhow'd the neceſſary Dependence and Connexion, not only of Geometry and Arithmetick, but of Mechanical Arts and Inſtruments with this Science. This leads us

us naturally to the Enquiry how they can uſe theſe Inſtruments and Engines for the Obſervation of the Stars, how they can write down ſuch their Obſervations, and perform other Things which we do with our Hands. So that we muſt neceſſarily give them Hands, or ſome other Member, as convenient for all thoſe Uſes, inſtead of them. One of the ancient Philoſophers laid ſuch Streſs upon the Uſe and Conveniency of the Hands, that he made no ſcruple to affirm, they were the Cauſe and Foundation of all our Knowledge. By which, I ſuppoſe, he meant no more, than that without their Help and Aſſiſtance Men could never arrive to the Improvement of their Minds in natural Knowledge: And indeed not without Reaſon. For ſuppoſe inſtead of them they had had Hoofs like Horſes or Bullocks given them, they might have laid indeed the Model and Deſign of Cities and Houſes in their Head, but they would never have been able to have built them. They would have had no Subject of Diſcourſe but what belong'd to their Vi-

Book I.

They have Hands.

Book I. Victuals, Marriages, or Self-preſervation. They would have been void of all Knowledge and Memory, and indeed would have been but one degree diſtant from brute Beaſts. What could we invent or imagine that could be ſo exactly accommodated to all the deſign'd Uſes as the Hands are? Elephants can lay hold of, or throw any thing with their Proboſcis, can take up even the ſmalleſt Things from the Ground, and can perform ſuch ſurpriſing Things with it, that it has not very improperly been call'd their Hand, tho' indeed it is nothing but a Noſe ſomewhat longer than ordinary. Nor do Birds ſhow leſs Art and Deſign in the Uſe of their Bills in the picking up their Meat, and the wonderful Compoſure of their Neſts. But all this is nothing to thoſe Conveniences the Hand is ſo admirably ſuited to; nothing to that amazing Contrivance in its Capacity of being ſtretched, or contracted, or turned to any Part as Occaſion ſhall require. And then, to paſs by that nice Senſe that the Ends of the Fingers are endued with, even to the feeling and di-

distinguishing most sorts of Bodies in the Dark, what Wisdom and Art is shown'd in the Disposition of the Thumb and Fingers, so as to take up or keep fast hold of any Thing we please? Either then the Planetary Inhabitants must have Hands, or somewhat equally convenient, which it is not easy to conceive; or else we must say that Nature has been kinder not only to us, but even to Squirrels and Monkeys than them. Book 1.

And Feet.

That they have Feet also scarce any one can doubt, that does but consider what we said but just now of Animals different Ways of going along, which it's hard to imagine can be perform'd any other ways than what we there recounted. And of all those, there's none can agree so well with the state of the Planetary Inhabitants, as that that we here make use of. Except (what is not very probable, if they live in Society, as I shall show they do) they have found out the Art of flying in some of those Worlds.

That they are upright.

The Stature and Shape of Men here does show forth the Divine Providence

Book I. dence so much in its being so fitly adapted to its design'd Uses, that it is not without reason that all the Philosophers have taken notice of it, nor without Probability that the Planetary Inhabitants have their Eyes and Countenance upright, like us, for the more convenient and easy Contemplation and Observations of the Stars. For if the Wisdom of the Creator is so observable, so Praise-worthy in the Position of the other Members; in the convenient Situation of the Eyes, as Watches in the higher Region of the Body; in the removing of the more uncomely Parts out of sight as 'twere; we cannot but think he has almost observed the same Method in the Bodies of those remote Inhabitants. Nor does it follow from hence that they must be of the same Shape with us. For there is such an infinite possible variety of Figures to be imagined, that both the Structure of their whole Bodies, and every part of them, both outside and inside, may be quite different from ours. How warmly and conveniently are some Creatures cloath'd with Wool,

It follows not therefore that they have the same Shape with us.

Wool, and how finely are others deck- Book 1.
ed and adorn'd with Feathers? Perhaps among the rational Creatures in the Planets there may ſome ſuch diſtinction be obſerv'd in their Garb and Covering; a Thing in which Beaſts ſeem to excel Men in here. Unleſs perhaps Men are born naked, for this reaſon to put them upon employing and exerciſing their Wits, in the inventing and making that Attire that Nature had made neceſſary for them. And 'tis this Neceſſity that has been the greateſt, if not only occaſion of all the Trade and Commerce, of all the Mechanical Inventions and Diſcoveries that we are Maſters of. Beſides, Nature might have another great Conveniency in her Eye, by bringing Men into the World naked, namely, that they might accommodate themſelves to all places of the World, and go thicker or thinner cloth'd, according as the Seaſon and Climate they liv'd in requir'd. There may ſtill be conceiv'd a greater difference between us and the Inhabitants of the Planets; for there are ſome ſort of Animals, ſuch

Book 1. as Oysters, Lobsters, and Crab-fish, whose Flesh is on the inside of their Bones as 'twere. But that which hinders me from ascribing such a kind of Frame and Composition to the Planetary Inhabitants, is that Nature seems to have done it only in a few of the meanest Sort of Creatures, and that hereby they would be deprived of that quick easy motion of their Hands and Fingers, which is so useful and necessto them, otherwise I should not be much affected with the odd Shape and Figure.

A rational Soul may inhabit another Shape than ours.

For 'tis a very ridiculous Opinion, that the common People have got, that 'tis impossible a rational Soul should dwell in any other Shape than ours. And yet as silly as 'tis, it has been the occasion of many Philosophers allowing the Gods no other Shape; nay, the Foundation of a Sect among the Christians, that from hence have the Name of *Anthropomorphites*. This can proceed from nothing but the Weakness, Ignorance, and Prejudice of Men; the same as that other concerning humane Shape, that it is the

the handſomeſt and moſt excellent of all others, when indeed it's nothing but a being accuſtomed to that Figure that makes us think ſo, and a Conceit that we and all other Animals naturally have, that no Shape or Colour can be ſo good as our own. Yet ſo powerful are theſe, that were we to meet with a Creature of a much different Shape from Man, with Reaſon and Speech, we ſhould be much ſurpriſed and ſhocked at the Sight. For if we try to imagine or paint a Creature like a Man in every Thing elſe, but that has a Neck four times as long, and great round Eyes five or ſix times as big, and farther diſtant, we cannot look upon't without the utmoſt Averſion, altho' at the ſame time we can give no account of our Diſlike. Book I.

The Planetarians not leſs than we.

When I juſt now mentioned the Stature of the Planetary Inhabitants, I hinted that 'twas improbable they ſhould be leſs than we are. For it's likely, that as our Bodies are made in ſuch a proportion to our Earth, as to render us capable of travelling about it, and making Obſerva-

Book I. tions upon its Bulk and Figure, the same Order is obſerv'd in the Inhabitants of the other Planets, unleſs in this Particular alſo, which is very conſiderable, we would prefer our ſelves to all others. Then ſeeing we have before allow'd them Aſtronomy and Obſervations, we muſt give them Bodies and Strength ſufficient for the ruling their Inſtruments, and the erecting their Tubes and Engines. And for this the larger they are the better. For if we ſhould ſuppoſe them Dwarfs not above the Bigneſs of Rats or Mice, they could neither make ſuch Obſervations as are requiſite; nor ſuch Inſtruments as are neceſſary to thoſe Obſervations. Therefore we muſt ſuppoſe them larger than, or at leaſt equal to, our ſelves, eſpecially in *Jupiter* and *Saturn*, which are ſo vaſtly bigger than the Planet which we inhabit.

They live in Society. Aſtronomy, we ſaid before, could never ſubſiſt without the writing down the Obſervations: Nor could the Art of Writing (any more than the Arts of Carpenters and Founders) ever be found out except in a Society of

of reaſonable Creatures, where the Neceſſities of Life forc'd them upon Invention: So that it follows from hence, (as was before ſaid) that the Planetary Inhabitants muſt in this be like us, that they maintain a Society and Fellowſhip with, and afford mutual Aſſiſtances and Helps to one another. Hereupon we muſt allow them a ſettled, not a wandring *Scythian* way of living, as more convenient for Men in ſuch Circumſtances. But what follows from hence? Muſt they not have every thing elſe proper for ſuch a manner of living granted them too? Muſt they not have their Governours, Houſes, Cities, Trade and Bartering? Why ſhould they not, when even the barbarous People of *America* and other Places were at their firſt Diſcovery found to have ſomewhat of that nature in uſe among them. I don't ſay, that Things muſt be the ſame there as they are here. We have many that may very well be ſpared among rational Creatures, and were deſign'd only for the preſervation of Society from all Injury, and for the curbing of thoſe Book 1.

Book I. Men who make an ill uſe of their Reaſon to the Detriment of others. Perhaps in the Planets they have ſuch plenty and affluence of all good Things, as they neither need or deſire to ſteal from one another; perhaps they may be ſo juſt and good as to be at perpetual Peace, and never to lie in wait for, or take away the Life of their Neighbour: perhaps they may not know what Anger or Hatred are; and if ſo, they muſt be much happier than we. But it's more likely they have ſuch a mixture of Good with Bad, of Wiſe with Fools, of War with Peace, and want not that School-miſtreſs of Arts Poverty. For, as was before ſhown, ſome good uſe may be made of theſe things, but if not, there is no Reaſon why we ſhould prefer their Condition to our own.

They enjoy the Pleaſures of Society. What I am now going to ſay may ſeem ſomewhat more bold, and yet is not leſs likely than the former. For if theſe Nations in the Planets live in Society, as I have pretty well ſhow'd they do, 'tis ſomewhat more than probable that they enjoy not only the Profit,

Profit, but the Pleaſures ariſing from Society: ſuch as Converſation, Amours, Jeſting, and Shews. Otherwiſe we ſhould make them live without Diverſion or Merriment; we ſhould deprive them of the great Sweetneſs of Life, which it can't well be without, and give our ſelves ſuch an Advantage over them as Reaſon will by no means admit of. Book I.

But to proceed to a farther Enquiry into their Buſineſs and Employment, let's conſider what we have not yet mention'd, wherein they may bear any Likeneſs to us. And firſt we have good Reaſon to believe they build themſelves Houſes, becauſe we are ſure they are not without their Showers. For in *Jupiter* have been obſerved Clouds, big no doubt with Vapours and Water, which hath been proved by many other Arguments, not to be wanting in that Planet. They have Rain then, for otherwiſe how could all the Vapours drawn up by the Heat of the Sun be diſpoſed of? And Winds, for they are cauſed only by Vapours diſſolved by Heat, and it's

Book 1. plain that they blow in *Jupiter* by the continual Motion and Variety of the Clouds about him. To protect themselves from these, and that they may pass their Nights in Quiet and Safety, they must build themselves Tents or Huts, or live in Holes of the Earth. But why may we not suppose the Planetary Inhabitants to be as good Architects, have as noble Houses, and as stately Palaces as our selves? Unless we think that every Thing which belongs to our selves is the most beautiful and perfect that can be. And who are we, but a few that live in a little Corner of the World, upon a Ball ten Thousand times less than *Jupiter* or *Saturn*? And yet we must be the only skilful People at Building; and all others must be our Inferiours in the Knowledge of uniform Symetry; and not be able to raise Towers and Pyramids as high, magnificent, and beautiful, as our selves. For my part, I see no reason why they may not be as great Masters as we are, and have the Use of all those Arts subservient to it, as Stone-cutting and Brick-making,

They have Houses to secure 'em from Weather.

king, and whatſoever elſe is neceſſary for it, as Iron, Lead and Glaſs; or ornamental to it, as Gilding and Picture. Book I.

If their Globe is divided like ours, into Sea and Land, as it's evident it is (elſe whence could all thoſe Vapours in *Jupiter* proceed?) we have great Reaſon to allow them the Art of Navigation, and not vainly ingroſs ſo great, ſo uſeful a Thing to our ſelves. Eſpecially conſidering the great Advantages *Jupiter* and *Saturn* have for Sailing, in having ſo many Moons to direct their Courſe, by whoſe Guidance they may attain eaſily to the Knowledge that we are not Maſters of, of the Longitude of Places. And what a Multitude of other Things follow from this Allowance? If they have Ships, they muſt have Sails and Anchors, Ropes, Pullies, and Rudders, which are of particular Uſe in directing a Ship's Courſe againſt the Wind, and in ſailing different Ways with the ſame Gale. And perhaps they may not be without the Uſe of the Compaſs too, for the magnetical Matter, which continually paſſes thro' the Pores of our Earth, is

Book I. is of such a Nature, that it's very probable the Planets have something like it. But there's no doubt but that they must have the Mechanical Arts and Astronomy, without which Navigation can no more subsist, than they can without Geometry.

They have Navigation, and all Arts subservient.

But Geometry stands in no need of being prov'd after this manner. Nor doth it want Assistance from other Arts which depend upon it, but we may have a nearer and shorter Assurance of their not being without it in those Earths. For that Science is of such singular Worth and Dignity, so peculiarly imploys the Understanding, and gives it such a full Comprehension and infallible certainty of Truth, as no other Knowledge can pretend to: it is moreover of such a Nature, that its Principles and Foundations must be so immutably the same in all Times and Places, that we cannot without Injustice pretend to monopolize it, and rob the rest of the Universe of such an incomparable Study. Nay Nature it self invites us to be Geometricians; it presents us with Geometrical

As Geometry.

metrical Figures, with Circles and Squares, with Triangles, Polygones, and Spheres, and propoſes them as it were to our Conſideration and Study, which abſtracting from its Uſefulneſs, is moſt delightful and raviſhing. Who can read *Euclid*, or *Apollonius*, about the Circle, without Admiration? Or *Archimedes* of the Surface of the Sphere, and Quadrature of the Parabola without Amazement? or conſider the late ingenious Diſcoveries of the Moderns with Boldneſs and Unconcernedneſs? And all theſe Truths are as naked and open, and depend upon the ſame plain Principles and Axioms in *Jupiter* and *Saturn* as here, which makes it not improbable that there are in the Planets ſome who partake with us in theſe delightful and pleaſant Studies. But what's the greateſt Argument with me, that there are ſuch, is their Uſe, I had almoſt ſaid Neceſſity, in moſt Affairs of humane Life. Now we are got thus far, what if we ſhould venture ſomewhat farther, and ſay, that they have our Inventions of the Tables of Sines, of Logarithms, and Algebra? Book 1.

Book 1. Algebra? I know it would ſound very odd, and perhaps a little ridiculous, and yet there's no reaſon but the thinking our ſelves better than all the World, to hinder them from being as happy in their Diſcoveries, and as ingenious in their Inventions as we our ſelves are.

They have Muſick. It's the ſame with Muſick as with Geometry, it's every where immutably the ſame, and always will be ſo. For all Harmony conſiſts in Concord, and Concord is all the World over fix'd according to the ſame invariable Meaſure and Proportion. So that in all Nations the Difference and Diſtance of Notes is the ſame, whether they be in a continued gradual Progreſſion, or the Voice makes skips over one to the next. Nay very credible Authors report, that there's a ſort of Bird in *America*, that can plainly ſing in order ſix muſical Notes: Whence it follows, that the Laws of Muſick are unchangeably fix'd by Nature, and therefore the ſame Reaſon holds for their Muſick, as we e'en now ſhewed for their Geometry. For why, ſuppoſing other Na-

Nations and Creatures, endued with Reaſon and Senſe as well as we, ſhould not they reap the Pleaſures ariſing from theſe Senſes as well as we too? I don't know what Effect this Argument, from the immutable Nature of theſe Arts, may have upon the Minds of others; I think it no inconſiderable or contemptible one, but of as great Strength as that which I made uſe of above to prove that the Planetary Inhabitants had the Senſe of Seeing. Book I.

But if they take delight in Harmony, there is no doubt but that they have invented Muſical Inſtruments. For they could ſcarce help lighting upon ſome or other by chance; the Sound of a tight String, the Noiſe of the Winds, or the whiſtling of Reeds, might have given them the hint. From theſe ſmall Beginnings they perhaps, as well as we, have advanced by degrees to the Uſe of the Lute, Harp, Flute, and many ſtring'd Inſtruments. But altho' the Tones are certain and determinate, yet we find among different Nations a quite different manner and rule for Singing; as for-

Book I. formerly among the *Dorians*, *Phrygi-ans*, and *Lydians*, and in our Time among the *French*, *Italians*, and *Persians*. In like manner it may so happen, that the Musick of the Inhabitants of the Planets may widely differ from all these, and yet be very good. But why we should look upon their Musick to be worse than ours, there's no reason can be given; neither can we well presume that they want the Use of Half-Notes and Quarter-Notes, seeing the Invention of Half-Notes is so obvious, and the Use of them so agreeable to Nature. Nay, to go a Step farther, what if they should excel us in the Theory and practick part of Musick, and outdo us in Consorts of vocal and instrumental Musick, so artificially compos'd, that they shew their Skill by the Mixtures of Discords and Concords? and of this last sort 'tis very likely the 5th and 3d are in use with them.

This is a very bold Assertion, but it may be true for ought we know, and the Inhabitants of the Planets may possibly have a greater insight into the Theory of Musick than has yet been dis-

discover'd among us. For if you ask any of our Musicians, why two or more perfect Fifths cannot be used regularly in Composition; some say 'tis to avoid that Sweetness and Lushiousness which arises from the Repetition of this pleasing Chord. Others say, this must be avoided for the sake of that Variety of Chords that are requisite to make a good Composition; and these Reasons are brought by *Cartes* and others. But an Inhabitant of *Jupiter* or *Venus* will perhaps give you a better Reason for this, *viz.* because when you pass from one perfect Fifth to another, there is such a Change made as immediately alters your Key, you are got into a new Key before the Ear is prepared for it, and the more perfect Chords you use of the same kind in Consecution, by so much the more you offend the Ear by these abrupt Changes. Book II.

Again, one of these Inhabitants perhaps can show how it comes about, that in a Song of one or more Parts, the Key cannot be kept so well in the same agreeable Tenour, unless the intermediate Closes and Intervals be so temper'd,

as

Book 1. as to vary from their usual Proportions, and thereby to bear a little this way or that, in order to regulate the Scale. And why this Temperature is best in the System of the Strings, when out of the Fifth the fourth Part of a Comma is usually cut off; This same thing I have formerly shew'd at large.

But for the regulating the Tone of the Voice (as I before hinted) that may admit of a more easy proof, and we shall give you an Essay of it, since I have mentioned a thing that is not mere Imagination only: I say therefore, if any Person strike those Sounds which the Musicians distinguish by these Letters, C, F, D, G, C, by these agreeable Intervals, altogether perfect, interchangeable, ascending and descending with the Voice: Now this latter sound C will be one Comma, or very small portion lower than the first sounding of C. Because of these perfect Intervals, which are as 4 to 3, 5 to 6, 4 to 3, 2 to 3, an account is made in such a Proportion, as 160 to 162. that is, as 80 to 81, which is what they call a Comma. So that if the same Sound should

ſhould be repeated nine times, the Book I.
Voice would fall near the Matter a greater Tone, whoſe proportion is as 8 to 9. But this the Senſe of the Ears by no means endures, but remembers the firſt Tone, and returns to it again. Therefore we are compell'd to uſe an occult Temperament, and to ſing theſe imperfect Intervals, from doing which leſs Offence ariſes. And for the moſt part, all Singing wants this Temperament, as may be collected by the aforeſaid Computations. And theſe things we have offer'd to thoſe that have ſome Knowledge in Geometry.

We have ſpoke of theſe Arts and Inventions, which it is very probable the Inhabitants of the Planets partake of in common with us, beſides which it ſeems requiſite to take in many other Things that ſerve either for the Uſe or Pleaſure of their Lives. But what theſe Things are we ſhall the better account for, by laying before us many of thoſe Things which are found among us. I have before mention'd the Variety of Animals and Vegetables, which very much differ from each other,

Book I. among which there are ſome that differ but little; and I have ſaid, that there are no leſs differences in theſe Things in the Planetary Worlds.

I ſhall now take a ſhort view of the Benefits we receive both from thoſe Herbs and Animals, and ſee whether we may not with very good reaſon conclude that the Planetary Inhabitants reap as great and as many from thoſe that their Countries afford them.

And here it may be worth our while to take a Review of the Variety and Multitude of our Riches. For Trees and Herbs do not only ſerve us for Food, they in their delicious Fruits, theſe in their Seeds, Leaves and Roots; but Herbs moreover furniſh us with Phyſick, and Trees with Timber for our Houſes and Ships. Flax, by the means of thoſe two uſeful Arts of Spinning and Weaving, affords us Clothing. Of Hemp or Matweed we twiſt our ſelves Thread and ſmall Ropes, the former of which we employ in Sails and Nets, the latter in making larger Ropes for Maſts and Anchors. With the ſweet Smells and beau-

beauteous Colours of Flowers we feaſt our Senſes: and even thoſe of them that offend our Noſtrils, or are miſchievous to our Bodies, are ſeldom without excellent Uſes: or were made perhaps by Nature as a Foil to ſet off, and make us the more value the Good by comparing them with theſe. What vaſt Advantages and Profit do we reap from the Animals? The Sheep give us Clothing, and the Cows afford us Milk: and both of them their Fleſh for our Suſtenance. Aſſes, Camels, and Horſes do, what if we wanted them we muſt do our ſelves, carry our Burdens; and the laſt of them we make uſe of, either themſelves to carry us, or in our Coaches to draw us. In which we have ſo excellent, ſo uſeful an Invention of Wheels, that I can't ſuppoſe the Planets to enjoy Society and all its Conſequences, and be without them. Whether they are Pythagoreans there, or feed upon Fleſh as we do, I dare not affirm any Thing. Tho' it ſeems to be allowed Men to feed upon whatſoever may afford them Nouriſhment, either on Land, or in

Book I.

The Advantages we reap from Herbs and Animals.

Book I. Water, upon Herbs, and Pomes, Milk, Eggs, Honey, Fiſh, and no leſs upon the Fleſh of many Birds and Beaſts. But it is a ſurpriſing thing! that a rational Creature ſhould live upon the Ruin and Deſtruction of ſuch a number of other his Fellow-Creatures! And yet it does not ſeem at all unnatural, ſince not only he, but even Lions, Wolves, and other ravenous Beaſts, prey upon Flocks of other harmleſs Things, and make mere Fodder of them; as Eagles do of Pidgeons and Hares; and large Fiſh of the helpleſs little ones. We have different ſorts of Dogs for Hunting, and what our own Legs cannot, that their Noſe and Legs can help us to. But the Uſe and Profit of Herbs and Animals are not the only Things they are good for, but they raiſe our Delight and Admiration when we conſider their various Forms and Natures, and enquire into all their different ways of Generation: Things ſo infinitely multifarious, and ſo delightfully amazing, that the Books of natural Philoſophers are deſervedly filled with their Encomiums. For even in the very

very Insects, who can but admire the six-corner'd Cells of the Bees, or the artificial Web of a Spider, or the fine Bag of a Silk-worm, which last affords us, with the Help of incredible Industry, even Shiploads of soft delicate Clothing. This is a short Summary of those many profitable Advantages the animal and herbal World serve us with. Book I.

But this is not all. The Bowels of the Earth likewise contribute much to Man's Happiness. For what Art and Cunning does he employ in finding, in digging, in trying Metals, and in melting, refining, and tempering them? What Skill and Nicety in beating, drawing or dissolving Gold, so as with inconsiderable Changes to make every Thing he pleases put on that noble Lustre? Of how many and admirable Uses is Iron? and how ignorant in all Mechanical Knowledge were those Nations that were not acquainted with it, so as to have no other Arms but Bows, Clubs, and Spears, made of Wood. There's one Thing indeed we have, which it's a Question whether it has *And from Metals.*

Book 1. done more harm or good, and that is Gun-powder made of Nitre and Brimstone. At first indeed it seem'd as if we had got a more secure Defense than former Ages against all Assaults, and could easily guard our Towns, by the wonderful Strength of that Invention, against all hostile Invasions: but now we find it has rather encouraged them, and at the same time been no small Occasion of the Decay of Valour, by rendring it and Strength almost useless in War. Had the *Grecian* Emperor who said, *Virtue was ruin'd* only when Slings and Rams first came into use, liv'd in our Days, he might well have complain'd; especially of Bombs, against which neither Art nor Nature is of sufficient Proof: but which lays every Thing, Castles and Towers, be they never so strong, even with the Ground. If for nothing else, yet upon this one account, I think we had better have been without the Discovery. Yet, when we were talking of our Discoveries, it was not to be pass'd over, for the Planets too may have their mischievous as well as useful Inventions. We

We are happier in the Uſes for which the Air and Water ſerves us; both of which helps us in our Navigation, and furniſhes us with a Strength ſufficient, without any Labour of our own, to turn round our Mills and Engines; Things which are of uſe to us in ſo many different Employments. For with them we grind our Corn, and ſqueeze out our Oil; with them we cut Wood, and mill Cloth, and with them we beat our Stuff for Paper. An incomparable Invention! Where the naſtieſt uſeleſs Scraps of Linen are made to produce fine white Sheets. To theſe we may add the late diſcovery of Printing, which not only preſerves from Death Arts and Knowledge, but makes them much eaſier to be attained than before. Nor muſt we forget the Arts of Engraving and Painting, which from mean Beginnings have improved to that Excellence, that nothing that ever ſprung from the Wit of Man can claim Preeminence to them. Nor is the way of melting and blowing Glaſſes, and of poliſhing and ſpreading Quick-ſilver Book 1.

Book 1. over Looking-Glaſſes, unworthy of being mention'd, nor above all, the admirable uſes that Glaſſes have been put to in natural Knowledge, ſince the Invention of the Teleſcope and Microſcope. And no leſs nice and fine is the Art of making Clocks, ſome of which are ſo ſmall as to be no weight to the Bearer; and others ſo exact as to meaſure out the Time in as ſmall Portions as any one can deſire; the Improvement of both which the World owes to my Inventions.

* *The Author invented the Pendulum for Clocks.*

From the diſcoveries of our Age. I might add much here of the late Diſcoveries, moſt of them of this Age, which have been made in all ſorts of Natural Knowledge as well as in Geometry and Aſtronomy, as of the Weight and Spring of the Air, of the Chymical Experiments that have ſhown us a way of making Liquors that ſhall ſhine in the Dark, and with gentle moving ſhall burn of themſelves. I might mention the Circulation of the Blood through the Veins and Arteries, which was underſtood indeed before; but now, by the help of the Microſcope, has an ocular demon-

monſtration in the Tails of ſome Fiſhes: of the Generation of Animals, which now is found to be perform'd no otherwiſe than by the Seed of one of the ſame kind; and that in the Seed of the Male are diſcover'd, by the help of Glaſſes, Millions of ſprightly little Animals, which it's probable are the very Offspring of the Animals themſelves: a ſurpriſing thing, and never before now known! Book 1.

The Planets have, tho' not theſe ſame, yet as uſeful Inventions.

Thus have I put together all theſe late Diſcoveries of our Earth: and now, tho' perhaps ſome of them may be common to the Planetary Inhabitants with us, yet that they ſhould have all of them is not credible. But then they may have ſomewhat to make up that Defect, others as good and as uſeful, and as wonderful, that we want. We have allow'd that they may have rational Creatures among them, and Geometricians, and Muſicians: We have prov'd that they live in Societies, have Hands and Feet, are guarded with Houſes and Walls: Wherefore if a Man could be carried thither by ſome powerful Genius, ſome *Mercury*, I don't doubt

Book 1. doubt 'twould be a very curious ſight, curious beyond all Imagination, to ſee the odd ways, and the unuſual manner of their ſetting about any thing, and their ſtrange methods of living. But ſince there's no hopes of our going ſuch a Journey, we muſt be contented with what's in our Power: we may ſuppoſe our ſelves there, and inquire as far as we can into the Aſtronomy of each Planet, and ſee in what manner the Heavens preſent themſelves to their Inhabitants. We ſhall make ſome Obſervations of the Eminence of each of them, in reſpect of their Magnitude, and number of Moons they have to wait on them; and ſhall propoſe a new Method of coming to ſome Knowledge of the incredible diſtance of the fix'd Stars. But firſt after this long and deep Thoughtfulneſs we will give our ſelves a little Reſt, and ſo put an end to this Book.

New

Book 2.

New Conjectures concerning the Planetary Worlds.

BOOK the Second.

'TWAS a pretty many Years ago that I chanc'd to light upon *Athanasius Kircher*'s Book, call'd *The Ecstatick Journey*, which treats of the nature of the Stars, and of the Things that are to be found in the Superficies of the Planets: I wonderedto see nothing there of what I had often thought not improbable, but quite other Things, nothing but a Heap of idle unreasonable Stuff: which I was the more confirm'd in, when, after the writing of the former part, I ran over the Book again. And I thought mine were very considerable and weighty Matters if compar'd with *Kircher*'s. That other People may be satisfied in this, and see how vainly those, who cast off the only Foundations of Probability in such Matters, which we have all the way made use of, pretend to philoso-

phize

Book 2. phize in this caſe, I think it will not be beſide the Purpoſe to beſtow ſome few Reflections upon that Book.

Kircher's Journey in Ecſtacy examin'd.

That ingenious Man ſuppoſing himſelf carried by ſome Angel thro' the vaſt Spaces of Heaven, and round the Stars, tells us, he ſaw a great many things, ſome of which he had out of the Books of Aſtronomers, the reſt are the Product of his own Fancy and Thoughts. But, before he enters upon his Journey, he lays down theſe two Things as certain; that no Motion muſt be allowed the Earth, and that God has made nothing in the Planets, no not ſo much as Herbs, which has either Life or Senſe in it. Leaving then the Syſtem of *Copernicus*, he chuſes *Tycho* for his Guide. But when he ſuppoſes all the fix'd Stars to be Suns, and round each of them places their Planets, here (againſt his Will I ſuppoſe) he has unawares made an infinite number of *Copernican* Syſtems. All which, beſide their own Motion, he abſurdly makes to be carried, with an incredible ſwiftneſs, in twenty four Hours round the Earth. Since moſt of

of these Worlds are out of the Reach Book 2.
of any Man's sight, as he owns they are, I cannot think for what purpose he makes so many Suns to shine upon desolate Lands (like our Earth in every thing, he says, only that they have neither Plants nor Animals) where there's no one to whom they should give light. And from hence he still falls into more and more Absurdities. And because he could find no other use of the Planets, even in our System, he is forc'd to beg Help of the Astrologers; and would have all those vast Bodies made upon no other account than that the whole Universe might be preserved and continue secure by their means, and that they might govern the Mind of Man by their various and regular Influences. Accordingly, to gratify Astrology, he says that *Venus* was the most pleasant Place, every thing fine and handsome, its Light gentle, its Waters sweet and purling, and it self beset all about with shining Chrystals. In *Jupiter* he found wholesome and sweet Gales, delicate Waters, and a Land shining like Silver. For from these

Book 2. these two Planets it seems, Men have all that is happy and healthful poured down upon them; and all that renders them handsome and lovely, wise and grave, is owing to their Influences. *Mercury* had I don't know what Airiness and Briskness in it; whence Men derive, when they are first born, all their Wit and Cunning. *Mars* was nothing but infernal, stinking, black Flames and Smoke: and *Saturn* was all melancholy, dreadful, nasty, and dark: for these are the Planets (I don't know why, but all Fortune-tellers hate them) that bring all the Plagues and Mischiefs that we feel upon us, and would exercise their Spite still more, unless they were sometimes mitigated and corrected by the benign and kind Influences of the other Planets. All this and such like Stuff his Genius teaches him. Which he makes give a serious Answer to this idle Question, Whether a Jew or Heathen could be duly and rightly baptized in the Waters of *Venus*? Of him too he learns that the Heaven of the fix'd Stars is not made of solid Matter, but of a thin fluid, where-

wherein an innumerable company of Stars and Suns lie floating here and there, not chain'd down to any Place, (thus far he's in the right) and describing in the Space of a Day these prodigious Circles round the Earth. He forgets here, if there were such a Motion, with what an incredible swiftness they would fly off from every part of their Orbits. But I suppose the Intelligences that he has plac'd in them are to take care of that, those Angels that preside over, and regulate their Motions. And in that he follows a company of Doctors that harbour'd that idle fancy of *Aristotle* upon no Account or Consideration. But *Copernicus* has freed those Intelligences of all that Labour and Trouble, only by bringing in the Motion of the Earth: which, if upon no other Account, every one that is not blind purposely, must own to be necessary upon this. I dare say *Kircher*, if he had dar'd freely to speak his Mind, could have afforded us better sort of Things than these. But when he could not have that liberty, I think he might as well have

let

Book 2. let the whole Matter alone. But enough of this; let's have have done with this famous Author: And now that we have ventur'd to place Spectators in the Planets, let us examine each of them, and see what their Years, Days, and Astronomy are.

The System of the Planets in Mercury. To begin with the innermost and neareſt the Sun: We know that *Mercury* is three times nearer that vast Body of Light than we are. Whence it follows that they see him three times bigger, and feel him nine times hotter than we do. Such a degree of Heat would be intolerable to us, and set afire all our dry'd Herbs, our Hay and Straw that we use. And yet there is no doubt but that the Animals there, are made of such a Temper, as to be but moderately warm, and the Plants such as to be able to endure the Heat. The Inhabitants of *Mercury*, it's likely, have the same opinion of us that we have of *Saturn*, that we must be intollerably cold, and have little or no Light, we are so far from the Sun. There's reason to doubt, whether the Inhabitants of *Mercury*, tho' they live so much nearer

er the Sun, the Fountain of Life and Vigour, are much more airy and ingenious than we. For if we may gueſs at them by what we ſee here, we ſhall not be obliged to grant it. The Inhabitants of *Africa* and *Braſil*, that have got for their Share the hotteſt Places in the Earth, being neither ſo wiſe nor ſo induſtrious as thoſe that belong to colder and more temperate Climates; they have ſcarce any Arts or Knowledge among them; and thoſe of them that live upon the very Shore, underſtand little or no Navigation. Nor can I be willing to make all that vaſt number that muſt inhabit thoſe two large Planets, *Jupiter* and *Saturn*, and have ſuch noble Attendance, mere dull Blockheads, or without as much Wit as our ſelves, tho' they are ſo far more diſtant from the Sun. The Aſtronomy of thoſe that live in *Mercury*, and the appearance of the Planets to them, oppoſite at certain times to the Sun, may be eaſily conceived by the Scheme of the *Copernican* Syſtem in the former Part. At the times of theſe Oppoſitions *Venus* and the Earth muſt needs Book 2.

Book 2. appear very bright and large to them. For if *Venus* ſhines ſo glorioufly to us when ſhe is new and horned, ſhe muſt neceſſarily in oppoſition to the Sun, when ſhe is full, be at leaſt ſix or ſeven times larger, and a great deal nearer to the Inhabitants of *Mercury*, and afford them Light ſo ſtrong and bright, that they have no reaſon to complain of their want of a Moon. What the Length of their Days are, or whether they have different Seaſons in the Year, is not yet diſcovered, becauſe we have not yet been able to obſerve whether his Axis have any inclination to his Orbit, or what Time he ſpends in his diurnal Revolution about his own Axis: And yet ſeeing *Mars*, the Earth, *Jupiter* and *Saturn*, have certainly ſuch Succeſſions, there's no reaſon to doubt but that he has his Days and Nights as well as they. But his Year is ſcarce the fourth part ſo long as ours.

The Inhabitants of *Venus* have much the ſame Face of Things as thoſe in *Mercury*, only they never ſee him in oppoſition to the Sun, which is occaſioned

sioned by his never removing above 38 degrees, or thereabouts, from it. The Sun appears to them larger by half in his Diameter, and above twice in his Circumference, than to us: and by consequence affords them but twice as much Light and Heat, so that they are nearer our Temperature than *Mercury*. Their Year is compleated in seven and a half of our Months. In the Night our Earth, when 'tis on the other side of the Sun from *Venus*, must needs seem much larger and lighter to *Venus* than she doth ever to us; and then they may easily see, if their Eyes be not weaker than ours, our constant Attendant the Moon. I have often wonder'd that when I have view'd *Venus* when she is neareſt to the Earth, and resembled an Half-moon, just beginning to have something like Horns, through a Telescope of 45 or 60 Foot long, she always appeared to me all over equally lucid, that I can't say I observed so much as one Spot in her, tho' in *Jupiter* and *Mars*, which seem much less to us, they are very plainly perceiv'd. Book 2.

Book 2. For if *Venus* had any ſuch Thing as Sea and Land, the former muſt neceſſarily ſhow much more obſcure than the other, as any one may ſatisfy himſelf, that from a very high Mountain will but look down upon our Earth. I thought that perhaps the too brisk Light of *Venus* might be the occaſion of this equal appearance; but when I uſed an Eye-glaſs that was ſmok'd for the Purpoſe, it was ſtill the ſame Thing. What then, has *Venus* no Sea, or do the Waters there reflect the Light more than ours do, or their Land leſs? Or rather (which is moſt probable in my Opinion) is not all that Light we ſee reflected from an Atmoſphere ſurrounding *Venus*, which being thicker and more ſolid than that in *Mars* or *Jupiter*, hinders our ſeeing any thing of the Globe it ſelf, and is at the ſame time capable of ſending back the Rays that it receives from the Sun? For it is certain that if we looked on the Earth from the outſide of the Atmoſphere, we ſhould not perceive ſuch a difference as we do from a Mountain; but by reaſon of the interpoſed

posed Atmosphere, we should observe very little Disparity between Sea and Land. 'Tis the same Thing that hinders us from seeing the Spots in the Moon as plain in the Day as in the Night, because the Vapours that surround the Earth being then enlightned by the Rays of the Sun, are an Impediment to our Prospect. Book 2.

But *Mars*, as I said before, has some Parts of him darker than other some. By the constant Returns of which his Nights and Days have been found to be of about the same length with ours. But the Inhabitants have no perceivable Difference between Summer and Winter, the Axis of that Planet having very little or no Inclination to his Orbit, as has been discover'd by the Motion of his Spots. Our Earth must appear to them almost as *Venus* doth to us, and by the Help of a Telescope will be found to have its Wane, Increase, and Full, like the Moon: and never to remove from the Sun above 48 Degrees, by whose Discovery they see it, as well as *Mercury* and *Venus*, sometimes pass over the Sun's Disk. They as seldom see *In* Mars.

Book 2. *Venus* as we do *Mercury*. I am apt to believe, that the Land in *Mars* is of a blacker Colour than that of *Jupiter* or the Moon, which is the reaſon of his appearing of a Copper Colour, and his reflecting a weaker Light than is proportionable to his diſtance from the Sun. His Body, as I obſerved before, tho' farther from the Sun, is leſs than *Venus*. Nor has he any Moon to wait upon him, and in that, as well as *Mercury* and *Venus*, he muſt be acknowledged inferiour to the Earth. His Light and Heat is twice, and ſometimes three times leſs than ours, to which I ſuppoſe the Conſtitution of his Inhabitants is anſwerable.

Jupiter and Saturn the moſt eminent of the Planets both for bigneſs and attendants.

If our Earth can claim pre-eminence of the fore-mention'd Planets, for having a Moon to attend upon it, (for its Magnitude can make but a ſmall difference) how much Superiour muſt *Jupiter* and *Saturn* be to thoſe three and the Earth alſo? For whether we conſider their Bulk, in which they far exceed all the others, or the Number of Moons that wait upon them, it's very probable that they are the chief, the pri-

primary Planets in our Syſtem, in comparison with which the other four are nothing, and ſcarce worth mentioning. For the eaſier Conception of their vaſt Diſparity, I have thought fit to add a Scheme of our Earth, with the Moon's Orbit, and the Globe of the Moon itſelf, and the Syſtems of *Jupiter* and *Saturn*, where I have drawn every thing as near the true Proportion as poſſible. *Jupiter* you ſee is adorned with four, and *Saturn* with five Moons, all placed in their reſpective Orbits. The Moons about *Jupiter* we owe to *Galilæo*, 'tis well known: and any one may imagine he was in no ſmall Rapture at the Diſcovery. The outermoſt but one, and brighteſt of *Saturn*'s, it chanc'd to be my lot, with a Teleſcope not above 12 foot long, to have the firſt ſight of in the Year 1655. The reſt we may thank the induſtrious *Caſſini* for, who uſed the Glaſſes of *Joſ. Campanus*'s grinding, firſt of 36, and afterwards of 136 foot long. He has often, and particularly in the Year 1672, ſhew'd me the Third and Fifth. The Firſt and Second he gave

Book 2.

Fig. 3.

Book 2. me notice of by Letters in the Year 1684; but they are ſcarce ever to be ſeen, and I can't poſitively ſay, I had ever that Happineſs; but am as ſatisfied that they are there, as if I had; not in the leaſt ſuſpecting the Credit of that worthy Man. Nay, I am afraid there are One or Two more ſtill behind, and not without reaſon. For between the Fourth and Fifth there's a Diſtance not at all proportionable to that between all the others: Here, for ought I know, there may be a Sixth; or perhaps there may be another without the Fifth that may yet have eſcaped us: for we can never ſee the Fifth but in that part of his Orbit, which is towards the Weſt: for which we ſhall give you a very good reaſon.

Perhaps when *Saturn* comes into the Northern Signs, and is at a good height from the Horizon (for at the writing of this he is at his loweſt) you may happen to make ſome new Diſcoveries, good Brother, if you would but make uſe of your two Teleſcopes of 170 and 210 Foot long; the longeſt, and the beſt I believe now in

in the World. For tho' we have not yet had an opportunity of obſerving the Heavens with them (as well by reaſon of their Unweildineſs, as for the Interruption of our Studies by your Abſence) yet I am ſatisfied of their Goodneſs by our trial of them one Night, in reading a Letter at a vaſt diſtance by the Help of a Light. I cannot but think of thoſe times with Pleaſure, and of our diverting Labour in poliſhing and preparing ſuch Glaſſes, in inventing new Methods and Engines, and always puſhing forward to ſtill greater and greater Things. But to return to the Figures, of which there remains ſomething further to be ſaid. Book 2.

The proportion of the Diameter of Jupiter, *and of the Orbs of his* Satellites, *to the Orbit of the Moon round the Earth.*

I have there made the Diameter of *Jupiter* about two third parts of our diſtance from the Moon: for the Diameter of *Jupiter* is above twenty times bigger than that of the Earth; which is about a thirtieth part of the Moon's diſtance. The Orbit of the outermoſt of *Jupiter*'s Satellites is to that of the Moon round the Earth, as 8 and $\frac{1}{2}$ is to 1. And each of theſe Moons, by the Shadow they make upon *Jupiter*, can-

Book 2. cannot be less than our Earth. Their Periods, that I may not omit them, are according to *Cassini*'s Account these. That of the inmost is one day, 18 hours, 28 minutes, and 36 seconds. The Second spends 3 days, 13 hours, 13 min. 52 seconds in going round him. The Third 7 days, 3 hours, 59 min. 40 sec. The Fourth 16 days, 18 hours, 5 min. 6 sec. The Distance of the innermost from *Jupiter* himself is 2 ½ of his Diameters. That of the Second is 4 and a half: Of the Third 7 and one sixth part: Of the Fourth 12 and two thirds, of the same Diameters. The Innermost of *Saturn*'s Satellites moves round him in 1 day, 21 hours, 18 min. 31 sec. The Second in 2 days, 17 hours, 41 min. 27 sec. The Third in 4 days, 13 hours, 47 min. 16 sec. The Fourth in 15 days, 22 hours, 41 min. 11 sec. The Fifth in 79 days, 7 hours, 53 min. 57 sec. Their Distances from the Center of *Saturn* are, that of the first almost one, that is 39 fortieth parts of the Diameter of his Ring; that of the second one and a quarter of those Diameters;

The Periods of Jupiter's Moons.

And Saturn's.

meters; of the third one and three quarters of them; of the fourth four, or according to my Calculation, but 3 and a half; of the 5th 12, which were found with vaſt Pains and Labour. Book 2.

Now can any one look upon, and compare theſe Syſtems together, without being amazed at the vaſt Magnitude and noble Attendance of theſe two Planets, in reſpect of this little Earth of ours? Or can they force themſelves to think, that the wiſe Creator has diſpoſed of all his Animals and Plants here, has furniſh'd and adorn'd this Spot only, and has left all thoſe Worlds bare and deſtitute of Inhabitants, who might adore and worſhip him; or that all thoſe prodigious Bodies were made only to twinkle to, and be ſtudied by ſome few perhaps of us poor Mortals?

I do not doubt but there will be ſome who will think we are very much miſtaken about the Magnitude of theſe Planets. For will you pretend to make them who are taken up in admiring the Largeneſs of this Globe, its

This proportion true according to all modern Obſervations.

Book 2. its multitude of Nations, Cities, and Empires; can you pretend I say to make them ever believe that there are Places in compariſon of which the Earth is as inconſiderable as this Figure would make it? But they ought to be inform'd, that theſe Proportions are thoſe which the beſt Aſtronomers of this Age have agreed upon. For if the Earth be diſtant from the Sun ten or eleven thouſand of its own Diameters, according to the Accounts of Monſieur *Caſſini* in *France*, and Mr. *Flamſted* in *England*, wherein they made uſe of very exact Obſervations of the Parallaxes of *Mars*; or if, according to a very probable Conjecture of mine, it be diſtant twelve thouſand, then the Magnitudes of the other Orbs will very near anſwer the Proportions here ſettled.

The apparent magnitude of the Sun in Jupiter, *and a way of finding what Light they there enjoy.*

But to return to *Jupiter*. The Sun appears to them who are upon it five times leſs than to us, and conſequently they have but the five and twentieth part of the Light and Heat that we receive from it. But that Light is not ſo weak as we imagine, as is plain

plain by the Brightneſs of that Planet in the Night; and alſo from hence, that when the Sun is ſo far eclipſed to us, as that only the 25th part of his Disk remains uncovered, he is not ſenſibly darken'd. But if you have a mind exactly to know the Quantity of Light that *Jupiter* enjoys, you may take a Tube of what Length you pleaſe. Let one end of it be cloſed with a Plate of Braſs, or any ſuch thing, in the middle of which there muſt be a Hole, whoſe Breadth muſt have the ſame proportion to the length of the Tube, as the Chord of 6 Minutes bears to the Radius; that is, about as one is to 570. Let the Tube be turned ſo to the Sun, that no Light may fall upon a white Paper placed at the End of it, but what comes through the little Hole at the other end of the Tube. The Rays that come through this will repreſent the Sun upon the Paper of the ſame Brightneſs that the Inhabitants of *Jupiter* ſee it in a clear Day. And if removing the Paper you place your Eye in the ſame Place, you will ſee the Sun of the ſame Magnitude and Bright-

Book 2. Brightneſs as you would were you in *Jupiter.*

And in Saturn. If you make the Hole twice as little in breadth, you will ſee the ſame in *Saturn.* And altho' his Light be but the hundredth part of ours, yet you ſee it makes him ſhine tolerably bright in a dark Night. But in both theſe Planets, if there ever be any cloudy Days, it muſt be very dark in compariſon of us; yet without doubt the Inhabitants have no more reaſon to complain of the want of Light, than our Owls and Batts, to whom the Twilight or the Night itſelf is more agreeable than the Brightneſs of the Day.

In Jupiter *their days are five Hours.* But it's a little ſtrange, that when *Jupiter* is ſo much bigger than our Planet, their Days and Nights ſhould be but five of our Hours. By this we may ſee that Nature has not obſerv'd that proportion that their Bulk ſeems to require, ſeeing in *Mars* the Days are very little different from ours. But in the length of their Years, that is, in the Revolution of the Planets round the Sun, there is an exact proportion to their

ng

re you

e as litt
; fame i
t be bu
yet yo
ly brigh
oth the
y cloud
n compa-
oubt th
eafon t
ht, tha
hom th
is mor
of th

t whe
our Pla-
ould be
this we
bferv'd.
feems
ays are
But in
, in the
d the
ion to
their

their distances from the Sun followed. For as the Cubes of their Distances, so are the Squares of their Revolutions, as *Kepler* first found out. Which proportion the Moons of *Jupiter* and *Saturn* keep in their Courses round those Planets. As the Years and Days in *Jupiter* are different from ours in this respect, so are the Days in another; namely, that they are all of the same length. For they there enjoy a perpetual Equinox, their Axis having little or no inclination to their Orbit, as the Earth's has, as has been discovered by Telescopes. The Countries that lie near their Poles have little or no Heat, by reason the Rays of the Sun fall so obliquely upon them; but then they are freed from the Inconveniency that ours are troubled with, of tedious long half-year Nights, and have the constant returns of Day and Night every five Hours. Indeed such short Days would not be agreeable to us, but we think our selves much better done by, that ours are more than twice as long, tho' upon no other account, but that whatever is our own, we are apt to imagine, must be best. The

Always of the same length.

Book 2. The reſt of the Planets are ſo near the Sun (*Mars* himſelf never being above 18 degrees from it) that in *Jupiter* they have the ſight only of *Saturn*. But we cannot deny but that their four Moons ſtand them in greater ſtead than our one doth us, if 'twere only that they ſeldom know any ſuch Thing as to be without Moonſhiny Nights. And they are of great Advantage to them, as we ſaid before, in their Navigation, if they have any ſuch thing. Not to mention the pleaſant Sights of their frequent Conjunctions and Eclipſes, Things that they are ſeldom a Day without.

Saturn enjoys all thoſe Pleaſures and Advantages in a ſtill higher Degree, as well for his five Moons, as for the delightful Proſpect that the Ring about him affords his Inhabitants Night and Day. But we will give an account of their Aſtronomy, as we have done of the reſt of the Planets.

They ſee the fix'd Stars juſt as we do.

And firſt of all we ſhall obſerve what we might have remark'd before, but which will be more ſtrange here, that the fix'd Stars appear to them of the

the ſame Figure and Magnitude, and with the ſame degree of Light that they do to us: and this, by reaſon of their immenſe diſtance, of which we ſhall have occaſion to ſpeak by and by. In compariſon with which the Space that a Bullet-ſhot out of a Cannon could travel in 25 Years, would be almoſt nothing. Book 2.

Their Aſtronomers have all the ſame Signs of the Bear, the Lion, Orion, and the reſt, but not turning upon the ſame Axis with us: for that's different in all the Planets.

As *Jupiter* can ſee no Planet but *Saturn*, ſo *Saturn* knows of no Planet but *Jupiter*; which appears to him much as *Venus* doth to us, never removing above 37 Degrees from the Sun. The Length of their Days I cannot determine: But if from the Diſtance and Period of his innermoſt Attendant, and comparing it with the innermoſt of *Jupiter*'s, a Man may venture to give a Gueſs, they are very little different from *Jupiter*'s, 10 Hours or ſomewhat leſs. But whereas in *Jupiter* theſe are equally divided be-

Book 2. tween Light and Darkneſs, the Inhabitants of *Saturn* muſt perceive a more ſenſible difference than we, eſpecially between Summer and Winter. For our Axis inclines to the Plane of the Ecliptick but 23 degrees and a half, but there's above 31. Upon this Account his Moons muſt decline very much from the Path that the Sun ſeems to move in, and his Inhabitants can never have a full Moon but juſt at the Equinoxes; Two of which fall out in 30 of our Years. 'Tis this Poſition of the Axis too that is the Cauſe of thoſe delightful Appearances, and wonderful Proſpects that its Inhabitants enjoy: For the better underſtanding of which I ſhall draw a Figure of *Saturn* with his Ring about him: in which the Proportion between the Diameters of the Globe and Ring is as 9 to 4. And the empty Space between them is of the ſame Breadth with the Ring itſelf. All Obſervations conſpire to prove that That is of no great Thickneſs, altho' if we ſhould allow it ſix hundred *German* Miles, I think, conſidering its Diameter, we ſhould not overdo the Matter.

Sup-

Suppoſe then, agreeable to what has been ſaid, the Globe of *Saturn*, whoſe Poles are A, B. G N is the Diameter of the Ring, as you view it ſideways, repreſenting a narrow Oval. Thoſe that live about the Poles within the Arches C A D, E B F, each of which are 54 Degrees, (if the Cold will ſuffer any Body to live there) never have a Sight of the Ring. From all other parts it is continually to be ſeen for fourteen Years and nine Months, which is juſt half their Year. The other Half it is hid from their View. Thoſe then that dwell between the Polar Circle C D, and the Equator T V, all that time that the Sun enlightens the Part oppoſite to them; have every Night the Sight of a Piece of it H G L, much in the Shape of a ſhining Bow, which comes from the Horizon, but is darken'd in the Middle by the Shadow of *Saturn* G H, which reaches moſt commonly to the outermoſt Rim of it. But after Midnight that Shadow by little and little begins to move towards the right Hand to thoſe in the Northern, but the Left

Book 2. Fig. 4.

The Appearances of the Ring in Saturn.

Book 2. to thoſe in the Southern Hemiſphere. In the Morning it diſappears, leaving behind it a Likeneſs indeed of a Bow, but much paler and weaker than our Moon is in the Day-time. For they, as I ſaid before, have an Atmoſphere, or an Air ſurrounding them enlighten'd by the Sun. Otherwiſe Night and Day they would have their Ring, their Moons, and all the fix'd Stars, equally conſpicuous. Another thing that muſt make the Sight of their Ring very curious, is, that by ſome Spots in it, it is diſcover'd to turn round upon it ſelf: A thing that thoſe that are ſo near cannot but take notice of, when we that live at this Diſtance can deſcry a great Inequality, the inſide of it being brighter much than the outſide is. When the Shadow of the Globe falls upon that part of the Ring G H, the Shadow of the Ring at the ſame time darkens another Part of the Globe about P F, which otherwiſe would have the Sun upon it. So that there is always a Zone of the Globe P Y F E, ſometimes of a larger extent than at others, which is depriv'd of the Sight both

both of the Sun and Ring for a considerable time, the latter of which hides some part of the Stars from it too. And certainly an amazing Thing it must be, all of a sudden to have the Sun intercepted and to become as dark as Midnidght, without seeing any Cause of such an Accident. All which time their Moons are their only Comfort. The other half of the Year the Hemisphere T B V enjoys the same Light that T A U before did, and then this undergoes those long Eclipses that That before suffer'd. At the Equinoxes, when the Sun is in the same Plane with the Ring, the Inhabitants of *Saturn* cannot well perceive it: no not even we with our Glasses, by reason of its Darkness. This happens when *Saturn*, view'd from the Sun, is advanced one and twenty degrees and a half in *Virgo* or *Pisces*, as I have show'd formerly in my System of *Saturn:* Where there is an Account given of the Risings of the Sun above the Ring, throughout all the Saturnian Year. Book 2.

Book 2. With *Saturn* in this Scheme you have the Globes of the Earth and Moon drawn in their true proportion, to put you in mind again of a Thing worth remembring, *viz.* how very ſmall our Habitation is when compar'd with that Globe or the Ring about it. And now any one, I ſuppoſe, can frame to himſelf a Picture of the Night in *Saturn*, with two Arches of the Ring, and five Moons ſhining about, and adorning him. This then is what I had to ſay to the primary Planets.

We are now come a little lower, to make an enquiry into the Attendants of theſe Planets, eſpecially our own. And here we ſhall not only conſider their Aſtronomy, but ſhall alſo ſearch into their Furniture and Ornament, if they are found to have any ſuch thing, which we have deferred conſidering till now.

Very little to be ſaid of the Moon.

And here one would think that when the Moon is ſo near us, and by the Means of a Teleſcope may be ſo nicely and exactly obſerv'd, it ſhould afford us Matter for more probable Con-

Conjectures than any of the other remote Planets. But it is quite otherwise, and I can scarce find any thing to say of it, because I have not a Planet of the same Nature before my Eyes, as in all the primary ones I have. For they are of the same kind with our Earth; and seeing all the Actions, and every thing that is here, we may make a reasonable Conjecture at what we cannot see in those Worlds. Book 2.

The Guards of Jupiter and Saturn of the same nature with our Moon.

But this we may venture to say, without fear, that all the Attendants of *Jupiter* and *Saturn* are of the same Nature with our Moon, as going round them, and being carried with them round the Sun just as the Moon is with the Earth. Their Likeness reaches to other Things too, as you'll see by and by. Therefore whatsoever we can with reason affirm or conjecture of our Moon (and we may say a little of it) must be suppos'd with very little Alteration to belong to the Satellites of *Jupiter* and *Saturn*, as having no reason to be at all inferior to that.

The Moon hath Mountains.

The Surface of the Moon then is found, by the least Telescopes of about three

Book 2. three or four Foot, to be diverſified with long Tracts of Mountains, and again with broad Valleys. For in thoſe Parts oppoſite to the Sun you may ſee the Shadows of the Mountains, and often diſcover the little round Valleys between them, with a Hillock or two perhaps riſing out of them. *Kepler* from the exact roundneſs of them would prove that they are ſome vaſt work of the rational Inhabitants. But I can't be of his mind, both for their incredible Largeneſs, and that they might eaſily be occaſioned by natural Cauſes. Nor can I find any thing like Sea there, tho' he and many others are of the contrary Opinion I know. For thoſe vaſt Countries which appear darker than the other, commonly taken for and called by the Names of Seas, are diſcover'd with a good long Teleſcope, to be full of little round Cavities; whoſe Shadow falling within themſelves, makes them appear of that Colour: and thoſe large Champains there in the Moon you will find not to be always even and ſmooth, if you look carefully upon

upon them: neither of which two Things can agree to the Sea. Therefore thoſe Plains in her that ſeem brighter than the other Parts, muſt conſiſt, I ſuppoſe, of a whiter ſort of Matter than they. Nor do I believe that there are any Rivers, for if there were, they could never eſcape our Sight, eſpecially if they run between the Hills as ours do. Nor have they any Clouds to furniſh the Rivers with Water: For if they had, we ſhould ſometimes ſee one part of the Moon darken'd by them, and ſometimes another, whereas we have always the ſame Proſpect of her.

Book 2.

But no Sea.

Nor Rivers.

Nor Clouds.

'Tis certain moreover, that the Moon has no Air or Atmoſphere ſurrounding it as we have. For then we could never ſee the very outermoſt Rim of the Moon ſo exactly as we do, when any Star goes under it, but its Light would terminate in a gradual faint Shade, and there would be a ſort of a Down as it were about it; not to mention that the Vapours of our Atmoſphere conſiſt of Water, and conſequently that where there are no Seas or

Nor Air, and Water.

Book 2. or Rivers, there can be no Atmosphere. This is that notable difference between the Moon and us that hinders all probable Conjectures about it. If we could but once be sure that there were Seas and Rivers in it, it would be no weak Argument to prove that it has also all other Furniture which belongs to our Earth, and the Opinion of *Xenophanes* might be true, that it has its Inhabitants, Cities, and Mountains. But as 'tis, I cannot imagine how any Plants or Animals, whose whole nourishment comes from liquid Bodies, can thrive in a dry, waterless, parch'd Soil.

The Conjecture of its Plants and Animals very dubious.

What then, Is it credible that this great Ball was made for nothing but to give us a little Light in the Night-time, or to raise our Tides in the Sea? May there not be some People there that may have the Pleasure of seeing our Earth turn upon itself, presenting them sometimes with a Prospect of *Europe* and *Africa*, and then of *Asia* and *America*; sometimes half of it bright, and sometimes full? And must all those Moons round *Jupiter* and *Saturn*

turn be condemned to the ſame Uſe- Book 2.
leſneſs? I do not know what to ſay concerning it, becauſe I know of nothing like them to found a Conjecture upon. And yet 'tis not improbable that thoſe great and noble Bodies have ſomewhat or other growing and living upon them, though very different from what we ſee and enjoy here. Perhaps their Plants and Animals may have another ſort of Nouriſhment there. Perhaps the Moiſture of the Earth there is but juſt ſufficient to cauſe a Miſt or Dew, which may be very ſuitable to the Growth of their Herbs. This I remember is *Plutarch*'s Opinion, in his Dialogue upon this Subject. For in our Earth a very little Water drawn from the Sea into Dew, and falling down again upon the Herbs, would be ſufficient for all our Needs, without any Rain or Showers. But theſe are mere Gueſſes, or rather Doubts, but yet they are the beſt we can make of this, and all thoſe other Moons: for, as I ſaid before, they are all of the ſame nature, which is proved likewiſe by this, that as our Moon

Jupiter's and Saturn's Moons turn always the ſame Side to them.

Book 2. Moon can afford us the Sight never but of one Side of her, so they turn always the same Face to their primary Planets. It may perhaps seem strange, how we should come to know this; but 'tis no hard matter, after that Observation which I just now made, that the outermost of *Saturn*'s Moons can never be seen but when she is on the West-side of her Planet. The reason of which is plainly this, that one Side of her is darker, and does not reflect the Light so much as the other, which when it is turned towards us, we cannot see by reason of its weak Light. This always happening when 'tis East of him, and never on the other Side, is a manifest proof that she always keeps the same Side toward *Saturn*. Now since the outermost of *Saturn*'s and our Moon carry themselves thus to the Planets round which they move, who can well doubt it of all the rest round *Jupiter* and *Saturn*? And there's a very good reason for it, namely, that the matter of which those Moons consist, being heavier, and more solid on the Side that is averse from us, than on that

that which we have the Sight of, does consequently fly with a greater force from the Centre of its Orbit: for otherwise, according to the Laws of Motion, it should turn the same Side always, not to its Planets, but to the same fix'd Stars. Book 2.

This Position of the Moons, in respect of their Planets, must occasion a great many very surprizing Appearances to their Inhabitants, if they have any, which is very doubtful, but may for the present be suppos'd. An enquiry into our Moon may serve for all the rest. Its Globe is divided into two Parts, in such a manner, that those who live on one Side never lose the sight of us, and those on the other never enjoy it. Except only some few who live on the Confines of each of these, who lose us, and see us again by turns. The Earth to them must seem much larger than the Moon doth to us, as being in Diameter above four times bigger. But that which is most surprizing, is, that Night and Day they see it always in the very same part of the Heaven, as if it never moved: some of them as if 'twas falling

The Astronomy of the Inhabitants of the Moon.

Book 2. ling upon their Heads: others somewhat above the Horizon, and others always in the Horizon, ſtill turning upon it ſelf, and preſenting them every twenty four Hours with a View of all its Countries, even of thoſe that lie near the Poles (I could wiſh my ſelf in the Moon only for the ſight of them) yet unknown and undiſcovered by us. They have it in its monthly Wane and Increaſe, they ſee it half, and horned, and full, by turns, juſt as we do the Body of the Moon. But the Light that they receive of us is five times larger than what we receive from them. So that in dark Nights that part that hath the Advantage of being towards us, receives a very glorious Light from us, tho' *Kepler* thought otherwiſe. Their Days are always of the ſame Length with their Nights; and the Sun riſing and ſetting to them but once in one of our Months, makes the time both of their Light and Darkneſs to be equal to 15 of our Days. If their Bodies were of the ſame Materials with ours, thoſe that have the Sun pretty high in their Horizon, would be almoſt roaſted

ed in such long Days. For the Sun is not farther from them than he is from us. This will be the Case of those that live upon the Borders of the two Hemispheres we mentioned; but those that live under the Poles of the Moon will be just about as hot as our Whalefishers about *Island* and *Nova Zemla* are, in the Summer-time: who are in so little danger of being roasted, that in the middle of their Summer, in their Days of three Months length, they very often find it extreme Cold. I call those the Poles of the Moon, round which the fix'd Stars seem to turn to its Inhabitants, which are different from ours, and also from those of the Ecliptick, although they move round these latter, at the distance of five Degrees, in a period of nineteen Years. Their Year they count by the Motion of the Stars, and their return to the Sun, and 'tis the same with ours. They can easily do it, because they have the Stars Day and Night, notwithstanding the Light of the Sun: for they have no Atmosphere (which is the only reason that we don't every Day

Book 2. Day enjoy the ſame Sight) to hinder their Obſervations. Nor have they any Clouds to obſtruct their View, ſo that it is eaſier for them to find out the Courſes of the Planets, but more difficult to make a true Syſtem of them. For they will be apt to lay a wrong Foundation, by ſuppoſing that their Earth ſtands ſtill, which will lead them into more dangerous Errors than ever it did us. All that I have ſaid belongs as well to *Jupiter*'s and *Saturn*'s Satellites as to our Moon, in reſpect of the Planets they move round. The Length of their Day and Night is always equal to the Time of their Revolution: For example, the fifth Moon moves round *Saturn* in 80 Days, and the Days and Nights there are equal to Forty of ours. Both their Summer and Winter (*Saturn* moving round the Sun in thirty Years) are fifteen Years long. Therefore it is impoſſible but that their way of living muſt be very different from ours, having ſuch tedious Winters, and ſuch long watching and ſleeping times.

This may be applied to the Moons about Jupiter *and* Saturn.

Having

B
c

Th
be
sa
M
bo
te
Sa

Hav
and ſe
we ſho
the Su
do that
before
more p
Magni
Syſtem
do in
Leaves
Bodies
ly ſmal
But wh
made u
to the f
like it,
on a ve
outerm
of *Satu*
hundre
ter. I
Globe
Bigneſs
Let all
every
the mic
Bigneſs

Having thus explain'd the primary and ſecondary Planets round the Sun, we ſhould next ſet about the third Sort; the Sun and fix'd Stars; but before we do that, it would be worth while to ſet before you at once, in a clearer and more plain Method than hitherto, the Magnificence and Fabrick of the Solar Syſtem. Which we can't poſſibly do in ſo ſmall a Space as one of our Leaves will but admit of, becauſe the Bodies of the Planets are ſo prodigiouſly ſmall in compariſon of their Orbs. But what is wanting in Figure ſhall be made up in Words. Going back then to the firſt Scheme, ſuppoſe another like it, and proportionable, drawn upon a very large ſmooth Plain; whoſe outermoſt Circle repreſenting the Orb of *Saturn*, muſt be conceived three hundred and ſixty Foot in Semidiameter. In which you muſt place the Globe and Ring of *Saturn* of that Bigneſs as the 2d Figure ſhows you. Let all the other Planets be ſuppoſed every one in his own Orbit, and in the middle of all the Sun, of the ſame Bigneſs that That Figure repreſents, namely,

Book 2.

Fig. 1.

Fig. 2.

Book 2. namely, about four Inches in Diameter. And then the Orbit or Circle in which the Earth moves, which the Astronomers call the *Magnus Orbis*, must have about six and thirty Foot in Semidiameter. In which the Earth must be conceived moving, not bigger than a grain of Millet, and her Companion the Moon scarcely perceivable, moving round her in a Circle a little more than two Inches Diameter, as in Fig. 5. the Figure here adjoined, where the Line A B represents a small portion of that Circle which the Earth moves in: the small Circle therein C is the Earth, and the Circle D E the Path of the Moon round it, in which the Body of the Moon is D.

The outermost of *Saturn*'s Moons moves in an Orbit whose Semidiameter is 29 Inches; that of *Jupiter* in a somewhat smaller, whose Semidiameter is 19 and a quarter.

And thus we have a true and exact Description of the Sun's Palace, where the Earth will be Twelve thousand of its Semidiameters distant from him, which in *German* Miles makes above seven-

seventeen Millions. But perhaps we may have a clearer Comprehension of this vast Length, by comparing it with some very swift Motion after the Example of *Hesiod* the Poet, who imagin'd that an Anvil let fall from the Top of Heaven, reach'd the Earth the tenth Day of its Journey, and in ten more arriv'd at the Bottom of Hell, the end of it: so making the Earth the mid-way between Heaven and Hell. I shan't make use of the Anvil, but of something as good, namely, a Bullet shot out of a great Gun, which may travel perhaps in a Moment, or Pulse of an Artery, about a hundred Fathom, as is proved by those Experiments that *Mersennus* in a Treatise of his relates; by which the Sound was found to extend itself eighty hundredth parts in the same time. I say then, that supposing a Bullet to move with this Swiftness from the Earth to the Sun, it would spend 25 Years in its Passage. To make a Journey from *Jupiter* to the Sun, would require 125, and from *Saturn* thither 250 Years. This account depends upon the measure of the Earth's Dia-

Book 2.

The immense distance between the Sun and Planets illustrated.

Book 2. Diameter, which, according to the accurate Obſervations of the *French*, is 6538594 times ſix *Paris* Feet, one Degree being 57060 of that Meaſure. This ſhows us how vaſt thoſe Orbs muſt be, and how inconſiderable this Earth, the Theatre upon which all our mighty Deſigns, all our Navigations, and all our Wars are tranſacted, is when compared to them. A very fit Conſideration, and Matter of Reflection, for thoſe Kings and Princes who ſacrifice the Lives of ſo many People, only to flatter their Ambition in being Maſters of ſome pitiful Corner of this ſmall Spot. But to return to the matter in hand, now we have given you an account of the Sun's proportion to thoſe Orbs and Bodies, we'll ſee what more we can ſay of him.

No ground for Conjecture in the Sun. And ſome have thought it not improbable but that the Sun himſelf has alſo his Inhabitants. But upon what reaſon I cannot imagine, there being leſs ground for a Probability in him than in the Moon. For we are not yet ſure, whether he be a ſolid or liquid Globe; altho', if my Notion of Light be

be true, upon that account I ſhould rather think him liquid: which his Roundneſs and equal diſtribution of his Light to all parts are an Argument for. For that very ſmall inequality on his Surface, which is diſcovered by the Teleſcopes, (and that not always neither) which makes Men fancy they ſee boiling Seas and belching Mountains of Fire, is nothing but the trembling Motion of the Vapours our Atmoſphere is full of near the Earth; which is likewiſe the Cauſe of the Stars twinkling. Nor could I ever have the Luck to diſcern thoſe bright Spots in the Sun which they boaſt as much of as they do of his dark ones, which latter I have very often ſeen; ſo that I have very good Reaſon to doubt whether there be any thing in the Sun brighter than the Sun itſelf. For by the moſt exact Obſervations, I could never find any ſuch pretended to be ſeen any where but juſt about his dark Spots; and it is no great wonder that thoſe Parts which are ſo near the darker, ſhould appear ſomewhat brighter than the reſt. That the Sun is extremely hot and fiery, is be-

Book 2.

The Faculæ in the Sun not eaſily ſeen.

By reaſon of its Heat no Inhabi-

Book 2. yond all diſpute, and ſuch Bodies as ours could not live one Moment in ſuch a Furnace. We muſt ſuppoſe a new ſort of Animals then, ſuch as we have no Idea or Likeneſs of among us, ſuch as we can neither imagine nor conceive: which is as much as to ſay, that we can make no Suppoſition at all about them. No doubt that glorious and vaſt Body was made for ſome noble End and Uſe, and fram'd with excellent Deſign. And I think we all very well know and feel its Uſefulneſs in that effuſion of Light and Heat to all the Planets round it; in the Preſervation and Happineſs of all living Creatures, and that not only in our Ball, but in thoſe vaſt Globes of *Jupiter* and *Saturn*, not contemptible when compared with its own. Theſe are ſuch great, ſuch wiſe Ends, that it is not ſtrange that the Sun ſhould have been made, if it had been only upon their account. For, as for *Kepler*'s Fancy, that he hath another Office, namely, to help on the Motion of the Planets in their own Orbs, by turning about his own Axis (which he would fain eſtabliſh in his Epitome of the *Copernican*

tants like ours can live in the Sun.

nican Syſtem) I ſhall give good Reaſons why I cannot aſſent to it. Book 2.

The fix'd Stars ſo many Suns.

Before the Invention of Teleſcopes, it ſeemed to contradict *Copernicus's* Opinion, to make the Sun one of the fix'd Stars. For the Stars of the firſt Magnitude being eſteem'd to be about three Minutes Diameter; and *Copernicus* (obſerving that tho' the Earth changed its Place, they always kept the ſame diſtance from us) having ventur'd to ſay that the *Magnus Orbis* was but a Point in reſpect of the Sphere in which they were placed, it was a plain Conſequence that every one of them that appeared any thing bright, muſt be larger than the Path or Orbit of the Earth: which is very abſurd. This is the principal Argument that *Tycho Brahe* ſet up againſt *Copernicus*. But when the Teleſcopes took away thoſe Rays of the Stars which appear when we look upon them with our naked Eye, (which they do beſt when the Eye-glaſs is black'd with Smoke) they ſeemed juſt like little ſhining Points, and then that Difficulty vaniſhed, and the Stars may yet be ſo many Suns. Which is

Book 2. the more probable, becauſe their Light is certainly their own: for it's impoſſible that ever the Sun ſhould ſend, or they reflect it at ſuch a vaſt Diſtance. This is the Opinion that commonly goes along with *Copernicus*'s Syſtem. And the Patrons of it do alſo with reaſon ſuppoſe, that all theſe Stars are not in the ſame Sphere, as well becauſe there's no Argument for it, as that the Sun, which is one of them, cannot be brought to this Rule. But it's more likely they are ſcatter'd and diſpers'd all over the immenſe Spaces of the Heaven, and are as far diſtant perhaps from one another, as the neareſt of them are from the Sun.

They are not all in the ſame Sphere.

Here again too I know *Kepler* is of another Opinion in his Epitome of *Copernicus*'s Syſtem, that we mention'd above. For tho' he agrees with us, that the Stars are diffus'd through all the vaſt Expanſe of the Heavens, yet he cannot allow that they have as large an empty Space about them as our Sun has. For then 'twas his Opinion, we ſhould ſee but very few, and thoſe of very different Magnitudes: *For, ſeeing*

ing the largeſt of all appear ſo ſmall to us, that we can ſcarce obſerve or meaſure them with our beſt Inſtruments; how muſt thoſe appear that are three or four times farther from us? Why, ſuppoſing them no larger than theſe, they muſt ſeem three or four times leſs, and ſo on 'till a little farther they will not be to be ſeen at all: Thus we ſhall have the ſight of but very few Stars, and thoſe very different one from another; Whereas we have above a Thouſand, and thoſe not conſiderably bigger or leſs than one another. But this by no means proves what he would have it; and his Miſtake was chiefly, that he did not conſider the Nature of Fire and Flame which may be ſeen at ſuch diſtances, and at ſuch ſmall Angles as all other Bodies would totally diſappear under. A thing that we need go no farther than the Lamps ſet along the Streets to prove. For altho' they are a hundred Foot from one another, yet you may count Twenty of them in a continued Row with your Eyes, and yet the twentieth Part of them ſcarce makes an Angle of ſix Seconds. Certainly

Book 2. tainly then the glorious Light of the Stars muſt do much more than this; ſo that it's no wonder we ſhould ſee a Thouſand or two of them with our bare Eyes, and with a Teleſcope diſcover twenty times that number. But *Kepler* had a private Deſign in making the Sun thus ſuperiour to all the other Stars, and planting it in the Middle of the World, attended with the Planets: For his Aim was hereby to ſtrengthen his Coſmographical Myſtery, that the Diſtances of the Planets from the Sun are in a certain proportion to the Diameters of the Spheres that are inſcribed within, and circumſcribed about *Euclia*'s Regular Bodies. Which could never be ſo much as probable, except there were but one Chorus of Planets moving round the Sun, and ſo the Sun were the only one of his kind.

But that whole Myſtery is nothing but an idle Dream taken from *Pythagoras* or *Plato*'s Philoſophy. And the Author himſelf acknowledges that the Proportions do not agree ſo well as they ſhould, and is fain to invent two or

or three very ſilly Excuſes for it. And he uſes yet poorer Arguments to prove that the Univerſe is of a ſpherical Figure, and that the Number of the Stars muſt neceſſarily be finite, becauſe the Magnitude of each of them is ſo. But what is worſt of all is, that he ſettles the Space between the Sun and the Concavity of the Sphere of the fix'd Stars, to be ſix hundred thouſand of the Earth's Diameters. For this reaſon, which he has no Foundation for, that as the Diameter of the Sun is to that of the Orbit of *Saturn*, which he makes to be as 1 to 2000, ſo is this Diameter to that of the Sphere of the fixed Stars. I cannot but wonder how ſuch things as theſe could fall from ſo ingenious a Man, and ſo great an Aſtronomer. But I muſt be of the ſame Opinion with all the greateſt Philoſophers of our Age, that the Sun is of the ſame Nature with the fix'd Stars. And this will give us a greater Idea of the World, than all thoſe other Opinions. For then why may not every one of theſe Stars or Suns have as great a Retinue as our Sun, of Planets, with their Moons,

The Stars have Planets about them like our Sun.

Book 2. Moons, to wait upon them? Nay, there's a manifeſt reaſon why they ſhould. For if we imagine our ſelves placed at an equal diſtance from the Sun and fix'd Stars; we ſhould then perceive no difference between them. For, as for all the Planets that we now ſee attend the Sun, we ſhould not have the leaſt glimpſe of them, either becauſe their Light would be too weak to affect us, or that all the Orbs in which they move would make up one lucid Point with the Sun. In this Station we ſhould have no occaſion to imagine any difference between the Stars, and ſhould make no doubt if we had but the Sight, and knew the Nature of one of them, to make that the Standard of all the reſt. We are then plac'd near one of them, namely, our Sun, and ſo near as to diſcover ſix other Globes moving round him, ſome of them having others performing them the ſame Office. Why then may not we make uſe of the ſame Judgment that we would in that caſe; and conclude, that our Star has no better attendance than the others? So that what

what we allowed the Planets, upon the account of our enjoying it, we must likewise grant to all those Planets that surround that prodigious number of Suns. They must have their Plants and Animals, nay and their rational Creatures too, and those as great Admirers, and as diligent Observers of the Heavens as our selves; and must consequently enjoy whatsoever is subservient to, and requisite for such Knowledge. Book 2.

What a wonderful and amazing Scheme have we here of the magnificent Vastness of the Universe! So many Suns, so many Earths, and every one of them stock'd with so many Herbs, Trees, and Animals, and adorn'd with so many Seas and Mountains! And how must our Wonder and Admiration be encreased when we consider the prodigious Distance and Multitude of the Stars?

That their Distance is so immense, that the Space between the Earth and Sun (which is no less than Twelve thousand of the Earth's Diameters) is almost nothing when compar'd to it, has more Proofs than one to confirm

Book 2. firm it. And this among the reſt. If you obſerve two Stars near one another, as for example thoſe in the middle of the Great Bears Tail, differing very much from one another in Clearneſs, notwithſtanding our changing our Poſition in our Annual Orbit round the Sun, and that there would be a Parallax were the Star which is brighter nearer to us than the other, as is very probable it is, yet whatever Part of the Year you look upon them, they will not in the leaſt have altered their diſtance. Thoſe that have hitherto undertook to calculate their Diſtance, have not been able perfectly to compaſs their Deſign, by reaſon of the extreme Niceneſs and almoſt Impoſſibility of the Obſervations requiſite for their Purpoſe. The only Method that I ſee remaining, to come at any tolerable Probability in ſo difficult a Caſe, I ſhall here make uſe of. Seeing then that the Stars, as I ſaid before, are ſo many Suns, if we do but ſuppoſe one of them equal to ours, it will follow that its diſtance from us is as much greater than that of the Sun, as its apparent

parent Diameter is leſs than the Dia- Book 2.
meter of the Sun. But the Stars, even
thoſe of the firſt Magnitude, though
view'd through a Teleſcope, are ſo
very ſmall, that they ſeem only like ſo
many ſhining Points, without any per-
ceivable Breadth. So that ſuch Obſer-
vations can here do us no good. When
I ſaw this would not ſucceed, I ſtudied
by what way I could ſo leſſen the Dia-
meter of the Sun, as to make it not
appear larger than the Dog, or any
other of the chief Stars. To this pur-
poſe I clos'd one End of my twelve-
foot Tube with a very thin Plate, in
the Middle of which I made a Hole not
exceeding the twelfth Part of a Line,
that is the hundred and forty fourth
Part of an Inch. That End I turn'd
to the Sun, placing my Eye at the
other, and I could ſee ſo much of the
Sun as was in Diameter about the 182d
part of the Whole. But ſtill that lit-
tle piece of him was brighter much
than the Dog-ſtar is in the cleareſt
Night. I ſaw that this would not do,
but that I muſt leſſen the Diameter of
the Sun a great deal more. I made
then

A way of making a probable gueſs at the diſtance of the Stars.

Book 2. then such another Hole in a Plate, and against it I plac'd a little round Glass that I had made use of in my Microscopes, of much about the same Diameter with the former Hole. Then looking again towards the Sun (taking care that no Light might come near my Eye to hinder my Observation) I found it appeared of much the same Clearness with *Sirius*. But casting up my account, according to the Rules of *Dioptricks*, I found his Diameter now was but $\frac{1}{152}$ part of that hundred and eighty second part of his whole Diameter that I saw through the former Hole. Multiplying $\frac{1}{152}$ and $\frac{1}{182}$ into one another, the Product I found to be $\frac{1}{27664}$. The Sun therefore being contracted into such a Compass, or being removed so far from us (for it's the same thing) as to make his Diameter but the 27664 part of that we every Day see, will send us just the same Light as the Dog-star now doth. And his distance then from us will be to his present distance undoubtedly as 27664 is to 1; and his Diameter little above four Thirds, $4'''$. Seeing then

then *Sirius* is ſuppoſed equal to the Sun, it follows that his Diameter is likewiſe $4'''$, and that his Diſtance to the Diſtance of the Sun from us is as 27664 to 1. And what an incredible Diſtance that is, will appear by the ſame way of reaſoning that we uſed in meaſuring that of the Sun. For if 25 Years are required for a Bullet out of a Cannon, with its utmoſt Swiftneſs, to travel from the Sun to us; then by multiplying the Number 27664 into 25, we ſhall find that ſuch a Bullet would ſpend almoſt ſeven hundred thouſand Years in its Journey between us and the neareſt of the fix'd Stars. And yet when in a clear Night we look upon them, we cannot think them above ſome few Miles over our Heads. What I have here enquir'd into, is concerning the neareſt of them. And what a prodigious Number muſt there be beſides of thoſe which are placed in the vaſt Spaces of Heaven, as to be as remote from theſe as theſe are from the Sun! For if with our bare Eyes we can obſerve above a Thouſand, and with a Teleſcope can Book 2.

Book 2. discover ten or twenty times as many; what bounds of Number can we set to those which are out of the Reach even of these Assistances! especially if we consider the infinite Power of God. Really, when I have been reflecting thus with my self, methoughts all our Arithmetick was nothing, and we are vers'd but in the very Rudiments of Numbers, in comparison of this great Sum. For this requires an immense Treasury, not of twenty or thirty Figures only, in our decuple Progression, but of as many as there are Grains of Sand upon the Shore. And yet who can say, that even this Number exceeds that of the Fix'd Stars? Some of the Ancients, and *Jordanus Brunus* carry'd it further, in declaring the Number infinite: he would perswade us that he has prov'd it by many Arguments, tho' in my opinion they are none of them conclusive. Not that I think the contrary can ever be made out. Indeed it seems to me certain, that the Universe is infinitely extended; but what God has been pleas'd to place beyond the Region of the

the Stars, is as much above our Knowledge, as it is beyond our Habitation. Book 2.

Or what if beyond such a determinate Space he has left an infinite Vacuum; to show, how inconsiderable all that he has made is, to what his Power could, had he so pleas'd, have produced? But I am falling, before I am aware, into that intricate Dispute of Infinity: Therefore I shall wave this, and not, as soon as I am free of one, take upon me another difficult Task. All that I shall do more is to add somewhat of my Opinion concerning the whole World, as it is a Place for the Reception of the Suns or fix'd Stars, every one of which, I have showed, may have their Planetary Systems about them.

Every Sun has a Vortex round it, very different from those of Cartes.

I am of Opinion then that every Sun is surrounded with a Whirl-pool or Vortex of Matter in a very swift Motion; tho' not in the least like *Cartes*'s either in their Bulk, or manner of Motion. For *Cartes* makes his so large, as every one of them to touch all the others round them, in a flat Surface, just as you have seen the Bladders that

Book 2. Boys blow up in Soap-ſuds do; and would have the whole Vortex to move round the ſame way. But the Angles of every Vortex will be no ſmall hindrance to ſuch a Motion. Then the whole Matter moving round at once, upon the Axis as it were of a Cylinder, did not a little puzzle him in giving Reaſons for the Roundneſs of the Sun: which however they may ſatisfy ſome People that do not conſider them, really prove nothing of the Matter. In this æthereal Matter the Planets float, and are carried round by its Motion: and the thing that keeps them in their own Orbs is, that they themſelves, and the Matter in which they ſwim, equally ſtrive to fly off from the Center of this Motion. Againſt all which there are many Aſtronomical Objections, ſome of which I touch'd upon in my Eſſay of the Cauſes of Gravity. Where I gave another Account of the Planets not deſerting their own Orbs; which is their Gravitation towards the Sun. I ſhow'd there the Cauſes of that Gravitation, and cannot but wonder that *Cartes*,

Cartes, the first Man that ever began to talk reasonably of that Matter, should never meddle with, or light on it. *Plutarch* in his Book of the Moon above-mentioned says, that some of the Ancients were of Opinion, that the Reason of the Moon's keeping her Orbit was, that the Force of her Circular Motion was exactly equal to her Gravity, the one of which pull'd her to, as much as the other forc'd off from the Centre. And in our Age *Alphonsus Borellus*, who was of this same Opinion in the other Planets as well as the Moon, makes the Gravitation of the primary Planets to be towards the Sun, as that of the Secondary is towards the Planets round which they move: Which Sir *Isaac Newton* has more fully explain'd, with a great deal of Pains and Subtilty; and how from that Cause proceeds the Ellipticity of the Orbs of the Planets, found out by *Kepler*. According to my Notion of the Gravitation of the Planets to the Sun, the Matter of his Vortex must not at all move the same way, Book 2.

Book 2. way, but after such a manner as to have its Parts carry'd different ways on all Sides. And yet there is no fear of its being destroyed by such an irregular Motion, because the Æther round it, which is at rest, keeps the Parts of it from flying out. With the Help of such a Vortex as this I have undertook in that Essay to explain the Gravity of Bodies on this Earth, and all the Effects of it. And I suppose there may be the same Cause as well of the Gravitation of the Planets, and of our Earth among the rest, towards the Sun, as of their Roundness: A Thing so very hard to give an Account of in *Cartes*'s System.

I must differ from him too in the Bigness of the Vortices, for I cannot allow them to be so large as he would make them. I would have them dispersed all about the immense Space, like so many little Whirl-pools of Water, that one makes by the stirring of a Stick in any large Pond or River, a great way distant from one another. And as their Motions do not all intermix

termix or communicate with one another, so in my Opinion must the Vortices of Stars be placed as not to hinder one anothers free Circumrotations. Book 2.

So that we may be secure, and never fear that they will swallow up or destroy one another; for that was a mere Fancy of *Cartes*'s, when he was a showing how a fix'd Star or Sun might be turn'd into a Planet. And 'tis plain that when he writ it, he had no Thoughts of the immense Distance of the Stars from one another; particularly, by this one Thing, that he would have a Comet as soon as ever it comes into our Vortex, to be seen by us. Which is as absurd as can be. For how could a Star, which gives us such a vast Light only from the Reflection of the Beams of the Sun, as he himself owns they do; how I say could that be so plainly seen at a distance Ten thousand times larger than the Diameter of the Earth's Orbit? He could not but know that all round the Sun there is a vast *Extensum*; so vast, that in *Copernicus*'s System the

magnus

Book 2. *magnus Orbis* is counted but a Point in comparison with it. But indeed all the whole Story of Comets and Planets, and the Production of the World, is founded upon such poor and trifling Grounds, that I have often wonder'd how an ingenious Man could spend all that pains in making such Fancies hang together. For my part, I shall be very well contented, and shall count I have done a great Matter, if I can but come to any Knowledge of the Nature of Things, as they now are, never troubling my self about their Beginning, or how they were made, knowing that to be out of the reach of human Knowledge, or even Conjecture.

F I N I S.