Adam Smith: The Principles which lead and direct Philosophical Enquiries; illustrated by the History of Astronomy

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The much lamented Author of these Essays left them in the hands of his friends to be disposed of as they thought proper, having immediately before his death destroyed many other manuscripts which he thought unfit for being made public.1 When these were inspected, the greater number of them appeared to be parts of a plan he once had formed, for giving a connected history of the liberal sciences and elegant arts. It is long since he found it necessary to abandon that plan as far too extensive; and these parts of it lay beside him neglected until his death. His friends are persuaded however, that the reader will find in them that happy connection, that full and accurate expression, and that clear illustration which are conspicuous in the rest of his works; and that though it is difficult to add much to the great fame he so justly acquired by his other writings, these will be read with satisfaction and pleasure.

The History of Astronomy

Preface

1Wonder, Surprise, and Admiration, are words which, though often confounded, denote, in our language, sentiments that are indeed allied, but that are in some respects different also, and distinct from one another. What is new and singular, excites that sentiment which, in strict propriety, is called Wonder; what is unexpected, Surprise; and what is great or beautiful, Admiration.

2We wonder at all extraordinary and uncommon objects, at all the rarer phaenomena of nature, at meteors, comets, eclipses, at singular plants and animals, and at every thing, in short, with which we have before been either little or not at all acquainted; and we still wonder, though forewarned of what we are to see.

3We are surprised at those things which we have seen often, but which we least of all expected to meet with in the place where we find them; we are surprised at the sudden appearance of a friend, whom we have seen a thousand times, but whom we did not imagine we were to see then.

4We admire the beauty of a plain or the greatness of a mountain, though we have seen both often before, and though nothing appears to us in either, but what we had expected with certainty to see ……

SECTION I: *Of the Effect of Unexpectedness, or of Surprise*

1When an object of any kind, which has been for some time expected and foreseen, presents itself, whatever be the emotion which it is by nature fitted to excite, the mind must have been prepared for it, and must even in some measure have conceived it before–hand; because the idea of the object having been so long present to it, must have before–hand excited some degree of the same emotion which the object itself would excite: the change, therefore, which its presence produces comes thus to be less

considerable, and the emotion or passion which it excites glides gradually and easily into the heart, without violence, pain, or difficulty.

2But the contrary of all this happens when the object is unexpected; the passion is then poured in all at once upon the heart, which is thrown, if it is a strong passion, into the most violent and convulsive emotions, such as sometimes cause immediate death; sometimes, by the suddenness of the extacy, so entirely disjoint the whole frame of the imagination, that it never after returns to its former tone and composure, but falls either into a frenzy or habitual lunacy; and such as almost always occasion a momentary loss of reason, or of that attention to other things which our situation or our duty requires.

3How much we dread the effects of the more violent passions, when they come suddenly upon the mind, appears from those preparations which all men think necessary when going to inform any one of what is capable of exciting them. Who would choose all at once to inform his friend of an extraordinary calamity that had befallen him, without taking care before–hand, by alarming him with an uncertain fear, to announce, if one may say so, his misfortune, and thereby prepare and dispose him for receiving the tidings? …. [Moreover,] Surprises of joy are still more insupportable than Surprises of grief. We are told[2] that after the battle of Thrasimenus, while a Roman lady, who had been informed that her son was slain in the action, was sitting alone bemoaning her misfortunes, the young man who escaped came suddenly into the room to her, and that she cried out and expired instantly in a transport of joy. Let us suppose the contrary of this to have happened, and that in the midst of domestic festivity and mirth, he had suddenly fallen down dead at her feet, is it likely that the effects would have been equally violent? I imagine not. The heart springs to joy with a sort of natural elasticity, it abandons itself to so agreeable an emotion, as soon as the object is presented; it seems to pant and leap forward to meet it, and the passion in its full force takes at once entire and complete possession of the soul. But it is otherways with grief; the heart recoils from, and resists the first approaches of that disagreeable passion, and it requires some time before the melancholy object can produce its full effect.

5Surprise, therefore, is not to be regarded as an original emotion of a species distinct from all others. The violent and sudden change produced upon the mind, when an emotion of any kind is brought suddenly upon it, constitutes the whole nature of Surprise. ….

10Upon this are founded, in a great measure, some of the effects of habit and custom. It is well known that custom deadens the vivacity of both pain and pleasure, abates the grief we should feel for the one, and weakens the joy we should derive from the other. The pain is supported without agony, and the pleasure enjoyed without rapture: because custom and the frequent repetition of any object comes at last to form and bend the mind or organ to that habitual mood and disposition which fits them to receive its impression, without undergoing any very violent change.

SECTION II: Of Wonder, or of the Effects of Novelty

1It is evident that the mind takes pleasure in observing the resemblances that are discoverable betwixt different objects. It is by means of such observations that it endeavours to arrange and methodise all its ideas, and to reduce them into proper classes and assortments. Where it can observe but one single quality, that is common to a great variety of otherwise widely different objects, that single circumstance will be sufficient for it to connect them all together, to reduce them to one common class, and to call them by one general name. It is thus that all things endowed with a power of self–motion, beasts, birds, fishes, insects, are classed under the general name of Animal; and that these again, along with those which want that power, are arranged under the still more general word Substance: and this is the origin of those assortments of objects and ideas which in the schools are called Genera and Species, and of those abstract and general names, which in all languages are made use of to express them.1

2The further we advance in knowledge and experience, the greater number of divisions and subdivisions of those Genera and Species we are both inclined and obliged to make. We observe a greater variety of particularities amongst those things which have a gross

resemblance; and having made new divisions of them, according to those newly–observed particularities, we are then no longer to be satisfied with being able to refer an object to a remote genus, or very general class of things, to many of which it has but a loose and imperfect resemblance. A person, indeed, unacquainted with botany may expect to satisfy your curiosity, by telling you, that such a vegetable is a weed, or, perhaps in still more general terms, that it is a plant. But a botanist will neither give nor accept of such an answer. He has broke and divided that great class of objects into a number of inferior assortments, according to those varieties which his experience has discovered among them; and he wants to refer each individual plant to some tribe of vegetables, with all of which it may have a more exact resemblance, than with many things comprehended under the extensive genus of plants. A child imagines that it gives a satisfactory answer when it tells you, that an object whose name it knows not is a thing, and fancies that it informs you of something, when it thus ascertains to which of the two most obvious and comprehensive classes of objects a particular impression ought to be referred; to the class of realities or solid substances which is calls *things,* or to that of appearances which it calls *nothings.*

3Whatever, in short, occurs to us we are fond of referring to some species or class of things, with all of which it has a nearly exact resemblance; and though we often know no more about them than about it, yet we are apt to fancy that by being able to do so, we show ourselves to be better acquainted with it, and to have a more thorough insight into its nature. But when something quite new and singular is presented, we feel ourselves incapable of doing this. The memory cannot, from all its stores, cast up any image that nearly resembles this strange appearance. If by some of its qualities it seems to resemble, and to be connected with a species which we have before been acquainted with, it is by others separated and detached from that, and from all the other assortments of things we have hitherto been able to make. It stands alone and by itself in the imagination, and refuses to be grouped or confounded with any set of objects whatever. The imagination and memory exert themselves to no purpose, and in vain look around all their classes of ideas in order to find one under which it may be arranged. They fluctuate to

no purpose from thought to thought, and we remain still uncertain and undetermined where to place it, or what to think of it. It is this fluctuation and vain recollection, together with the emotion or movement of the spirits2 that they excite, which constitute the sentiment properly called *Wonder,* and which occasion that staring, and sometimes that rolling of the eyes, that suspension of the breath, and that swelling of the heart, which we may all observe, both in ourselves and others, when wondering at some new object, and which are the natural symptoms of uncertain and undetermined thought. What sort of a thing can that be? What is that like? are the questions which, upon such an occasion, we are all naturally disposed to ask. If we can recollect many such objects which exactly resemble this new appearance, and which present themselves to the imagination naturally, and as it were of their own accord, our Wonder is entirely at an end. If we can recollect but a few, and which it requires too some trouble to be able to call up, our Wonder is indeed diminished, but not quite destroyed. If we can recollect none, but are quite at a loss, it is the greatest possible.

4With what curious attention does a naturalist examine a singular plant, or a singular fossil, that is presented to him? He is at no loss to refer it to the general genus of plants or fossils; but this does not satisfy him, and when he considers all the different tribes or species of either with which he has hitherto been acquainted, they all, he thinks, refuse to admit the new object among them. It stands alone in his imagination, and as it were detached from all the other species of that genus to which it belongs. He labours, however, to connect it with some one or other of them. Sometimes he thinks it may be placed in this, and sometimes in that other assortment; nor is he ever satisfied, till he has fallen upon one which, in most of its qualities, it resembles. When he cannot do this, rather than it should stand quite by itself, he will enlarge the precincts, if I may say so, of some species, in order to make room for it; or he will create a new species on purpose to receive it, and call it a Play of Nature, or give it some other appellation, under which he arranges all the oddities that he knows not what else to do with. But to some class or other of known objects he must refer it, and betwixt it and them he must find out some resemblance or other, before he can get rid of that Wonder, that uncertainty and anxious curiosity excited by its

singular appearance, and by its dissimilitude with all the objects he had hitherto observed.

5As single and individual objects thus excite our Wonder when, by their uncommon qualities and singular appearance, they make us uncertain to what species of things we ought to refer them; so a succession of objects which follow one another in an uncommon train or order, will produce the same effect, though there be nothing particular in any one of them taken by itself.

6When one accustomed object appears after another, which it does not usually follow, it first excites, by its unexpectedness, the sentiment properly called Surprise, and afterwards, by the singularity of the succession, or order of its appearance, the sentiment properly called Wonder. We start and are surprised at feeling it there, and then wonder how it came there. The motion of a small piece of iron along a plain table is in itself no extraordinary object, yet the person who first saw it begin, without any visible impulse, in consequence of the motion of a loadstone at some little distance from it, could not behold it without the most extreme Surprise; and when that momentary emotion was over, he would still wonder how it came to be conjoined to an event with which, according to the ordinary train of things, he could have so little suspected it to have any connection.

73When two objects, however unlike, have often been observed to follow each other, and have constantly presented themselves to the senses in that order, they come to be so connected together in the fancy, that the idea of the one seems, of its own accord, to call up and introduce that of the other. If the objects are still observed to succeed each other as before, this connection, or, as it has been called, this association of their ideas, becomes stricter and stricter, and the habit of the imagination to pass from the conception of the one to that of the other, grows more and more rivetted and confirmed. As its ideas move more rapidly than external objects, it is continually running before them, and therefore anticipates, before it happens, every event which falls out according to this ordinary course of things. When objects succeed each other in the same train in which the ideas of the imagination have thus been accustomed to

move, and in which, though not conducted by that chain of events presented to the senses, they have acquired a tendency to go on of their own accord, such objects appear all closely connected with one another, and the thought glides easily along them,4 without effort and without interruption. They fall in with the natural career of the imagination; and as the ideas which represented such a train of things would seem all mutually to introduce each other, every last thought to be called up by the foregoing, and to call up the succeeding; so when the objects themselves occur, every last event seems, in the same manner, to be introduced by the foregoing, and to introduce the succeeding. There is no break, no stop, no gap, no interval. The ideas excited by so coherent a chain of things seem, as it were, to float through the mind of their own accord, without obliging it to exert itself, or to make any effort in order to pass from one of them to another.

8But if this customary connection be interrupted, if one or more objects appear in an order quite different from that to which the imagination has been accustomed, and for which it is prepared, the contrary of all this happens. We are at first surprised by the unexpectedness of the new appearance, and when that momentary emotion is over, we still wonder how it came to occur in that place. The imagination no longer feels the usual facility of passing from the event which goes before to that which comes after. It is an order or law of succession to which it has not been accustomed, and which it therefore finds some difficulty in following, or in attending to. The fancy is stopped and interrupted in that natural movement or career, according to which it was proceeding. Those two events seem to stand at a distance from each other; it endeavours to bring them together, but they refuse to unite; and it feels, or imagines it feels, something like a gap or interval betwixt them. It naturally hesitates, and, as it were, pauses upon the brink of this interval; it endeavours to find out something which may fill up the gap, which, like a bridge, may so far at least unite those seemingly distant objects, as to render the passage of the thought betwixt them smooth, and natural, and easy. The supposition of a chain of intermediate, though invisible, events, which succeed each other in a train similar to that in which the imagination has been accustomed to move, and which link together those two disjointed appearances,

is the only means by which the imagination can fill up this interval, is the only bridge which, if one may say so, can smooth its passage from the one object to the other. Thus, when we observe the motion of the iron, in consequence of that of the loadstone, we gaze and hesitate, and feel a want of connection betwixt two events which follow one another in so unusual a train. But when, with Des Cartes, we imagine certain invisible effluvia to circulate round one of them, and by their repeated impulses to impel the other, both to move towards it, and to follow its motion, we fill up the interval betwixt them, we join them together by a sort of bridge, and thus take off that hesitation and difficulty which the imagination felt in passing from the one to the other. That the iron should move after the loadstone seems, upon this hypothesis, in some measure according to the ordinary course of things. Motion after impulse is an order of succession with which of all things we are the most familiar. Two objects which are so connected seem no longer to be disjoined, and the imagination flows smoothly and easily along them.

9Such is the nature of this second species of Wonder, which arises from an unusual succession of things. The stop which is thereby given to the career of the imagination, the difficulty which it finds in passing along such disjointed objects, and the feeling of something like a gap or interval betwixt them, constitute the whole essence of this emotion. Upon the clear discovery of a connecting chain of intermediate events, it vanishes altogether. What obstructed the movement of the imagination is then removed. Who wonders at the machinery of the opera–house who has once been admitted behind the scenes? In the Wonders of nature, however, it rarely happens that we can discover so clearly this connecting chain. With regard to a few even of them, indeed, we seem to have been really admitted behind the scenes, and our Wonder accordingly is entirely at an end. Thus the eclipses of the sun and moon, which once, more than all the other appearances in the heavens, excited the terror and amazement of mankind, seem now no longer to be wonderful, since the connecting chain has been found out which joins them to the ordinary course of things. Nay, in those cases in which we have been less successful, even the vague hypotheses of Des Cartes, and the yet more indetermined notions of Aristotle, have, with their followers, contributed to give some coherence to the appearances of nature,

and might diminish, though they could not destroy, their Wonder. If they did not completely fill up the interval betwixt the two disjointed objects, they bestowed upon them, however, some sort of loose connection which they wanted before. ….

11 ….Philosophers, indeed, who often look for a chain of invisible objects to join together two events that occur in an order familiar to all the world, have endeavoured to find out a chain of this kind betwixt the two events I have just now mentioned; in the same manner as they have endeavoured, by a like intermediate chain, to connect the gravity, the elasticity, and even the cohesion of natural bodies, with some of their other qualities. These, however, are all of them such combinations of events as give no stop to the imaginations of the bulk of mankind, as excite no Wonder, nor any apprehension that there is wanting the strictest connection between them. But as in those sounds, which to the greater part of men seem perfectly agreeable to measure and harmony, the nicer ear of a musician will discover a want, both of the most exact time, and of the most perfect coincidence: so the more practised thought of a philosopher, who has spent his whole life in the study of the connecting principles of nature, will often feel an interval betwixt two objects, which, to more careless observers, seem very strictly conjoined. By long attention to all the connections which have ever been presented to his observation, by having often compared them with one another, he has, like the musician, acquired, if one may say so, a nicer ear, and a more delicate feeling with regard to things of this nature. And as to the one, that music seems dissonance which falls short of the most perfect harmony; so to the other, those events seem altogether separated and disjoined, which fall short of the strictest and most perfect connection.

12Philosophy is the science of the connecting principles of nature. Nature, after the largest experience that common observation can acquire, seems to abound with events which appear solitary and incoherent with all that go before them, which therefore disturb the easy movement of the imagination; which make its ideas succeed each other, if one may say so, by irregular starts and sallies; and which thus tend, in some measure, to introduce those confusions and distractions we formerly mentioned. Philosophy, by

representing the invisible chains which bind together all these disjointed objects, endeavours to introduce order into this chaos of jarring and discordant appearances, to allay this tumult of the imagination, and to restore it, when it surveys the great revolutions of the universe, to that tone of tranquillity and composure, which is both most agreeable in itself, and most suitable to its nature. Philosophy, therefore, may be regarded as one of those arts which address themselves to the imagination; and whose theory and history, upon that account, fall properly within the circumference of our subject. Let us endeavour to trace it, from its first origin, up to that summit of perfection to which it is at present supposed to have arrived, and to which, indeed, it has equally been supposed to have arrived in almost all former times. It is the most sublime of all the agreeable arts, and its revolutions have been the greatest, the most frequent, and the most distinguished of all those that have happened in the literary world. Its history, therefore, must, upon all accounts, be the most entertaining and the most instructive. Let us examine, therefore, all the different systems of nature, which, in these western parts of the world, the only parts of whose history we know any thing, have successively been adopted by the learned and ingenious; and, without regarding their absurdity or probability, their agreement or inconsistency with truth and reality, let us consider them only in that particular point of view which belongs to our subject; and content ourselves with inquiring how far each of them was fitted to sooth the imagination, and to render the theatre of nature a more coherent, and therefore a more magnificent spectacle, than otherwise it would have appeared to be. According as they have failed or succeeded in this, they have constantly failed or succeeded in gaining reputation and renown to their authors; and this will be found to be the clew that is most capable of conducting us through all the labyrinths of philosophical history: for, in the mean time, it will serve to confirm what has gone before, and to throw light upon what is to come after, that we observe, in general, that no system, how well soever in other respects supported, has ever been able to gain any general credit on the world, whose connecting principles were not such as were familiar to all mankind. Why has the chemical philosophy in all ages crept along in obscurity, and been so disregarded by the generality of mankind, while other systems, less useful, and not more agreeable to experience, have possessed

universal admiration for whole centuries together? The connecting principles of the chemical philosophy are such as the generality of mankind know nothing about, have rarely seen, and have never been acquainted with; and which to them, therefore, are incapable of smoothing the passage of the imagination betwixt any two seemingly disjointed objects. Salts, sulphurs, and mercuries, acids, and alkalis, are principles which can smooth things to those only who live about the furnace; but whose most common operations seem, to the bulk of mankind, as disjointed as any two events which the chemists would connect together by them. Those artists, however, naturally explained things to themselves by principles that were familiar to themselves. As Aristotle observes, that the early Pythagoreans, who first studied arithmetic, explained all things by the properties of numbers; and Cicero tells us, that Aristoxenus, the musician, found the nature of the soul to consist in harmony. In the same manner, a learned physician lately gave a system of moral philosophy upon the the principles of his own art, in which wisdom and virtue were the healthful state of the soul; the different vices and follies, the different diseases to which it was subject; in which the causes and symptoms of those diseases were ascertained; and, in the same medical strain, a proper method of cure prescribed. In the same manner also, others have written parallels of painting and poetry, of poetry and music, of music and architecture, of beauty and virtue, of all the fine arts; systems which have universally owed their origin to the lucubrations of those who were acquainted with the one art, but ignorant of the other; who therefore explained to themselves the phaenomena, in that which was strange to them, by those in that which was familiar; and with whom, upon that account, the analogy, which in other writers gives occasion to a few ingenious similitudes, became the great hinge upon which every thing turned.

SECTION III : Of the Origin of Philosophy

1Mankind, in the first ages of society, before the establishment of law, order, and security, have little curiosity to find out those hidden chains of events which bind together the seemingly disjointed appearances of nature. A savage, whose subsistence is precarious, whose life is every day exposed to the rudest dangers, has no inclination to amuse himself with searching out what, when

discovered, seems to serve no other purpose than to render the theatre of nature a more connected spectacle to his imagination. Many of these smaller incoherences, which in the course of things perplex philosophers, entirely escape his attention. Those more magnificent irregularities, whose grandeur he cannot overlook, call forth his amazement. Comets, eclipses, thunder, lightning, and other meteors, by their greatness, naturally overawe him, and he views them with a reverence that approaches to fear. His inexperience and uncertainty with regard to every thing about them, how they came, how they are to go, what went before, what is to come after them, exasperate his sentiment into terror and consternation. But our passions, as Father Malbranche observes, all justify themselves; that is, suggest to us opinions which justify them. As those appearances terrify him, therefore, he is disposed to believe everything about them which can render them still more the objects of his terror. That they proceed from some intelligent, though invisible causes, of whose vengeance and displeasure they are either the signs or the effects, is the notion of all others most capable of enhancing this passion, and is that, therefore, which he is most apt to entertain. To this too, that cowardice and pusillanimity, so natural to man in his uncivilized state, still more disposes him; unprotected by the laws of society, exposed, defenceless, he feels his weakness upon all occasions; his strength and security upon none.

2But all the irregularities of nature are not of this awful or terrible kind. Some of them are perfectly beautiful and agreeable. These, therefore, from the same impotence of mind, would be beheld with love and complacency, and even with transports of gratitude; for whatever is the cause of pleasure naturally excites our gratitude. A child caresses the fruit that is agreeable to it, as it beats the stone that hurts it. The notions of a savage are not very different. The ancient Athenians, who solemnly punished the axe which had accidentally been the cause of the death of a man, erected altars, and offered sacrifices to the rainbow. Sentiments not unlike these, may sometimes, upon such occasions, begin to be felt even in the breasts of the most civilized, but are presently checked by the reflection, that the things are not their proper objects. But a savage, whose notions are guided altogether by wild nature and passion, waits for no other proof that a thing is the proper object of any sentiment,

than that it excites it. The reverence and gratitude, with which some of the appearances of nature inspire him, convince him that they are the proper objects of reverence and gratitude, and therefore proceed from some intelligent beings, who take pleasure in the expressions of those sentiments. With him, therefore, every object of nature, which by its beauty or greatness, its utility or hurtfulness, is considerable enough to attract his attention, and whose operations are not perfectly regular, is supposed to act by the direction of some invisible and designing power. The sea is spread out into a calm, or heaved into a storm, according to the good pleasure of Neptune. Does the earth pour forth an exuberant harvest? It is owing to the indulgence of Ceres. Does the vine yield a plentiful vintage? It flows from the bounty of Bacchus. Do either refuse their presents? It is ascribed to the displeasure of those offended deities. The tree, which now flourishes, and now decays, is inhabited by a Dryad, upon whose health or sickness its various appearances depend. The fountain, which sometimes flows in a copious, and sometimes in a scanty stream, which appears sometimes clear and limpid, and at other times muddy and disturbed, is affected in all its changes by the Naiad who dwells within it. Hence the origin of Polytheism, and of that vulgar superstition which ascribes all the irregular events of nature to the favour or displeasure of intelligent, though invisible beings, to gods, daemons, witches, genii, fairies. For it may be observed, that in all Polytheistic religions, among savages, as well as in the early ages of Heathen antiquity, it is the irregular events of nature only that are ascribed to the agency and power of their gods. Fire burns, and water refreshes; heavy bodies descend, and lighter substances fly upwards, by the necessity of their own nature; nor was the invisible hand of Jupiter ever apprehended to be employed in those matters. But thunder and lightning, storms and sunshine, those more irregular events, were ascribed to his favour, or his anger. Man, the only designing power with which they were acquainted, never acts but either to stop, or to alter the course, which natural events would take, if left to themselves. Those other intelligent beings, whom they imagined, but knew not, were naturally supposed to act in the same manner; not to employ themselves in supporting the ordinary course of things, which went on of its own accord, but to stop, to thwart, and to disturb it. And

thus, in the first ages of the world, the lowest and most pusillanimous superstition supplied the place of philosophy.

3But when law has established order and security, and subsistence ceases to be precarious, the curiosity of mankind is increased, and their fears are diminished. The leisure which they then enjoy renders them more attentive to the appearances of nature, more observant of her smallest irregularities, and more desirous to know what is the chain which links them all together. That some such chain subsists betwixt all her seemingly disjointed phaenomena, they are necessarily led to conceive; and that magnanimity, and cheerfulness, which all generous natures acquire who are bred in civilized societies, where they have so few occasions to feel their weakness, and so many to be conscious of their strength and security, renders them less disposed to employ, for this connecting chain, those invisible beings whom the fear and ignorance of their rude forefathers had engendered. Those of liberal fortunes, whose attention is not much occupied either with business or with pleasure, can fill up the void of their imagination, which is thus disengaged from the ordinary affairs of life, no other way than by attending to that train of events which passes around them. While the great objects of nature thus pass in review before them, many things occur in an order to which they have not been accustomed. Their imagination, which accompanies with ease and delight the regular progress of nature, is stopped and embarrassed by those seeming incoherences; they excite their wonder, and seem to require some chain of intermediate events, which, by connecting them with something that has gone before, may thus render the whole course of the universe consistent and of a piece. Wonder, therefore, and not any expectation of advantage from its discoveries, is the first principle which prompts mankind to the study of Philosophy, of that science which pretends to lay open the concealed connections that unite the various appearances of nature; and they pursue this study for its own sake, as an original pleasure or good in itself, without regarding its tendency to procure them the means of many other pleasures.

4Greece, and the Greek colonies in Sicily, Italy, and the Lesser Asia, were the first countries which, in these western parts of the world,

arrived at a state of civilized society. It was in them, therefore, that the first philosophers, of whose doctrine we have any distinct account, appeared. Law and order seem indeed to have been established in the great monarchies of Asia and Egypt, long before they had any footing in Greece: yet, after all that has been said concerning the learning of the Chaldeans and Egyptians, whether there ever was in those nations any thing which deserved the name of science, or whether that despotism which is more destructive of security and leisure than anarchy itself, and which prevailed over all the East, prevented the growth of Philosophy, is a question which, for want of monuments, cannot be determined with any degree of precision.

5…. The first philosophers, therefore, as well as the first poets, seem all to have been natives, either of their colonies, or of their islands. It was from thence that Homer, Archilochus, Stesichorus, Simonides, Sappho, Anacreon, derived their birth. Thales and Pythagoras, the founders of the two earliest sects of philosophy, arose, the one in an Asiatic colony, the other in an island; and neither of them established his school in the mother country.

6What was the particular system of either of those two philosophers, or whether their doctrine was so methodized as to deserve the name of a system, the imperfection, as well as the uncertainty of all the traditions that have come down to us concerning them, makes it impossible to determine. The school of Pythagoras, however, seems to have advanced further in the study of the connecting principles of nature, than that of the Ionian philosopher. The accounts which are given of Anaximander, Anaximenes, Anaxagoras, Archelaus, the successors of Thales, represent the doctrines of those sages as full of the most inextricable confusion. ….. It was in the school of Socrates, however, from Plato and Aristotle, that Philosophy first received that form, which introduced her, if one may say so, to the general acquaintance of the world. It is from them, therefore, that we shall begin to give her history in any detail. Whatever was valuable in the former systems, which was at all consistent with their general principles, they seem to have consolidated into their own. …..

SECTION IV: The History of Astronomy

1Of all the phaenomena of nature, the celestial appearances are, by their greatness and beauty, the most universal objects of the curiosity of mankind. Those who surveyed the heavens with the most careless attention, necessarily distinguished in them three different sorts of objects; the Sun, the Moon, and the Stars. These last, appearing always in the same situation, and at the same distance with regard to one another, and seeming to revolve every day round the earth in parallel circles, which widened gradually from the poles to the equator, were naturally thought to have all the marks of being fixed, like so many gems, in the concave side of the firmament, and of being carried round by the diurnal revolutions of that solid body: for the azure sky, in which the stars seem to float, was readily apprehended, upon account of the uniformity of their apparent motions, to be a solid body, the roof or outer wall of the universe, to whose inside all those little sparkling objects were attached.

2The Sun and Moon, often changing their distance and situation, in regard to the other heavenly bodies, could not be apprehended to be attached to the same sphere with them. They assigned, therefore, to each of them, a sphere of its own; that is, supposed each of them to be attached to the concave side of a solid and transparent body, by whose revolutions they were carried round the earth. …..

4This is the system of concentric Spheres, the first regular system of Astronomy, which the world beheld, as it was taught in the Italian school before Aristotle and his two contemporary philosophers, Eudoxus and Callippus, had given it all the perfection which it is capable of receiving. Though rude and inartificial, it is capable of connecting together, in the imagination, the grandest and the most seemingly disjointed appearances in the heavens. The motions of the most remarkable objects in the celestial regions, the Sun, the Moon, and the Fixed Stars, are sufficiently connected with one another by this hypothesis. The eclipses of these two great luminaries are, though not so easily calculated, as easily explained, upon this ancient, as upon the modern system. When these early philosophers

explained to their disciples the very simple causes of those dreadful phaenomena, it was under the seal of the most sacred secrecy, that they might avoid the fury of the people, and not incur the imputation of impiety, when they thus took from the gods the direction of those events, which were apprehended to be the most terrible tokens of their impending vengeance. The obliquity of the ecliptic, the consequent changes of the seasons, the vicissitudes of day and night, and the different lengths of both days and nights, in the different seasons, correspond too, pretty exactly, with this ancient doctrine. And if there had been no other bodies discoverable in the heavens besides the Sun, the Moon, and the Fixed Stars, this old hypothesis might have stood the examination of all ages, and have gone down triumphant to the remotest posterity.

5If it gained the belief of mankind by its plausibility, it attracted their wonder and admiration; sentiments that still more confirmed their belief, by the novelty and beauty of that view of nature which it presented to the imagination. …..

6Whatever are the defects which this account of things labours under, they are such, as to the first observers of the heavens could not readily occur. If all the motions of the Five Planets cannot, the greater part of them may, be easily connected by it; they and all their motions are the least remarkable objects in the heavens; the greater part of mankind take no notice of them at all; and a system, whose only defect lies in the account which it gives of them, cannot thereby be much disgraced in their opinion. If some of the appearances too of the Sun and Moon, the sometimes accelerated and again retarded motions of those luminaries but ill correspond with it; these too, are such as cannot be discovered but by the most attentive observation, and such therefore as we cannot wonder that the imaginations of the first enquirers should slur over, if one may say so, and take little notice of.

7It was, however, to remedy those defects, that Eudoxus, the friend and auditor of Plato, found it necessary to increase the number of the Celestial Spheres. Each Planet is sometimes observed to advance forward in that eastward course which is peculiar to itself, sometimes to retire backwards, and sometimes again to stand still.

To suppose that the Sphere of the Planet should by its own motion, if one may say so, sometimes roll forwards, sometimes roll backwards, and sometimes do neither the one nor the other, is contrary to all the natural propensities of the imagination, which accompanies with ease and delight any regular and orderly motion, but feels itself perpetually stopped and interrupted, when it endeavours to attend to one so desultory and uncertain. It would pursue, naturally and of its own accord, the direct or progressive movement of the Sphere, but is every now and then shocked, if one may say so, and turned violently out of its natural career by the retrograde and stationary appearances of the Planet, betwixt which and its more usual motion, the fancy feels a want of connection, a gap or interval, which it cannot fill up, but by supposing some chain of intermediate events to join them. The hypothesis of a number of other spheres revolving in the heavens, besides those in which the luminous bodies themselves were infixed, was the chain with which Eudoxus endeavoured to supply it. He bestowed four of these Spheres upon each of the Five Planets; one in which the luminous body itself revolved, and three others above it. Each of these had a regular and constant, but a peculiar movement of its own, which it communicated to what was properly the Sphere of the Planet, and thus occasioned that diversity of motions observable in those bodies. One of these Spheres, for example, had an oscillatory motion, like the circular pendulum of a watch. As when you turn round a watch, like a Sphere upon its axis, the pendulum will, while turned round along with it, still continue to oscillate, and communicate to whatever body is comprehended within it, both its own oscillations and the circular motion of the watch; so this oscillating Sphere, being itself turned round by the motion of the Sphere above it, communicated to the Sphere below it, that circular, as well as its own oscillatory motion; produced by the one, the daily revolutions; by the other, the direct, stationary, and retrograde appearances of the Planet, which derived from a third Sphere that revolution by which it performed its annual period. The motions of all these Spheres were in themselves constant and equable, such as the imagination could easily attend to and pursue, and which connected together that otherwise incoherent diversity of movements observable in the Sphere of the Planet. The motions of the Sun and Moon being more regular than those of the Five Planets, by assigning three Spheres to each of them, Eudoxus imagined he

could connect together all the diversity of movements discoverable in either. The motion of the Fixed Stars being perfectly regular, one Sphere he judged sufficient for them all. So that, according to this account, the whole number of Celestial Spheres amounted to twenty–seven. Callippus, though somewhat younger, the cotemporary of Eudoxus, found that even this number was not enough to connect together the vast variety of movements which he discovered in those bodies, and therefore increased it to thirty–four. Aristotle, upon a yet more attentive observation, found that even all these Spheres would not be sufficient, and therefore added twenty–two more, which increased their number to fifty–six. Later observers discovered still new motions, and new inequalities, in the heavens. New Spheres were therefore still to be added to the system, and some of them to be placed even above that of the Fixed Stars. So that in the sixteenth century, when Fracostorio, smit with the eloquence of Plato and Aristotle, and with the regularity and harmony of their system, in itself perfectly beautiful, though it corresponds but inaccurately with the phaenomena, endeavoured to revive this ancient Astronomy, which had long given place to that of Ptolemy and Hipparchus, he found it necessary to multiply the number of Celestial Spheres to seventy–two; neither were all these enough.

8This system had now become as intricate and complex as those appearances themselves, which it had been invented to render uniform and coherent. The imagination, therefore, found itself but little relieved from that embarrassment, into which those appearances had thrown it, by so perplexed an account of things. Another system, for this reason, not long after the days of Aristotle, was invented by Apollonius, which was afterwards perfected by Hipparchus, and has since been delivered down to us by Ptolemy, the more artificial system of Eccentric Spheres and Epicycles. ….

12But with all those combined and perplexed circles; though the patrons of this system were able to give some degree of uniformity to the real directions of the Planets, they found it impossible so to adjust the velocities of those supposed Spheres to the phaenomena, as that the revolution of any one of them, when surveyed from its own centre, should appear perfectly equable and uniform. From that point, the only point in which the velocity of what moves in a circle

can be truly judged of, they would still appear irregular and inconstant, and such as tended to embarrass and confound the imagination. They invented, therefore, for each of them, a new Circle, called the Equalizing Circle, from whose centre they should all appear perfectly equable: that is, they so adjusted the velocities of these Spheres, as that, though the revolution of each of them would appear irregular when surveyed from its own centre, there should, however, be a point comprehended within its circumference, from whence its motions should appear to cut off, in equal times, equal portions of the Circle, of which that point was the centre.

13Nothing can more evidently show, how much the repose and tranquillity of the imagination is the ultimate end of philosophy, than the invention of this Equalizing Circle. The motions of the heavenly bodies had appeared inconstant and irregular, both in their velocities and in their directions. They were such, therefore, as tended to embarrass and confound the imagination, whenever it attempted to trace them. The invention of Eccentric Spheres, of Epicycles, and of the revolution of the centres of the Eccentric Spheres, tended to allay this confusion, to connect together those disjointed appearances, and to introduce harmony and order into the mind's conception of the movements of those bodies. It did this, however, but imperfectly; it introduced uniformity and coherence into their real directions. But their velocities, when surveyed from the only point in which the velocity of what moves in a Circle can be truly judged of, the centre of that Circle, still remained, in some measure, inconstant as before; and still, therefore, embarrassed the imagination. The mind found itself somewhat relieved from this embarrassment, when it conceived, that how irregular soever the motions of each of those Circles might appear, when surveyed from its own centre, there was, however, in each of them, a point, from whence its revolution would appear perfectly equable and uniform, and such as the imagination could easily follow. Those philosophers transported themselves, in fancy, to the centres of these imaginary Circles, and took pleasure in surveying from thence, all those fantastical motions, arranged, according to that harmony and order, which it had been the end of all their researches to bestow upon them. Here, at last, they enjoyed that tranquillity and repose which they had pursued through all the mazes of this intricate hypothesis;

and here they beheld this, the most beautiful and magnificent part of the great theatre of nature, so disposed and constructed, that they could attend, with ease and delight, to all the revolutions and changes that occurred in it.