COSMOLOGY without HEADACHES

(Lecture Series)

(compiling, transcribing, researching, editing always in progress)

LECTURE **XV**: **Cartesian Doubt; Mathematizing the Universe**

René Descartes [1596-1650]

Descartes came to philosophy via mathematics. While serving in Holland in the Army of Maurice of Nassau (30-Years War) he had a dream, or a series of dreams, that he interpreted as an assignment from God to found a system of thought: a science of nature based on mathematics. This was 1618, but God seems to have allowed deferral of the assignment while he continued to travel after his military contract was satisfied. Eventually settling in Holland, he began his never completed *Rules for the Direction of the Mind* (cir.1628), showing his early inclination toward a strict method as the means to scientific advance—a method by which he thought he could establish a basis for certainty in knowledge equal to the certainty inherent in mathematics. By 1634 he had worked out his scientific treatise, *Le Monde*, which included his open support for the Copernican solar system. Having been barely published, he hurriedly had his book suppressed when word came to him of Galileo's fate at the hands of the Inquisition (1633). Thereafter he would write with extreme caution, always conciliatory of religious authority, so that his work is, here and there, interrupted by statements intended to immunize him from theological condemnation: remarks about God and scripture that contradict or limit the logical implications of his thought. On the other hand, he depended on God (though not always the God of the Bible) as an important part of his logic.

In 1637 Descartes published his famous ***Discourse on Method*** as the preface to a book containing three treatises: *Geometry*; *Dioptric*; and *Meteors*. Most notable is his method of doubt, found in Part II of the *Discourse*. There we find his four rules expressing that method:

> *The first* of these was to accept nothing as true which I did not clearly recognize to be so: that is to say, carefully to avoid precipitation and prejudice in judgments, and to accept in them nothing more than was presented to my mind so clearly and distinctly that I could have no occasion to doubt it.
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> *The second* was to divide up each of the difficulties which I examined into as many parts as possible, and as seemed requisite for it to be resolved in the best manner possible.
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> *The third* was to carry on my reflections in due order, beginning with objects that were the most simple and easy to understand, in order to rise little by little, or by degrees, to knowledge of the most complex, assuming an order, even if a fictitious one, among those which do not follow a natural sequence relative to one another.
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> *The last* was in all cases to make enumerations so complete and reviews so general that I should be certain of having omitted nothing.
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> [Translation by E.S.Haldane & G.T.Ross *in* THE PHILOSOPHICAL WORKS OF DESCARTES; Cambridge, 1911-1912 (paperback, NY, 1955); *found in* **MACMILLAN** COMPENDIUM: PHILOSOPHY AND ETHICS; Donald Borcher editor In chief; Macmillan Library Reference, NY, 1999]

The first entails what Descartes often refers to as 'sufficient clarity'—i.e., something incontestably factual on its face—sufficient to overrule prejudice and by-pass judgment by eliminating doubt. This search for a position of doubtlessness is the central scheme of Descartes' thought-adventures. So much so that he finds himself doubting everything except that he doubts, thus providing certainty to his existence—at least the existence of a doubter: a thinker (doubting is a form of thinking—or maybe he can be certain only that doubt occurs, and that there is awareness of it), which he identifies as self. *Je pense, donc je suis*; thus, *Cogito ergo sum*: the bedrock of reality he sought, and on which he would begin building his philosophical castle. But he was led to its base by doubting every other conceivable thing. He is not really a Skeptic, in that he believes he has found certainty and expects to discover more by a new means to knowledge and truth. He uses the skeptical method only to refute it: to prove skepticism has a limit and there *is* something certain. But what is left as material for his modernist structure? Along his trail of doubt, every stone and timber that might have fortified his philosophy have been infected with uncertainty. What in the 'real' world—the physical world—can be trusted?

He relies on God to get him out of this fix, and to end his loneliness as the only indisputable being in the Universe—if there *is* a universe. Now, to move forward he must look back—to St.Anselm. To use God as a supporting column of his system, he must first establish Gods existence. The very definition of God includes absolute perfection (an axiom of Scholasticism that has a suspicious relation to revelation theology and the very metaphysics Descartes had hoped to avoid). Hoping no one will notice that his definition of God begs the question, he claims the Deity's existence has been proven by the logic that non-existence is somehow an imperfection. In fact, Descartes considered that he had thus fortified Anselm's famous ontological proof, having added the *necessity* of God's existence. Besides, Descartes did not cause himself to come into being. Only God could have done that. Furthermore, a cause must possess at least as much reality as the effect. The cause of his idea of a Perfect Being must, therefore be a Perfect Being. So now we

have at least two certainties: a thinker and its Creator. Now, would a god who cared enough to create a thinker act in such a way as to deceive him? Descartes thinks not—but how can he be certain? He presumes that deceit, too, is an imperfection, which cannot, therefore, be an attribute of God, since God is in every way perfect—the very consummation of perfection.

Could it be that Descartes, the ultimate doubter, has failed to doubt sufficiently? He has come to within a single step of complete skepticism. To avoid losing both reason and reality he allows or, perhaps, *wills* himself to believe. But it is more likely that he thinks of God's perfection as an axiom, as in geometry—like the axiom of Euclid that two parallel lines would never meet. That unproven assumption was the basis of many formal proofs in geometry. Through the ages it had been thought self-evident. Few, if any, considered that this axiom might not be provable, since proof of such an obvious truth was superfluous—until modern men, still unborn at the time of Descartes, would discover other geometries: 'non-Euclidean' geometries, thus effectively isolating the parallel-lines axiom within a special 'Euclidean space.' I.e., it was true only within the abstract world that had been constructed around it by Euclid (a world expanded by other geometers for over 2000 years). So, in Descartes' era there was *only* Euclidean geometry—Descartes himself depended upon it in inventing his own analytical geometry.

Tending to see the world geometrically, there was, for him, a pinnacle of perfection (like the apex of an ideal equilateral triangle), something devoid of all imperfection, thus devoid of evil: the Absolute Positive, and that was God. Deceit was unquestionably evil, thus God would be incapable of it (though such a proposition is complicated, logically, by God's equally assumed omnipotence). Anyway, in accordance with this logic, Descartes proclaimed his trust that God would not, *could* not mislead him. Yet, as an imperfect mortal, or as a thinker *de novo*, he could hardly trust his own judgment. Could he be sure he understood God properly? Thus his obsession with eliminating doubt—so that judging would be rendered unnecessary. Mathematics seemed the only guide to certainty, so he tried to build a mathematical universe—plus, this would be a completely cerebral universe, proven (as was his existence) only abstractly.

The second rule, dividing wholes into easier to handle and understand parts, might seem more at home with the idea of atomism: the assumption of a world of discrete parts rather than a continuum. As for physics, Descartes does not ascribe to Gassendi's revival of Lucretius. Yet he seems to suggest that atomism is applicable to the world of ideas: perhaps the very basis of reductionism that became the hallmark of classical physics.

> . . . I only consider [in physics] the divisions, shapes and movements [of quantity, regarded geometrically]; and I do not want to receive as true anything but what can be deduced from these with as much evidence as will allow it to stand as a mathematical demonstration.
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> [*Principles II, 64 as quoted by* Garber *in* PHILOSOPHY AND ETHICS: *Descartes, René*; Macmillan, NY, 1999; p.208]

The third requires one to begin the search for knowledge with examination of the simple and easy to understand, the method of geometry, proceeding through the more complex to gain knowledge by small steps, 'assuming an order, even if a fictitious one.' But what has happened to the core of his epistemology: that only elimination of doubt brings certainty? Is there nothing to doubt concerning these unmentioned assumptions? E.g., he assumes he will be able to understand the most simple easily, but where to

start—what are the most simple things? And if there are such things, might we not call them atoms—or are the simplest things only in the mind? The only thing he could be sure of, it seems, was his existence (in some fashion, he wasn't even sure how, but it did not seem to be materially). And we have not moved from that one certainty, a certainty depending again on assumptions, though Descartes seems to have considered them as axioms, having to do with the nature of God: that God was the summation of perfection; that a necessary attribute of perfection was existence (God, therefore, must exist); and that deceitfulness was an imperfection (as if there could not be perfect deceitfulness).

Furthermore, even if we grant that he might come to understand the most simple (though we still, today, do not have such understanding), how can we be certain that this will lead us to the understanding of the more complex? Rather it seems unlikely that knowledge of molecular structure in bone chemistry, for instance, can lead us to understanding of a frog's leg. Nor would understanding of the frog's leg, even if we could achieve it completely, enable us to 'know' the frog—let alone provide understanding of life itself—since the whole is much more and has an entirely different meaning than an assembly of its parts. In any case, it seems all we can have is a succession of theories. In the end, through science, we might attain something like complete knowledge of these theories (even a GUT), yet know little or nothing of reality.

The last rule is simply: keep good records. Even here there is a limit to what can be recorded. And while records are for recall and dissemination of information, they are susceptible of misinterpretation. And no matter how well kept and how scrupulously organized, they are only records of knowledge gained in other ways—not themselves the means to that knowledge; merely part of the means of spreading that knowledge.

For these reasons and perhaps others, Leibniz complained glibly that Descartes' rules amounted to "Take what you need, and do what you should, and you will get what you want" [*quoted by* Garber *in* PHILOSOPHY AND ETHICS, Macmillan, p.199].

Cogito Ergo Sum:

"I think, therefore I am"—the most familiar phrase in all of philosophy. To reach this rock-bottom undeniable truth (the thinker *mus*t exist or no thought would be thought), Descartes has proceeded to doubt everything—wondering if he might not be deceived even by his 'belief' in the physical world and in history—even his own past. He comes to rest in this descent into skepticism, on something he cannot doubt: that *doubting* is occurring, therefore a doubter certainly exists. Upon reaching this final point of 'indubitability,' he must now find his way back, step by step, certifying the existence of the entire world, physical (the extended world) and psychological (the mental or metaphysical world). This will prove tricky, especially the material world, since he has only 'proved' (if anything) that 'he' is a mind or soul, which has no extension.

He understands that mind, thus, might not be dependent upon the body (in fact, cannot be if it is identified with an immortal soul). While thoughts and dreams and doubts have no extension, they do seem to have an effect on the world of extension, but he cannot prove it by doubting—only by faith: faith that God is not a deceiver, and that God exists. He apparently believed he had proved both, but his proof rests on the assumption that his definition of God is accurate and complete. I.e., he has faith that his definition, (based not upon reason alone, but at least partly upon dogma) corresponds to truth. It seems, then, that for Descartes, logic (at least Catholic logic) not only confirms the Deity,

but thus forms the otherwise unexplained connection between non-corporeal mental events and corporeal extension and action. In fact, he says that God, in a way, creates Himself, or at least, sustains Himself eternally by some sort of action—by willing—by which He also sustains the thinker/doubter as well as the world of extension. But how can the doubter progress in knowledge beyond his own mere thoughts; how can the thinker be certain he is not deceived by an illusion of reality? The answer is the Perfect Being continually acting/willing to sustain the Universe, which otherwise (even according to Leibniz) would dissolve, and Who would not, *could* not, deceive His creatures: His precious thinkers. Does God, then, have extension? Is that what we mean by His existence? One might suggest (as did Henry More) that the Universe *is* God's extension, but Descartes never goes so far. Thus, God, for Descartes, exists in a similar manner to a thinker—except in a perfect rather than imperfect way—e.g., He remains incorporeal, so Descartes has not established a causal connection between the spirit and matter.

In fact, there is no explanation of matter in Descartes' work, except the notion of extension. Yet he denies the void (so necessary to the atomists), saying that a void is nothing, and if there were 'nothing' separating the various objects, they would not be separate. So things must be separated by 'something'. Space, itself, thus, must have substance: attributes. It thus has 'extension,' even if we have no 'sense' of it (or do we somehow 'sense' it negatively as vacuousness?). Otherwise, if nothing, it could not be measured. Since the senses are deficient and do not prove 'realilty,' (or prove anything at all), no dependable notion of the physical world can be attained through sense perception.

Daniel Garber (in his article concerning Descartes for the Macmillan COMPENDIUM, PHILOSOPHY AND ETHICS; p.207), states that:

> [Descartes'] conception of the physical world is totally kinematic and involves no concept that cannot be explained in terms of pure geometry together with time. His physics, in fact contains no physical (as opposed to mathematical) concept at all; the only departure from a totally abstract geometrical picture is the principle, itself sufficiently abstract, that matter excludes other matter from the place that it occupies.

Later, near the end of our study, we will encounter a living professional mathematician, Max Tegmark, the latest in a line of mathematical philosophers who try to apply up-to-date equations and advanced mathematics to suggest much the same thing: that a mathematics perfectly descriptive of reality (which he does not provide, but wishes he could, and thinks it might be done, eventually) will prove that *A* (the universal mathematical formula) = *B* (reality), therefore reality *is* mathematics. This is tempting for mathematics savants and mathematically oriented theoretical physicists and even modern philosophers because a lot of headaches would be avoided by thus eliminating physics—something reminiscent of modern physics having eliminated metaphysics. But wait: Isn't pure mathematics just the return of metaphysics in disguise? (It reminds me of baseball manager Bobby Valentine, once having been thrown out of a game for arguing a call and insulting the plate umpire, re-entering the dug-out with the classic comedy mask: the big nose, fake eye-glasses, and bushy eyebrows, while still in uniform. Naturally the umpire noticed, Valentine was again ejected and ultimately fined for making a joke of the game.)

For Descartes, the world is entirely filled with matter (extension); i.e., a plenum (space is not a vacuum) and is continuous (not atomic; not discrete). Certain volumes of matter form systems which can be recognized and percieved as separate entities by our

senses due to their motion and 'place' relative to other systems. So, while there may be indefinitely many thinkers or minds—or 'souls,' as it were—the physical universe is but one continuous and homogeneous extended body. Since there is no space or void into which a body or system might move, existing matter (the substance of space) must be moved out of the way simultaneously in some sort of closed curve. This concept is behind Descartes' theory of vortices as the cause of cosmic appearances and the movement of planets (reminiscent of Anaxagoras, c.550 B.C.). Despite the shortcomings of this attempt to assimilate physics and geometry, Garber points out some important results: the sine law of refraction; an approximation to the law of rectilinear inertia; and

> … a framework of scientific and cosmological ideas robust enough still to be reagarded in the early eighteenth century as a real rival to the Newtonian system; Newton himself considered it worthy of painstaing refutation.
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> [Macmillan COMPENDIUM, p.208]

Descartes is "the first of the modern school of mathematics," according to W.W. Rouse Bell [A SHORT ACCOUNT OF THE HISTORY OF MATHEMATICS, chapter XV; Dover, NY, 1960 (republication of 4th Edition, 1908); p.269], and his greatest contribution to science was the development of **analytical geometry** (we still refer to the plotting of curves or lines between the *x* and *y* axes as 'Cartesian Coordinates") and the **theory of vortices**. Alternately debunked and revived, it was the first full-fledged attempt to explain cosmic phenomena by means of the same principles that apply to natural events on earth.

Analytical geometry was not exactly invented by Descartes. Pierre Fermat [1601-1665] used it earlier, but never published anything in that regard, and Boneventura Cavallieri had written *Geometria indivisibilibus* in 1635. But it was from Descartes that the world of science learned its use. "The key to analytical geometry is deceptively obvious," says A.Rupert Hall [FROM GALILEO TO NEWTON; Dover; NY, 1981 (p.92)]:

> All geometrical problems may easily be reduced to such terms that afterwards one only needs to know the lengths of certain straight lines in order to construct them. As arithmetic consists of four or five operations only (namely addition, subtraction, multiplication, division and the extraction of roots, which is a kind of division), so in geometry to find the lines required it is only necessary to add or subtract others; or, given two lines, to take a third line as unity and discover a fourth proportional (which is multiplication) . . .
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> [THE GEOMETRY OF RENÉ DESCARTES, facsimile with trans. by D.E.Smith & R.E.Latham; NY, 1954 – *as found in* Hall: FROM GALILEO TO NEWTON; p.92]

Descartes' method and his greatly improved system of symbols managed to fuse geometry and algebra into the much needed language of physics, without which "the application of mathematics to science would have been stultified" [Hall, *ibid.*, p.93]

It was Galileo who noted:

> Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it; without these, one wanders about in a dark labyrinth.

[S.Drake; DISCOVERIES AND OPINIONS OF GALILEO, NY, 1957 (pp.237-8),
quoted in A.Rupert Hall; FROM GALILEO TO NEWTON; Dover, NY, 1981 (p.84)]

While Galileo's most conspicuous application of this quantizing to his laws of motion was sufficient to transform our concept of the Universe, here he suggests that all manner of science is subject to mathematizing. Hall himself points out [*Ibid.*, p.80] that "mathematics is not just an abstract science exploring the relations of numbers, for in those relations lies a model of physical reality."

One might say '*potentially* within those relations'. But do they not remain abstract? Besides, it could be argued that mathematical models are made, not found. To make advanced models, mathematics must advance. So are we 'discovering' new mathematical relationships with advancement, or 'inventing' them in order to 'advance'?

If we are *discovering* them, does that imply the models we make are in some sense natural (e.g., potentially there, like Aristotle's oaks in acorns), and might they be perfected to correspond to the 'real' world in its every aspect—thus leading us to ultimate truth? Further, does this natural potential lying within purely abstract mathematics, as some believe, actually break-out of the Platonic 'ideal world,' somehow, to become what we perceive to be hard reality (i.e., is the world really just mathematics)? Or could it be that mathematical models, however sophisticated, logical, intuitive, or even 'natural' (in the sense given) will never be more than models: useful rather than truthful.

If we are *inventing* mathematical relationships, the latter seems the more likely: that we are attempting to advance knowledge. But then are we not also inventing the *material* relationships: our theories of reality being thus significantly colored (if not completely formulated) by our mathematical concepts? If so, we will find ourselves always chasing but never capturing reality and gaining no certainty as to what is true outside of the world of pure logic, as we are trapped forever in Descartes' mental universe while our bodies intuitively blunder through the restrictive landscape so tentatively revealed by unreliable senses—as if something were really there.

Descartes' argument that matter cannot be fully known through the senses, by fostering serious consideration that the whole material universe might be illusion, has had lasting influence on modern thought. "If we begin with matter," says Will Durant:

> … and rise through levels of organic life to man, we shall be tempted by the logic of continuity to interpret mind as material [or as an illusion caused by brain activity]. But [according to Descartes] matter is known to us only through mind; only mind is known directly. Here begins modern idea-lism [perhaps we should write: 'idea-*ism*], not as ideal-ism in an ethical sense, but as a philosophy that starts with the immediate fact of ideas, rather than with things known through the ideas. Descartes sets the epistemological theme of modern European philosophy: "No more useful inquiry can be proposed than that which seeks to determine the nature and scope of human knowledge" [Descartes, in "Rules for Direction of the Mind," VIII, in *Selections, 69*]. Now for three centuries philosophy would wonder if the "external world" exists except as idea.
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> [THE AGE OF REASON BEGINS; chapter XXIII: *Philosophy Reborn;*
> Simon & Schuster, NY, 1961; p.619]

This is in direct opposition to Gassendi's no less modern notion (the very foundation of positivism) that the *only* knowledge we can have is through the senses. In other objections to Descartes,

> . . . Gassendi rejects the clarity and distinctness criterion, seeks to undermine the reasoning behind the *cogito*, and assails the ontological argument. Each of these views represents a battle Gassendi has taken up against the Aristotelian tradition or the Cartesian stance; his thoroughgoing empiricism poses an alternative to both of these competing perspectives.
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> [Stanford Encyclopeia of Philosophy; http://plato.stanford.edu/entries/gassendi/]

Certainly Descartes had detractors beyond Gassendi, Henry More, Newton, and Leibniz, and many were French. Still, though he lived in Holland, the French generally tended toward his ideas (the 'Cartésiennes') and away from Gassendi, whose thought became more influential in England than on the Continent. An advantage to Descartes was his use of French in explaining his modernist ideas, making these concepts (though some of his work is still rather obscure) available to a wider audience than ever before, as philosophers and scholars in his era were still, for the most part, eschewing the vernacular in favor of Latin. These concepts began to be hotly debated in popular and intellectually oriented salons all over France, spilling over into the literature of the day, furthering the Age of Reason and giving a tremendous push toward 'The Enlightenment.' Even while he still lived, and even in France where he was favored, it was widely apprehended that his philosophy was weak. Hobbes complained, says John Aubrey [1626-1697], that "…had Descartes kept himself wholly to geometry ... he had been the best geometer in the world, but that his head did not lie for philosophy" [AUBREY'S BRIEF LIVES; ed. O.L.Dick, Ann Arbor, 1957 (p.95) -- *as found in* Durant: THE AGE OF REASON BEGINS; Simon & Schuster, NY, 1961 (p.643)]. And Fontenelle [1657-1757] later explained "It is Descartes ... who gave us a new method of reasoning, much more admirable than his philosophy itself, in which a large part is false or very doubtful according to the very rules he has taught us" [*from* Fontenelle; *Digression sur les anciens et les modernes*; *in* Fellows & Torrey; AGE OF THE ENLIGHTENMENT, NY, 1942 (p.57) *as found in* Durant, *Ibid*. (p.645)].

It was his mathematical-mechanical cosmos that grabbed attention; especially the idea that a non-Aristotelian cosmology could be systematized. If the resulting system was flawed, still his attempt was magnificent. Marin Mersenne [1588-1648] (theologian, philosopher, mathematician, music theorist [*Harmonie Universelle,* 1636, *with full descriptions of all contemporary instruments*], also known as the 'father of acoustics) reported, as against Bacon, that the scientific revolution had not been brought about by any particular new scientific method nor by the notion of empiricism but by the replacement of the ancient Aristotelian system of thought—which, as we have seen, began well before Descartes (or Francis Bacon or Galileo or even Copernicus). Here was a laudable attempt, if rash and much too early, to describe and/or summarize that change.

To overly generalize: Descartes' universe could never decide if it was *purely mental* (*Cogito ergo sum*) and that material was an illusion created by pure mind with the help of God, or if it was *nothing but matter* wherein there was no place for mind or spirit or void or even God, all these things being illusions created by nothing but motion and extension. Paradoxically, he started from pure thought, everything else being doubtful, proving even God ontologically and ended with pure, soulless stuff extended

'indefinitely,' which opened him to charges of atheism. It was the latter understanding that blossomed and allowed what was called natural philosophy to become physics and to prosper and to separate itself from metaphysics, which was all that was left to philosophy.

So, if Descartes was not a truly great philosopher—even if he was a poor one—paradoxically, his influence on philosophy may have been greater than any modern thinker until Kant. In spite of obeisance to the Church, he helped deflect Western thought out of its religious rut and advanced the Great Debate between reason and revelation. Thus he was a major impetus in the development of Western science and modern ideas.

We are in the midst, here, of the overthrow of the pagan Aristotle. This, one might think, ought to have pleased the Church—but no. Through the centuries-long, sometimes bitter and complicated corroboration or interpenetration, a tense but effective rapprochement had been achieved between Greek philosophy and Christian theology. Scripture, at the height of scholasticism, seemed to support the pre-scriptural cosmos, as best illustrated by Ptolemy: a closed system of geocentric spheres, each carrying one of the known celestial objects, except for the all-encompassing sphere that carried the fixed stars. So in the early 17th century the Copernican Revolution was still in progress, though Copernicus would hardly recognize his original vision and might have been astounded by the various shapes and the enormous size the Universe was assuming. Our modern concept was not fully formed, of course, and Descartes' best gift was to expose the host of problems that needed resolution before universal truth could be discovered—*if* it could be discovered, or if truth could be known at all—or if there *is* any real truth to be known.

So this is where we, as Western culture, stood cosmologically just prior to Newton:

Aristotle's physics were fairly demolished, except in the eyes of anti-modern clerics on both sides of the Reformation and among their uneducated faithful. Though the ancient system was seen by many honest intellectuals of the mid-17th century to be fatally flawed, it had managed to help stabilize the psycho-political drama of life for centuries. Its momentum was tremendous, yet it was becoming increasingly clear that it was obsolete and needed replacing. But with what? There had been a few competing quasi-conceptions, but all of them incomplete: hinted cosmologies with little promise.

Copernicus had the audacity to argue that a tolerably good idea supported by sound mathematics was superior, as a basis of scientific development, to any assumptions (however logical they may seem) founded on observation. Kepler's notion of the orbital ellipses of the planets, too, was certainly elegant mathematically, but could not yet be explained by natural causes. Galileo's expansion of the outer, starry sphere and, worse, the suggestion of limitlessness were unimaginable concepts at the time and jarred with the traditional understanding of God, impeding acceptance of such ideas and feeding an already menacing atheism. The way of the world was opening to the wildest speculation.

Francis Bacon, realizing the difficulty involved in sorting out truth from dreamweaving, suggested that reason could be directed and curbed in its propensity toward excess by strictly following deductive reasoning. But his method was so strict as to prevent any real progress from being made in formulating general hypotheses.

Galileo thought intuition followed by experiment was more productive. But what was proved, other than that the given experiments worked? The hypotheses, however satisfying and couched in beautiful rhetoric, were still unproven. So, while allowing for technological improvements, there was no consistent theory generated to hold the various hypotheses together, without which general 'laws of physics' could not be established.

Gassendi, in the spirit of his time, looked back to previous anti-Aristotelians for guidance, rediscovering and rejuvenating atomic theory—even extending it to thought and the soul—and proffering space as a void. Most folks, however, during the gestation period of theoretical physics, could not accept 'nothingness' as a part of creation, nor conceive of a reality that included the *non*real. And why did these atoms not coalesce, all 'falling' to the center of the Universe to make one big ball of material, instead of forming separate celestial spheres? And if space was infinite, why would they coalesce at all?

Henry More, in his opposition to Descartes, tried to solve the God vs. nature difficulty (thus to close the Cartesian gap between body and mind) by proposing a pantheistic approach: God *is* Nature—the extended (and infinite) material universe was, in a way, the Body of God—which met with rebuttals tinged with insinuations of heresy.

Without solving these problems the revolutionaries could not effectively exterminate Aristotelianism and annihilate the Ptolemaic cosmos. Meanwhile, the threat of any such intention stirred the ire of the Inquisition (where Catholicism was still in power), and set the radicals at loggerheads with some even more scripture-strict Protestant sects—not to mention the still ancient-oriented European Jews who, in their long interaction with the West, had come to see the physical world pretty much through the eyes of Aquinas, meaning is was (at least in its imagined appearance) Ptolemaic.

However questionable even to his defenders and as jumbled and shaky as his final product may have seemed to his opponents (not to mention how absurd some of it would appear to later generations), Descartes had the courage (or naïveté) to attempt a full-blown description of the natural world and its workings, even inventing some of the mathematical language necessary to support it and braving the raillery of minds sharp enough to see the contradictions here and there in his fabrication but insufficiently deep to understand the enormous ramifications of the whole. The difficult challenge of penetrating the thick forest of his thought, however, would ultimately provide stimulation for clearing those woods for construction of the great highway of 'classical physics.'

"Descartes, with his universal doubt, gave another cue to the Age of Reason," says Will Durant in the closing sentences of Part VII of THE STORY OF CIVILIZATION:

> Morals and manners were molded by the vicissitudes of belief. Literature itself was touched by the conflict, and the ideas of philosophers echoed in the poetry of Marlowe, Shakespeare, and Donne. Soon all the wars and revolutions of the rival states would sink into minor significance compared with that mounting, spreading contest between faith and reason which was to agitate and transform the mind of Europe, perhaps of the world.
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> [*Ibid.*, p.647]

HANDOUT: Essay by Lawrence Bern's, Thomas Hobbes
in Strauss/Cropsey HISTORY OF POLITICAL PHILOSOPHY; PP. 396-420.

By this point students should have finished reading Kuhn, THE COPERNICAN REVOLUTION and have started on (? -Einstein-Infeld, THE EVOLUTION OF PHYSICS- ? *or* ? -Crowe, MODERN THEORIES OF THE UNIVERSE: FROM HERSCHEL TO HUBBLE- ? *or* ? –Butterfield, THE ORIGINS OF MODERN SCIENCE- ? *or* Kuhn, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS- ?) – *still undecided*.