Galileo's  Telescope

COSMOLOGY without HEADACHES

(Lecture Series)

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

LECTURE XIV: Francis Bacon Points the Way to a New Science; Galileo Intuits a Shorter Path; Gassendi Finds Open Space

Nearing the end of the Renaissance we find scholasticism still alive but on the wane. The esoteric tête-à-têtes of philosophical specialists were lacking in innovation, and ancient thought had been pretty much mined out. It had become obvious, and rather quickly to the wise, that, much as they admired the best of it, there was no going back to the Hellenic world. How to move forward sensibly and efficiently became the problem, and how to establish goals against which progress could be measured? In other words, agreed: knowledge was the proper quest, but how to attain it with certainty? Classical philosophy, thick with metaphysics and laden with poorly founded but virtually sacred traditions regarding physics and politics, was glaringly inadequate to the task. Undeterred, it occurred to

Francis Bacon [1561-1626]

that there was a way to discover something really true, at least about the physical world. This might well entail a lowering of philosophical expectations by limiting the scope of knowledge (as Machiavelli had done with his new science of politics), but it seemed the most likely place to start. Bacon's was a wide-ranging intellect, epitomizing the 'Renaissance man' and, he claimed, "…taking all knowledge to be my province". Not only was he Lord Chancellor under James I, but he is considered, particularly in view of his formulation and promotion of the inductive scientific method, to be the founder of the Royal Society of London (though that still existing scientific society was not 'officially' organized until nearly 40 years after his death).

Of all Bacon's writing, his best known work, today, and perhaps the most influential is the *Novum Organum*, in which he advocates careful and repeated observation and the collecting of facts based on experiment. While he was not an experimental scientist himself, he seems to have expected that these facts would pile up over time into a structure, which would take shape as a self-explanatory principle or law of physics; an empirical certainty; something that could be depended upon as a foundation for new experiments and the gathering of new facts that would lead to more such principles. In this way true knowledge would be unerringly uncovered and advanced—if only of the physical world—out of which would arise (if not wisdom) improved technologies of benefit to humanity. *See, here, how the sights are lowered to get results, as with Machiavelli in the realm of politics; small results, granted, but tiny steps, he expected, would tend to accumulate, gaining major accomplishments.*

Francis Bacon's legacy, then, is the setting forth of the scientific method of inductive reasoning. In his 1605 treatise *The Proficience and Advancement of Learning*, he opines that, due in great part to an excessive fascination with the past, European intellectualism had stagnated; that learning had come to a standstill. He identifies what he calls intellectual 'distempers': "There be therefore chiefly three vanities in studies, whereby learning hath been most traduced." These three he identifies as:

> *Fantastical learning* (“vain imaginations”) or pseudo-science and ideas of the occult: magic, astrology, alchemy—concepts without a solid foundation and that constituted belief more than knowledge.
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> *Contentious learning* (“vain altercations”) such as arguments over Aristotelian philosophy (the contemporary *mis*interpretations, as he admired Aristotle himself) and the logical hair-splitting of scholasticism and perhaps the varied tenets of metaphysics, generally, and the quibbling over theology for the sake of winning arguments and winning fame as a rhetorician rather than for real learning.
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> *Delicate learning* (“vain affectations”) including the passion for humanism, which concerned itself not with knowledge but with rhetoric and fancy expression; with “words more than matter”; with “choiceness of phrase” and the “sweet falling of clauses”—a most seductive and decadent literary vice.
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> [*from* Internet Encyclopedia of Philosophy; http://www.iep.utm.edu/b/bacon.htm]

Such as these ‘vanities’ served as distractions from the pursuit of new discoveries. Here was the distinct voice of progress; a strong forward tug on a stalled culture. While Bacon is lauded for his outline of inductive reasoning, no scientist ever utilized that much-too-narrow method without joining it to other methods in formulating new ideas. Bacon criticized natural philosophers (early ‘sciencists’) for being too quick to generalize their way to an overarching principle without sufficiently testing the factual foundation. He proposed arriving at principles by first establishing each and every fact. Perhaps he, himself, has been unjustly criticized for characterizing scientists as ‘busy bees’ gathering their horde of facts without some guiding insight as to purpose; expecting the mountain of scientific law to form by itself. Whereas the actual tendency is for facts not to compile themselves but to spread out eternally in a shapeless puddle awaiting some visionary to organize them. Anyway, his initial presentation of this method was more of an outline, to be fully explained, he said, in a later work (a work which was never accomplished).

Bacon’s significant contribution to Western culture (conceding, for the time being, that he did not write Shakespeare’s plays) is mainly optimism regarding historical as well as scientific progress. His *New Orgonon* (‘Orgonon’ in Greek meaning ‘instrument’ or ‘tool’), he says, contains ‘True Directions Concerning the Interpretation of Nature.” Once Nature is known, she can be manipulated to humanity’s advantage. Thus, in opposition to the rich but motionless stewing of his own age (and to the actual historical decline envisioned by ancients like Hesiod), he has a new vision: the possibility of progress through improving technology. He does not claim to be anything like the founder of science, but only a ‘trumpeter’ heralding a new world. And yet he could not accept the moving earth of Copernicus. Nor was the Catholic Church the only organized opponent:

> There was mention of a certain new astrologer who wanted to prove that the earth moves and not the sky, the sin, and the moon. This would be as if somebody were riding on a cart or in a ship and imagined that he was standing still while the earth and the trees were moving. “So it goes now [Luther remarked]. Whoever wants to be clever must agree with nothing that others esteem. He must do something of his own. This is what that fellow does who wishes to turn the whole of astronomy upside down. Even in these things that are thrown into disorder I believe the Holy Scriptures, for Joshua commanded the sun to stand still and not the earth.”

[Martin Luther, *from* TISCHREDEN (Tabletalk), *per* Edward Rosen,
COPERNICUS AND THE SCIENTIFIC REVOLUTION; Malabar, FL, 1984; pp.182-3; *found in*
Michael J. Crowe, THEORIES OF THE WORLD: *From Antiquity to the Copernican Revolution*
(2nd Edition); Dover Press, Minneola, NY, 1990; *Epilogue* (p.173)]

A new path:

While Bacon criticized Medieval Aristotelianism and instructed as to how to gain secure knowledge and prognosticated scientifically in England, a Florentine was finding his own way of doing science.

Galileo Galilei [1564-1642], credible organist; excellent lutenist, was the son of Vincenzo Galilei, member of the *Camerata* with Jacopo Peri, Giulio Caccini, and Octavio Rinuccini, founders of Florentine opera. Galileo, semi-self-taught geometer, became a professional mathematician and physicist-in-retrospect. He did not seek Bacon's guidance (probably did not read Bacon) and did not bind himself to preconceived notions of scientific method. To the contrary, he showed that science need not—*ought* not—be confined to a particular scheme but, with his law of falling bodies; discovery of the parabolic motion of projectiles and principles of the pendulum; his invention of the thermometer and telescopic astronomy; and his alternative to Aristotelian dynamics (suggested and necessitated by his 'faith' in Copernicus), he illustrated that intuition, reason, rhetoric, even propaganda could move things ahead much faster than mere fact-finding and complicated attempts at proving hypotheses. If science is a tool, then like a paint brush or a chisel it is at its best in the hands of an artist.

As the late philosopher of science Paul Feyerabend explained [AGAINST METHOD; Verso, London/NY, 1988], Copernicanism (condemned by the Church and disregarded by the long-enduring physical understanding of the age) needed protection (and some respect) in an intellectual atmosphere still dominated by the integrated world system of Aristotle: a system that , subconsciously for most folks, worked well enough—seemed to have done so since the beginning of time; a system with which they were imprinted, as it were, so that it all seemed commonsensical. One can feel and experience, for instance, the solidity and absolute motionlessness of the Earth—weights drop straight to the bottom of a tower; cannon balls travel equally either east or west—every conceivable experiment confirmed it. The idea that this was just another planet whirling about the sun at unimaginable speed seemed ludicrous. The sheer absurdity of it, perhaps more than any other factor, allowed the Copernican notion to persist on paper as simply an incredibly esoteric joke, thus evading the Inquisition.

Galileo admired the panache of Copernicus for having placed theory above appearances, such that it was the seemingly obvious but fraudulent '*facts*' (facts that supported Earth's motionlessness) that would need adjustment to support the new *hypothesis*. Actually, to suit his new concept, old 'facts' would have to be re-understood as illusion and new 'facts' established. In time, with Bruno's martyrdom, Kepler's refinements of the planetary motions, and Galileo's polemics (despite Inquisition-forced recanting of his support of heliocentrism), that 'crazy Copernicus,' dead now half-a-century, began reshaping human thought in the West; changing the world-picture.

As Bruno saw it, Copernicus did not go far enough:

> [Copernicus] in regard to natural judgment was far superior to Ptolemy, Hipparchus, Eudoxus, and all the others who walked in the footsteps of these; a man who had to liberate himself from some false presuppositions of the common and commonly accepted philosophy, or perhaps I should say blindness. But for all that he did not move too much beyond them; being more intent on the study of mathematics than of nature, he was not able to go deep enough and penetrate beyond the point of removing from the way the stumps of inconvenient and vain principles, so as to resolve completely the difficult objections, and to free both himself and others from so many vain investigations and to set attention firmly on things constant and certain.
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> [Giodano Bruno *from his* *La cena de le cerneri* (1584),
> *as given in* GIORDANO BRUNO, THE ASH WEDNESDAY SUPPER,
> *trans. with intro. by* Stanley L. Jaki; The Hague, 1975; pp.56-7;
> *found in* Michael J. Crowe, THEORIES OF THE WORLD; Dover, Minneola, 1993; *Epilogue*; p.174]

In fact, a new concept of physics was needed to support the Copernican cosmos (especially as refined by Bruno and Kepler). Galileo, alone, could not supply that view. Even if he could have fully envisioned it, he could not have so revolutionized the cosmic outlook of his age in but one lifetime. This new world system was hard to accept (even more so if one argued that it was infinite and *non*centric). It needed much more thought and research and at least another generation or so to develop.

As Goethe [1749-1832] would see it, looking back from the early 19th century:

> Humanity has perhaps never faced a greater challenge; for by [Copernicus's] admission [that humanity is not the center of the universe], how much else did not collapse in dust and smoke: a second paradise, a world of innocence, poetry and piety, the witness of the senses, the conviction of a religious and poetic faith . . . ; no wonder that men had no stomach for all this, that they ranged themselves in every way against such a doctrine.
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> [*from* Johann Wolfgang von Goethe, *Zur Farbenlehre*,
> *in* GOETHE, *SAMTLICHE WERKE*, vol.40, Stuttgart, 1902, p.185.
> *Quotation found in* Crowe, THEORIES OF THE WORLD; Dover, 1993; *Epilogue*; p.193]

Galileo made use of all of Bacon's 'vanities' as he patched over gaping logical holes with logical tricks, dazzling rhetoric, and forceful argument, always expecting (as would Einstein with his special relativity) that supporting scientific principles would, in time, be discovered. So, instead of 'distracting from new discoveries,' Galileo used those 'vanities' as a kind of camouflage to hide the weaknesses in the foundation of his position. In thus granting Copernicus extra time, in keeping his concept alive, and in presenting this radically new understanding to the public (though it must have been hard for most to swallow, even seeming absurd to many), Galileo performed magnificently.

It was clear that, if heliocentrism—or helio-*ec*centrism—were true, Aristotelian physics would have to be abandoned. In his alternative to Aristotle's dynamics, Galileo explained that sentient beings moving together in a system or in coordinated systems that moved in synchrony, would perceive their system(s) to be at rest. The Earth is just such a system. Though we are in motion with it due to gravity (not yet understood, but Kepler had already suggested, based on increasing speed of the planets as they approached the sun, that it might have something to do with Gilbert's new science of magnetism, and he provided by his laws of planetary motion part of the basis for Newton's theory of gravity), and because (taking a page from the ancient atomists, via Pierre Gassendi) we move through a void offering no resistance, we are presented with the *illusion* of rest. Only by observing objects *not* part of the Earthian coordinate system (the planets and 'fixed' stars), and by comparing all their changing positions can we have any information about our own motion through space. In evaluating that information, Copernicans came to believe (against common sense) that we, too, are in motion; that we live on a planet.

Galileo's new dynamics further dispensed with the series of concentric heavenly spheres that had embedded planets circling the sun inside the indeterminate expanse of 'fixed' stars, but without explaining, now that they were supposed to be free-flying bodies, how they avoided the ravages of centrifugal force (leaving the counterforce of gravity to be discovered and calculated much later, but still not explained, by Newton) and simply leaving out the complicated epicycles needed to 'save the phenomena.'

Even new evidence as derived from Galileo's telescope lacked substance. There was serious disagreement about what could actually be seen through that crude instrument. Some refused to look into it at all, considering whatever might be displayed therein to be false since it was an instrument of the Devil. But even those who did peer through it could not be sure of what they saw. Some saw only a fuzziness; nothing that made any sense even when they were given an inkling of what to expect. Without corroborative witnesses who understood what they were witnessing—and even more detrimental: without anything resembling an optical theory of how the telescope actually worked—all evidence thus collected was of little use without being 'adjusted' for public consumption: 'spun,' as we would say today.

Although Galileo claimed to have some knowledge of optics, it was Kepler who was the reigning expert in that field. But it was not until much too late to have had an effect on his early telescope designs that Galileo even saw Kepler's treatises on the subject (*Optics*, published in1604 and *Dioptrice,* 1611). "In a letter to Giuliano de Medici of 1 October, 1610," Feyerabend notes:

> more than half a year after publication of the *Sedereus Nuncius,* he asks for a copy of Kepler's *Optics* [*Ad Vitellionem Paralipomena quibus Astronomiae Pars Optica Traditur*] of 1604, pointing out that he had not yet been able to obtain it in Italy. Jean Tarde, who in 1614 asked Galileo about the construction of telescopes of pre-assigned magnification, reports in his diary that Galileo regarded the matter as a difficult one that he had found Kepler's *Optics* of 1611 [he meant *Dioptrice*, which is where Kepler refers to Tarde's problem] so obscure 'that perhaps its own author had not understood it.'
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> [AGAINST METHOD; Paul Feyerabend; Verso, London/NY, 1988; pp85-86 & footnotes]

Some see Galileo's continued improvements on his telescope as essentially the product of trial and error. It seems to have worked just fine for terrestrial voyeurism (the natural desire that sold many version of his *perspicilli*) and for spotting incoming ships hours before they could be seen by the naked eye. Military advantages were obvious. And, to his credit, in Galileo's hands it unveiled much in the heavens: a vast increase in stars, the stellar constitution of the Milky Way, mountains and craters on the moon, the 'Medicean Planets' (four of Jupiter's nine moons), etc., even revealed the rotation of the sun. But it remained for Kepler to redesign the instrument for serious astronomical use.

"What is needed for a test of Copernicus," then, says Feyerabend, "is an entirely new world view containing a new view of man and of his capacities of knowing." Even the man who would limit knowledge to what could be gleaned through inductive reasoning understood that [Feyerabend]:

> Bacon realized that scientific change involves a reformation not only of a few ideas, but of an entire world view and, perhaps, of the very nature of humans. 'For the senses are weak and erring,' he writes in *Novum Organum*, Aphorism 50. 'For man's sense is falsely asserted to be the standard of things; on the contrary, all the perceptions, both of the senses and of the mind bear reference to man and not to the universe, and the human mind resembles those uneven mirrors which impart their own properties to different objects from which rays are emitted and distort and disfigure them' (Aphorism 41). Bacon repeatedly comments on the 'dullness, incompetency and errors of the senses' (50) and permits them only to 'judge … the experiment' while it is the experiment that functions as a judge 'of nature and the thing itself' (50). Thus when Bacon speaks of the 'unprejudiced senses' he does not mean sense-data, or immediate impressions, but reactions of a sense organ *that has been rebuilt* in order to mirror nature in the right way. Research demands *that the entire human being be rebuilt.* This idea of a physical and metal reform of humanity has religious features. A 'demolishing branch' (115), an 'expiatory process', a 'purification of the mind' (69) must precede the accumulation of knowledge. 'Our only hope of salvation is to begin the whole labour of the mind again' (Preface) but only 'after having cleansed, polished, and levelled [sic] its surface' (115). Preconceived notions (36), opinions (42ff), even the most common words (59, 121) 'must be abjured and renounced with firm and solemn resolution … so that the access to the kingdom of man, which is founded on the sciences, may resemble that to the kingdom of heaven, where no admission is conceded except to children' (68).
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> A reform of man is necessary for a correct science—but it is not sufficient. Science, according to Bacon, not only orders events, it is also supposed to give physical reasons [Aristotle agrees]. Thus Ptolemy and Copernicus give us 'the number, situation, motion, and periods of the stars, as a beautiful outside of the heavens [he means the superficial aspect], whilst the flesh and the entrails are wanting; that is, a well fabricated system, or the physical reasons and foundations for a just theory, that should not only solve phenomena, as almost any ingenious theory may do, but show the substance, motions and influences of the heavenly bodies as they really are.' *Advancement of Learning*, Chapter 4, quoted from Wiley Books, New York, 1944, p. 85. Cf. also the *Novum Organum*, op. cit., p. 371: 'For let no one hope to determine the question whether the earth or heaven revolve in the diurnal motion, unless he have first comprehended the nature of spontaneous motions': the new man needs a new physics in order to give substance to his astronomy. Galileo did not succeed in providing such a physics.
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> [*Quoted from* Feyerabend; *in* AGAINST METHOD; Verso, London/NY, 1988, Ch.11, footnote 4, pp.116-117 *(notes in brackets are mine)*]

In the absence of such a physics, Bacon could not accept the Copernican cosmos. "It is obvious," Feyerabend continues:

> that such a new world view will take a long time appearing, and that we may never succeed to formulate it in its entirety. It is extremely unlikely that the idea of the motion of the earth will at once be followed by the arrival, in full formal splendor, of all the sciences that are now said to constitute the body of 'classical physics'. Or, to be a little more realistic, such a sequence of events is not only extremely unlikely, *it is impossible in principle*, given the nature of man and the complexities of the world he inhabits.
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> [Ibid., *(body text; emphasis in original),* p.117]

The various bits and pieces, in other words, which might together constitute a full-blown scientific theory do not march in orderly fashion onto the world stage. They appear here and there serendipitously. That means an absurd hypothesis today might be the accepted cosmology in fifty or a hundred or more years. But to fulfill that potential, seemingly absurd or outmoded hypotheses must be somehow preserved among all the latest accepted theories of 'knowledge' or 'factual' information that is passed along continually through generations of scholars, scientists, and philosophers—until one day the accepted 'facts' are seen through as absurd, and a once seemingly absurd or previously rejected notion becomes the norm. Since scientists tend to unburden themselves of archaic ideas, maybe keeping account of this bank of knowledge is the true and most valuable work of historians—yet another argument for studying history.

We have seen rejection of several almost-modern ideas in the ancient world because they simply did not mesh with the pervading assumptions and cosmological perceptions. Now, in the Renaissance, the moving-earth idea of ancient Pythagoreans and the scrapped and dormant heliocentric ideas of Heraclides and Aristarchus are rediscovered or re-invented by Copernicus, but the world into which all these have been introduced has been altered sufficiently this time around, by capricious history, to allow them sustenance, however meager at their rebirth—after all, it is the Renaissance.

If manured only with confusion, the ground was sufficiently conditioned so that such strange weeds as 'planet Earth' and 'infinite space' could now root. A century more of erosion of Aristotelian physics and they would overwhelm the old crops. We will see, later, a similar event: reappearance and proliferation of the rare 'atomic' vine from long dormant seeds, once sown unsuccessfully in Greece by Democritus and Leucippus, and which Lucretius vainly nurtured in Rome, but which could not get a foot-hold: could not flourish in that moribund soil.

So, what did Galileo's universe look like? With his '*perspicillum*' he became much more interested in what was out there in space than in 'saving the phenomena.' He accepted the Copernican idea, basically—at least concerning the shape of the solar system—but apparently agreed with Kepler about the absence of the concentric spheres that bound it together. Concerning the expanse of the Universe, he sided neither with Bruno (infinite) nor Kepler (finite), declaring it only to be 'indeterminate.' Despite his enormous expansion of the cosmos via his telescope, he understood that to whatever immense proportions we might increase the size of the Universe we do not thereby approach closer to infinity (which would lack any size and configuration), although he admits the possibility that the cosmos might not have a center or shape.

Yet Alexandre Koyré points out that, in Galileo's *Dialogue on the Two Greatest World-Systems*, "he does not assert that the stars are scattered in space without end":

> SALVIATI — Now , Simplicius, what shall we do with the fixed stars? Shall we suppose them scattered through the immense abysses of the universe, at different distances from one determinate point; or else placed in a surface spherically distended about a center of its own, so that each of them may be equidistant from the said center?
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> SIMPLICIUS – I would rather take a middle way and would assign them a circle described about a determinate center and comprised within two spherical surfaces, to wit, one very high and concave, the other lower and convex betwixt which I would constitute the innumerable multitude of stars, but yet at diverse altitudes, and this might be called the sphere of the universe, containing within it the circles of the planets already by us described.
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> SALV. — But now we have all this while, Simplicius, disposed the mundane bodies exactly according to the order of Copernicus. . . .

Koyré goes on to explain the "moderation of Salviati" in this part of the discussion, "agreeing perfectly with Copernican astronomy by the very nature of the *Dialogue*: a book intended for the 'general reader;' a book which aims at the destruction of the Aristotelian world-view in favor of that of Copernicus; a book which pretends, moreover, not to do it, and where, therefore, subjects both difficult and dangerous are obviously to be avoided.

"We could even go so far as to discard the outright negation of the infinity of space in the *Dialogue*—which had to pass the censorship of the Church—and to oppose to it a passage found in a *Letter to Ingoli* where its possibility is just as strongly asserted. In the *Dialogue*, indeed, Galileo tells us, just as Kepler does, that it is":

> . . . absolutely impossible that there should be an infinite space superior to the fixed stars, for there is no such place in the world; and if there were, the star there situated would be imperceptible to us.

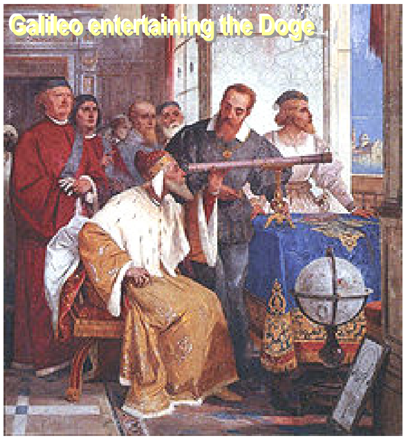
"Whereas in his *Letter to Ingoli* he writes":

> Don't you know that it is as yet undecided (and I believe that it will ever be so for human knowledge) whether the universe is finite or, on the contrary, infinite.

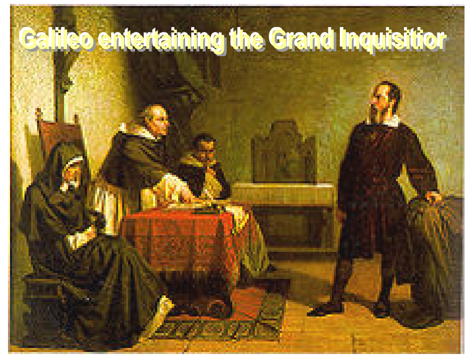
Koyré reminds us "It is possible, of course, that *all* the pronouncements of Galileo have to be taken *cum grano salis*, and that the fate of Bruno, the condemnation of Copernicus in 1616, and his own condemnation in 1633 incited him to practise (sic) the virtue of prudence."

[*Quotations from* Galileo, *Dialogues and* *Letter to Ingoli*,
as well as the quotes from Koyré himself, are found in FROM THE CLOSED WORLD TO THE INFINITE UNIVERSE
by Alexandre Koyré; Johns Hopkins, Baltimore/London, 1957; pp.95-99]

Prudence was not exactly Galileo's strongest suit. He loved to argue; was arrogant in his opinions; brutally, often jokingly, scornful in debate. He was, at the least, insufficiently prudent to evade having to publicly abjure his belief in Copernicanism and to avoid doing his relatively mild penance (mild when compared to such as Bruno and that of his own pupil, Vanini ["Let us go," Vanini said when it was time for his execution. "let us go cheerfully and die like a philosopher."], or even some others who were allowed to live but only after years of incarceration and torture, like Tommoso Campanella [27 years in prison; tortured 12 times, once for 40 hours]).



On the other hand, having published his opinions concerning how Galileo succeeded in advancing science even while breaking all the expected rules (accolades richly deserved), Feyerabend then (characteristically) turns about to defend the Church's actions and he even voices disagreement with her relatively recent 'apologies' to Galileo: an 'expression of regret' given by Pius XII in 1939, then the official admission that the Earth moves from Pope John-Paul II in 1992—even though all the old works favoring heliocentrism had been dropped from the Index by 1835. And now the Church is building statues to Galileo, not unlike the Athenians did for Socrates. Please pardon me while I continue to quote from Feyerabend rather extensively as he effectively makes this interesting case for the seventeenth century Catholic Church.



In his book, AGAINST METHOD, his subheading or epigram at Chapter 13 states:

> *The Church at the time of Galileo not only kept closer to reason as defined then and, in part even now; it also considered the ethical and social consequences of Galileo's views. Its indictment of Galileo was rational and only opportunism and a lack of perspective can demand a revision.*

The whole idea of the Inquisition, he reminds us, was to exterminate heresy. Consider the general cosmological understanding of the age and the sincere and widespread belief that the Church was responsible not only for the salvation of souls but for establishing and maintaining a society conducive to that end. The serious concern about this is evident in a letter of 1642 to a supporter of Copernicanism; an ally of Galileo; and a proponent of a revised atomism,

Pierre Gassendi [1592-1655],

who no less dangerously claimed 'although atoms were created by God, space is eternal and infinite,' thus, in some minds, placing limits on God (i.e., that He couldn't create space). This clearly anticipated Newton's absolute space and was "a timely concession to the requirements of the new Physics," says Max Jammer [CONCEPTS OF SPACE, Dover, 1993, p.94]. (Incidentally, Gassendi is the man who named the *aurora borealis*.)

The letter to Gassendi was from Pierre de Cazre [1589-1664]:

> Ponder less on what you yourself perhaps think than on what will be the thoughts of the majority of others who carried away by your authority or your reasons, become persuaded that the terrestrial globe moves among the planets. They will conclude at first that, if the earth is doubtless one of the planets and also has inhabitants, then it is well to believe that inhabitants exist on the other planets and are not lacking in the fixed stars, that they are even of a superior nature and in proportion as the other stars surpass the earth in size and perfection. This will raise doubts about Genesis which says that the earth was made before the stars and that they were created on the fourth day to illuminate the earth and measure the seasons and years. Then in turn *the entire economy of the Word incarnate and of scriptural truth will be rendered suspect.*

[*Emphasis in Orig., as translated in* Michael J. Crowe, THE EXTRATERRESTRIAL LIFE DEBATE 1750-1900: *The Idea of a Plurality of Worlds from Kant to Lowell*; Cambridge Univ., 1986; pp.17-18; *found in* Crowe, THEORIES OF THE WORLD: *From Antiquity to the Copernican Revolution*; Dover, 1990; *Epilogue*, pp.179-180]

While wealth and power considerations often blurred the scene, even through the Reformation and the Thirty Years War the Church maintained that all Protestantism was heresy and that the Pope had sovereignty over Christian princes, at least in matters of faith (which always meant politically, too, as the Church dwells in a political world). Given the tenets of the time, the Church had a legitimate interest in protecting Christian society from infectious ideas; ideas that, it was generally agreed, might lead to atheism, thus to anarchy. Feyerabend reminds us that the general public has always been protected from what its governors have considered dangerous information. That is still true, even in our secular-oriented and more 'open' societies. "There are many ways to silence people apart from forbidding them to speak," he remarks, "and all of them are being used today. The process of knowledge production and knowledge distribution was never the free, 'objective', and purely intellectual exchange rationalists make it out to be." We will see this become more and more complex as science and politics interpenetrate.

"The trial of Galileo," Feyerabend adds:

> was one of many trials. It had no special features except perhaps that Galileo was treated rather mildly, despite his lies and [much too thinly veiled] attempts at deception. But a small clique of intellectuals aided by scandal-hungry writers [what's new?] succeeded in blowing it up to enormous dimensions so that what was basically an altercation between an expert and an institution defending a wider view of things now looks almost like a battle between heaven and hell.

Perhaps, as Feyerabend notes, "This is childish and unfair towards the many other victims of 17th century justice … especially … Bruno who was burned," but whom we tend to forget. But, aside from that, Galileo's punishment (resulting from the trial in 1632/33) was not for his heresy, which had been the point of his first trial of 1616, but for disobeying the previous order of the Inquisition—which was only to stop treating the Copernican doctrine as true and to express that view as merely hypothetical.

The judgment of experts—witnesses for the Church in the 2nd trial, were asked their opinion on two points: Was the Copernican idea presented by Galileo scientific, and What were its social implications? They declared, first, that the doctrine was "foolish and absurd in philosophy" (i.e., unscientific), which was undoubtedly the correct decision, unbiased by Catholic dogma and based squarely on the Aristotelianism of the age. Second, As far as ethics were concerned, the experts saw the Copernican system as dangerous and 'formally heretical'. This rests on an assumption that Scripture holds the last word on the way of human life, and thus acts as a boundary for restricting research. "The assumption was shared" says Feyerabend "by all great scientists, Copernicus, Kepler, and [even later] Newton among them." The Church, no different than any powerful institution, claimed the right to exclusive interpretation of its laws—in this case, Divine Law. Lay people were forbidden to speculate in that regard. Of course, science went on and, sometimes, research results seemed to conflict with the plain meaning of the Bible. The Church was not unbending when science could prove its contentions. "There are many Bible passages which seem to suggest a flat earth," Feyerabend explains. "Yet Church doctrine accepted the spherical earth as a matter of course," based on such proof as the measurements of Ptolemy and Eratosthenes and assuming the axioms of Euclid). But there was no proof yet of heliocentrism, so Galileo had been forbidden to teach it as true. Even Aristotle's version as reworked by Ptolemy was not proved, and "few astronomers thought of deferents and epicycles as real roads in the sky; most regarded them as roads on paper which might aid calculation but which had no counterpart in reality". The same with the Copernican model, especially "considering the difficulties the model faced when regarded as a description of reality". So, concludes Feyerabend, Cardinal Bellarmine had logic on his side. The Church had it "scientifically correct and had the right social intention". Thus, he contends, while circumstances have since changed, her decision was correct when it was made and need never have been revised.

[*Quotes in last six paragraphs from* Feyerabend; in AGAINST METHOD; Verso, London/NY, 1988, Ch.13, pp.129-138, var. (notes in brackets are mine)]

ADDITIONAL HANDOUTS: (1)Ch.13, complete, *from* AGAINST METHOD, pp.129-138.
(2) Galileo: Sidereal Messenger; 5 pages, *free content from* 'Great Courses'

Pierre Gassendi Initiates 'Absolute Space':

Regardless of Feyerabend's view of the action taken by the Inquisition, he seems to be in accord with Stephen Hawking, who has expressed his belief that Galileo was more responsible than anyone else for the birth of classical physics, and with Einstein, who called him the 'father of modern science.' "Be that as it may," says Koyré, "it is not Galileo, in any case, nor Bruno, but Descartes who clearly and distinctly formulated principles of the new science, its dream *de reductione scientiae ad mathematicam*, and of the new mathematical cosmology."

Before we move on to Descartes, let us have a look at the contributions to this new science brought by Pierre Gassendi. Something like the Aquinas of atomism, Gassendi is to Epicurus as St.Thomas is to Aristotle: trying to correlate the strictest materialism with Christian doctrine. He is principally responsible for the revival of atomism, very much along the lines of Lucretius (*recall:* prime matter as individual indivisible sub-micro particles, mutually influential and always in motion, variously colliding, repelling, attracting, and attaching such as to establish a molecular theory of matter). In line with that, even his optics and sonics were corpuscular in nature, with tiny atoms of light traveling from the objects of our perception, striking our eardrums and being deflected through the lens of our eye to present the images on the retina.

Along with atoms comes the void and his was the clearest concept of absolute space before Newton. Space no longer had anything to do with 'place,' and was essentially divorced from matter, except that one might consider it non-matter. "Physical phenomena could now be explained," says Max Jammer,

> on the assumption of an infinite space that was partly filled and partly empty. Hence Gassendi's conception of space became the foundation, both of the atomistic theories of the seventeenth century with their discontinuous matter filling continuous space, on the small scale, and of celestial mechanics on the large scale. It was Newton who incorporated Gassendi's theory of space into his great synthesis and placed it as the concept of absolute space in the front line of physics.
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> [CONCEPTS OF SPACE: *The History of Theories of Space in Physics*; 3rd ed.; Dover; NY, 1993 (*from original of* Havard Univ., 1969) *quote from* ch.3, p.94]

Space was thus understood as infinite and uncreated (since it was nothingness) while matter was finite—but only in its extension: its foundation, 'primal matter' as represented by the atoms, had to be eternal, since nothing comes out of nothing, so motion, too, must also be eternal.

Gassendi further considered that such material activity must be behind not only perception but thought, too—i.e., atomic brain activity. He was probably best known for his disagreements with Descartes, particularly over the Cartesian version of old Anselm's ontological proof of God, but also over the mind-body duality [both of which we will contemplate when we investigate Descartes]. But he but had to introduce a duality of his own to preserve the immortality of the soul. Since the thinking part of the soul was material (atomic) in nature (thus finite), it had to have a second, incorporeal nature to last eternally in agreement with scripture. Was Gassendi prevented from becoming the total materialist (clearly suggested in his theories) by his sincere faith in Catholic dogma, or was he *actually* that total materialist disguised as a man of God and speaking cautiously in light of the well established consequences of heresy regarding alternate cosmologies? We will refer again to Gassendi's ideas when we return to such problems in our examination of Descartes' cosmic view).

After his death there arose in France a group called *Gassendistes*, in opposition to the *Cartésiennes*. While his influence in France was ultimately eclipsed by Descartes, his ideas gained recognition and respect in England (which may have been contributory to staining his reputation in France) with the prominence of another early empiricist, Hobbes, and Gassendi clearly influenced Boyle, Locke, and (particularly with regard to the absolute space and absolute time concepts) the theories of Newton.

Gassendi was an admirer, supporter, and friend of Galileo, but expressed his opinion that Copernicanism was only 'plausible'. Unable as a priest and thus in deference to the Church to openly admit its reality, he instead professed his preference for the likelihood of the Tychonian system: more in line with scripture as it left the Earth unmoved. While he did not claim his thought to be completely new (as Descartes did), and while lavishing credit on ancient sources (consistent with the tenor of Renaissance humanism), he represents to us the earliest modernism —perhaps more so even than Galileo, in that Gassendi preaches an empiricism that makes all knowledge of the world (excepting theological knowledge) result from sense perception and, from this foundation, proposes that all claims to knowledge must be subjected to reason and experiment—in which he took active part.

If all knowledge is derived from the senses, but the senses are limited and do not provide the whole picture—in fact provide distortions of reality—it might seem Gassendi is more Skeptic (i.e., denial that any sort of knowledge can be attained) than Epicurean in his deepest understanding of the world. Yet he presents a sort of proto-probability view, allowing comparison of many perceptions (observations/experiences/experiments) to form general pictures, combined with the study and interpretation of authoritative concepts borne through the ages (recall that the philosophies of ancient Greece and Rome remained a powerful force in what was still considered 'natural philosophy;' not yet transformed into 'science'). The most likely scenario suggested by these combined perceptions, then, is what becomes the working hypothesis. In other words, we *do* get knowledge empirically, even if it is distorted. And by collecting and organizing and comparing and studying the implications that penetrate through the haze of uncertainty—and by further testing our theories about these bits of information—we can approach truth, even if we can never completely attain it. So his epistemology has been called 'constructive skepticism.' In essence: we can know nothing for certain, but that which we know even *un*certainly can still be effective, progressive, useful.

So, ironically, along with the concept of complete materialism and an empiricist epistemology [the only way to certain knowledge is by establishing undeniable facts] comes *doubt of everything*. We will see how far that can be carried when we discuss Descartes in our next session.