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NEWTON: THE CLASSICAL SCHOLIA

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INTRODUCTION

The reader of the first edition of the *Principia mathematica* (1687) of Newton might cherish the illusion of encountering a science without a history. Setting aside a brief allusion to the mechanics of the Ancients and to Pappus, to be read near the beginning of the book, all links with the past seem to have been broken. Other writings published by Newton in his lifetime are equally sparing of historical recollections or references; whether because of a precise methodological choice, or because of a reluctance to make known thoughts not expressed in a clear mathematical form, Newton imposed a rigorous censorship upon himself. He kept to himself, or communicated only to a few intimates, his own 'historical' researches, that is to say those on chronology and scriptural exegesis. Also confined to the cold storage of the private and unpublished was the belief in the ancient wisdom of the *veteres*, which Newton shared with a tradition that was still in his time quite widely diffused. Often he was hesitant to make pronouncements on this theme. For example, the first version of the book of the *Principia mathematica* entitled *De mundi systemate*, expressed in a 'popular way' in 1686 but left unpublished by its author, opens solemnly:

> The most ancient opinion of the Philosophers was that the fixed stars stood motionless in the highest parts of the world, and that the planets revolved about the Sun beneath these stars; that the Earth likewise is moved in an annual course, as well as with a daily motion about its own axis, and that the Sun or hearth of the Universe rests quietly at the centre of all things. For this was the belief of Philolaus, of Aristarchus of Samos, of Plato in his riper years, of the sect of the Pythagoreans, and (more ancient than these) of Anaximander and of that most sage king of the Romans, Numa Pompilius. The latter erected a temple to Vesta, round in form, and ordained perpetual fire to be maintained at its centre, to symbolize the round shape of the Orb with the solar fire at its centre. It is very probable that the Egyptians disseminated this opinion, however, for they were the oldest observers of the stars. It seems that the Greeks, a race more given to philology than to philosophy, obtained this philosophy which was the oldest and soundest of all from the Egyptians and neighbouring peoples; and the rites of Vesta

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> speak of the spirit of the Egyptians, who depicted their mysteries in rites, ceremonies and hieroglyphs far surpassing the understanding of the vulgar. Afterwards Anaxagoras, Democritus and several others taught that the Earth stands unmoved in the middle of the world.[1]

Having published a different version of the third book of the *Principia*, rigorously mathematical and stripped of all mention of the Ancients, Newton formed the idea of joining to its Propositions IV-IX — with an eye to a second edition — an equal number of Scholia, carefully worked out and furnished with erudite glosses. Here was attributed to the wisdom postulated as existing among the Ancients a knowledge of universal gravitation, of its laws, and of its 'cause': the *anima mundi*, that is, the animation of the celestial bodies and of nature in general by the divine impulse. The theses were expressed with copious quotations drawn from the customary repertory of Stoic/neo-Platonic sources. But these Scholia too — the so-called 'classical Scholia', which are here published in their entirety for the first time — were subjected to their author's own censorship. The mathematician David Gregory, to whom Newton transmitted them, used them generously and textually in the Preface to his *Astronomiæ physicæ & geometricæ elementa* (1702), but without naming Newton. He himself, throughout the remainder of his life, allowed only a few vague allusions concerning the Ancients to escape from him. He censored also a compendium of the classical Scholia, which has remained in manuscript among the drafts of the "Queries" in the *Opticks*:

> QU. 23. By what means do bodies act on one another at a distance? The ancient Philosophers who held Atoms & Vacum attributed gravity to Atoms without telling us the means unless perhaps in figures: as by calling God Harmony & representing him & matter by the God Pan & his Pipe, or by calling the Sun the prison of Jupiter because he keeps the Planets in their Orbs. Whence it seems to have been an ancient opinion that matter depends upon a Deity for its laws of motion as well as for its existence.[2]

The theological allusions that Newton decided to publish in Query 31 no longer refer to the Ancients; these are indeed quoted — though in a somewhat cursory and sybilline manner — in a passage of Query 28.[3] In the end, Newton contented himself with inserting in the Scholium generale, where he writes of the ubiquity and omnipotence of God, a marginal gloss reading (in part, and in its final form of 1726):

> This was the opinion of the Ancients, as Pythagoras according to Cicero, *De natura deorum*, Bk. I; Thales, Anaxagoras, Virgil in the *Georgics*, Bk. IV, v. 220 and in the *Aeneid*, Bk. VI, v. 721; Philo in his *Allegorica*, at the opening of the first book; Aratus in *Phaenomena*, also at the beginning....[4]

Of the classical Scholia scarcely a trace remains here.

II

An article by J. E. McGuire and P. M. Rattansi — stimulating from its very title and published in the heated atmosphere of the re-discovery of a Newton who was a theosophist and a neo-Platonist, as a successful debunking of the image of the positivist scientist — made the first important contribution to the interpretation of the classical Scholia, if one that falls short of being definitive.[5] The two scholars have referred the references made by Newton to the wisdom of the Ancients to a common denominator: the *prisca philosophia* or *prisca theologia.* Following the trail blazed by Frances Yates in her notable studies, they have indicated its genealogy in the syncretist tradition that starts from Ficino, Pico and the *Corpus hermeticum* and flows — via the Platonic Academy of Florence — into the works of the Cambridge Platonists, Cudworth and More, and into the vast alchemical literature which was familiar to Newton. The précis which McGuire and Rattansi give of the "various *prisca* traditions and their modifications" is intended to show, by means of more-or-less happy textual comparisons, that Newton inherited from his predecessors a belief in a universal gnosis, essentially theosophical in its content, which had been directly revealed by God to the most ancient sages and by them concealed under the shape of symbols and fables, then obliterated and at last re-interpreted by the moderns from their surviving fragments. It is well to observe that the interpretation of McGuire and Rattansi attributes to the *prisca philosophia* (or, one might better say, to the *prisca* taken as a substantive) a monolithic consistency in doctrine, or a constancy and permanence, which are such as to make it virtually an eternal truth revealed to man, or a synonym for the 'perennial philosophy' of Steuco and Leibniz.[6]

Stimulating as the strategic lines of this reading of the classical Scholia proposed by these two scholars may be, it appears less convincing when subjected to detailed analysis. In order to restore the Newtonian version of the *prisca*[7] to the context of the above-mentioned tradition, understood virtually as an eternal truth, McGuire and Rattansi have in fact had to make an anthology of the Scholia and to give emphasis to certain passages found in them, in a manner visibly pre-conditioned by the same hypothesis of their interpretation. They proceeded with the aid of a third collaborator, an excellent Latinist, who has furnished them with "the basic translations of the main passages quoted from the Royal Society manuscript". They have, however, made the unfortunate decision not to present the texts *in extenso*, with the strange justification that "there is no space". Finally, and a failing even more grave, they have confined themselves to superficial indications of the doxography quoted by Newton, without bothering to make a precise recension of it.[8] Thus the 'readings' of Newton that do not

square with the pre-selected image of the *prisca* are all alike sacrificed; the *prisca* is spoken of, but not very much attention is paid to the testimony of its pre-Socratics and Pythagoreans drawn from Diogenes Laertius, nor to the important citations from *De facie lunae* by Plutarch, nor to the passage taken from the *Dialogo dei massimi sistemi*. Scarcely any of the notable excerpts from Lucretius, Macrobius and Natale Conti are quoted.[9]

The obvious result of such a procedure is a disengagement of the strictly philological process of establishing the text from the process of interpreting it, whereas these two processes should, in the correct reading of an unpublished manuscript, be fused into one. Here we propose to bridge the gap by proceeding to

(a) the recovery of the *whole* of the manuscript, and
(b) the recension of the sources cited by Newton.

Thus we shall arrive at a correction of certain viewpoints of McGuire and Rattansi, based on the letter — rather than the 'spirit' — of the classical Scholia.

III

A first and important reservation is to be made concerning the two 'sources' where Newton initially would have encountered the theme of the *prisca*: Ralph Cudworth and Henry More. It has for some time been known that the two Platonist philosophers, with whom Newton was probably acquainted at Cambridge, are quoted in various of his manuscript notes. Of Henry More's works Newton possessed *An antidote against atheisme* (1653) and *The immortality of the soul* (1659),[10] the two great apologetic works in which "the angel of Christ's College" had expounded his ideas about Cartesian mechanism, the hypothesis of the 'Spirit of Nature', or 'Plastik Nature', the concept of space deified. Newton had read them during the 'sixties and had probably drawn from them his own conception of the vacuum.[11] It is indeed true that in the context of his prolix argumentation in defence of the immortality of the soul, More relies upon the *consensus gentium*, that is to say, the "suffrage of the renowndest Philosophers in all ages of the World", citing the Egyptians, Hermes Trismegistus (nevertheless suspected of 'fraud' after the critique by Casaubon), the Brahmins, the Magi, Moses, and the usual genealogy: "Zoroaster, Pythagoras, Epicharmus, Empedocles, Cebes, Euripides, Plato, Euclid, Philo, Virgil, Marcus Cicero, Plotinus, Iamblicus, Proclus, Boethius, Psellus."[12] This is, certainly, the authentic *prisca theologia* of the Platonic mould, which More in other writings fuses with the Hebrew Cabbala and Pythagorean numerology, considered together as the depositories of an ancient theosophical revelation. But familiar as More's books may have been to Newton, nothing convinces us that it was on More's account that Newton has treated the concept of a settled order of the physico-astronomical world as being already known to the

Ancients, as appears from the classical Scholia. Such a theme is not a feature of More's writings, and the name of More does not occur in the glosses to these Scholia.

The case of Cudworth's *True intellectual system of the universe* (1678) is more complex. Newton has transcribed in his own hand certain passages from this massive folio of *apologia*.[13] These passages deal with the atomism of the Ancients, the predecessors of Leucippus and Democritus, from whom Cudworth strives to avert the stigma of atheism. According to his apologetic thesis the Atomic Physiology of the predecessors of Leucippus and Democritus — the fabulous Phoenician, Moschus,[14] and then Pythagoras and the Pythagoreans, Ecphantus, Zenocrates, Heraclides, Diodorus, and Metrodorus of Chios — did not exclude the notion of an immaterial God (Bk I, cap. I, §§ 6-16). In one of the Scholia Newton rehearses this atomist tradition, but does not concern himself to reproduce the apologetic arguments of Cudworth also.[15] It may be noted, moreover, that he has recourse to the text of the impious Lucretius, without any theological scruple, a text that Cudworth had involved in his own anti-materialist polemic. Thus, Newton's argument about the atomism of the Ancients is rather different from that of Cudworth. The situation is exactly the same with regard to the pantheism of the Orphic texts: while Cudworth cites numerous Orphic hymns among which he claims to find an anticipation of the idea of the Trinity, Newton confines himself — in Scholium IX — to the second-hand quotation of two Orphic fragments not cited by Cudworth and of a monotheistic tendency, rather than otherwise.[16]

A comparison, here barely sketched out, between the classical Scholia and the works of Cudworth and More yields, in substance, little fruit. Rather than writing of their clear and direct influence upon Newton, one should in this instance speak of a common cultural climate, of a common literary substrate. McGuire and Rattansi too, at bottom, recognize as much. Thus, curiously, their thesis ("when Newton was developing his 'classical' annotations, he drew considerably on Cudworth's erudite *True intellectual system*.... There was a large body of shared assumptions between Newton and Cudworth") undergoes a severe restriction only a few lines further on: "Despite these similarities, Newton did not borrow a great deal from Cudworth's learned account in his historical annotations.... It must also be pointed out that Newton disagrees with the other two authors [Cudworth and More] on certain important points of interpretation."[17] Since the whole discourse involves this sort of contradiction the premise from which it departs is evidently erroneous.

The question is badly posed. The *prisca philosophia* cannot be separated from the context of the writings of Cudworth and More as a specific theme, nor could it have influenced Newton under such a form. It is rather a cultural stratum common to many writers of quite different tendencies. Doxographies that attribute to the Ancients this or that physico-astronomical thesis, even if only

differing in their emphases, are in fact to be read in the various erudite *summa* which Newton had at his elbow: the *Syntagma* of Gassendi, the *Physiologia* of Walter Charleton, the richly-stocked *Almagestum novum* of the Jesuit astronomer Giovanni Battista Riccioli, the *Archaeologia philosophica* of Burnet. Accordingly, it may be argued, even if from silence (as must also be the case with Cudworth and More who are not quoted in the classical Scholia), that their author has drawn hints from any one of these sources whatever.

IV

His recourse to a doxography of the Ancients disseminated in the seventeenth century, though certainly not originating then, may also be interpreted as the use by Newton of a non-dogmatic principle of authority, turned to the legitimization of action at a distance within the framework of the new mathematical astronomy. If one cares to use the expression *prisca philosophia*, one certainly may do so; but with the condition that it must not be hypostasized into an eternal truth revealed to man. For one is dealing with a pseudo-concept, a metaphorical expression beneath which are gathered together intellectual forms which are not homogeneous and which are changeable through time and continually adapted to different cultural contexts. It is not the case that Francis Bacon — in the heat of his polemic against the tradition of philosophy — has devoted much attention to the 'wisdom of the Ancients'.

If Newton dwells in a predominantly 'Platonic' environment he does so while imposing on the Ancient authors demands which are new and idiosyncratic. Rehearsing the current doxographies he selects particular works in a sagacious and precise manner, and this is the peculiar characteristic of the classical Scholia, differentiating them from the mass of the *prisca*. Among the ancient philosophers — atomists, pre-Socratics, Platonists, Pythagoreans — Newton did not so much seek for a broad revelation as, particularly, for the fundamental technical propositions of his own mathematical astronomy; more precisely, he 'read' into their testimony the law of gravitational attraction. Obviously in so doing he had no predecessors.

The classical Scholia should be re-read in strict relation to the enunciations of the Propositions in Book III of the *Principia* which they were intended to bond together and complete. A precise plan of exposition may be discerned in the rigorous logico-empirical architecture of this third book. After expounding as Phenomena of observation the three laws of Kepler which govern all the motions of the bodies in our solar system (Phenomena I-IV), Newton gives a first dynamic re-interpretation of them according to the law of universal gravitation (Propositions I-III). Then follow Propositions IV-IX for which the classical Scholia were intended: here, starting with the mutual attraction of the Earth and the Moon (the particular case which had been the object of Newton's first

thought on gravity),[18] the inverse-square law is generalized more and more until it embraces all the bodies of the solar system and all the bodies in the physical universe. This procedure recapitulates the historical stratification of Galileo's astronomical discoveries and the intellectual pathway followed later by Newton himself. Now the author himself intended to integrate Propositions VI-IX, which expound the more original nucleus of the theory of gravitation, with the testimony drawn from the Ancients. If we set this out schematically we obtain the frame of reference displayed in Table 1.

The first four Scholia contain, then, propositions about universal gravitation which have nothing to do with the theosophical tradition, and which Newton attributes to the Ancients, citing chiefly the *De facie in orbe lunae* of Plutarch, the *Lives* of Diogenes Laertius, the pseudo-Plutarchian *Placita philosophorum* and Lucretius's *De rerum natura*. The 'Pythagorean' thematic touching the harmony of the spheres, founded on the texts of Pliny, Eusebius, Proclus and Macrobius (Scholium to Proposition VIII), introduces the theosophical *finale*, which emerges in the last Scholium out of a paraphrase of passages from Aristotle and the Orphic-Pythagoreans, of which the latter are derived entirely from the *Mythologia* of Natale Conti. There follow excerpts from the *Commentarium in Somnium Scipionis* of Macrobius of which neither the function nor the destination is clear, but which speak volumes as to Newton's 'Platonism'.

One cannot fail to note the sobriety with which Newton manipulates his authors, selecting again and again from the great mass of testimony that he had at his disposal the quotations which serve his purpose exactly. It is a work of delicate engraving, the result of many successive drafts,[19] carried through with the skill and scrupulous care of a thoroughly experienced doxographer. It presupposes a critical re-examination of the entire thematic content of the *prisca philosophia* from an original point of view.

The choice of the quotations corresponds to Newton's intention to show that the Ancients had known the phenomena and laws of gravitational astronomy. The fully mathematical precision of the propositions of the *Principia*, concerning the gravity that operates between the celestial bodies, certainly does not exclude the possibility that Newton was also sensitive to the vague 'musical' and theosophical suggestions of the Pythagorean sources. The treatment which he reserves in the last two Scholia for the texts of Macrobius and of the two Orphic fragments — canonical texts in an ancient Platonizing tradition, texts regarded for many centuries as pregnant with meaning and which are here read with the aid of a new key — shows the strict relation which exists in Newton's thought between the numero-musical ratios that preside over the law of the inverse squares and the image of God. For Newton has put back his own image of a God "highly skilled in mechanics and geometry" who has exactly calculated (by means of fluxions?) the masses, distances and the mutual attractions of the

TABLE 1.

	Proposition	Content of the Scholium	Principal authors cited
IV.	The gravitation of the Moon in its orbit	The Moon another Earth, like the other heavenly bodies	Plutarch, *De facie in orbe lunae; De placitis*; Diogenes Laertius; N. Conti; Galileo
V.	The mutual gravitation common to the planets and satellites	The various centres of gravity of the celestial bodies	Plutarch, *De facie in orbe lunae*; Democritus from Origen; Lucretius
VI.	The gravity of bodies upon the planets is proportional to the masses of the same bodies	Proportionality of mass and gravity	Lucretius; the atomists from Aristotle; Plutarch, *De placitis*
VII.	Universal gravitation in the ratio of the masses of the heavenly bodies	Gravitational attraction and magnetic attraction	Plutarch, *De facie in orbe lunae*; Lucretius
VIII.	The law of the inverse-square of the distances in the case of two bodies	The ratio between gravity and distance and the musical scale	Pythagoras from Macrobius; Pliny; Proclus; Eusebius; Macrobius
IX.	The law of inverse-squares generalized	Universal attraction and its cause according to the Ancients	Thales from Diogenes Laertius; Pythagoras from Aristotle; the myth of Pan and the Orphic hymns from N. Conti; Macrobius

celestial bodies, into the context of the Pythagorean or Platonic tradition of the "God who eternally geometrizes".

V

Before a rehearsal like this of such traditional texts, so canonical — obvious, if you like, in the classical learning of the late seventeenth century — two different attitudes are possible: (a) to establish the trite and conventional character of Newton's reading and quotations, and to consider him as a belated, not to say nostalgic, exponent of Renaissance syncretism, identified with the corpus of the *prisca philosophia*; or (b) to pick out the *differences* in Newton's approach, the new inflections and the different symbolic significance that the testimony of the Ancients assumes under his pen.

Excluding the former of these attitudes, which has a trivializing effect (in the sense of crediting the great mathematician with a mere philological hobby, indulged at moments of leisure), it is worth while to dwell on the second. To penetrate deeply into the web formed by the Scholia, it is necessary to make a brief reference to other possible examples of Newton's endeavour, obvious in themselves but completely avoided by McGuire and Rattansi.

Book III of the *Principia*, "De systemate mundi", summarizes under a unique, simple mathematical law — which is both universal and necessary — the astronomical observations, the partial efforts, the attempts at interpretation of the astrologers and the astronomers of all preceding ages. The models which had up to this time been thought of in order to explain the aspects and motions of the planets, are here replaced by a unitary model that has the advantage of perfect correspondence with the phenomena and a perfected mathematical rationality. In other words, Newton has in truth realized the 'Platonic' or 'Pythagorean' dream which, in varying degrees, had been shared by the protagonists of the astronomical revolution. And they too had searched in the testimony of the Ancients for signs of an ancient astronomy that was 'true' (harmonic, heliocentric) to counterbalance the geometric system of Aristotle and Ptolemy: I refer to some well-known passages in Copernicus, Galileo and Kepler which Newton certainly bore in mind when he composed the classical Scholia.

The pseudo-Plutarchian passage in the *Placita philosophorum* from which Copernicus had drawn the heliocentric inspiration which had induced him "to think of the mobility of the Earth"[20] is adjacent to the texts that Newton in his turn draws from the same *Placita*, with the intention of documenting the 'Copernicanism' of the ancient philosophers.[21] And whatever Newton's familiarity with the *Mysterium cosmographicum*, the *Epitome* and the *Harmonices mundi* of Kepler, works so thoroughly imbued with numerological, Pythagorean and 'mystical' hints, he understood their strict functionality in relation to the laws of elliptical astronomy.[22] If anything is surprising, it is that

Newton — who names Kepler so often — should have refrained from mentioning his Pythagorean doxography and speculation. We limit ourselves here to one reflection, concerning an ancient source well known to both Kepler and Newton: the *De facie in orbe lunae* of Plutarch. This provided the chief inspiration for Kepler's *Somnium*, and he made a Latin translation of it. Newton, who was very probably ignorant of both, 'rediscovered' for himself some passages of significance for the lunar gravitation and centre of gravity in a Latin translation of Plutarch.

These are merely indirect indications of a way of reading the Ancients characteristic of the protagonists of the astronomical revolution. Much more of an indication is given by the textual reference to Galileo's *Dialogo dei massimi sistemi*, placed by Newton at the conclusion of the first Scholium. It is a quotation of the celebrated 'Platonic Myth' — in reality a pseudo-Platonic pastiche whose pregnancy has long since been noted by scholars — framed by Galileo to justify the various orbital velocities of the planets around the Sun. In his turn Newton seizes upon this "most lofty concept, fully worthy of Plato" from the First Day of the *Dialogo* as a confirmation of the argument concerning the lunar orbit and the planetary orbits unfolded in the Scholium. He offers the passage from Galileo with the words: "Since it seems that Plato admitted himself to be of the same opinion...."[23] One may deduce from this that Newton, adopting the attribution of this opinion to "Plato", shares with Galileo the same way of using the principle of authority, of asking for the testimony of the Ancients and re-discovering modern ideas.

Seen in this light, the classical Scholia belong to a particular tradition: rather than consorting with the tradition of the *prisca* in the broad sense, they belong to a variant properly called 'Copernican' which was used to vindicate the validity — on both the technical and the philosophical level — of the ancient cosmological models which were alternatives to the geostatic system. Copernicus, Galileo, Kepler and their followers had often understood the progress of astronomy as being also a reversion towards propositions comprehended intuitively by the Ancients. However antithetical to the idea of progress, indeed preposterous, such a way of thinking inherently seems to us — to us and to so many who from the end of the seventeenth century already were convinced of the superiority of the Moderns and of the unambiguous progress of knowledge — it was not repugnant to Newton, who thought of the book of Nature as a palimpsest, long ago deciphered by the Ancients, but whose meaning had been obliterated by time and so had to be recovered by the experimental and mathematical method.

VI

In various places in the classical Scholia Newton alludes to the 'encoding' activity of the Ancients and to his own deciphering of the ancient texts by means

of an allegorical key:

> The philosophers loved to modify their mystic utterances in this way [he writes marginally beside a quotation from Macrobius] so that they might unfittingly set commonplace things before the crowd to amuse it, and conceal the truth beneath this kind of utterance.[24]

A good part of his commentary is dedicated to the exegesis of the Pythagorean "fictions", such as the symbolic representation of the Sun and the seven planets by the image of Pan and his pipe with seven reeds.[25] This particular image — already present in the *De sapientia veterum* of Bacon[26] — and its associated context concerning the cryptography of the Ancients derived directly from the widely diffused, modest manual of Natale Conti, which Newton himself quotes and which is also Bacon's source, and which had in a broad way nourished the literary and artistic preoccupation with allegory among numerous English authors of the seventeenth century.[27] Also drawn by Newton from the *Mythologia* of Conti are the two Orphic fragments concerning the Gods which appear in the Scholium to Proposition IX. It is useful, in order to grasp the limits of Newton's originality in exegesis, to re-read Conti:

> The universal teachings of philosophy are embraced within these ancient fables; indeed, at a period not very long before Aristotle and Plato and the rest of the philosophers, all the doctrines of philosophy were treated not openly, but secretly under disguises. For when the Greeks introduced the occult way of philosophizing from Egypt into their own country, in order not to publish those wonderful things before the vulgar crowd which, when improperly understood, often detract from religion and ordinary morality, they themselves started on the secret way of philosophizing by means of fables.[28]

The Milanese student of myths had proposed for himself the task of unveiling "the oldest and most recondite secrets of the fables" for an edifying purpose: "either for the correction of morals and the establishment of a just way of life, or for understanding *the virtues and movements of the stars.*"[29]

These words and the whole context of the *Mythologia* which are, like the analogous manuals of Gregorio Giraldi and Vincenzo Cartari, at the root of so much of the sixteenth century interest in allegory and also of much of the discussions of the 'wisdom of the Ancients' by Bacon and Vico, undoubtedly stimulated Newton to edit the Scholia destined for Propositions VIII and IX. Thus, his paraphrase of Conti's text moves within a literary and allegorical stratum of thought which is well defined and not at all uncommon.

This does not mean that he could not be persuaded to singular flights of Pindaric fancy. J. M. Keynes, the praiseworthy saviour of the Newtonian manuscripts in 1936, concluded after a summary examination of them that

Newton was an occultist, a *magus*. His alchemical manuscripts bear the imprint of a belief in a mystic and esoteric cryptography springing from the Babylonians and "handed down by the brethren in an unbroken chain".[30] The sensational proposition of Keynes has been given certain new dimensions by recent scholars. It contains the marks of the exegesis practised on the alchemical manuscripts by Newton. The same theme of the *prisca*, considered in this perspective, appears to broaden out into a project for the wholesale re-interpretation from the first foundations of Newton's extra-scientific interests and papers: the study of chronology, the exegesis of the prophetic books of Scripture, the theory and practice of alchemy. In these diverse fields, it is asserted, Newton had pursued systematically the dream of a literal deciphering of symbols, allegories, fictions; of an esoteric philology capable of unveiling the most recondite mysteries of the cosmos and of human history, revealed by God himself to the most ancient men of learning and by them shadowed in a 'mystic' form. But it may be asked whether such a point of view as this does not go beyond Newton's purpose, in the sense of positing a systematic, universal, exhaustive knowledge of all things; that is, a 'pansophia' similar to that of which Comenius, Hartlib and Leibniz dreamed. Is it possible to attribute to the author of the *Principia mathematica* and the *Opticks* a similar project, one which moreover he disguised in a great mass of manuscript which he left unpublished?

Certainly, after the recent studies of R. S. Westfall and B. J. T. Dobbs it can no longer be doubted that Newton knew and studied from his youth onwards a vast corpus of alchemical writings. Among the books of his library appear manuals and manuscripts composed by occultists, Rosicrucians, alchemists; there are more than one hundred of them, including those of Michael Mayer, the *Museum Hermeticum*, Ripley, Starkey, the *Theatrum chemicum*, Sendivogius, Rosencreutz, Arthephius, Flamel, Synesius.[31] Among the very numerous autograph manuscripts on alchemy, three are attributed to "Hermes Trismegistus";[32] others demonstrate in unequivocal fashion that Newton personally experimented on the transmutation of metals and the other operations of the Great Work, manipulating copper, lead and 'philosophic' mercury in the crucible of his laboratory at Trinity College, Cambridge.

The significance of Newton's alchemy — always carried out in secret and subjected to a rigorous self-censorship — is today at the centre of an embarrassing controversy. Faithful students of Newton's physical and mathematical works tend to minimize or wipe out the disconcerting revelations of the manuscripts collected by Keynes. Others, taking exactly the opposite view, lose sight of the mathematics and geometry of the *Principia* and *Opticks* in the name of alchemy and Hermeticism. Others again have attempted to mediate between the two extremes, seeking to demonstrate, for example, that the Newtonian notion of force springs from the meeting-point of two seemingly irreconcilable doctrines: the 'animated' responsive Nature of the alchemists and

Hermeticists, and the mechanism of the atomists. According to this perspective — looking beyond the polemic between Mersenne and Kepler on the one side and Fludd on the other — the Hermetic trends of the late Renaissance and the dream of the alchemists should not be seen as withered branches of the scientific culture of the seventeenth century. On the contrary, they must have made a substantial contribution to the genesis of the key concepts of classical dynamics, such as those of force and instantaneous attraction in the void.[33] The dispute among Newtonian scholars, with its complex implications, is still going on.

But let us turn to the classical Scholia. It is understandable that those who support the Hermetic-alchemist interpretation have seized upon the occurrence of the theme of the *prisca philosophia* in Newton's thought as a strong argument in their favour. Were not the *Corpus Hermeticum* and its Renaissance derivatives the prime sources of the *prisca*? Were not the alchemists of the seventeenth century among those who — despite the textual criticism of Casaubon — rediscovered the suggestion of a very ancient wisdom attributed to 'Egypt' contained in the writings of the Hermetics? Certainly Mayer, Ashmole and the other alchemists over whose books Newton pored followed this line. There remains the question — and it is no trivial one — whether, and at what point, Newton himself subscribed to the myth of Hermes: it cannot be answered from the classical Scholia.

Then there is the further issue of cryptography, which is of closer concern here. McGuire and Rattansi have already postulated a strict connection between the esoteric symbolism of the alchemical literature, the exegetical technique that Newton applied to the prophetic books, and his decipherment of the Pythagorean images:

> Both alchemy, as well as biblical exegetics, rested on the assumption that a true body of knowledge had been available to wise men in the remotest Antiquity, and that the knowledge was couched in an enigmatical, symbolical form to conceal it from the vulgar. It is evident that the same assumptions underlie Newton's exegesis of the natural philosophy of the ancients. *His tortuous interpretation of the Lyre of Apollo, the Pipes of Pan, and the 'Harmony of the Spheres'* rests on the belief that the true system of the world was known to the ancients, but had been turned into a 'great mystery' which only the initiates could penetrate.[34]

The argument would run smoothly if the "tortuous interpretation of the Lyre of Apollo, the Pipes of Pan, and the Harmony of the Spheres" had been an authentic invention of Newton, or if it had resulted from a sophisticated application of 'mystical keys' to the ancient texts, reputed to be capable of revealing sublime truths to the initiated. But this is not in question. What is involved here, alas, is a commonplace of writers of handbooks of mythology, lifted from the modest Conti.

Thus the picture of Newton as cryptographer, occultist and initiate (which is so closely assimilated to the caricature of Leonardo current in the early 1900s) proves to be supported here by a common-place of which the source had been overlooked even though it was candidly indicated by the author of the classical Scholia. The author of the recent and profound investigation of Newton the alchemist encounters the same obstacle. She in turn insists upon the *prisca*, which Newton had learned from the Cambridge Platonists. She declares that her entire reconstruction — which is undoubtedly ingenious and supported by a vast erudition — is founded on the thesis of McGuire and Rattansi with respect to the *prisca*: "that tradition played such an enormous role in Newton's study of alchemy that any real understanding of Newton's alchemy is precluded if his adherence to the *prisca sapientia* doctrine is ignored."[35]

Here we face an exaggeration. The less certain conclusions resulting from a reading of McGuire and Rattansi are generalized far beyond any critical caution:

> The paper by McGuire and Rattansi has shown how Newton utilized this double approach [that is, experimental method and occultism in the classical Scholia]... it appears that Newton had decided that some discoveries of Pythagoras on musical harmonies had been applied by that famous ancient to celestial relationships, and that Pythagoras had as a consequence of that application recognized the inverse square law of gravity, the true harmony of the heavens. Pythagoras had hidden his knowledge in parables to keep it from the vulgar, but the knowledge was nevertheless kept alive in the myths that dealt with the musical instruments of the Gods — the Pipes of Pan and Apollo's Harp.[36]

The unqualified attribution to Newton of a 'decision' to interpret the myths of Apollo and Pan allegorically — without taking account of the common-place of the time underlying Scholia VIII and IX — indicates a loss of a sense of proportion. It presumes that a highly original system of decipherment of the 'mystic' writings may be found in what are, in fact, obvious paraphrases of Pythagorean themes, a triviality for a seventeenth century scholar. Mrs Dobbs generalizes this point of view, misrepresenting the hints for an allegorical exegesis suggested to Newton by Conti, and developing a polyvalent analysis which Newton is supposed to have applied systematically to his studies of chronology, of alchemy and of biblical exegesis. The esoteric wisdom of the Ancients, "the old knowledge occultly preserved", thus proves to be an essential component in the Newtonian synthesis: "The conclusion Newton drew from his interpretations of the myths then undoubtedly influenced his scientific thinking in its turn."[37]

Certainly, everything holds together in the mind of a genius; but it is hardly necessary to recall that Newton arrived at the formulation of the law of universal

gravitation by following a quite different route. He had started from the principles of Galilean mechanics, Descartes's principle of inertia and Kepler's planetary laws in order to calculate the orbit of the Moon, then proceeded by successive approximations — recently reconstructed by Koyré, Cohen, Herivel and Whiteside — to systematize the laws of motion and to construct "in the mathematical way" the marvellous architecture of the *Principia mathematica*. It is by no means insignificant that the record of the Ancients and the reinterpretation of their 'fictions' should be super-added to a completed work, with a view to a second edition. The classical Scholia were destined to confer upon a perfectly modern 'reading' of the Book of Nature the anachronistic aura of a truth already inscribed in an ancient palimpsest.

VII

It is not an easy undertaking, perhaps an impossible one, to define in a satisfactory way the role that the Hermetic suggestions, the testimony of the Ancients, the Platonism of Macrobius or the rubbish of the Alchemists had on the creative thought of Newton or upon his subconscious mind. At all events, it seems necessary to reformulate the picture of an occultist intent upon resolving crossword-puzzles and rebuses, or — as Keynes wrote — upon the search for the philosopher's stone and the hunt for mystic keys capable of revealing the great enigma of the universe. Such is the picture of a charlatan, which does not seem appropriate to the author of the *Principia*: that author did not devise esoteric systems of cryptography, but limited himself to developing, in writings of various natures and taking each case separately, a rationalist exegesis inspired by the method of common sense. That he had in mind a coherent, pansophic design is a conjecture to be ascribed rather to certain recent interpreters of Newton than to Newton himself. In the case of the classical Scholia, as follows from a proper listing of the sources, he made use of the widely disseminated methods of allegorical philology. He partialiy brought its content up-to-date by attributing to the ancient texts knowledge of his own physico-astronomical synthesis. He is guilty in this — as Vico would have put it — of the "arrogance of the learned, who wish anything that they know themselves to be as old as the world".

But in Newton's arrogance there was also a certain modesty. Intended as they were for the second edition of the *Principia* and already put into their definitive form — as the imperative "adde" written before each Scholium shows — the Scholia did not overcome the barrier of self-censorship. This too is a feature that the modern reader should bear in mind: what is in question is no mere curiosity of psychology or character — for Newton behaves in an analogous way with respect to his other writings — but a more complex problem. The decision between publishing or not publishing one of his own writings — and the matter is

of particular significance in the case of these Scholia — was surely not without epistemological importance, so to speak, since the decision would contribute directly to the definition or modification of the public image of Newtonian science. When he renounces publication, Newton is making a carefully weighed choice. As for the reasons for this choice one may make a variety of conjectures: an added perplexity concerning the basic thesis of the Scholia? Second thoughts about the fitness of combining historical allusions with a treatise on physico-mathematical science? The conviction that it would be sufficient to add the General Scholium with its gloss on the ancient theologians?

Another guess, which would merit deeper examination, is that Newton kept back the Scholia in order to avoid being personally involved in the last struggles of the 'quarrel' between the Ancients and the Moderns, where the protagonists at this tail-end of the century were William Temple and William Wotton, to which Swift added as a satirical codicil his *Battle of the books*. So the work of Newton could not but serve as an essential point of reference, certainly not on the side of those who maintained the superiority of the Ancients. The classical Scholia, if they had been inserted in the *Principia*, would have carried the flavour of paradox.

VIII

Nevertheless, Newton allowed others to make use of his manuscript, though without citing its source and author. The privilege extended to his protegé, the young mathematician David Gregory. Born in 1661, precociously appointed professor of mathematics at Edinburgh (1683), Gregory was introduced to Newton by the Astronomer Royal, John Flamsteed, in these words: "You will find him a very ingenious person and a good Mathematician worth your acquaintance."[38] The acquaintance became more intimate through the years; in 1692, through Newton's influence, Gregory was nominated Savilian Professor at Oxford and a Fellow of the Royal Society.[39] His intimacy with Newton leaves many traces in the *Memoranda* of Gregory, partially published in *The correspondence of Isaac Newton*.[40] The annotations dated 4-7 May 1694 relate to the classical Scholia; these days were spent by Gregory on a visit to Newton at Cambridge, where he received from Newton much information and many confidences. There the two men discussed certain modifications that Newton was preparing for "a new edition of his philosophy", that is, for a second edition of the *Principia mathematica*.[41]

Among the astronomical and mathematical questions are also indications of other concerns. Gregory writes:

> Physical, Mathematical and Theological Annotations from Newton. There is need continually of a miracle to prevent the Sun and the fixed stars coming

> together because of gravity. The great excentricity of the Comets, moving in different directions and opposite to that of the planets, denotes the divine hand, and implies that the Comets have some other purpose than that of the Planets.... He will demonstrate at length the agreement between this philosophy and that of the Ancients, especially the philosophy of Thales. The philosophy of Epicurus and Lucretius is the true and ancient one, wrongly twisted towards atheism by the ancients.... From the names of the planets conferred by Thoth (the Egyptian Mercury) — for he gave to them the names of his predecessors, whom he wished to have accepted as Gods — it is clear that he was a follower of the Copernican system.[42]

These are hasty allusions but significant both for the text of the General Scholium later and for the classical Scholia. Almost certainly Gregory may have cast an eye on the latter during these days. When Newton entrusted the manuscript of the classical Scholia to Gregory "as a gift or a loan" (as the editor of the *Correspondence* remarks)[43] is, on the other hand, unknown. One cannot believe that he would have done so if immediate publication was firmly in his mind. In fact it seems that Newton no longer had under consideration the intention, recorded by Gregory in his own papers, of republishing the *Principia mathematica* with a commentary prepared by Gregory himself; Gregory would never become responsible for preparing the second edition, whereas such a responsibility was temporarily given to both Nicolas Fatio de Duillier and to Richard Bentley, the two editors who failed.[44]

Yet it is a fact that the manuscript of the classical Scholia in Newton's autograph is to be found in the papers of David Gregory, which passed after his early death (1708) into the archives of the Royal Society (MS. 247, ff. 6-14). Gregory made an accurate copy of it in his own hand, to be found at the end of his *Notae Principiorum*, his commentary on the *Principia mathematica* which has remained unpublished.

IX

The preparation of the classical Scholia has been attributed to a pretty wide spread of time.[45] Recent scholars tend to limit it, dating the composition as "in the 1690s".[46] In two places in the Scholia Newton touches on particular issues identical with those which he had discussed with Richard Bentley between the end of 1692 and the beginning of 1693: the 'Platonic Myth' of Galileo (Scholium to Prop. IV, below and note 20) and the equilibrium of the celestial masses in infinite space, as a gloss to a text of Lucretius (Scholium to Prop. VII and note 34). Let us record Koyré's discussion of why, in all probability, Newton at least owed the Galilean quotation to Bentley.[47] It is likely enough, therefore, that the conclusion of the first Scholium was composed after 25 February 1693.

If this is not a true and proper *terminus a quo*, this date does make a precise point of reference. Why should we not think that Newton might have been induced to gather together the classical quotations and to compose his own Scholia by the occurrence of his epistolary dialogue with Bentley, as his own personal contribution to the apologetic interpretation of the third book of the *Principia*, a task brilliantly begun by Bentley in his *Boyle lectures*?[48] At all events, one can suppose 'philological' intentions, latent through many years — at least since the time of the composition of the first version of *De mundi systemate* — to have been concretely realized in 1693. As for the *terminus ad quem*, it seems reasonable to place it in May 1694, in accordance with the evidence from Gregory's *Memoranda*, quoted above.

Obviously these two indications are approximate. One realizes this more clearly when one considers, besides the version of the classical Scholia which has survived in Gregory's papers at the Royal Society, the earlier drafts which have remained among the papers of the Portsmouth Collection in the Cambridge University Library (Add. 3965.11, ff. 277-8 and 3965.17, f. 640, all both recto and verso). These very puzzling drafts have a content generally identical with that of the Gregory version, which virtually seems to be the definitive text. Another autograph rendering of two of the Scholia is to be found in a copy of the *Principia* belonging to Newton; it is partial — containing only the Scholia to Propositions IV and VII — and has been reproduced by I. B. Cohen.[49] It is therefore clear that Newton, as was his habit, wrote and re-wrote many times in his elegant script not only his own reflections on the Ancients but also the quotations and glosses of the texts in Greek and Latin; a scribal task, which testifies to his full devotion to the thematic of the Scholia.

Scholium by scholium, the position is as follows:

Prop. IV.	MS. Gregory, ff. 9-8; C.U.L. Add. 3965.17, f. 640r and 3965.11, f. 277v; Adv. b. 39.1 (Cohen).
Prop. V.	MS. Gregory, f. 6r; C.U.L. Add. 3965.11, f. 277r (partially).
Prop. VI.	MS. Gregory, f. 6v; f. 10r and v.
Prop. VII.	MS. Gregory, f. 11r and v; C.U.L. Add. 3965.11, f. 278r (partially) and v (Cohen).
Prop. VIII.	MS. Gregory, f. 12r and v; C.U.L. Add. 3965.11, f. 278r and v.
Prop. IX.	MS. Gregory, ff. 13r, 14v.

We have transcribed the Scholia from the Gregory MS., not without taking account in making the transcription of the drafts in the Cambridge University Library, the variant readings of which however have not been recorded here. Cancelled or obliterated words are scrupulously indicated by means of

appropriate symbols, with the aid of the drafts.

The Gregory manuscript is composed of nine folios of 18 x 30 cm bound together within the volume numbered 247, in a wholly erroneous order; the numbering of folios 6 to 14 should be corrected to form the correct succession, thus: 9, 8, 6, 10, 11, 12, 13, 14. The quotations from the *Commentary* of Macrobius, written on f. 7r and v, seem to be an appendix to the final Scholium, and so we have placed them next after that (even if these should most likely be considered as being excerpts for Newton's private use, they offer precious evidence concerning his 'Platonism').

We have, moreover, introduced one text which is not part of the Gregory manuscript; the Scholium destined for Corollary 2 of Proposition VII. It is a significant exposition of the atomism of the Ancients, visibly inspired — in part — by Cudworth's *True intellectual system*, and stiff with Lucretian quotations. It is transcribed from the final version in C.U.L. Add. 3965.11, ff. 270r, 272r; lacunae — caused by charring of the lower left margin of the three folios — have been completed by reference to the annexed drafts on ff. 268r and v, 269r and v.

It is evident from the unfinished treatment of this last Scholium that Newton did not include it among the others because its topic was comprehended within the Scholium to Proposition VII as this is presented in the Gregory manuscript. But the earlier treatment is more ample and detailed; note that it proceeds, in the two fragments, to the reference to Pliny, Macrobius and the harmony of the spheres which was afterwards incorporated — in the final version — into the Scholium to Proposition VIII.

X

The classical Scholia were to have a paradoxical 'career'; although they remained unpublished, they were in great part summarized by David Gregory in his Preface (1702) also reproduced here. Colin Maclaurin took up the same subject in his *Account of Sir Isaac Newton's philosophical discoveries* (London, 1748) and it became current in Europe through the French translation of this work. Louis Dutens in turn rehearsed verbatim the themes and the quotations from the Ancients in his *Recherches sur l'origine des découvertes attribuées aux modernes. Où l'on démontre que nos plus célèbres Philosophes ont puisé la plupart de leurs connoissances dans les Ouvrages des Anciens* (Paris, 1766). A whole chapter (vol. i, chap. VI, 145-65) is dedicated to Newtonian attraction; it is a paraphrase of Gregory's Preface.

In this way, transcending the issues of the *Battle of the books* and the victory of the Moderns, the classical Scholia were smuggled into the Age of the Enlightenment. No one — other than Gregory — knew that Newton himself had authorized such a 'leak' of his private thoughts regarding the *turba philosophantium* of Antiquity.

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1. I. Newton, *De mundi systemate* (London, 1728). The work was sold to the booksellers Tonson, Osborn & Longman by the administrators of Newton's intestate estate for £31.10s; see the memoir by John Conduitt (King's College, Cambridge, Keynes MS. 127 A5) reproduced by D. T. Whiteside in *The mathematical papers of Isaac Newton*, i (Cambridge, 1967), xviii-xx. Numa Pompilius and the Temple of Vesta as a symbol for the heliocentric universe are a quotation from Plutarch, as Newton has taken the trouble to note in the margin. Indeed, one reads in the life of Numa: "Ferunt Numam aedem quoque Vestae sacro igni orbicularem circumjecisse, ut ibi asservaretur, adumbrans non effigiem terrae, quasi ea Vesta sit, sed universi mundi, cujus in medio ignis sedem locant Pythagorici, eamque vestam nominant & unitatem." Newton consulted a Latin edition of Plutarch, *Opera* (see note 3 below, p. 38); the passage is at vol. i, col. 67a. Newton returns to the symbolic circular temple at the end of Scholium IX; *cf.* note 50 below.
2. Cambridge University Library, MS. Add. 3970, f. 619r; Professor Maurizio Mamiani kindly furnished me with a photocopy of it. A very similar formula is in the draught of Query 27, Add. 3970, f. 292v.
3. Speaking of the hypothesis of the aether: "And for rejecting such a medium, we have the authority of those the oldest and most celebrated Philosophers of Greece and Phoenicia, who made a vacuum, and Atoms, and the gravity of Atoms, the first principles of their Philosophy, tacitly attributing gravity to some other cause than dense matter" (*Opticks*, Query 28 (20 in the first edition, 1704), third edn (1721), 343-4; Dover reprint (1952), 369).
4. The Scholium generale was added to the second edition of the *Principia* in 1713, and revised in the third.
5. J. E. McGuire and P. M. Rattansi, "Newton and the Pipes of Pan", *Notes and records of the Royal Society of London*, xxi (1966), 108-43.
6. The thesis of McGuire and Rattansi has indeed found a pretty favourable echo among the students of this current of thought, who have still further isolated it from its cultural context from the end of the sixteenth to the beginning of the eighteenth centuries. See Charles B. Schmitt, "Prisca Theologia e Philosophia Perennis: Due temi del Rinascimento italiano e la loro fortuna", in *Il pensiero italiano del rinascimento e il tempo nostro*, Atti del V Convegno internazionale del Centro di Studi Umanistici, Montepulciano, 8-13 agosto 1968, 211-63; *idem*, "Perennial Philosophy from Agostino Steuco to Leibniz", *Journal of the history of ideas*, xxvii (1966), 505-32; and D. P. Walker, *The Ancient Theology: Studies in Christian Platonism from the 15th to the 18th century* (Ithaca, N.Y., 1972) (on Newton, 254-63 and *passim*).
7. I use the term, but only as a metaphor or pseudoconcept, as is made clearer below.
8. McGuire and Rattansi, *op. cit.* (ref. 5), 142, note 71: "These sources cannot be discussed in any detail here, although the historical sketch of the prisca doctrines in the text should help to clarify the significance of some of these citations"; as will be seen, a procedure has been chosen which is inverse to the correct one, by which a text is only to be interpreted historically *after* an analysis has been made of its internal stratification.

9. *Ibid.*, 135. Plutarch's *De facie in orbe lunae*, from which Newton takes three important quotations, is not recorded at all; Natale Conti is mentioned by name, but without defining the use that Newton made of his book.
10. Besides several of his theological and exegetical writings; *cf.* J. Harrison, *The library of Isaac Newton* (Cambridge, 1978), 195, nos. 1109-16.
11. All recent students of Newton agree on this point; see, for example, Alexandre Koyré, *Newtonian studies* (Cambridge, Mass., 1965), 89ff.; F. E. Manuel, *A portrait of Isaac Newton* (Cambridge, Mass., 1968), 99ff. More is quoted in Newton's *juvenilia*, "Quaestiones quaedam philosophicae", Cambridge University Library, MS. Add. 3996, ff. 88-135.
12. *The immortality of the soul*, 115, in Henry More, *A collection of several philosophical writings* (London, 1662) (each treatise is paginated separately).
13. In a manuscript now preserved at the William Andrews Clark Memorial Library, Los Angeles, Newton transcribes p. 13 *et seq.* of the *True intellectual system of the universe*, Bk. I, chap. I, §§6-16 concerning the atomic physiology of the Ancients.
14. Whose identification with Moses was accepted by Cudworth (§10), in a way that had become canonical after this hypothesis was put forward by Arcerius and Selden; but he does not admit the tradition of atomism from Moschus-Moses to Pythagoras. *Cf.* D. B. Sailor, "Moses and atomism", *Journal of the history of ideas*, XXV (1964), 3-16.
15. See the last Scholium, marked "p. 412, post Corol. 2".
16. On the Orphics, *True intellectual system*, Bk. I, chap. IV, 297; Newton cites the text of the "little Krater" and a remark attributed to Ermenesianathus, but directly from the Latin of Natale Conti; see below.
17. McGuire and Rattansi, *op. cit.* (ref. 5), 134-5.
18. See the texts and evidence collected by J. Herivel in *The background to Newton's Principia* (Oxford, 1965), 65ff., and P. Casini, *L'universo-macchina: Origini della filosofia newtoniana* (Bari, 1969), 28ff. (with bibliography).
19. At least three, on the evidence of the drafts at Cambridge, see below.
20. "To his holiness Pope Paul III", quoted from Nicolas Copernicus, *De revolutionibus orbium caelestium*, Preface. Copernicus cites *De placitis philosophorum*, III, 13, from which Newton also borrows. See, for the implications of the passage, Eugenio Garin, *La rivoluzione copernicana e il mito solare*, in *Rinascite e rivoluzioni: Movimenti culturali dal XIV al XVIII secolo* (Bari, 1976), 255ff.
21. See below, notes 46, 17, 18.
22. See A. Koyre, *La révolution astronomique* (Paris, 1961); a good survey is S. Tangherlini, *Temi platonici e pitagorici nell'Harmonice Mundi di Keplero*, "Rinascimento", ser. 2, XIV (1947), 117-78.
23. See below, Scholium to Prop. IV, Bk III of the *Principia* (1687), 407.
24. *Cf.* below, "Ad Prop. VIII".
25. The image is in the Scholium to Prop. IX (see below, note 46, p. 44); a variant is the other image of the Lyre of Apollo which Newton cites in the Scholium to Prop. VIII from passages in Pliny and Macrobius (*cf.* notes 35 and 36). In the Queries in *Opticks*, composed later, Newton quotes both the images without naming the sources for them.
26. "Fistula enim ex septem calamis concentum rerum et harmoniam, sive concordiam cum discordia mixtam, quae ex septem stellarum errantium mota conficitur, evidenter ostendit" (F. Bacon, *De sapientia veterum*, in *Works*, ed. by Ellis, Spedding and Heath (London, 1887-92), VI, 638). Newton possessed the *Essays* (1706) and the *Opuscula varia* (1658) of Bacon; among the *Essays* present was the *Discourse on the wisdom of the Ancients* (*cf.* Harrison, *op. cit.* (ref. 10), nos. 108-9). It is certain that Bacon too was greatly indebted to Natale Conti, see P. Rossi, *Francesco Bacone, della magia alla scienza* (Bari, 1957), 206ff.

(English trans. (1968), 78, 93, 255).

27. Rossi, *op. cit.* (ref. 26); F. L. Schoell, *Les mythologistes italiens de la Renaissance et la poésie élisabéthaine* in *Études sur l'humanisme continental en Angleterre à la fin de la Renaissance* (Paris, 1920), 21-42, to be completed by W. Schrckx, "Chapman's borrowings from Natale Conti", *English studies*, xxxii, no. 3 (1951), 107-12. Especially indispensable is the work of J. Seznec, *La survivance des dieux antiques* (1940), of which there is an English translation, *The survival of the pagan gods: The mythological tradition and its place in Renaissance humanism and art* (Kingsport, 1953); on handbooks of mythology and Conti see p. 279ff.
28. Natale Conti, *Mythologiae, sive explicationis fabularum libri X* (Coloniae Allobrogum, 1636), 1-2.
29. *Ibid.*, my emphasis. Newton owned an edition at Cologne of 1612 (Harrison, *Library*, no. 439); on the use he made of it, see below, notes 46-48, p. 44.
30. J. M. Keynes, "Newton, the man" (1942), in *Royal Society Newton tercentenary celebrations, 1946* (Cambridge, 1947), 29.
31. *Cf.* Harrison, *op. cit.* (ref. 10), *passim*; and the appendices and bibliography to B. J. T. Dobbs, *The foundations of Newton's alchemy* (Cambridge, 1975), 235ff.
32. Dobbs, *Foundations*, 238.
33. Besides the book by Dobbs, one should consult the earlier studies by R. S. Westfall, "Newton and the Hermetic tradition", in *Science, medicine and society in the Renaissance: Essays to honor Walter Pagel*, ed. by A. G. Debus (New York, 1972), ii, 183-98; "The role of alchemy in Newton's career", in *Reason, experiment and mysticism in the Scientific Revolution*, ed. by M. L. Righini Bonelli and W. R. Shea (New York, 1975), 199-232 (with commentaries by P. Casini and M. Boas Hall). Westfall first disclosed his researches into the Hermetic Key in the large volume *Force in Newton's physics* (London, 1971). It is interesting to note that one of the authors of "Newton and the Pipes of Pan", J. E. McGuire, has in a recent essay proposed a sharp discrimination between the 'Platonism' that Newton shares with the Cambridge Platonists, and the 'Hermeticism' which he, McGuire, rejects: "There is no evidence that Hermetic magic appealed to Newton.... Nor does Newton make any significant references to Hermes in his writings. Where he does, 'Hermetic' is a stock phrase referring to alchemy and cannot be pressed unduly. The materials he gathered in the 1690s for inclusion in the opening proposition of the third book of the *Principia* [the classical Scholia] do not make mention of Hermes or of Hermeticism, although they refer to the opinions of many of the Neoplatonists" ("Neoplatonism and active principles: Newton and the Corpus Hermeticum", in *Hermeticism and the Scientific Revolution* (William Andrews Clark Memorial Library, Los Angeles, 1977), 131). This is a distinction one may well accept, against the thesis of Westfall and Dobbs.
34. McGuire and Rattansi, *op. cit.* (ref. 5), 136, my emphasis.
35. Dobbs, *op. cit.* (ref. 31), 111.
36. *Ibid.*, 110.
37. *Ibid.*, 110. See, on the other hand, the balanced point of view of McGuire in his 1977 essay, *op. cit.* (ref. 33), 130: "...it cannot be concluded that Newton perceived himself as a mere renovator of lost wisdom.... The problems that Newton conceived and tackled in his science were not set by the parameters of ancient thought, nor did ancient thought function as a direct source for his creative ideas. The enterprise of interpreting ancient thought could only commence for Newton *after* the techniques of seventeenth-century science had revealed anew the real structure of things."
38. Letter to Newton from Flamsteed, 10 August 1691, in *The correspondence of Isaac Newton*, ed. by H. W. Turnbull, J. F. Scott, A. R. Hall and L. Tilling (Cambridge, 1959-77), iii, 164.
39. *Ibid.*, iii, see the letters exchanged between Newton and Gregory in 1691.
40. *Ibid.*, iii, 191, 272, etc.

Notae Principiorum, see I. Bernard Cohen, *Introduction to Newton's Principia* (Cambridge, 1971), 188-99.

45. They must have been composed between 1687 and 1697, as was first remarked by J. C. Gregory, "Notice concerning an autograph manuscript of Sir Isaac Newton", *Transactions of the Royal Society of Edinburgh*, xii (1834), 65-76.
46. "Most probably before 1694 ... and not later than 1697", according to McGuire and Rattansi, *op. cit.* (ref. 5), 139, note 3.
47. Koyré, *Newtonian studies* (ref. 11), 206-9. Newton himself had found this 'myth' not in Galileo, but in François Blondel, *L'Art de jetter les bombes* (Amsterdam, 1683), ch. 8, 166. *Cf.* note 20, below.
48. *Cf.* Casini, *op. cit.* (ref. 18), 55-82.
49. In his edition of the *Principia*, "with variant readings" (Cambridge, 1972), ii, 803-7, I. Bernard Cohen has confined himself to a transcription of the autograph leaf by Newton that is folded in four and inserted between pages 412 and 413 of a copy of the *Principia* (1687), once Newton's property and now in Cambridge University Library, pressmarked Adv. b. 39.1. No one knows how this leaf came there; it was surely not inserted there by Newton himself (who, if he had done so, would have added all the classical Scholia); probably it was done by some ill-informed custodian of the book. Cohen does not transcribe the texts in the correct order, nor indicate the sources of them.

STATEMENTS OF PROPOSITIONS IV TO IX OF BOOK III OF THE *PRINCIPIA*

Prop. IV, Theor. IV.

Lunam gravitare in terram, & vi gravitatis semper a motu rectilineo, & in orbe suo retineri.

Prop. V, Theor. V.

Planetas circumjoviales gravitare in Jovem, & circumsolares in Solem, & vi gravitatis suae retrahi semper a motibus rectilineis, & in orbibus curvilineis retineri.

Prop. VI, Theor. VI.

Corpora omnia in Planetas singulos gravitare, & pondera eorum in eundem quemvis Planetam, paribus distantiis a centro Planetae, proportionalia esse quantitati materiae in singulis.

Prop. VII, Theor. VII.

Gravitatem in corpora universa fieri, eamque proportionalem esse quantitati materiae in singulis.

Corol. 1. Oritur igitur & componitur gravitas in Planetam totum ex gravitate in partes singulas...

Corol. 2. Gravitatio in singulas corporis particulas aequales est reciproce ut quadratum distantiae locorum a particulis...

Prop. VIII, Theor. VIII.

Si globorum duorum in se mutuo gravitantium materia undique, in regionibus quae a centris aequaliter distant, homogenea sit: erit pondus globi alterutrius in alterum reciproce ut quadratum distantiae inter centra.

Corol. 1. Hinc inveniri & inter se comparari possunt pondera corporum in diversos Planetas...

Prop. IX, Theor. IX.

Gravitatem pergendo a superficiebus Planetarum deorsum decrescere in ratione distantiarum a centro quam proxime.

[from the first edition, London 1687, pp. 406-16]

THE CLASSICAL SCHOLIA

Conventional symbols:

Two vertical strokes | | indicate the beginning or end of a page of the MS.
Between angle brackets < > are printed words or phrases deleted by the author.
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The square brackets [ ] are all the author's, without indication to the contrary.
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Harrison, followed by a number, indicates the number of a volume owned by Newton as given in the catalogue of John Harrison, *The library of Isaac Newton* (Cambridge, 1978).

f°. 9 r.

In Prop. IV Lib. III Princip. Math. p. 407 [2].

Schol.

Lunam esse corpus ⟨densum⟩ terrestre & grave & vi gravitatis in Terram nostram casuram esse nisi vi motus circolaris cohiberetur ⟨et in orbe suo suspensa tenetur⟩ antiqua fuit opinio. Nam cum Philosophi aliqui Lunam esse Terram in sublimi suspensa docerent & alii ⟨Lunam aeris et ignis mixturam esse contenderent, nec si⟩ corpus densum et terrestre esse negarent & aquis ac ignis mixturam esse voluerunt ne gravitate sua caderet in Terram nostram: [a] Plutarchus introducit Lucium quendam pro priori opinione sic disputantem. Ne Terra cadat non metuit Pharnaces, miseretur autem Lunae conversioni suppositos Aethiopes & Tapobrenos ne in eos tanta moles decidat sollicitus. Atqui Lunae auxilio est ne cadat, motus suus revolutionis impetus: quomodo quae fundis imposita sunt & in orbem rotantur, per rotationem suam impediuntur ne delabi possit. Nam motus naturalis [sc. gravitatis] rem unamquamquam agit si non ab alia aliqua re alio avertatur. Ea de causa Lunam gravitas non movet, cum conversionis circularis impetu descensus eius inhibeatur. [a] Plutarch. de facie in orbe Lunae.

Desumpta videtur haec sententia a Philosophia Jonica. Haec enim a Thalete per Anaximandrum & Anaximenem ad Anaxagoram propagata fuit, & [b] *Anaxagoras aetherem igneum esse dixit & circumvolutionis vehementia abripuisse lapides e terra eosque adussisse & sic in stellas convertisse.* [c] *Totum vero coelum* [i.e.

a. καίτοι τῇ μὲν σελήνῃ βοήθεια πρὸς τὸ μὴ πεσεῖν ἡ κίνησις αὐτὴ καὶ τὸ ῥοιζῶδες· τῆς περιαγωγῆς, ὥσπερ ὅσα ταῖς σφενδόναις ἐντεθέντα τῆς καταφορᾶς κώλυσιν ἴσχει τὴν κύκλῳ περιδίνησιν. ἄγει γὰρ ἕκαστον ἡ κατὰ φύσιν κίνησις, ἂν ὑπ' ἄλλου μηδενὸς ἀποστρέφηται. διὸ τὴν σελήνην οὐκ ἄγει τὸ βάρος ὑπὸ τῆς περιφορᾶς τὴν ῥοπὴν ἐκκρουόμενον.[3]

b. Plutarch. Placit. Philos. lib. 2. c. 13.[4]

c. Laertius in vita Anaxagorae.[5]

corpora omnia coelestia] *lapidibus constare, sed conversionis celeritate contineri cujus remissione casurum est.* [d] Lapidem quoque e Sole casuram esse finxit & Solem vocavit [e] μύδρον ἢ πέτρον διάπυρον, lapidem igne candentem. Idem sensere [f] Archelaus & [g] Euripides Anaxagorae discipuli, ut et [h] Democritus et Metrodorus & [i] Diogenes Apolloniata qui dixit stellam saxeam ignis forma in Aegos fluvium decidisse. Per saxa vero nihil aliud intelligebant quam corpora gravia ⟨decidentia⟩ densa et fixa ⟨ad instar lapidum⟩ saxorum instar ut ignem sustinere possent. Nam et Solem [k] glebam auream nonnunquam vocabant, hoc nomine tam fixitatem materiae quam densitatem & pondus designantes. Sed nec Lunam Anaxagoras nudum lapidem esse voluit at Terram gravem et densam qualis est ea cui inambulamus. [l] In Luna enim habitari docuit & esse in ea colles & convalles & [m] latam quandam regionem e qua Leo Nemeus deciderat. Per figmenta Leonis e Luna et lapidis e Sole cadentium docebat gravitatem corporum Solis et Lunae in Terram, & per figmentum lapidum ascendentium docebat vim rotationis gravitati contrariam. Haec ad literam intelligenda non sunt. Philosophi mystici sub huiusmodi figmentis et sermonibus mysticis dogmata adumbrare solebant. ⟨Et haec⟩ Haec autem Philosophia tam late per Graeciam ad usque tempora Platonis propagata fuit ut [n] Plato de ea sic conquestus sit. *Cum Solem Lunam, Sidera et Terram quasi Deos et res divinas in medium* || *adducimus tunc* f°. 8 r. *juvenes ab istis* [qui nuper in Graecia philosophati sunt] *aliter persuasi, terram et lapides haec esse dicant, nullamque rerum humanarum curam habere posse.* [p] Democritus autem *sententias Anaxagorae de Sole & Lunae ab ipsis excogitatas esse negabat, antiquas enim esse dicebat, easque ipsum suffuratum esse.* Proinde hae ad Philosophiam Jonicam merito referendae sunt. Nam et Thales ⟨Philosophiae illius⟩ [q] Anaximenes Anaxagorae magister *naturam siderum* (fixorum scilicet) *esse igneam censuit, tum corpora quaedam terrena sed inaspectabilia* (id est Planetas terrestres ob distantiam invisibiles in sideris cuiusque systemate revolventes) *commiscuit.* Et Thales [r] Philosophiae Jonicae fundator censuit γεώδη μὲν, ἔμπυρα δὲ τὰ ἄστρα, *terrestres esse stellas fixas, sed ignitas interim.*

Eadem sententia obtinuit etiam in Philosophia Italica. Nam [s] Pythagorei dicebant ⟨Solem esse ignem⟩ *Lunam terrestrem esse, quia, sicut et nostra terra,*

d. Laertius ib.[6]
e. Plato in Apolog. Socr., Plutarch. Placit. Philos. 2 c. 20, Laertius ib. Cyrillus Alexandrinus 1. 6., Comm. Suidas Anaxagora.
f. Stobaeus Ecl. phys. 20 vel 25[7].
g. Plato in Apolog.[8]
h. Plutarch. Placit. Philos. l. 2. c. 13, 20.[9]
i. Plutarch.[10]
k. Laertius in Anaxag.[11]
l. Laertius in Anaxag.[12]
m. Natalis Comes in Hercule p. 672.[13]
n. Plato de Leg. lib. 10 sub initio.[14]
p. Apud Laertium in Anaxagora.[15]
q. Stobaeus Ecl. Phys. 125.[16]
r. Plutarch. ib. l. 2. c. [17]
s. Plutarch. ib. l. 2. c. 30.[18]

circumhabitatur a majoribus quidem & pulchrioribus animalibus ob dierum longitudinem. & Pythagoreorum aliqui ⟨fingebant stellam⟩ gravitatem siderum adumbrabant ⟨docebant⟩ [t] fingendo *stellam tempore incendij a Phaetonte excitati de loco suo delapsam loca quae circulari cursu peragravit adussisse & in viam lacteam convertisse.*

Quinetiam Plato in eandem sententiam concessisse videtur. Hic enim [u] statuit corpora mundana, etiam tum cum jam fabricata et omnio stabilita essent aliquandiu motu recto agitata fuisse sed postquam ad certa determinataque loca pervenissent paulatim in gyrum revolvi coepisse motu recto commutato cum circulari in quo postea perstiterunt: et Galilaeus hoc refert ad gravitatem qua corpora illa primum motu recto accelerato caderent dein flecterentur in gyrum.

t. Plutarch. ib. l. 3. c. 1.[19]
u. Galilaeus in Syst. cosm. sub initio.[20]

f°. 6 r. pag. 408 Ad Prop. 5. ⟨adde⟩

Scholium.

Gravitatem in Solem ac Lunam aeque ac in Terram fieri Plutarchus [a] ex mente ⟨Veterum⟩ Philosophorum quorundam sic docet. Praejudicijs onusti eos dicunt inferiora superioribus adjungere qui Lunam quae Terra sit, non in medio sed in sublimi collocant. At enim si omne corpus grave eodem fertur, et ad centrum suum ab omnibus partibus vergit, Terra non ut centrum Universi potius quam totum, quoddam sibi omnia gravia ut suas partes vindicabit. Et indicium erit corpora convergere non ut occupent medium mundi locum sed ob cognatione cum Terra, a qua vi repulsa rursum ad eam se conferunt. Sicut enim Sol omnes partes, ex quibus constat ad se convertit, sic et Terra lapidem ut ad se pertinentem accipit et fert ad eum. Itaque horum unumquodque temporis progressu unitur cum ea et coalescit. Quod si quod est corpus ab initio Terrae non attributum, neque ab ea avulsum sed peculiari natura pro sese constat (qualem ipsi Lunam faciant) quid obstat quin deorsin id subsistat suis compactum ac constrictum partibus.

a. Plutarch. de Facie in orbe Lunae p. 92.[21]

Democritus autem ⟨cum diceret infinitos esse mundos⟩ [22] et per mundos singulos non singulos Planetas sed singula Planetarum systemata intelligeret non solum Planetas qui in eodem sunt systemata in se mutuo graves esse voluit, sed etiam gravitatem eorum in alia undique systemata extendi. Docuit enim mundos alios generari, alia deficere, φθείρεσθαι δὲ ἀυτοὺς ὑπ' ἀλλήλων προσπίπτοντας, corrumpi autem illos in se invicem cadendo. [Origenes in Philosophicis.] [23] Ad quam sententiam ⟨Epic⟩ Lucretius sic alludit

Lucret. l. 5. sub initio.[24]

quod superest, ne te in promissis plura moremur,
principio maria ac terras caelumque tuere;
quorum naturam triplicem, tria corpora, Memmi,

tris species tam dissimilis, tria talia texta,
una dies dabit exitio, multosque per annos
sustentata ruet moles et machina mundi.
nec me animi fallit quam res nova miraque menti
accidat exitium caeli terraeque futurum,

Et paulo post

dictis dabit ipsa fidem res
forsitan et graviter terrarum motibus ortis
omnia conquassari in parvo tempore cernes,
quod procul a nobis flectat fortuna gubernans,
et ratio potius quam res persuadeat ipsa
succidere horrisono posse omnia victa fragore.

Ad Prop. VI

f°. 6 v.

Scholium

Corpora omnia quae circa terram sunt tam aerem et ignem quam reliqua esse gravia in Terram et eorum gravitatem proportionalem esse quantitati materiae ex qua constant Veteribus etiam innotuit. Nam Lucretius pro vacuo sic disputat [25]

denique cur alias aliis praestare videmus
pondere res rebus nilo maiore figura?
nam si tantundemst in lanae glomere quantum
corporis in plumbo est, tantundem pendere par est,
corporis officiumst quoniam premere omnia deorsum,
contra autem natura manet sine pondere inanis.
ergo quod magnumst aeque leviusque videtur,
nimirum plus esse sibi declarat inanis;
at contra gravius plus in se corporis esse
dedicat et multo vacui minus intus habere.
est igitur nimirum id quod ratione sagaci
quaerimus, admixtum rebus, quod inane vocamus.

Lucretius hic refert gravitatem ad corporis officium seu naturam qua ab inani non gravitate distinguitur et inde concludit pondus corpori semper proportionale esse. Quo argumento corpora omnia tam insensibilia quam sensibilia comprehendit. Nam et atomis ipsis ex quibus alia omnia constant gravitatem hanc attribuit. Docet enim ignem et corpora alia quae laevia dicuntur non sponte sed vi subigente ascendere perinde ut lignum quod corpus grave est ascendit in aqua: corpora autem omnia per spatium inane deorsum ferri.

Lucret. l. 2. vers 183.[26]

nunc locus est, ut opinor, in his illud quoque rebus
confirmare tibi, nullam rem posse sua vi
corpoream sursum ferri sursumque meare;
ne tibi dent in eo flammarum corpora fraudem.
sursus enim versus gignuntur et augmina sumunt
et sursum nitidae fruges arbustaque crescunt,

pondera, quantum in se est, cum deorsum cuncta ferantur.
nec cum subsiliunt ignes ad tecta domorum
et celeri flamma degustant tigna trabesque,
sponte sua facere id sine vi subiecta putandum est.
quod genus e nostro cum missus corpore sanguis
emicat exsultans alte spargitque cruorem.
nonne vides etiam quanta vi tigna trabesque
respuat umor aquae? nam quo magis ursimus alte
f°. 10 r. derecta et magna vi multi pressimus aegre, ||
tam cupide sursum revomit magis atque remittit,
plus ut parte foras emergant exsiliantque.
nec tamen haec, quantum est in se, dubitamus, opinor,
quin vacuum per inane deorsum cuncta ferantur.
sic igitur debent flammae quoque posse per auras
aeris expressae sursum succedere, quamquam
pondera, quantum in sest, deorsum deducere pugnent.

Et quamvis res laeviores quae aeris vel aquae resistentiam difficilius vincant in his fluidis descendant tardius, tamen in spatio vacuo ubi nulla est resistentia atomos omnes tam graviores quam minus graves propter gravitatem sibi proportionalem aequali celeritate descendere, ⟨docet Lucretius⟩ sic docet Lucretius [27]

illud in his quoque te rebus cognoscere avemus,
corpora cum deorsum rectum per inane feruntur
ponderibus propriis, incerto tempora ferme
incertisque locis spatio depellere paulum,
⟨tantum quod momen mutatum dicere possis.⟩
quod nisi declinare solerent, omnia deorsum,
imbris uti guttae, caderent per inane profundum,
nec foret offensus natus nec plaga creata
principiis: ita nil umquam natura creasset.
quod si forte aliquis credit graviora potesse
corpora, quo citius rectum per inane feruntur,
incidere ex supero levioribus atque ita plagas
gignere quae possint genitalis reddere motus,
avius a vera longe ratione recedit.
nam per aquas quaecumque cadunt atque aera rarum,
haec pro ponderibus casus celerare necessest
propterea quia corpus aquae naturaque tenvis
aeris haud possunt aeque rem quamque morari,
sed citius cedunt gravioribus exsuperata.
at contra nulli de nulla parte neque ullo
tempore inane potest vacuum subsistere rei,
quin, sua quod natura petit, concedere pergat;
OMNIA QUAPROPTER DEBENT PER INANE QUIETUM
AEQUE QUAPROPTER NON AEQUIS CONCITA FERRI.
haud igitur poterunt levioribus incidere umquam
ex supero graviora neque ictus gignere per se
qui varient motus per quos natura gerat res.
quare etiam atque etiam paulum inclinare necessest
corpora ||

f°. 10 v. Haec Lucretius ex mente Epicuri Epicurus ex mente Democriti et antiquorum docuit nam quidam aequalitatem atomorum statuentes gravitatem corporum numero atomorum ex quibus constabant proportionalem esse volebant, alii autem quibus ⟨inaequalitatem⟩ atomi ⟨orum statuebant⟩ inaequales erant, gravitatem

non numero solidorum sed gravitati solidi proportionalem esse docebant. Id Aristoteles in libro quarto de caelo capite secundo sic docet[28] *Quidam*, ait, *de laeviore & graviore sic dicunt, ut in Timaeo est scriptum. Gravius quidem esse quod ex iisdem pluribus constet* [id est ex pluribus solidis quae quod magnitudinem & figuram eadem sunt] *levius autem quod ex ijsdem paucioribus, quemadmodum* [plumbo] *et aes aere majus gravius est ... eodem modo et ligno plumbum gravius dicunt. Omnia corpora ex ijsdem quibusdam & una materia esse aiunt.* Et paulo post recenset opiniones aliorum ⟨(e quorum numero Simplicius, in commentario suo[29] hunc locum dicit esse Leucippum et Democritum)⟩ qui tribuunt gravitatem numero solidorum sed quantitati solidi et levitatem quantitati vacui in singulis corporibus. Et ex horum philosophorum numero Simplicius in hunc locum, dicit esse Leucippum et Democritum. Per vacui vero levitatem Philosophi illi non positivam vacui qualitatem, ut opinatus est Aristoteles, sed defectum ⟨tantum⟩ gravitatis solummodo intellexerunt.

Inter philosophos igitur qui corpora ex atomis composuere gravitatem tam atomis quam corporibus compositis competere & in singulis corporibus quantitati materiae proportionalem esse recepta fuit opinio. Ex Atomis autem corpora composuere philosophi tam Jonici ⟨Thales⟩ quam Italici. *Thaletis et Pythagorae sectatores*, inquit Plutarchus, *negant in infinitum progredi sectionem eorum corporum quae motibus sunt obnoxia sed subsistere in iis quae individua sunt & atomi dicuntur.* Plutarch. Placit. Philos. lib. I. c. 16.[30]

Ad Prop. VII adde. fº. 11 r.

Gravitatem non fieri per vim puncti alicujus in quod gravia undique tendunt, sed per vim materiae totius in Globo Terrae corpora omnia ad se trahentis Plutarchus ex mente Veterum sic docet. Si quicquid quocumque modo extra centrum Terrae est dici oportet supra esse, nulla pars mundi infra erit: sed supra fuerit et Terra & omnia quae ei incumbunt & simpliciter quodvis corpus centro circumpositum; infra autem unicum illud corporis expers punctum, atque hoc omni mundi naturae opponi necesse erit quando superum et inferum naturae ratione invicem opponuntur. Neque hoc dumtaxat est in hac re absurdum; sed causam quoque gravia perdunt, ob quam deorsum vergant atque ferantur, cum nullum sint infra corpus ad quod moveantur. Nam quod corporeum non est, id neque probabile est, neque ipsi volunt tanta esse vi praeditum ut omnia ad se trahat & circa se contineat. Plutarch. de facie in Orbe Lunae. p. 926.[31]

Igitur quemadmodum vis attractiva Magnetis totius componitur ex viribus attractivis particularum singularum ex quibus Magnes constat ⟨componitur⟩ sic gravitatem in Terram totam ea gravitate in singulos ejus particulas oriri ⟨sententia fuit Veterum⟩ antiqua fuit opinio. Propterea si Terra tota in globos complures divideretur deberet gravitas ex mente Veterum in globum unumquemque tendi, perinde atque attractio magnetica in singula magnetis fragmenta. Et par est ratio gravitatis in corpora universa.[32]

Hinc docet Lucretius nullum esse universi centrum et locum infinitum sed infinitos esse in spatio infinito mundos huic nostro similes, et praeterea pro rerum infinitate sic disputat.

Lucret. Lib. I. sub finem.[33]

Praeterea spatium summai totius omne
undique si inclusum certis consisteret oris
finitumque foret, jam copia materiai
undique ponderibus solidis confluxet ad imum
nec res ulla geri sub caeli tegmine posset
nec foret omnino caelum neque lumina solis,
quippe ubi materies omnis cumulata iaceret
ex infinito iam tempore subsidendo.
at nunc nimirum requies data principiorum
corporibus nullast, quia nil est funditus imum
11 v. quo quasi confluere et sedis ubi ponere possint. ||
semper in assiduo motu res quaeque geruntur
partibus e cunctis infernaque suppeditantur
ex infinito cita corpora materiai.

Vis argumenti est quod si rerum natura alicubi finiretur, corpora extima, cum nulla haberent exteriora in quae gravia essent non starent in aequilibrio sed per gravitatem suam peterent interiora, et undique ex infinito tempore confluendo jamdudum in medio totius quasi in loco imo iacuissent [34]. Igitur corpus unumquodque ex mente Lucretii grave est in materiam circumcirca positam et per gravitatem praepollentem fertur in regionem ubi materia copiosior est & mundi universi graves sunt in se mutuo & per gravitatem suam in mundos qui sunt ex una parte impediuntur ne cadant in mundos qui sunt ex altera. Cadent tamen aliquando in praepollentis gravitatis ex mente Democriti, ut supra dictum est.

12 r. Ad Prop. VIII

Qua proportione gravitas recedendo a Planetis decrescit Veteres non satis explicaverunt. Adumbrasse tamen videntur per harmoniam sphaerarum caelestium, designantes Solem & reliquos sex Planetas Mercurium, Venerem, Terram ⟨Jovem⟩, Martem, Jovem, Saturnum per Apollinem cum Lyra Chordarum septem & mensurantes intervalla sphaerarum per intervalla tonorum. Ita septem tonos effici voluerunt quam diapasôn harmoniam vocabant & Saturnum Dorio moveri phtongo hoc est gravi, caeteros Planetas acutioribus (ut Plinius lib. I c. 22 ex mente Pythagoreorum refert) & solem chordas pulsare [35]. Unde Macrobius (lib I c. 19) [36] ait *Lyra Apollinis chordarum septem tot caelestium sphaerarum motus praestat intelligi quibus Solem Moderatorem natura constituit.* Et Proclus in Timaeum Plat. l. 3. p. 200 [37], *Septinarium dedicarunt Apollini veluti ei qui concentus universos complectitur. Quapropter Deum vocabant Hebdomagetam, id est septinarij Principem.* Similiter ab Oraculo Apollinis apud Eusebium Praep. Evangel. l. 5. c. 14 [38]. Sol vocatur τῆς ἑπταφθόγγου βασιλεύς *Rex harmoniae septisonae* [a]. Hoc autem symbolo significarunt Solem vi sua agere in Planetas in ratione illa harmonica distantiarum qua vis tensionis agit in chordas diversarum longitudinum, hoc est in ratione duplicata distantiarum reciproce. Nam vis ⟨et po-

a. Ἑπτ. ἐπὶ Θηβ. v. 739. Aeschilus: ὁ σεμνὸς ἑβδομαγέτης Ἄναξ Ἀπόλλων. Venerandus Hebdomageta, Rex Apollo.

tentia⟩ qua tensio ⟨agit⟩ eadem agit in eandem chordam diversarum longitudinum est reciproce ut quadratum longitudinis chordae. Tensio eadem in chordam duplo breviorem quadruplo potentius agit: ⟨quam⟩ Octavam enim generat, et Octava per vim quadruplo majorem editur. Nam si chorda datae longitudinis dato pondere tensa datum tonum edit, eadem quadruplo pondere tensa Octavam edet. Et similiter eadem tensio in chordam triplo breviorem noncuplo plus agit. Nam duodecimam efficit, et chorda quae dato pondere ⟨tensa debet ut duodecimam⟩ tensa datum tonum ⟨edit efficit⟩ edit, noncuplo pondere tendi debet ut duodecimam ⟨edet⟩ efficiat. Et universaliter si chordae duae crassitudine aequales ponderibus appensis tendantur, hae chordae unisonae erunt ubi pondera sunt reciproce ut quadrata longitudinum chordarum [39]. Subtilis quidem est haec argumentatio, sed veteribus tamen innotuit [40]. Nam Pythagoras, ut author est [b] Macrobius, intestina ovium, vel boum nervos, variis ponderibus illigatis tetendit, et inde didicit rationem harmoniae caelestis. Igitur per talia experimenta cognovit quod pondera quibus toni omnes in chordis aequalibus audirentur essent reciproce ut quadrata longitudinum chordae quibus instrumentum musicum tonos eosdem emittit. Proportionem vero his experimentis inventam, teste Macrobio, applicuit ad caelos. || Ideoque conferendo pondera illa cum ponderibus Planetarum & longitudines chordarum cum distantijs Planetarum, intellexit per harmoniam caelestem quod pondera Planetarum in solem essent reciproce ut quadrata distantiarum eorum a sole. f°. 12 v.

Caeterum Philosophi sermones suos mysticos ita temperare amabant ut apud vulgus vulgaria inepte proponerent irrisionis ergo & sub hujusmodi sermonibus veritatem occultarent [41]. Hoc sensu Pythagoras tonos suos musicos numerabat a Terra, quasi hinc ad Lunam tonus esset, inde ad Mercurium semitonum & inde ad reliquos Planetas intervalla alia musica; sonos autem edi docebat per motum. Et attritum sphaerarum solidarum quasi sphaera maior graviorem tonum emitteret perinde ut fit in malleis ferreis percussis. Et hinc natum videtur systema Ptolemaicum orbium solidorum, cum interea Pythagoras sub hujusmodi Parabolis systema proprium & veram caelorum harmoniam occultaret.

b. Macrob. lib. 2 in Somn. Scip. c. I.

[42] Nam Pythagoras, ut refert Macrobius, dum praeteriret officinam fabrii ferrarii, reperit per experimenta ibidem facta quod soni, quos mallei ferrei emittunt, acutiores essent vel graviores pro variis ponderibus malleorum; deinde intestina ovium vel boum nervos, variis etiam ponderibus alligatis, tendendo didicit quod soni ponderibus appensis similiter responderent. ⟨Certum est igitur quod Pythagoras per huiusmodi experimentis cognovit veram rationem quae est arcani⟩ secreti compos deprehendit etiam numeros ex quibus soni sibi consoni nascerentur. Certum est Phythagoras per experimenta illa cognovit veram rationem quae est inter sonos chordarum et pondera appensa, hoc est, quod pondera, quibus toni omnes in chordis aequalibus audiuntur sunt reciproce ut quadrata longitudinum chordae quibus instrumentum musicum tonos eosdem emittit. Proportionem vero his experimentis inventam Pythagoras applicuit ad caelos et inde didicit harmoniam sphaerarum. Ideoque conferendo pondera illa cum pon- f°. 11 v.

deribus Planetarum et intervalla tonorum cum intervallis sphaerarum, atque longitudines chordarum cum distantiis Planetarum ab orbium centro, intellexit per harmoniam caelorum quod pondera Planetarum in Solem (ad cujus utique Lyram omnes saltant) essent reciproce ut quadrata distantiarum earum.

13 r. Ad Prop. IX.

Schol.

Hactenus proprietates gravitatis explicui. Causam ejus minime expendo. Dicam tamen quid Veteres hac de re senserint. Thales [a] corpora omnia pro animatis habuit, id colligens ex attractionibus magneticis et electricis. ⟨Et multo magis attractionem gravitatis in vacuo quantitati materiae proportionale ad animam materiae trahentis retulit⟩ [44]. Et eodem argumento attractionem gravitatis ad animam materiae referre debuit. Hinc omnia Deorum plena esse docuit, per Deos intelligens corpora animata. Et eodem sensu Pythagoras pro Dijs habuit Solem et Planetas & Solem propter ingentem ejus vim attractivam dixit ⟨dixit Solem⟩ esse τὴν τοῦ Διὸς φυλακήν carcer Jovis, id est corpus vi maxima divina quam maxima praeditum, quae Planetae in orbibus suis incarcerantur. Et mysticis Philosophis Pan [46] erat Numen supremum hunc Mundum tamquam instrumentum musicum ratione harmonica inspirans & modulate tractans, iuxta illud Orphei Ἁρμονίαν κόσμοιο κρέκων φιλοπαίγμονι μολπῇ. Indeque Deum et harmoniam nominabant et animam mundi ex numeris harmonicis compositam. Planetas id est vi gravitatis ab actione animarum oriunda. Unde nata videtur ⟨opinio⟩ autem vi animarum suarum ⟨moveri dicebant⟩ in orbibus suis moveri dicebant, Peripateticorum de Intelligentijs orbes solidos ⟨rotantibus⟩ moventibus opinio. Animas autem Solis et Planetarum omnium ⟨pro eodem num⟩ Philosophi antiquiores ⟨mystici⟩ pro uno et eodem numine vires suas in corporibus universis exercente habuere, juxta illud Orphei in Cratere [47]

> Nuncius interpres Cyllenius omnibus ipse est.
> Nympha aqua sunt, frumenta Ceres, Vulcanus at ignis.
> Est mare Neptunus canentia littora pulsans.
> Mars bellum, pax alma Venus, mortalibus ipse
> Taurigena, & superis animi, curaeque levamen,
> Corniger est Bacchus convivia laeta frequentans,
> Aurea justitiamque Themis, rectumque tuetur;
> Sol est mox idem contorquens spicula Apollo,
> Eminus et peragens, et Divinator, et Augur
> Morborum expulsor Deus est Epidaureus: ista
> Omnia sunt unum, sint plurima nomina quamvis.

De ijsdem Hermesianax: [48]

> Pluto Persephone, Ceres et Venus alma et Amores
> Tritones, Nereus, Thetis, Neptunus et ipse
> Mercurius, Juno, Vulcanus, Jupiter et Pan,
> Diana et Phaebus Jaculator, sunt Deus unus.

a. Aristoteles et Hippias apud Laertium in Thalete.[43]

[49] Hunc unum Deum in corporibus universis tamquam templo suo habitare voluerunt et inde templa antiqua ad modum caelorum formabant ⟨ignem in medio templi pro Sole⟩ Solem representatem per ignem in medio Atrij, et Planetas per homines circa euntes quos inde Microcosmos vocabant. Ad quam consuetudinem cum a Cicerone allusum esset [50], Macrobius in ejus verba commemoratus sic scripsit: Bene inquit universus mundus Dei templum vocatur; propter illos et [51] ...

Eadem Philosophorum sententiam ⟨expressit⟩ Vergilius ⟨qui⟩ expressit: nam et [materia] animam dedit et ut gravitati attestaretur mentem vocavit.

Ad Prop. IX (*variant*) [52] f°. 14 v.

Hactenus proprietates gravitatis explicui. Causas ejus minime expendo. Dicam tamen quid Veteres hac de re senserint. ⟨nimirum spiritum quendam per caelos⟩ Nempe caelos esse corporis prope vacuos ⟨?⟩ sed spiritu tamen quodam infinito quem Deum nuncupant undique impleri: ⟨?⟩ corpora autem in spiritu illo libere moveri ejus vi et virtute ⟨corpora⟩ naturali ad invicem ⟨impelli⟩ perpetuo impelli, idque magis vel minus pro ratione harmonica distantiarum, & in hoc [impulsu] gravitatem consistere. Hunc spiritum aliqui a Deo summo distinxerunt & animam mundi vocarunt. Et quemadmodum corpora animalium ex [massa] ⟨spatia omnia relativa quae corporibus spiritu infinito ex mente Veterum impleri sic⟩ Planetarum desumpta sunt, sic animam eorum ab anima mundi ⟨spiritu infinito oriri⟩ originem habere docuerunt. Corpora ⟨quae in ipsis sunt⟩ secundum rationes harmonicas agere, sed et Planetas et corpora universa animatos esse nonnulli crediderunt et vi animarum suarum in se mutuo ad distantiam agere.

Nam Thales Jonicae Philosophiae fundator corpora pro animatis habuit, id colligens ex attractionibus magneticis et electricis, ut Laertius refert, et eo ⟨dem argumento⟩ magis attractionem gravitatis ad animam materiae ⟨refert⟩ retulit. Nam et omnia Deorum plena esse docuit, per Deos intelligens corpora animata. Et eodem sensu Pythagoras pro Dijs habuit ⟨solem⟩ et Planetas, & solem propter ingentem ejus vim attractivam, qua Planetas in orbibus suis retinet, dixit esse τὴν τοῦ Διὸς φυλακήν[45], carcer Jovis, id est corpus a Deo quam maxime animatum seu vi divina quam maxima praeditum. Pla⌈netas⌉ autem vi animarum suarum in orbibus moveri dicebant ⟨Philosophi⟩ veteres, id est vi gravitatis ab actione animarum oriunda. Et inde ⌈nata⌉ videtur opinio Peripateticorum ⟨opinio⟩ de Intelligentijs orbes solidos moventibus. Animas autem solis et Planetarum omnium Philosophi antiquiores ⌈pro⌉ uno et eodem numine vires suas in corporibus universis exerc ⌈ente⌉ habuere juxta illud Orphei in Cratere [47]

Nuncius interpres Cyllenius & c

[quotations from Macrobius][53] f°. 7 r.

nullus sapientum animam ex symphonijs [quoque] musicis constitisse dubitavit.
Macrob. Som. Scip. 1. 1. c. 6. [43]

bene autem universus mundus dei templum [a Cicerone] [54] vocatur propter illos qui aestimant nihil esse aliud deum nisi caelum ipsum et caelestia ista quae cernimus. ideo ut summi omnipotentiam dei ostenderet posse vix intellegi, numquam videri, quicquid humano subicitur aspectui templum eius vocavit qui sola mente concipitur, ut qui haec veneratur ut templa, cultum tamen maximum debeat conditori, sciatque quisquis in usum templi huius inducitur sibi vivendum sacerdotis.

Macrob. Som. Scip. l. 1. c. 14. [2]

hunc rerum ordinem et Vergilius expressit. nam et mundo animam dedit et, ut puritati eius attestaretur, mentem vocavit. caelum enim, ait, et maria et sidera *spiritus intus alit* id est anima, sicut alibi pro spiramento animam dicit — *quantum ignes animaeque valent* — et ut illius mundanae animae adsereret dignitatem, mentem esse testatus [est] [55] — *mens agitat molem* — nec non ut ostenderet ex ipsa anima constare et animari universa quae vivunt, addidit, *inde hominum pecudumque genus*

Macrob. ib. l. 1. c. 14. [14]

Platon dixit animam essentiam se moventem, Xenocrates numerum se moventem, [Aristoteles ἐντελέχειαν,] Pythagoras et Philolaus harmoniam, [Posidonius ideam, Asclepiades quinque sensuum exercitium sibi consonum, Mippocrates spiritum tenuem per corpus omne dispersum, Heraclides Ponticus lucem, Heraclitus physicus scintillam stellaris essentiae, Zenon concretum corpori spiritum] [56] Democritus spiritum insertum atomis hac facilitate motus ut corpus illi omne sit pervium

Macrob. ib. l. 1. c. 14 [19]

Hinc Plato postquam et Pythagoricae successione doctrinae et ingenii propri divina profunditate [cognovit] [57] nullam esse posse sine his numeris [sc. musicis] [58] iugabilem competentiam, in Timaeo suo mundi animam per istorum numerorum contextionem ineffabili providentia dei fabricatoris instituit.

Et paulo post:

Ergo mundi anima quae ad motum hoc quod videmus universitatis corpus impellit, contexta numeris musicam de se creantibus concinentiam necesse est ut sonos musicos de motu quem proprio impulsu praestat efficiat, quorum originem in fabrica suae contextionis invenit.

Macrob. Som. Scip. l. 2 cap. 2 .[19]

inesse enim mundanae animae causas musicae quibus est intexta praediximus, ipsa autem mundi anima viventibus omnibus vitam ministrat:

hinc hominum pecudumque genus vitaeque volantum
et quae marmoreo fert monstra sub aequore pontus

iure igitur musica capitur omne quod vivit, quia caelestis anima, qua animatur universitas, originem sumpsit ex musica, haec dum ad sphaeralem motum mundi corpus impellit, sonum efficit qui *intervallis* est *disiunctus imparibus.*

Macrob. Somn. Scip. l. 2. c. 3. [11]

Et paulo post:

> Porphyrius ait Platonicos credere ad imaginem contextionis animae haec esse in corpore mundi intervalla, quae epitritis, hemioliis, epogdois, hemitoniisque complentur et limmate, et ita provenire concentum cuius ratio in substantia animae contexta mundano quoque corpori, quod ab anima movetur, inserta est. ib.
> versari caelum mundanae animae natura et vis et ratio docet, cuius aeternitas in motu est. quia numquam notus reliquit quod vita non deserit, nec ab eo vita discendit in quo viget semper agitatus: igitur et caeleste corpus, quod mundi anima futurum sibi immortalitatis particeps fabricata est, ne umquam vivendo deficiat, semper in motu est et stare nescit, quia nec ipsa stat anima qua impellitur.

Et paulo post: f°. 7 v.

> Quod autem [Cicero][52] extimum globum || qui ita volvitur, summum deum vocavit, non ita accipiendum est, ut ipse prima causa et deus ille omnipotentissimus aestimetur: cum globus ipse, quod caelum est, animae sit fabrica, anima ex mente processori, mens ex deo, qui vere summus est, procreata sit: sed summum quidem dixit ad ceterorum ordinem, qui subiecti sunt, [unde mox subiecit *arcens et continens ceteros*, deum vero quod non modo immortale animal ac divinum sit et plenum inditae ex illa purissima mente rationis, sed quod et virtutes omnes, quae primae omnipotentiam summitatis sequuntur aut ipse faciat aut ipse contineat.][60] ipsum denique Iovem veteres vocaverunt, et apud theologos Iuppiter est mundi anima. hinc illud est,
> *ab Iove principium, Musae, Iovis omnia plena,*
> quod de Arato poetae alii mutuati sunt, qui de sideribus locuturus a caelo in quo sunt sidera exordium sumendum esse decernens, ab Iove incipiendum esse memoravit.

Macrob. in Somn. Scip. lib. 1. c. 17. [12-14]

p. 412, post Corol. 2.[61]

Scholium

Materiam omnem ex atomis constare perantiqua fuit opinio. Sic docuit philosophantium turba quae Aristotelem praecessit, Epicurus, Democritus, Ecphantus, Empedocles, Zenocrates, Heraclides, Asclepiades, Diodorus, Metrodorus Chius, Pythagoras et ante hos Moschus Phaenix quem Strabo bello Trojano antiquiorem facit. Nam et in Philosophia illa mystica quae ab Aegypto et Phoenicia ad Graecos manavit eandem sententiam obtinuisse puto ⟨videtur, et atomos per monades hieroglyphice designasse⟩ cum atomi quandoque per monades a mystis ⟨hieroglyphice⟩ designati reperiantur. Numerorum enim mysteria aeque ac caetera hieroglyphica ad philosophiam mysticam spectabant. Atomos vero corpora solida esse voluerunt et figuris varijs praedita, non mathematicè sed physicè tantum indivisibilia. Nam et atomorum unumquemque ex partibus innumeris minoribus constare sed quae non ex conventu conciliatae sunt, at arctè et sine poris et interstitijs ab aeterno stipatae et adeo condensatae et in solidum compactae ut nullis Naturae viribus ab invicem avelli et separari ⟨quae⟩ possint. Quae ex atomorum f°. 270 r.

congressu conflantur iterum dividi posse et in atomos eosdem resolvi propterea quod atomi non in solidum congrediatur sed se mutuò in puncto tantum mathematico contingant, spatijs reliquis inter se vacuis relictis: sed atomos ipsos ob soliditatem et plenum partium contactum ac densitatem summam nec dividi posse nec alteri nec ulla ratione commiscui nec ⟨augeri⟩ augmentum unquam sumere sed immutabilia rerum semina in aeternum manere, et inde fieri ut rerum species perpetuò conserventur. Haec enim Lucretius ex mente veterum docuit Lib. I vers. 601 [62]. Praeterea atomos in Terram graves esse docuerunt et ⌈gravi⌉ [63] tatem earum proportionalem esse quantitati materiae ⌈ex qua⌉ constant; et propterea corpora omnia, densa ⌈ac rara,⌉ graviora ac minus gravia aequali cum velocitate ⌈(sed accelerata⌉ tamen) in Terram descendere, & hanc ⌈gravitatem⌉ non ex causis mechanicis oriri sed atomis essen⌈tialem esse⌉ ideoque corporibus universis competere. Quae om⌈nia Lucretius⌉ commemorat Lib. I vers. 39 & Lib. II vers. ⌈182 et 238.⌉ [64] Atomos autem perpetuo motu agitari voluerunt ⌈et quoties per caelos nostros⌉ errant in terram descendere ⌈vi gravitatis suae at non⌉ perpendicularem sed parti⌈cipando motus priores declinare ad laterem⌉ idque
271 r. magis vel || minus pro varietate motuum priorum quos participant. Cadendo verò motum acquirere longe velocissimum: et ex atomis sic obliquè cadentibus motus innumeros diversos in superficie Terrae cieri, ex quibus innumerae diversae oriantur. Et hic est motus declinationis quem Epicurus ⟨dedit⟩ atomis cadentibus assignavit.

Atomos verò non in Terram solum sed etiam in materiam universam graves esse voluerunt et eorum vim gravitatis ad distantias omnes finitas extendi. Ex hac enim atomorum proprietate pro infinitate mundi sic disputabant. Si, inquiunt, mundus finitus esset, corpora ⟨universa⟩ omnia ponderibus suis incitata in medium locum confluerant et undique ex infinito jam tempore subsidendo cumulata jacerent. Argumentum in eo fundatur quod corpora omnia gravia sunt in se mutuò, ideoque extima cum nulla sint exteriora in quae gravitent, petent interiora donec in centro totius conveniant. Mundum igitur infinitum esse statuebant ideoque locum imum seu medium in quem materia omnis confluat non habere, et propterea materiam cum ex infinitis ⌈spatijs⌉ [65] in massam unam descendere et confluere non possit, congregatam fuisse vi gravitatis mutuae in massas innumeras huic mundo consimiles et mundos infinitos constituisse. Haec enim Lucretius ex Epicureorum philosophia commemorat Lib. I vers. 983 et Lib. II vers. 1064 & 1074 [66]. Epicurum verò haec a philosophis mysticis didicisse verisimile est cum Heraclides et Pythagoram et Orphei sectatores stellas omnes esse mundos in ⟨infinito⟩ aethere infinito dicerent ut habet Plutarchus lib. 2 de placit. Philos. c. 13 [67]. Quam opinionem etiam Anaximander tenuit, a Thalete magistro proculdubio edoctus.

Igitur Terra Sol et Planetae omnes qui in nostro systemate ex mente veterum graves sunt in se ⌈mutuo et vi⌉ [68] gravitatis mutuae caderent in se invicem & ⌈in unam massam⌉ coirent nisi descensus ille a motibus ⌈circularibus impedir⌉etur. At qua proportione gravitas ⌈recedendo a Planetis⌉ decrescit Veteres
272 r. non tradiderunt. ⌈Adumbrarunt tamen⌉ per harm⌈oniam⌉ sphaerarum caelestium || designantes solem et septem planetas per Apollinem cum Lyra chordarum septem & mensurantes intervalla sphaerarum per intervalla tonorum sic, ut septem efficiantur toni per diapasôn harmoniam; in qua Saturnus Dorio moveatur phtongo id est gravi seu tardo et caeteri Planetae acutioribus ut refert Plinius l. 2.

Nat. Hist. c. 22[69]. Hoc enim symbolo significarunt Solem agere in Planetas ut musicus in chordas Lyrae et pro rata aliqua orbium ratione motus tardiores in Planetis remotioribus excitare. ⟨Rationem igitur notaverant eamque distantiarum reciprocam esse, sed quaenam ea sit ex his non liquet⟩ Observarat (*sic*) enim Pythagoras (ut refert Macrobius l. 2 Somn. Scip. c. I)[70] quod mallei majores pro ponderum ratione graviores edunt sonos et inde

Two Fragments[71]

Scribit Macrobius quod Pythagoras observarat (*sic*) aliquando quod Mallei pro ponderibus suis sonos edunt ⟨graviores vel⟩ acutiores vel graviores et inde (⟨ut scribit fides Macrobius⟩ ut ⟨Macrobius⟩ Plinius refert) determinabat harmoniam sphaerarum. ⟨Ea vera ratio⟩ Sphaera major graviorem edet sonum pro ratione magnitudinis. [Aperto sermone numerabat distantias sphaerarum a Terra, quasi tonus esset, inde ad Lunam. Et semitonus a Luna ad Mercurium ⟨semitonus⟩, et sic deinceps:] ⟨sphaeris⟩ Nam de sphaeris locutus fuit coram populo tamquam corporibus solidis ⟨locutus fuit⟩ ut ex earum magnitudinibus toni varii oriri viderentur ⟨?⟩ Et Terram collocabant in omnium centro ut fit in systemate pythagorico

ex philosophia antiqua non commemoratur. Epicurei naturam totam in corpus et inane distinguentes Deum pernegarunt: at absurde nimis. Nam Planetae duo ab invicem longo vacui intervallo distantes non ⟨?⟩ vi gravitatis neque ullo modo agent in se invicem nisi ⟨?⟩ movente principio aliquo activo quod utrumque intercedat & per quod vis ab utroque in alterum propagetur. [Hoc medium ex mente veterum non erat corporeum cum corpora universa ex essentia sua gravia esse dicerent, atque atomos ipsa vi aeterna naturae suae absque aliorum corporum impulsa per spatia vacua in terram cadere]. Ideoque Veteres qui mysticam Philosophiam rectius tenuere ⟨?⟩ docebant spiritum quendam infinitum spatia omnia ⟨in infinitum⟩ pervadere & mundum universum continere & vivificare; et hic spiritus supremum fuit egresso numen (*sic*), juxta Poetam ab Apostolo citatum: in eo vivimus et movemur et ⟨existentiam⟩ sumus. Unde Deus omnipraesens a Judaeis Locus dicitur ⟨et a Christianis agnoscitur omnipotens⟩ Philosophis mysticis Pan erat Numen ⟨illud mundum⟩ Mundum hunc tamquam instrumentum musicum harmoniam inspirans & modulate tractans juxta illud Orphei Ἁρμονίαν κόσμοιο κρέκων φιλοπαίγμονι μολπῇ Hoc symbolo Philosophi materiam in spiritu illo infinito moveri docebant et ab eodem agitari non inconstanter sed ⟨harmonice id set secundum accuratas Geometricas naturae leges⟩

NOTES TO THE SCHOLIA

1. Note in another hand, probably that of David Gregory.
2. The pagination refers to the first edition of the *Philosophiae naturalis principia mathematica, autore* Is. Newton, *Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano, & Societatis Regalis Sodali*, Londini, Jussu Societatis Regiae ac Typis Josephi Streater ... Anno MDCL XXXVII (copy consulted, Bibl. Univ. Alessandrini, Roma, O.g. 33, f.2).
3. Newton reproduces the Greek text and the Latin translation of Plutarch's dialogue, *De facie in orbe lunae* from his own copy of the Greek and Latin edition in two volumes, *Plutarchi Chaeronensis quae extant omnia, cum latina interpretatione H. Cruserii,*

G. Xylandri ... (Frankfurt, 1599) (*cf.* Harrison, 1331; copy consulted: Bibl. Apost. Vaticana, Racc. Gen. III). The quoted passage, in the modern edition 923 C 9-D 6, is found in vol. ii, col. 922a.

4. The passage is taken from *De placitis philosophorum* attributed to Plutarch, *cf. op. cit.* (note 3), ii, col. 888b. Newton modifies the Latin of G. Xylander, writing "igneum esse dixit" instead of "circumsitum ignea quidem esse natura"; he removes "autem" preceding "vehementia".
5. The passage is extracted from *Laertii Diogenis de vitis dogmatis et apophtegmatis ... libri X. T. Aldobrandino interprete* ... (London, 1664), owned by Newton (Harrison, 519; col. 36, A. 3-5). To Aldobrandini's Latin text Newton adds the second word ("vero") besides the expression between square brackets. He removed a "dixisse" preceding the words "sed conversionis" and the comma after "contineri".
6. Quotation in Greek and Latin translation from the Pseudo-Plutarchian *De placitis, op. cit.* (note 3), ii, cols. 890 a-b. Newton derives the evidence in note (e) from his own books: the Latin and Greek *Plato* of Marsilo Ficino (*cf.* Harrison, 1325, and note 14 below); the Greek and Latin *Cyril* of Denis Petau (*cf.* Harrison, 476); the Greek and Latin *Suidas* of A. Porta (*cf.* Harrison, 1581).
7. Harrison records no edition of Stobaeus among Newton's books. It is probable that Newton had in mind — even though the numeration does not agree — *Johannis Stobaei Eclogarum libri duo interprete G. Cantoro* (Greek and Latin) (Antwerp, 1575); col. 53b: "Archelaus ferreas laminas candentes dixit stellas" (copy used: Bibl. Apost. Vaticana, Barb. I.9.20).
8. A mistake by Newton. In Plato, *Apolog.* 26d there is no mention of Euripides, where Anaxagoras only is named; on the contrary, Diogenes Laertius reads: "Ferunt cum lapidis, ad Aigos fluvium, ruinam praedixisse, quem a sole casuram dixerit; quocirca Euripidem eius discipulum in Phaetonte Solem auream glebam appellavisse", Latin text of T. Aldobrandini, *op. cit.* (note 5), col. 35, D. 4-8, partly quoted below at Newton's note k.
9. Democritus and Metrodorus are named in *De placitis*, Bk II, chap. 20. The reference to chap. 13 relates to the following note (i).
10. The reference should be completed with "Bk II, chap. 13". One reads, in fact, at this point in *De placitis*: "Diogenes ... ad Aegos potamos sub ignis forma decidit stella saxea"; *op. cit.* (note 3), ii, col. 888b.
11. See the passage from Diogenes Laertius cited above, note 8.
12. Diogenes Laertius, *op. cit.* (note 5), col. 35, A. 8-10, lightly paraphrased.
13. A reference to the widely disseminated sixteenth century manual of mythology by Natale Conti — see the Introduction above — of which Newton possessed one edition, *Natalis Comitis Mythologiae, sive explicationis fabularum libri X ... nuper ab ipso autore recogniti & locupletati* (Coloniae Allobrogorum, 1612) (*cf.* Harrison, 439); there one reads (p. 672): "Primum igitur omnium laborum Herculi fuisse memorandum leonem Cithaeroneum: nam, cum puer adhuc esset Hercules leonem interfecit, invulnerabilem, qui (ut ferunt) de lunae circulo descenderat atque qui in sylva Nemea vagabatur." The following sentence in the text ("Per figmenta...") is a typical extension to the theory of universal gravitation of Conti's allegorical interpretation, introduced by Newton. Further, when he adds: "Haec ad literam intelligenda non sunt" and speaks of the fictions of the "mystical philosophers", Newton returns to Conti's text, and is not alluding to the Corpus Hermeticum or a general tradition of the *prisci theologi*; see the Introduction above and the quotations from the *Mythologia* of Conti in the last of these classical Scholia.

14. The quotation, fairly close to the text of the Latin translation by Marsilio Ficino, is taken from *Platonis opera quae extant omnia: M. Ficino interprete* (Frankfurt, 1602), a book owned by Newton (*cf.* Harrison, 1325), col. 946b. The passage reads exactly: "Cum ego & tu haec ipsa signa esse, quod dii sint, asserimus, solemque, ac lunam, sidera & terram etc. ..."; after "ab istis" the text has "sapientibus", which Newton has replaced by the words enclosed in square brackets.
15. Newton's mistake; for "in Anaxagora" read "in Democrito". Diogenes Laertius says: "Phavorinus ... ait Democritum hostili in Anaxagoram animo, quod ab eo non sit receptus, de sole, ac luna sententias illius esse negare, antiquas autem esse dicere, easque ipsum furatum esse." As will be seen, Newton corrects and adapts the Latin of Aldobrandini in his own way (*op. cit.* (note 5), lib. IX, cap. 7, col. 245, F. 5-10).
16. The edition cited in note 7 above has: "Anaximenes ut igneam indicavit esse stellarum naturam, ita permixta quaedam ipsis terrena corpora non aspectabilia credidit." Newton has translated the Greek text in his own way (it may be found in *J. Stobaei Anthologii ... rec. C. Wachsmuth* (Berlin, 1884), i, 203) or has used a different Latin version.
17. The passage is extracted from *De placitis*, lib. II, chap. 13, col. 888 a-b. Newton barely paraphrases the Latin text, adding the adjective "fixas", which completes the addition in parentheses in the previous quotation. The 'Newtonian' interpretation of this passage is obviously to be understood in the sense, not foreseen by the ancient authors, of considering the fixed stars as so many suns, centres of gravitational systems of planets: see on this point M. A. Hoskin, "Newton, Providence, and the universe of stars", *Journal for the history of astronomy*, vii (1977), 77-101, where many important published and unpublished texts bearing on this theme are quoted.
18. A passage taken from *De placitis*, col. 892b, lightly paraphrased; Newton substitutes "Lunam terrestrem esse" for "terrestrem videri" and "ob longitudinem" for "tanta item diei longitudinem".
19. Plutarch, *op. cit.* (note 3); but the text reads: "Pythagoreorum alii dixerunt stellae ardore effectum, quae suo loco delapsa tempore incendii a Phaetonte excitati, quidquid loci circulari cursu peragravit, addusserit." The passage seems to refer to the Sun, or the central fire of the Pythagoreans; the reading which Newton gives of this passage, with the addition concerning the Milky Way, seems to introduce a modern 'gravitational' element, which is, however, attributed to the Pythagoreans themselves, as to Plato in the next passage.
20. A literal quotation from the celebrated passage in Galileo, which Newton takes from the current Latin translation, *Galilaei Galilaei Systema cosmicum* (2nd edn (Leyden, 1641); Harrison, 648, records a later edition), 10. This is the sole *direct* quotation of a Galilean text to be found in all the published and unpublished writings of Newton; it has already been observed by I. B. Cohen, "Galileo, Newton and the divine order of the solar system" in E. McMullin (ed.), *Galileo man of science* (New York and London, 1967), 207-31, p. 225. Contrary to the argument, expressed with caution, of Alexandre Koyré in *Newtonian studies* (Cambridge, Mass., 1965), 207, that Newton was "ignorant of the source" of the 'pseudo-Platonic myth' discussed by various contemporaries of Galileo and repeated by the ballistician Nicolas-François Blondel, Cohen justly remarked that Newton had at least read the *Dialogue*, as this quotation demonstrates. It is curious that Newton only speaks of Galileo in connection with the 'Platonic myth' in the course of his correspondence with Bentley of 1692-93 *after* Bentley has directed him to its source (*Correspondence*, iii, 255). This detail leads one to think that Newton had looked up the passage in Galileo

quoted here only *after* 17 January 1693, the date of the related letter to Bentley in which Blondel is mentioned (see the Introduction). There is also the fact that Newton in turn accepts the attribution to Plato of this "sublime idea", which Galileo causes his spokesman Salviati to express, but for which seventeenth century readers and modern students have searched in vain in the *Timaeus* and other writings of Plato. Rather curious, to conclude, is Newton's omission of the words in the Galilean text concerning the divine intervention in effecting the straight-line descent of the planets ("aliquandiu *sic ordinante conditore* moto recto" or, in the original Italian, "furono per alcun tempo *dal suo Fattore* mossi di moto retto"); Newton lets them fall here, while re-introducing the divine intervention for a quite different purpose in the letter to Bentley mentioned above. May one deduce that Newton omitted this expression because in writing to Bentley *he had already submitted this Platonic myth to critical discussion*? If so, this strengthens the assumption that the composition of the classical Scholia took place *after* February 1693.

21. Read 924 for 92, in the pagination of G. Xylander's translation of the dialogue by Plutarch (*op. cit.* (note 3)). In employing here the Latin text, instead of the Greek preceding it in the edition, Newton introduces a few trivial modifications at the beginning of the quotation. Further, the third sentence ("Et indicium erit ... cognatione cum Terra") makes the meaning agree more closely with the Newtonian 'gravitational' thesis as compared with the Latin of Xylander ("Argumento est [erit] vergentium quibus non medium mundi causa est suorum momentorum, sed cognatio cum Terra"); in the next phrase, modified by Newton, Xylander has: "sic et lapidem Terra ut sibi convenientem accipit"; and at the end he has "suis compactum propriis ac". The passage from *De facie lunae* is denoted here in the modern editions as 924 D-F.
22. Phrase cancelled and restored.
23. Newton quotes the text and translation from *Origenis contra Celsum libri VIII: Ejusdem Philocalia, G. Spencerus ... recognovit ...* (Cambridge, 1658) (Harrison, 1209), or else from the *Opera* edited by Erasmus (Harrison, 1212).
24. Newton had Lucretius at hand in a recent edition: *De rerum natura libri VI: Quibus additae sunt conjecturae & emendationes T. Fabricum notulis perpetuis* (Cambridge, 1686) (Harrison, 990); the numbers of the verses, missing from the text, have been partially added by hand in the margin of his own copy by Newton himself; where they are lacking, Newton confines himself to a rough indication. These verses quoted are: Bk V, 91-98, and 104-9.
25. *De rerum natura*, Lib. I, 358-69.
26. In reality, *De rerum natura*, Lib. II, 186-205.
27. *Ibid.*, 216-45.
28. Aristotle, *De caelo*, 308 a 3-13. Trans. by G. Argiropulo; *cf.* Aristotle, *Opera*, ed. by Bekker (Berlin, 1880), iii, col. 162. Harrison records no Aristotelian text owned by Newton.
29. *Cf. Comment. in Aristotelem Graeca*, ed. by I. L. Heiberg (Berlin, 1894), vii, 684.
30. Plutarch, *op. cit.* (note 3), ii, col. 882b.
31. Latin text from G. Xylander, with trivial modifications by Newton. In the first sentence, at the beginning "Si *enim*"; at the end of the sentence he has transposed the words: "atque hoc necesse erit omni mundi naturae opponi." In the modern editions the passage is denoted 926 A-B.
32. The first version of the whole section, much altered and crossed out, reads: "Igitur quemadmodum vis attractiva Magnetis totius componitur ex viribus attractivis

particularum singularum ex quibus Magnes componitur sic gravitas in terram totam (ex mente Veterum) ex gravitate in <singulas Terrae particulas. Et qua ratione corpora omnia ab omnibus Terrae partibus ex mente Veterum trahuntur a corpora ad se debebunt omnia alia corpora omnia ab alijs omnibus trahi> materiam omnem ex qua globus Terrae constat. <Et quemadmodum> Et qua ratio nec gravitas in omnes Terrae particulas ex mente veterum." Having reached this point, Newton crossed out the whole and began the section again as it is here reproduced above.

33. Lucretius, *op. cit.* (note 24), Lib. I, 986-97.

34. The argument is resumed in the letter to Bentley of 10 December 1692: "It seems to me, that if the matter of our Sun & Planets & all ye matter in the Universe was evenly scattered throughout all the heavens, & every particle had an innate gravity toward all the rest & the whole space throughout wch this matter was scattered was but finite: the matter on ye outside of this space would by its gravity tend towards all ye matter on the inside & by consequence fall down to ye middle of the whole space & there compose one great spherical mass" (*Correspondence*, iii, 234). But, if in the context of the letter the argument is used *ad absurdum*, in order to suggest to Bentley the need for a direct divine interference with the force of gravitation, in this Scholium there is no trace of such an intervention. Here Newton limits himself to interpreting the passage of Lucretius in terms of a dynamic equilibrium between the masses of the heavenly bodies. Divine intervention is evoked only in the final Scholium. It is very difficult to determine whether Newton wrote the letter to Bentley first, or this text; at any rate, even when replying to Bentley he evidently had in mind the passage of Lucretius (I, 986ff.) though without naming the poet.

Cf. an analogous passage in the Scholium of the Portsmouth Collection, Cambridge University Library, MS. Add. 3956.11, ff. 270-2, see note 61.

35. All this rambling discourse recapitulates Pliny, Lib. II, cap. 22 (20 in some editions): "Sed Pythagoras interdum ex musica ratione appellat tonum quantum absit a terra luna, ab ea ad Mercurium spatii eius dimidium et ab eo ad Venerem fere tantundem a qua ad Solem sescuplum, a sole ad Martem tonum, id est quantum ad lunam a terra, ab eo usque Jovem dimidium et ab eo ad Saturnum dimidium et inde sescuplum ad signiferum: ita septem tonos effici quam diapason harmoniam vocant, hoc est universitatem concentus; in ea Saturnum Dorio moveri Mercurium phthongo Jovem phrigio et in reliquis similia, iucunda magis quam necessaria subtilitate."

36. In question is the *Saturnalia*, I, 19, 15, which Newton quotes from the edition *A. Theodori Macrobii opera accedunt notae integrae I. Pontani, J. Meursii, J. Gronovii* (Leiden, 1628) (Harrison 1013; I have been able to consult a copy of the reprint of 1670, Bibl. Naz., Rome, 1.6.C.25, where the passage quoted by Newton is on p. 294).

37. I have not been able to discover the exact source of the Latin translation used by Newton; at all events, the passage is from Proclus, *In Timaeum*, Lib. III, 197, 27-30. At this point Newton inserts a direction to a marginal note of his own, where he cites Aeschylus, *Seven against Thebes*, verses 800-1 (see at the end). Newton's quotation is second-hand, from Proclus, *In Timaeum, ibid.*

38. Newton quotes from *Eusebii Pamphili Praeparatio Evangelica, F. Vigerius ... recensuit ...* (Cologne, 1688) (Harrison, 591).

39. It is to be noted that Newton interprets the harmonic proportions of the Pythagoreans symbolically or, in other words, he twists the texts by applying to their interpretation the general principle of the law of inverse squares discovered by himself. More exactly, the Pythagoreans, by all accounts, simply postulated a relation of

proportionality between the weights stretching the musical string (or its 'tension') and the sounds resulting from it (*cf.* also for the literature bearing on this argument E. Zeller and R. Mondolfo, *La filosofia dei Greci nel suo sviluppo storico*, Pt I, ii (Florence, 1938), 504ff.). However, Newton 'reads' the evidence in his own way, amending the Pythagoreans' mistake in physics and substituting the correct proportion (from the modern point of view): the 'tension' is proportional to the inverse of the *squares* of the lengths of the strings to make the same sound. Hence the texts submit to a 'Newtonian' interpretation. It may be said that Newton is conscious that he is subjecting the evidence of the Pythagoreans to a modernized method of examination. But even on this point he is following the hermeneutic suggestions of Natale Conti, who invariably invites his reader to seek out the symbolic significance of the fables and myths that is concealed beneath the delusive veil of words.

40. There may be noted, between these assertions and the restricted *incipit* of the Scholium — "qua proportione gravitas recedendo a Planetis decrescit Veteres *non satis* explicaverunt" — a certain contradiction: did the Pythagoreans know, or not know, the inverse square law? Once again, Newton seems to be aware of committing an anachronism.

41. On the concealment of the true philosophy from the vulgar, see the passages from Natale Conti quoted in the Introduction. The concluding sentences of this Scholium examine the authors already quoted and their testimony with respect to the Pythagoreans: Macrobius, Pliny, the *Timaeus* of Plato, the *De die natali* of Censorinus, owned by Newton in an edition of 1695 (Harrison, 362).

42. This addition, separately written by Newton on f. 11v, clearly corresponds to the note (b) (Macrobius, *In somnium Scipionis*, Lib. 2, ch. 1). In fact, Newton here paraphrases the text of Macrobius, which is here printed complete to facilitate comparison: "ex his inexpugnabili ratiocinatione collectum est musicos sonos de sphaerarum caelestium conversione procedere, quia et sonum ex motu fieri necesse est, et ratio quae divinis inest fit sono causa modulaminis. haec Pythagoras primus omnium Graiae gentis hominum mente concepit, et intellexit quidem compositum quiddam de sphaeris sonare propter necessitatem rationis quae a caelestibus non recedit, sed quae esset illa ratio vel quibus observanda modis non facile deprehendebat, cumque eum frustra tantae tamque arcanae rei diuturna inquisitio fatigaret, fors obtulit quod cogitatio alta non repperit. cum enim casu praeteriret in publico fabros ignitum ferrum ictibus mollientes, in aures eius malleorum soni certo sibi respondentes ordine repente ceciderunt, in quibus ita gravitati acumina consonabant, ut utrumque ad audientis sensum stata dimensione remearet, et ex variis impulsibus unum sibi consonans nasceretur. hic occasionem sibi oblatam ratus deprehendit oculis et manibus quod olim cogitatione quaerebat. fabros adit et imminens operi curiosius intuetur, adnotans sonos qui de singulorum lacertis conficiebantur, quos ferientium viribus adscribendos putaret, iubet ut inter se malleolos mutent. quibus mutatis sonorum diversitas ab hominibus recedens malleolos sequebatur. tunc omnem curam ad pondera eorum examinanda convertit, cumque sibi diversitatem ponderis quod habebatur in singulis adnotasset, aliis ponderibus in maius minusve ecedentibus fieri malleolos imperavit; quorum ictibus soni nequaquam prioribus similes nec ita sibi consonantes exaudiebantur, tunc animadvertit concordiam vocis lege ponderum provenire collectisque numeris, quibus consentiens sibi diversitas ponderum continebatur, ex malleis ad fides vertit examen, et intestina ovium vel boum nervos tam variis ponderibus inligatis tetendit, qualia in malleis fuisse didicerat, talisque ex his concentus evenit qualem prior

observatio non frustra animadversa promiserat, adiecta dulcedine quam natura fidium sonora praestabat. hic Pythagoras tanti secreti compos deprehendit numeros ex quibus soni sibi consoni nascerentur, adeo ut fidibus sub hac numerorum observatione compositis certae certis aliaeque aliis convenientium sibi numerorum concordia tenderentur, ut una impulsa plectro alia, licet longe posita sed numeris conveniens, simul sonaret. ex omni autem innumera varietate numerorum pauci et numerabiles inventi sunt qui sibi ad efficiendam musicam convenirent." (ed. cit., 118-19)

43. *Laertii Diogenis de vitis* (see note 5), col. 34.
44. N.B. Newton had written an excessively modernized expression concerning Thales, which he had then cancelled and replaced. Instead of attributing to Thales the discovery of the connection between gravity and mass, Newton assigns to him an animistic concept of attraction.
45. A quotation, probably second-hand, from Aristotle, *De caelo*, B 193 b.
46. Without naming him, from this point onwards Newton makes free use of Conti, *Mythologia* (see note 13), 1636, Lib. V, cap. VI, *De pane*, 454-5. Among other things Conti writes: "Fama est praeterea Echo fuisse a Pane amatam, quippe cum caelorum harmoniam Echo esse putarent, quae redundarent e ratione motuum. Atque ad septem planetarum imitationem septem chordarum instrumenta musica prius fuerunt inventa, quamvis Severinus Boethius in libro de Musica refellere conatur Pythagoricorum opinionem, qui caelos harmoniam efficere censuerunt, cum nulla fiet sine aere. Pan igitur omnium mortalium primus, vel Deorum potius creditur septem calamorum concinne inter se connexorum fistulam excogitasse, quare ait Vergilius, Aegl. 2, 'Pan primus calamos cera conjungere plures/Instituit'." A little later he continues: "[Pan] amavit etiam Lunam, quia materia rerum omnium naturalium astrorum beneficio & Lunae praecipue informatur, & ad procreationem properat. Ea materia cum Pan vocetur, moreque ipsum etiam intra se contineat, Pan piscatorium etiam fuit Deus, quae omnia breviter complexus est Orpheus in hymnis hoc pacto: Ἁρμονίαν κόσμοιο κρέκων φιλοπαίγμονι μολπῇ. Harmoniam mundi faciens dulcedine cantus. Atque totus fere hymnus consumitur in commemorandis iis potestatibus et viribus, quae tribuuntur elementis: quippe cura illud fuerit antiquorum istitutum, ut sub fabularum figmentis universa naturae consilia & seriem occultarent." It is clear that Newton has taken the verse of the Orphic initiate from the handbook of the Milanese mythographer, and not from the edition, which he nevertheless owned and consulted: *Orphei hymni ... curante A. C. Eschenbachio* (Utrecht, 1689) (Harrison, 1214); in this edition the verse Ἁρμονίαν κόσμοιο etc. is on p. 108.
47. Equally, the Μικρότερος Κρατήρ of the pseudo-Orpheus comes from the *Mythologia* of Natale Conti (see note 13), Lib. II, cap. IV, *De vulcano*, 147, Greek and Latin text. There is a modern edition of the Greek in O. Kern, *Orphicorum fragmenta* (Berlin, 1882), 309-11.
48. This hymn too, attributed to Ermenesiana thus, is found in Greek and Latin in Conti's *Mythologia* (see note 13), 148.
49. We have placed here this concluding sentence, which Newton added at the foot of the variant; see below, and note 52.
50. In fact Cicero writes, *Somnium Scipionis*, 2.4: "...deus is, cuius hoc templum est omne quod conspicis, istis te corporis custodiis liberaverit, huc tibi aditus patere non potest. Homines enim sunt hac lege generati qui tuerentur illum globum quem in hoc templo medium vides, quae terra dicitur, hisque animus datus est ex illis sempiternis

ignibus quae sidera et stellas vocatis, quae globosae et rotundae, divinis animatae mentibus, circulos suos orbesque conficiunt celeritate mirabili." But under the theme of central fire Newton certainly had in mind the passage in Plutarch's *Vita* of Numa, which he had quoted indirectly in the popular version of *De systemate mundi* (see above). And likely enough he had in mind too the theme of the cult of the Sun which is reflected in Copernicus, *De revolutionibus*, Lib. I, cap. X and in many Platonizing texts of the Renaissance; see in general *Le Soleil à la Renaissance, science et mythe* (Brussels and Paris, 1965).

51. The passage from Macrobius, *Comment. in Somnium Scipionis*, Lib. I cap. 14, 2 and the related reference to Virgil appear to be inserted in the MS but they are evidently complementary to the excerpts from Macrobius which we have placed here in sequence.
52. Here is reproduced a variant to the Scholium to Prop. IX, written on f. 14v; the concept of space is treated more clearly there. The variant is followed, on f. 14v, by the passage which follows note 49.
53. In the Gregory MSS. these quotations are found on a folio numbered 7, but they evidently belong to the last Scholium.
54. Addition by Newton.
55. Omitted by Newton.
56. The passages between square brackets are omitted by Newton.
57. Omitted by Newton.
58. Addition by Newton.
59. Addition by Newton.
60. The passage between square brackets was omitted by Newton.
61. This incomplete Scholium, which does not form part of the Gregory MSS. in the Library of the Royal Society, is transcribed from the original autograph in the Portsmouth Collection (Cambridge University Library, MS. Add. 3956.11.9, 270r, 271r, 272r), see the Introduction. The author intended to work it into Corollary 2 of Prop. VII (transcribed above) to which the page-number 412 (of the first edition) refers.
62. The reference invokes these verses of *De rerum natura*:

    corporis illius quod nostri cernere sensus
    iam nequeunt, id nimirum sine partibus exstat
    et minima constat natura nec fuit unquam
    per se secretum neque posthac esse valebit....

63. The MS. is damaged by fire at the lower left corners of ff. 270r-272r; the missing words or parts of words, which amount at bottom to a draft of the same Scholium which is found on adjacent folios (268r and 269r), much altered and crossed out, appear between the marks [ ].
64. In the first book of Lucretius's poem, v. 39, one reads the conclusion of the invocation of Venus; the reference must therefore be looked upon as an oversight by the author to be corrected, probably, to Lib. I, vv. 359-69. These are the lines already quoted in the Scholium to Prop. VI; see above. For the other references to verses in Book II the other quotations may be consulted, and notes 26, 27.
65. The word *Spatijs* is lacking in the definitive MS. but is found in the corresponding passage of the draft, f. 269r. For the whole argument, see note 34.
66. For the first of these references, see note 33 above.
67. This place in Plutarch is also quoted above, Scholium to Prop. IV and note 4.
68. This and the following additions also are made below the text of the drafts, *cf.* note 63.
69. This place in Pliny is quoted also in the Scholium to Prop. VIII (see note 35).

David Gregory set out Newton's ideas on the antiquity of the theory of gravitation (without any indication of their source) in the Preface to his *Elementa astronomiae physicae et geometricae* (London, 1702). In the following pages we reprint this text from the English version of this book (London, 1715, 1726).

THE AUTHOR's PREFACE.

MY Deſign in publiſhing this Book, was, that the Celeſtial Phyſics, which the moſt ſagacious *Kepler* had got the Scent of, but the Prince of Geometers Sir *Iſaac Newton*, brought to ſuch a Pitch as ſurprizes all the World, might, by my Care and Pains in illuſtrating them, become eaſier to ſuch as are deſirous of being acquainted with Philoſophy and Aſtronomy. The Title informs you ſufficiently that the Arithmetical or Calculatory Part of Aſtronomy is here omitted, tho' that, perhaps, may be publiſh'd hereafter in its proper Place. As for the Phyſics, it is all taken out of the above-mention'd Authors; but is here intermix'd with Aſtronomy, in ſuch Places as ſeem'd proper and convenient; the Geometry to be

met with in it, I have either borrow'd elſewhere, and quoted the Place where 'tis to be found, or deliver'd it Lemmatically. Whatever is done in each Section, you have it expreſs'd either in the Title or Preface thereof, in ſuch a manner, as that thoſe who are leſs vers'd in the moſt abſtruſe Parts of Geometry, or leſs concern'd about the Phyſical Parts, may paſs over, and only read the Aſtronomy ſeparately and diſtinct from them.

The Celeſtial Phyſics, or Phyſical Aſtronomy, hath not only the preference in Dignity of all Enquiries into Nature whatever, but is the firſt in Order, becauſe it is the eaſieſt. For the Sun and Planets are ſeparated from one another by ſo immenſe a Diſtance, as renders them incapable of exerting moſt of thoſe Forces whereby all Bodies act upon one another; ſo that they have no other Force left them whereby they can affect one another, but the ſingle Force of univerſal Gravity: Whereas in the Production of ſeveral Phænomena that are obſerv'd upon our Earth, innumerable other Forces are exerted, ſuch as are very hard to be diſtinguiſh'd from one another; which notwithſtanding, if not accurately done, our attempting to make an Enquiry into Nature is vain. Upon this account it is, that every Problem in the Terreſtial Phyſics is very operoſe and perplex'd, but on the contrary, in the Celeſtial Phyſics, they are more

eaſy and ſimple; tho' even the latter has its Difficulties, ariſing from the different Diſtances and Magnitudes of the Celeſtial Bodies. For the Fix'd Stars are ſo vaſtly diſtant from each other, that they have no mutual Action upon each other, obſervable by us who are the Inhabitants of the Earth. The Primary Planets are remov'd ſo far from each other, that, tho' they have ſome ſmall Power and Effect upon one another, yet we cannot be ſenſible of it, till after many Years Obſervation. The Secondary Planets are not at ſo great a Diſtance from their Primary ones, or from the Sun, but that they may be conſiderably affected by the Powers of both, (if regard be had to the Quantity of Matter that is in theſe latter,) and this is the Spring of thoſe manifold Inequalities found in them, ſuch as, for Inſtance, manifeſtly ſhews it ſelf in our Moon; which yet is nothing at all, if compar'd with the Inequalities found among Terreſtrial Bodies, which are acted upon by an innumerable variety of other Forces, preſſing every way upon them. So that thoſe Perſons ſeem to apply their Thoughts but to a very indifferent Purpoſe in the Study of Nature, that overlook this Part of Aſtronomy, from whence the principal and moſt ſimple Laws of Nature are to be learn'd.

That none may think the Phyſics deliver'd in the following Work entirely new and unknown in Aſtronomy, I ſhall take

the Liberty to ſhew that it was both known and diligently cultivated by the moſt ancient Philoſophers. And I ſhall dwell a little longer upon this Argument, becauſe there is no need of ſpending a Preface, either upon the Order of the Parts of this Work, which may be ſeen in the Index, or upon the Uſefulneſs, Dignity, Hiſtory and Progreſs of Aſtronomy, or even of the true Syſtem of the World, approv'd of by *Pythagoras*, and others among the Ancients; theſe Things being all of them treated of at large by the common Writers of Aſtronomy. What I ſhall now therefore make out is, that we do ſtill tread in the Steps of the Ancients in this Phyſical Aſtronomy; inaſmuch as they knew that the Celeſtial Bodies gravitated towards each other, and were retain'd in their Orbits by the force of Gravity; and were alſo appriz'd of the Law of this Gravity.

For if we look back to the firſt Riſe of Aſtronomy, and take a view of it in its Infancy, as it were, we ſhall find nothing better approv'd of, nothing more univerſally entertain'd among the ſeveral Sects of Philoſophers, than this Notion of the Gravity of the Celeſtial Bodies. That Saying is well known, ſo often uſed by [a] *Anaxagoras*, and his Scholars, [b] *Archelaus*

[a] *He affirm'd the Sun to be a Maſs of red-hot Iron.* Diog. Laert. in Anaxag. *That the Subſtance of the Sun was Stone, that of the Moon, Earth.* Plat. in Apol. Socr.

[b] *That the Stars were Plates of red-hot Iron.* Stob. Ecl. Phyſ. cap. 25.

and [c] *Euripides*: Namely, "That the Sun "and Stars were *fiery or red-hot Stones* and "*Golden Clods.*" Of the ſame Mind alſo were [d] *Democritus*, *Metrodorus*, and [e] *Diogenes*. By theſe Expreſſions they meant no more, than that they were heavy, denſe and fix'd Bodies, (ſuch as Stones are) ſo as to bear a conſiderable Degree of Heat: And that this was really their meaning, will evidently appear, if we do but enquire more narrowly into the firſt Authors of this Opinion. For, as we are told by [f] *Democritus*, theſe Notions concerning the Sun and Moon are not aſcribed to *Anaxagoras* as their original, for he had really borrow'd them of the Ancients. Nor is it a difficult Matter to find out who they were that he borrow'd them of, or from whom they were handed down to him. He had them from his Maſter [g] *Anaximenes*, whoſe Opinion we know was, that the Stars were of a fiery Nature and Subſtance, that

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[c] *They ſay that* Euripides *uſed to call the Sun a Clod of Gold, or Golden Maſs.* Diog. Laert. in Anaxag.

[d] Anaxagoras, Democritus *and* Metrodorus *affirm'd, that the Sun was a Maſs of Iron or Stone red-hot.* Plut. de Placit. Phil. lib. 2. c. 20.

[e] Diogenes *thought that the Subſtance of the Stars was not unlike that of a Pumice Stone.* Ibid. c. 13.

[f] Favorinus, *in his various Hiſtory, relates, that* Democritus *uſed to ſay of* Anaxagoras, *that the Opinions which he taught concerning the Sun and Moon, were not his own, but far more ancient than* Anaxagoras's *time; and that he had ſtollen them.* Laert. in Democrit.

[g] Anaximines *ſaid, the Nature of the Stars were fiery, and that there were certain Terreſtrial Bodies that are inviſible, carried together about them.* Stob. Ecl. Phyſ. c. 25.

there were alſo mingled with them certain Earthly Bodies, which were carried round about them, tho' not viſible to us: By which Words he plainly means Planets of a Terreſtrial Nature, performing their Revolutions in the Syſtem of every Fix'd Star. Theſe Notions *Anaximenes* receiv'd from *Anaximander*, *Anaximander* from [h] *Thales* himſelf, who was the Head and Founder of the *Ionic* Philoſophy; and ſpread this Opinion of the Gravity of the Fix'd Stars among his Sect. Nor did this Doctrine concerning the Stars ſtop here, but afterwards it diffus'd it ſelf thro' the *Italic* Philoſophy, the [i] Followers of which taught, that each Star was a World in the infinite Æthereal Space, containing Earth, Air and Æther; and that the [k] Moon was not only like our Earth, but inhabited by Animals of a larger ſize, and furniſh'd with Plants of a beautiful appearance.

Nor were they ſo abſurd in their Conceptions about Gravity, as to think that it was done by the virtue of any Point with-

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[h] Thales *was of Opinion that the Stars conſiſted of an Earthly Subſtance, which was continually red-hot.* Stob. Ecl. Phyſ. c. 25. *And ſo* Plutarch. De Plac. Philoſ. lib. 2. c. 13.

[i] *The* Pythagoreans *affirm'd, that every Star is a World in the infinite Æthereal Space, wherein are contain'd Earth, Air, and Æther.* Plut. de Plac. Philoſoph. lib. 2. c. 13.

[k] *The* Pythagoreans *aſſerted, that the Moon ſeem'd to be of a like Nature with the Earth, is inhabited as our Earth is, by Animals, tho' of a larger ſize than ours, and fill'd with the ſame Plants, tho' much more beautiful than ours.* Plut. de Plac. Phil. lib. 2. c. 30.

in the Earth, or of a Center, to which all heavy Bodies placed any where, tended; but they thought it was done by the [l] Power of the whole Matter in the Terreſtrial Globe attracting all things to it ſelf: And as the Power of the Loadſtone is compos'd of the Powers of the ſeveral Parts combin'd together, ſo they believ'd that the Gravity towards the whole Earth, reſulted from the Gravity towards each ſingle Part of it. Beſides, they believ'd there was a [m] Gravity towards the Moon and Sun, acting in the ſame manner as it does towards the Earth; and that each [n] Planet, like a Stone whirl'd in a Sling, was kept in its Orbit by the ſame Principle, and for the ſame Reaſon revolving always about us. From ſome

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[l] *And yet if every heavy Body inclines towards the ſame place, and does with every one of its Parts tend to its Middle or Center, the Earth certainly will not appropriate to it ſelf theſe heavy Bodies, which are its Parts, becauſe it is the Center of the Univerſe, but rather becauſe it is the whole, of which they are the Parts.* Plut. de facie in Orbe Lunæ.

As for that which is incorporeal, 'tis not probable, nor will they themſelves allow it to be poſſeſs'd with ſo great a power as to draw all things towards it, and retain them about it. Ibid.

[m] *And this meeting together of Bodies here, and their Coalition likewiſe with the Earth's Body, ſhew us the manner how it is probable that the Parts, which are aſſembled at the Moon's Body, continue alſo there.*

[n] *But the Moon is help'd, and preſerv'd from falling down, by her very Motion and that impetuoſity of her Revolution; as Stones and other weighty Bodies put in Slings and ſwung round, are kept from dropping out by the ſwiftneſs of their Motion, and their being mov'd circularly. ——— Wherefore the Moon does not move downwards, as her own Weight wou'd naturally carry her, her tendency that way being ſtopt by the violence of her circular revolution.* Ibid.

things mention'd by [o] *Diogenes Laertius*, concerning *Plato*, which alſo are obſcurely hinted at in his [p] *Timæus*, I am apt to believe with [q] *Gallileo*, that the divine Philoſopher ſuppos'd the Mundane Bodies, when they were firſt formed, were moved with a Rectilinear Motion (by the means of Gravity,) but after that they had arrived to ſome determined Places, they began to revolve by degrees in a Curve, the Rectilinear Motion being chang'd into a Curvilinear one. 'Tis from this Doctrine of Gravity, that all Bodies gravitate mutually to one another; 'tis by this that [r] *Lucretius*, taught by *Epicurus* and *Democritus*, labours to prove, that the Univerſe has no Center or loweſt Place, but that there is an infinity of Worlds like ours in the immenſe Space. His Argument runs thus; If the Nature of things were bounded any where, then the outmoſt Bodies, ſince they have no other beyond them, towards which they may be made to tend by the force of Gravity, would not

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[o] *Theſe at firſt were mov'd in a confus'd and irregular manner, but when they were duly adjuſted and rightly ſettled, then the World was eſtabliſh'd by God in juſt order and proportion.* Diog. Laert. in Plat.

[p] *He gave it a Motion altogether agreeable to its Nature as a Body (that is, a direct one.)* And a little further; *Therefore he afterwards made it continue its courſe in a Circle.* Plat. in his Timeus.

[q] *In his* Coſmical Syſtem.

[r] *Suppoſe they all had Bounds, ſuppoſe an End;*
Then Bodies which by Nature muſt deſcend,
And from Eternity purſu'd the Race,
Had long e'er this time reach'd the Loweſt Place. Lucr. l. l. v. 986.

ſtand in an Equilibrio, but make towards the inner and lower Bodies, being neceſſarily inclin'd that way by their Gravity; and therefore having made towards one another, during an infinite ſpace of time, would have long ago met, and lye in the middle of the whole, as in the loweſt Place. 'Tis evident therefore from hence that *Lucretius*, and thoſe whom he followed, believ'd that all Bodies did Gravitate towards the Matter placed around them, and that every ſingle Body was carried by the more prevailing Gravity, towards that Place where there was moſt Mattter.

As it is manifeſt that the Ancients were apprized of, and had diſcover'd the Gravity of all Bodies towards one another, ſo alſo they were not unacquainted with the Law and Proportion which the Action of Gravity obſerv'd according to the different Maſſes and Diſtances. For that Gravity is proporrional to the Quantity of Matter in the heavy Body, [s] *Lucretius* does ſufficiently declare; [t] as alſo that what we call light Bodies, don't aſcend of their own accord, but by the action of a Force underneath them, impelling them upwards, juſt as a Piece of Wood is in Water; [u] and further,

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[s] *Beſides; why have not Bodies equal Weight*
With thoſe, whoſe Figure is but juſt as great? Lucr l.1.v.415.

[t] *And this I think a proper Place to prove,*
That nothing of it ſelf can upwards move. Lucr.l.2 v.178.

[u] *Therefore thro' Void, unequal Weights muſt be,*
Like Swift in Motion, all of like degree. Lucr. l. 2. v. 228.

that all Bodies, as well the heavy as the light, do deſcend *in vacuo*, with an equal celerity. It will be plain likewiſe, from what I ſhall preſently obſerve, that the famous Theorem about the proportion whereby Gravity decreaſes in receding from the Sun, was not unknown at leaſt to *Pythagoras*. This indeed ſeems to be that which he and his followers would ſignify to us by the Harmony of the Spheres : That is, they feign'd *Apollo* playing upon an Harp of ſeven Strings, by which Symbol, as it is abundantly evident from [x] *Pliny*, *Macrobius* and *Cenſorinus*, they meant the Sun in Conjunction with the ſeven Planets, for they made him the Leader of that Septenary Chorus, and Moderator of Nature ; and thought that by his Attractive Force he acted upon the Planets (and called it Jupiter's Priſon, becauſe it is by this Force that he retains and keeps them in their Orbits, from flying off in Right Lines) in the Harmonical Ratio of their Diſtances. For the Forces, whereby equal Tenſions act upon Strings of different Lengths (being equal in other Reſpects) are reciprocally as the Squares of the Lengths of the Strings.

[y] For *Pythagoras* as he was paſſing by a Smith's Shop, took occaſion to obſerve, that the Sounds the Hammers made, were more

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[x] Plin. lib. 2. c. 22. Macrob. lib. 1. c. 19. Cenſorin. c. 11.
[y] Macrobius lib. 2. inſomn. Scip. cap. 1.

acute or grave, in proportion to the Weights of the Hammers ; afterwards ſtretching Sheeps Guts, and faſtning various Weights to them, he learn'd that here likewiſe the Sounds were proportional to the Weights. Having ſatisfy'd himſelf of this, he inveſtigated the Numbers, according to which Conſonant Sounds were generated. Whether the whole of this Story be true, or but a Fable, 'tis certain *Pythogoras* found out the true Ratio between the Sound of Strings and the Weights faſten'd to them. The ſame Tenſion acts upon a String as ſhort again, four times more powerfully : For it produces an Octave, and an Octave is founded by a force that is four times greater ; for if a String, ſtretched by a given Weight, generates a given Tone the ſame String ſtretch'd by a Weight four times greater, will ſound an Octave. Thus likewiſe the ſame Tenſion upon a ſubſeſquialteran Chord, acts in a double ſeſquiquartan Ratio : For it generates a Fifth or Diapente ; and a String that ſounds a given Note, with a given Weight, ought to be ſtretch'd by a Weight that is a double ſeſquiquartan to ſound a Fifth. And univerſally, the Weights which generate all Tones in Strings, equally thick, are reciprocally as the Squares of the Lengths of thoſe of equal Tenſion, producing the ſame Sound in any Muſical Inſtrument. *Pythagoras* afterwards applied the Proportion he had thus found by Experiments, to the

Heavens, and from thence learn'd the Harmony of the Spheres. And by comparing theſe Weights with the Weights of the Planets, and the Intervals of the Tones produced by the Weights, with the Interval of the Spheres; and laſtly, the Lengths of Strings with the Diſtances of the Planets from the Center of the Orbs; he underſtood, as it were by the Harmony of the Heavens, that the Gravity of the Planets towards the Sun (according to whoſe Meaſures the Planets move) were reciprocally as the Squares of their Diſtances from the Sun.

We have thus far been ſhewing what was the Opinion of the Ancients concerning Gravity; and it is evident they were perſwaded that Gravity was not an affection of Terreſtrial Bodies only, but of the Celeſtial alſo, that all Bodies gravitate towards one another, and that the Planets are retain'd in their Orbits by the force of Gravity; and laſtly, that the Gravity of the Planets towards the Sun are reciprocally as the Squares of their Diſtances from it. What the Induſtry and Skill of the Moderns have added to theſe Inventions of the Ancients, the following Pages do declare at large.