

TE X N H
**THEORETICAL FOUNDATIONS OF ARTS,
SCIENCES AND TECHNOLOGY
IN THE GRECO-ROMAN WORLD**

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PRELIMINARY NOTES

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Greek science, arts and technology is a vast subject. Despite the sad fact that the majority of the relevant sources are lost for us, what is preserved is still an impressive library, which consists of both the first-rate achievements, like these by Aristotle and Archimedes, and somewhat inferior developments, like various anthologies and compendiums, composed in Late Antiquity, in the Byzantine period and the Arabic world. Besides we possess an ever-expanding range of archaeological artifacts, illustrating ancient technological and artistic achievements, which, thanks to contemporary technological advances, can now undergo a more profound study. Thus, as the result of collaboration between the historians and the scientists, we now know what was written in such badly damaged books, like the Archimedes palimpsest, which colors were used by the ancient artists, what kind of materials did they develop and process, what did they eat and even to which race did they belong, etc.¹ The major result of this development is that the history of sciences in Antiquity cannot any longer primarily rely on the written sources. The education system has to reflect these changes and our duty is to find the effective ways for accomplishing this task.

One of the most important consequences of our approach is our attempt to perceive ancient science not in a vacuum, but as influenced by contemporary social, political, economic and other circumstances. One has to assume that almost everything

¹ As they say, each generation rethinks its roots, re-evaluating and partially rewriting the history, and the process is clearly reflected in the changes in educational strategies and approaches. For our generation an incontestable value is still – despite some serious doubts risen – the technological progress and objectivity (usually symbolized by numbers and figures).

which appears to us strange and bewildering could make sense for ancient scientists and had been accepted by the specialists and general readers for many centuries. This certainly does not mean that we ignore mistakes, just we have to bring the context of Greek science, arts and technology to light “not by externally transposing it into another mode of presentation but rather by comprehending it in the one way which seemed comprehensible to the Greeks” (Klein).

An unexpected consequence of this approach is that any excessive acquaintance with contemporary science on the part of reader could turn out to be a disadvantage. For instance, Aristotle famously subdivided sciences into terrestrial and celestial. The latter ones deal with the divine substances and demonstrate remarkable uniformity, while the former are utterly irregular and have to account for change. The most conspicuous result of this development is that in Ancient science we find nothing similar to physics in the modern sense of the word. Physics as we know it is the offspring of a happy marriage between celestial mechanics and mathematics, arranged by Galileo, Newton and Leibniz, – something which the ancients consciously avoided. On the other hand, this new science, however practically effective and useful, inherited all sort of classical problems, such as the paradoxes of movement, and conceptual difficulties concerned such notions as time, space, change, creation, annihilation, the status of matter, elementary particles (atoms), forces, energy, etc. Scientific revolutions, including the most recent ones, always presuppose rethinking of these theoretical foundations, and recurrent returning to the classical thought is a necessary integral part of this process. Contemporary physics stems not only from Descartes, Newton, Huygens, Euler, Lagrange, Maxwell, Poincaré, Einstein, Dirac, Fermi or Feynman. Its fundamentals are based on the classical notions and arguments – the fact that contemporary scientists readily acknowledge: Erwin Schrödinger addresses the concept of nature by the Greeks in a special lecture (1954), Ilya Prigogine starts his book on Time and Chaos (*The End of Certainty*, 1997) with a detailed discussion of Epicurus’ dilemma, etc.

Some ancient works are so technical and complex that only specialists in the field can properly understand them. Take, for instance, Archimedes’ mathematical treatises. Any attempt to ‘make Archimedes simple’ violates his thoughts. And this is normally the case in existing textbooks. Polymaths like Heath are rare nowadays, and better results are achieved by mean of interdisciplinary cooperation. Good examples include the German Pliny translation group, the *Topoi* project (van der Eijk, Nutton and others, Berlin/London), the Theophrastus project, the Neoplatonists translation project (CRNS, Paris), etc. On the other hand, some ancient works, especially popular ones, are fairly simple from the doctrinal point of view, but comprehensible only if studied in cooperation with the historians.

In our studies of the history of sciences in antiquity we employ various approaches: we work collectively, attempt to look, as far as possible, at the ancients through their own eyes, and always trace the development of this or that particular notion to the present, and, in accordance with a recommendation of the committee, recruited specialists in modern science and mathematics as faculty members. For instance, Andrey Rodin presented Euclid’s *Elements* against the background of contemporary mathematics, Teun

Tieleman talked on Stoicism and 'its present-day appeal', Andrey Schetnikov and Eugene Afonasin discussed Archimedes' methods in the context of differential and integral calculus, Michael Chase and Marc Lachière-Rey focused on Ancient creationist ideas and contemporary cosmology, etc., etc.

In order to understand ancient thought properly we need to return to the Aristotelian scientific program. (1) First, we discuss the problem of the origin of sciences and the historical circumstances of the Aristotelian project. We observe that ancient theoretical thought always go hand in hand with synchronic technological and artistic developments. Peoples not only explain the world, they change it. (2) Next we turn to what can be known exactly (celestial science): arithmetic, geometry, astronomy, harmonics, as well as the techniques of measuring, some tasks of the theoretical mechanics and artistic skills, viewed from the point of the techniques of production rather than in terms of aesthetical value of artifacts, mechanisms and constructions created. This will be continued and expanded and the texts studied, presentations prepared and examples analyzed will enrich university curricula. It is really surprising how little is written on the subject and can be used in the classroom. (3) Simultaneously we approach what defined by the ancients as the vague and uncertain realm of nature (terrestrial science). The basic methodology in this realm is different: qualitative methods dominate over quantitative, what cannot be measured exactly can still be described and then used. This is true of such areas of knowledge and experience as geography, climate, navigation; living organisms, plants and diet; function and dysfunction of living organism, esp. this of human being; and, finally, the question concerned that nature as the whole, such as creation, change, time, space, etc.

Historically speaking these sciences were fully developed in the Aristotelian, Stoic and, to some extent, Epicurean schools – which explains why we started with a series of studies on Aristotelian scientific works (Summer 2010) and Stoicism (Spring 2011). Ancient descriptive sciences, such as geography and navigation are also seriously taken into consideration. Next go biology, zoology, mineralogy, and this are the plans for the future (Aristotelian *Parva naturalia*, Theophrastus, etc.). And again, we observe how *tekhne* impregnates science and how they develop together.

Human beings are taken by the ancients as a part of the nature, but a very distinctive part, and medicine, viewed mostly as 'empirical tradition' follows its intrinsic standards, often different from these adopted by other sciences. We approached the matter in Spring 2011 and continued in Summer 2011. Ancient teaching on the soul (*De anima*) is something really specific. First of all, the ancients mostly discourse on the soul in terms of metaphysics and physics (in ancient sense of the word); then these teachings certainly contain what later become physiology and psychology; finally anima as the seat of judgment is viewed in the context of ethics. This controversial issue also reserves discussion (on the basis of Plato's *Timaeus*, Aristotle and the Stoics).

Such notions as time, eternity, space, change, genesis and corruption, cause, etc., first revealed in ancient physics (the philosophy of nature) are still issues that undergo constant rethinking in contemporary methodology of science. These ideas are always in our focus. Finally an important question of the status of scientific knowledge is

discussed and will be discussed in the context of analysis of Ancient skepticism and 'dogmatic' response to its challenge.

Another important aspect of ancient science, often neglected in undergraduate teaching, is its institutional setting. We plan to prepare a series of presentations about major intellectual centers and schools (Ephesus, Miletus, Pergamon, Athens, Croton, Rome, Alexandria, etc.) and also address question of priorities in discoveries – ancient 'laws of intellectual property' and economic use of 'know-how'.

Finally, ancient technology, materials, techniques, instruments, scientific methods (the role of experiment), etc. are given ample treatment, which also hardly the case in nowadays curricula. As previously mentioned this study will trace the ways how *tekhne* and *episteme* influenced each other. The subject, often neglected, is quite fascinating and could be presented to the students in an interesting way. We believe this could become an important contribution to educational process which significantly change approach to teaching ancient science and the methods of presenting materials.

Our task then is to present the vast field of ancient science in a handy and accessible manner to those students who will later do science or themselves get involved in teaching. The best thing we can do is determining important areas, actual for the present day science and methodology and (which is also important) highlight the areas which can boast new development, either thanks to recent discoveries or as a result of relatively good progress achieved otherwise. This presupposes the collective efforts of both faculty and participants.

Our major concern is of course the ways ancient intellectual tradition could be presented in the classroom. For this purpose we repeatedly discuss the methodology of teaching (round tables), give 'classes' to each other and discuss their successes and failures afterwards, and try to present the topics in such a way that they could be directly used by the others as teaching tools. A good example is Andrey Schetnikov's class on Ancient techniques of measuring, now available as a small textbook. A series of presentations on Euclid by A. Rodin is another good example. A series of presentations dedicated to Ancient intellectual centers (Ephesus, Pergamon and Athens are ready to date) is being developed and actually used in teaching (Afonasin). In order to make ancient science more accessible to the students we need to produce new educational tools, such as graphic presentation, collection of extracts, even models and instructions for experiments. This is our major concern and all the participants are reported to actively participate in developing of these new educational tools, both as a part of this project and in their home universities.

All consequent meetings are individually planned and consist of plenary session, where the team leaders address the fundamental issues and outline the work of their teams already done, and a number of specialized sessions, seminars and workshops, where the participants are asked to present their parts of work. Series of presentations, conducted by the resource persons during the contact sessions, normally continue the courses, initiated the previous year, and even in case of replacement of a faculty member we are trying to substitute the person, not the subject. The round tables are

designed for discussion of the results of individual and collective work of the participants. First of all we plan to address new experience of the participants in their teaching and preparing new courses. Finalizing the seminars and outlining the plans for the future collaboration and research we will determine how participation in the project improved teaching abilities and the courses taught by the participants, which new ideas and teaching methods were applied in practice and how this affected educational process.

While leaving determining the exact content and the way of presentation to invited professors, we discussed with them the subjects to be addressed and corrected the course thematic structure according to our needs. We agreed that our sessions concentrate on serious textual studies, and had always tried to avoid subjects which provoke too much ideological discussions and seminars consisted of too many "words". On the other hand, some peoples in our group are ready to propose and – quite successfully – moderate debates and discuss many controversial philosophical questions. After all philosophy is the art of dialogue. Evening informal meetings also give the participants and the faculty an opportunity to tell about themselves and express their opinions.

Finally, some notes on the group work which will result in creating an extended hyper-syllabus of an undergraduate course on *Ancient science and technology*. This is the most important part of our last-year work and will be subdivided into a set of topics and done by few groups. One understands that we always try to classify matters according to our representation and often tend to tear apart what the ancients would link together. Still, the most obvious however provisional subdivision would be the exact sciences, the study of nature, the study of live, medicine, and the applied science and technology (various arts, crafts, and the like). Scientific methods and epistemology also deserve a separate treatment. Besides, we have to deal with things nowadays justly regarded unscientific and even anti-scientific, such as astrology, eschatology, magic, – not on their own right, of course, but as an integral part of ancient reasoning and world picture, not easily separated from things we now consider scientific properly. The same is applied to metaphysics, another type of thinking the contemporary scientist would avoid. For the ancients the divine principle was as important as measurability for modern theorists.

Another recurrent problem (unfortunately typical for many contemporary studies) is that ancient science is treated in a virtually complete isolation of the corresponding social, cultural, political and economic events, that is to say from its history and institutional settings, and (which is almost inevitable for short introductions) focus on the greatest achievements and major lights. For instance one can study the results of medical anatomical and clinical observations on the basis of Galen's summaries, being unaware that the majority of this material is collected by anonymous physicians on service of Mithridates who tested their poisons on prisoners and the (mostly anonymous) human vivisectionists of the Hellenistic period. Likewise, the institutional setting in Antiquity is rather a 'likeness of mind' not of space and time, the philosophers and scientists tended to be individualistic (and did science in their spare

time, being otherwise engaged in various crafts, politics, business, etc.), while various reports about the ancient schools often prove to be later or – worse – hostile inventions. Contextualization is important therefore and beneficial not only for the historians of science, but also for the historians of antiquity in general, since the scientific works (take the Aristotelian *Problems* or the *Prognosis* of Galen, for instance) could prove to be ‘the finest contemporary accounts of society’ (as Nutton observes).

Ancient theories developed in competition with each other. Inevitably there were winners and losers, and the rules of this *agon* not always comply with the scientific standards: other social, political and even personal factors played (then and now) their role just too often. If we focus on those theories which seem the most successful and consistent with contemporary science and ignore all those that failed to contribute to what we consider as the growth of scientific knowledge, we risk presenting a much distorted picture of ancient science.

Starting with Plato and Aristotle science (*logos*) in theory is clearly distinct from technology (*tekhne*). Science is fundamental and academic, technology is applied and practical. But in fact this distinction is never valid. Ptolemy not only describes constellations and musical intervals, but also invents instruments for measuring and observation. Vitruvius tries to apply Archimedes’ theorems in determining the shape of water. New ideas require original equipment. Cicero linked human ability to change environment with human dignity. Still, in antiquity the distinction is more visible than now, and many areas of science, such as the theory of nature (physiology), psychology and, especially, cosmology, viewed by their creators as pure divine contemplation, valid independently of and even despite the phenomena.

OUTLINE OF THE COURSES AND RECOMMENDED READINGS

GREEK HISTORIOGRAPHY OF PHILOSOPHY AND SCIENCES IN THE PERIPATETIC SCHOOL IN THE SECOND PART OF THE FOURTH CENTURY BC

Leonid Zhmud (St. Petersburg)

For the session in August I would like to propose a subject that is closely related to my previous courses. In a sense it summarizes and substantiates all the matters discussed previously. In my course I would like to focus on several topics:

1) Aristotle and the origin of the history of philosophy. Doxographic overviews in Aristotle’s works, especially in *Metaphysics A*.

2) Theophrastus and his doxographic compendium *Opinions of the Natural Philosophers*.

3) Eudemus of Rhodes as the first historian of exact sciences (mathematics and astronomy).

4) Menon and the origin of the history of medicine (medical doxography).

Readings:

Ancient histories of medicine. Essays in medical doxography and historiography in classical Antiquity, ed. by Ph. J. van der Eijk, Leiden 1999.

Eudemus of Rhodes, ed. by I. Bodnár, W. W. Fortenbaugh, New Brunswick 2002 (Rutgers University Studies in Classical Humanities, Vol. 11).

Jones W. H. S. *Philosophy and Medicine in Ancient Greece*. Baltimore, 1961.

Mansfeld, J. *Studies in historiography of Greek philosophy*, Assen 1990.

Mansfeld, J., Runia, D. *Aëtiana: The method and intellectual context of a doxographer*, Vol. 1, Dordrecht 1997.

Theophrastus of Eresus: Sources for his life, writings, thought, and influence, ed. by W. W. Fortenbaugh, P. M. Huby, R. W. Sharples, D. Gutas, Pt. 1–2, Leiden 1992.

Zhmud L. *The Origin of the History of Science in Classical Antiquity*. Berlin, 2006.

Aristoteles, *Metaphysica A*

ἀεὶ γὰρ εἶναι τινα φύσιν ἢ μίαν ἢ πλείους μιᾶς ἐξ ὧν γίγνεται τᾶλλα σωζομένης ἐκεῖνης. τὸ μέντοι πλήθος καὶ τὸ εἶδος τῆς τοιαύτης ἀρχῆς οὐ τὸ αὐτὸ πάντες λέγουσιν, ἀλλὰ Θαλῆς μὲν ὁ τῆς τοιαύτης ἀρχηγὸς φιλοσοφίας ὕδωρ φησὶν εἶναι (διὸ καὶ τὴν γῆν ἐφ' ὕδατος ἀπεφήνατο εἶναι), λαβὼν ἴσως τὴν ὑπόληψιν ταύτην ἐκ τοῦ πάντων ὄραν τὴν τροφὴν ὑγρὰν οὔσαν καὶ αὐτὸ τὸ θερμὸν ἐκ τούτου γιγνόμενον καὶ τούτῳ ζῶν (τὸ δ' ἐξ οὗ γίγνεται, τοῦτ' ἐστὶν ἀρχὴ πάντων)—διὰ τε δὴ τοῦτο τὴν ὑπόληψιν λαβὼν ταύτην καὶ διὰ τὸ πάντων τὰ σπέρματα τὴν φύσιν ὑγρὰν ἔχειν, τὸ δ' ὕδωρ ἀρχὴν τῆς φύσεως εἶναι τοῖς ὑγροῖς. εἰσὶ δὲ τινες οἱ καὶ τοὺς παμπαλαίους καὶ πολὺ πρὸ τῆς νῦν γενέσεως καὶ πρώτους θεολογήσαντας οὕτως οἴονται περὶ τῆς φύσεως ὑπολαβεῖν· Ὠκεανὸν τε γὰρ καὶ Τηθὺν ἐποίησαν τῆς γενέσεως πατέρας, καὶ τὸν ὄρκον τῶν θεῶν ὕδωρ, τὴν καλουμένην ὑπ' αὐτῶν Στύγα [τῶν ποιητῶν]· τιμιώτατον μὲν γὰρ τὸ πρεσβύτατον, ὄρκος δὲ τὸ τιμιώτατόν ἐστιν. εἰ μὲν οὖν ἀρχαία τις αὕτη καὶ παλαιὰ τετύχηκεν οὔσα περὶ τῆς φύσεως ἢ δόξα, τάχ' ἂν ἀδηλον εἴη, Θαλῆς μὲντοι λέγεται οὕτως ἀποφήνασθαι περὶ τῆς πρώτης αἰτίας (Ἴππωνα γὰρ οὐκ ἂν τις ἀξιώσει θεῖναι μετὰ τούτων διὰ τὴν εὐτέλειαν αὐτοῦ τῆς διανοίας)· Ἀναξιμένης δὲ ἀέρα καὶ Διογένης πρότερον ὕδατος καὶ μάλιστ' ἀρχὴν τιθέασι τῶν ἀπλῶν σωμάτων, Ἴππασος δὲ πῦρ ὁ Μεταποντῖνος καὶ Ἡράκλειτος ὁ Ἐφέσιος, Ἐμπεδοκλῆς δὲ τὰ τέτταρα, πρὸς τοῖς εἰρημένοις γῆν προστιθεὶς τέταρτον (ταῦτα γὰρ ἀεὶ διαμένειν καὶ οὐ γίγνεσθαι ἀλλ' ἢ πλήθει καὶ ὀλιγότητι, συγκρινόμενα καὶ διακρινόμενα εἰς ἓν τε καὶ ἐξ ἑνός)· Ἀναξαγόρας δὲ ὁ Κλαζομένιος τῇ μὲν ἡλικίᾳ πρότερος ὢν τούτου τοῖς δ' ἔργοις ὕστερος ἀπείρους εἶναι φησὶ τὰς ἀρχάς· σχεδὸν γὰρ ἅπαντα τὰ ὁμοιομερῆ καθάπερ ὕδωρ ἢ πῦρ οὕτω γίγνεσθαι καὶ ἀπόλλυσθαι φησὶ, συγκρίσει καὶ διακρίσει μόνον, ἄλλως δ' οὔτε γίγνεσθαι οὔτ' ἀπόλλυσθαι ἀλλὰ διαμένειν ἄϊδια. <...>

οὔτοι μὲν οὖν, ὥσπερ λέγομεν, καὶ μέχρι τούτου δυοῖν αἰτίαι ὧν ἡμεῖς διωρίσαμεν ἐν τοῖς περὶ φύσεως ἡμμένοι φαίνονται, τῆς τε ὕλης καὶ τοῦ ὅθεν ἢ κίνησις, ἀμυδρῶς μὲντοι καὶ οὐθὲν σαφῶς ἀλλ' οἷον ἐν ταῖς μάχαις οἱ ἀγύμναστοι ποιοῦσιν· καὶ γὰρ ἐκεῖνοι περιφερόμενοι τύπτουσι πολλάκις καλὰς πληγὰς, ἀλλ' οὔτε ἐκεῖνοι

ἀπὸ ἐπιστήμης οὔτε οὔτοι ἐοίκασιν εἰδέναι ὅ τι λέγουσιν· σχεδὸν γὰρ οὐθὲν χρώμενοι φαίνονται τούτοις ἀλλ' ἢ κατὰ μικρόν. Ἀναξαγόρας τε γὰρ μηχανῇ χρῆται τῷ νῶ πρὸς τὴν κοσμοποιίαν, καὶ ὅταν ἀπορήσῃ διὰ τίν' αἰτίαν ἐξ ἀνάγκης ἐστί, τότε παρέλκει αὐτόν, ἐν δὲ τοῖς ἄλλοις πάντα μᾶλλον αἰτιᾶται τῶν γιγνομένων ἢ νοῦν, καὶ Ἐμπεδοκλῆς ἐπὶ πλέον μὲν τούτου χρῆται τοῖς αἰτίοις, οὐ μὴν οὔθ' ἰκανῶς, οὔτ' ἐν τούτοις εὐρίσκει τὸ ὁμολογούμενον. <...> Ἐμπεδοκλῆς μὲν οὖν παρὰ τοὺς πρότερον πρῶτος τὸ τὴν αἰτίαν διελεῖν εἰσήνεγκεν, οὐ μίαν ποιήσας τὴν τῆς κινήσεως ἀρχὴν ἀλλ' ἑτέρας τε καὶ ἐναντίας, ἔτι δὲ τὰ ὡς ἐν ὕλης εἶδει λεγόμενα στοιχεῖα τέτταρα πρῶτος εἶπεν (οὐ μὴν χρῆταί γε τέτταρσιν ἀλλ' ὡς δυσὶν οὔσι μόνοις, πυρὶ μὲν καθ' αὐτὸ τοῖς δ' ἀντικειμένοις ὡς μιᾷ φύσει, γῆ τε καὶ ἀέρι καὶ ὕδατι· λάβοι δ' ἂν τις αὐτὸ θεωρῶν ἐκ τῶν ἐπῶν).

Theophrastus, **Φυσικῶν δόξαι** (fr. 1, 2, 9 Diels)

Τῶν δὲ μίαν καὶ κινουμένην λεγόντων τὴν ἀρχὴν, οὓς καὶ φυσικοὺς ἰδίως καλεῖ (Aristoteles), οἱ μὲν πεπερασμένην αὐτὴν φασιν, ὥσπερ Θαλῆς μὲν Ἐξαμύου Μιλήσιος καὶ Ἴππων, ὃς δοκεῖ καὶ ἄθεος γεγονέναι, ὕδωρ ἔλεγον τὴν ἀρχὴν ἐκ τῶν φαινομένων κατὰ τὴν αἴσθησιν εἰς τοῦτο προαχθέντες· καὶ γὰρ τὸ θερμὸν τῷ ὑγρῷ ζῆ καὶ τὰ νεκρούμενα ξηραίνεται καὶ τὰ σπέρματα πάντων ὑγρὰ καὶ ἡ τροφή πᾶσα χυλώδης· ἐξ οὗ δὲ ἐστὶν ἕκαστα, τούτῳ καὶ τρέφεσθαι πέφυκε· τὸ δὲ ὕδωρ ἀρχὴ τῆς ὑγρᾶς φύσεως ἐστὶ καὶ συνεκτικὸν πάντων· διὸ πάντων ἀρχὴν ὑπέλαβον εἶναι τὸ ὕδωρ καὶ τὴν γῆν ἐφ' ὕδατος ἀπεφάναντο κείσθαι. Θαλῆς δὲ πρῶτος παραδέδοται τὴν περὶ φύσεως ἱστορίαν τοῖς Ἕλλησιν ἐκφῆσαι, πολλῶν μὲν καὶ ἄλλων προγεγονότων, ὡς καὶ Θεοφράστῳ δοκεῖ, αὐτὸς δὲ πολὺ διενεγκῶν ἐκείνων ὡς ἀποκρύψαι πάντας τοὺς πρὸ αὐτοῦ· λέγεται δὲ ἐν γραφαῖς μηδὲν καταλιπεῖν πλήν τῆς καλουμένης Ναυτικῆς ἀστρολογίας.

Τῶν δὲ ἐν καὶ κινούμενον καὶ ἄπειρον λεγόντων Ἀναξίμανδρος μὲν Πραξιάδου Μιλήσιος Θαλοῦ γενόμενος διάδοχος καὶ μαθητῆς ἀρχὴν τε καὶ στοιχείων εἴρηκε τῶν ὄντων τὸ ἄπειρον, πρῶτος τοῦτο τούνομα κομίσας τῆς ἀρχῆς· λέγει δὲ αὐτὴν μήτε ὕδωρ μήτε ἄλλο τι τῶν καλουμένων εἶναι στοιχείων, ἀλλ' ἑτέραν τινὰ φύσιν ἄπειρον, ἐξ ἧς ἅπαντας γίνεσθαι τοὺς οὐρανοὺς καὶ τοὺς ἐν αὐτοῖς κόσμους· ἐξ ὧν δὲ ἡ γένεσις ἐστὶ τοῖς οὔσι, καὶ τὴν φθορὰν εἰς ταῦτα γίνεσθαι κατὰ τὸ χρεῶν, δίδοναι γὰρ αὐτὰ δίκην καὶ τίσιν ἀλλήλοις τῆς ἀδικίας κατὰ τὴν τοῦ χρόνου τάξιν, ποιητικωτέροις οὕτως ὀνόμασιν αὐτὰ λέγων. δῆλον δὲ ὅτι τὴν εἰς ἀλληλα μεταβολὴν τῶν τεσσάρων στοιχείων οὗτος θεασάμενος οὐκ ἠξίωσεν ἐν τι τούτων ὑποκείμενον ποιῆσαι, ἀλλὰ τι ἄλλο παρὰ ταῦτα.

‘Τούτοις’ φησὶν ἐπιγενόμενος Πλάτων τῇ μὲν δόξῃ καὶ τῇ δυνάμει πρότερος τοῖς δὲ χρόνοις ὕστερος καὶ τὴν πλείστην πραγματείαν περὶ τῆς πρώτης φιλοσοφίας ποιησάμενος ἐπέδωκεν ἑαυτὸν καὶ τοῖς φαινομένοις ἀψάμενος τῆς περὶ φύσεως ἱστορίας, ἐν ἧ δὴ δύο τὰς ἀρχὰς βούλεται ποιεῖν τὸ μὲν ὑποκείμενον ὡς ὕλην ὃ προσαγορεύει πανδεχές, τὸ δὲ ὡς αἴτιον καὶ κινουῖν ὃ περιάπτει τῇ τοῦ θεοῦ καὶ τῇ τοῦ ἀγαθοῦ δυνάμει’.

Eudemus Rhodius, Γεωμετρική ιστορία (fr. 133 Wehrli)

ἐπεὶ δὲ χρὴ τὰς ἀρχὰς καὶ τῶν τεχνῶν καὶ τῶν ἐπιστημῶν πρὸς τὴν παροῦσαν περίοδον σκοπεῖν, λέγομεν, ὅτι παρ' Αἰγυπτίοις μὲν εὐρήσθαι πρῶτον ἢ γεωμετρία παρὰ τῶν πολλῶν ιστόρηται, ἐκ τῆς τῶν χωρίων ἀναμετρήσεως λαβοῦσα τὴν γένεσιν. ἀναγκαία γὰρ ἦν ἐκείνοις αὕτη διὰ τὴν ἄνοδον τοῦ Νείλου τοὺς προσήκοντας ὅρους ἐκάστοις ἀφανίζοντος. καὶ θαυμαστὸν οὐδὲν ἀπὸ τῆς χρείας ἀρξασθαι τὴν εὐρεσιν καὶ ταύτης καὶ τῶν ἄλλων ἐπιστημῶν, ἐπειδὴ πᾶν τὸ ἐν γενέσει φερόμενον ἀπὸ τοῦ ἀτελοῦς εἰς τὸ τέλειον πρόεισιν. ἀπὸ αἰσθήσεως οὖν εἰς λογισμὸν καὶ ἀπὸ τούτου ἐπὶ νοῦν ἢ μετάβασις γένοιτο ἂν εἰκότως. ὥσπερ οὖν παρὰ τοῖς Φοίνιξιν διὰ τὰς ἐμπορίας καὶ τὰ συναλλάγματα τὴν ἀρχὴν ἔλαβεν ἢ τῶν ἀριθμῶν ἀκριβῆς γνῶσις, οὕτω δὲ καὶ παρ' Αἰγυπτίοις ἢ γεωμετρία διὰ τὴν εἰρημένην αἰτίαν εὕρηται.

Θαλῆς δὲ πρῶτον εἰς Αἴγυπτον ἐλθὼν μετήγαγεν εἰς τὴν Ἑλλάδα τὴν θεωρίαν ταύτην καὶ πολλὰ μὲν αὐτὸς εὗρεν, πολλῶν δὲ τὰς ἀρχὰς τοῖς μετ' αὐτὸν ὑφηγησάτο, τοῖς μὲν καθολικώτερον ἐπιβάλλων, τοῖς δὲ αἰσθητικώτερον. μετὰ δὲ τοῦτον Μάμερκος [?] ὁ Στησιχόρου τοῦ ποιητοῦ ἀδελφός, ὃς ἐφαψάμενος τῆς περὶ γεωμετρίας σπουδῆς μνημονεύεται, καὶ Ἰππίας ὁ Ἡλεῖος ιστόρησεν ὡς ἐπὶ γεωμετρίας δόξαν αὐτοῦ λαβόντος.

ἐπὶ δὲ τούτοις Πυθαγόρας τὴν περὶ αὐτὴν φιλοσοφίαν εἰς σχῆμα παιδείας ἐλευθέρου μετέστησεν, ἄνωθεν τὰς ἀρχὰς αὐτῆς ἐπισκοπούμενος καὶ αὐλῶς καὶ νοερῶς τὰ θεωρήματα διερευνώμενος, ὃς δὴ καὶ τὴν τῶν ἀλόγων πραγματείαν καὶ τὴν τῶν κοσμικῶν σχημάτων σύστασιν ἀνεῦρεν. μετὰ δὲ τοῦτον Ἀναξαγόρας ὁ Κλαζομένιος πολλῶν ἐφήψατο τῶν κατὰ γεωμετρίαν καὶ Οἰνοπίδης ὁ Χίος, ὀλίγῳ νεώτερος ὢν Ἀναξαγόρου, ὢν καὶ ὁ Πλάτων ἐν τοῖς Ἀντερασταῖς ἐμνημόνευσεν ὡς ἐπὶ τοῖς μαθήμασι δόξαν λαβόντων.

ἐφ' οἷς Ἴπποκράτης ὁ Χίος ὁ τὸν τοῦ μηνίσκου τετραγωνισμὸν εὐρών, καὶ Θεόδωρος ὁ Κυρηναῖος ἐγένοντο περὶ γεωμετρίας ἐπιφανεῖς. πρῶτος γὰρ ὁ Ἴπποκράτης τῶν μνημονευομένων καὶ στοιχεῖα συνέγραψεν. Πλάτων δ' ἐπὶ τούτοις γενόμενος μεγίστην ἐποίησεν ἐπίδοσιν τὰ τε ἄλλα μαθήματα καὶ τὴν γεωμετρίαν λαβεῖν διὰ τὴν περὶ αὐτὰ σπουδὴν, ὃς που δηλὸς ἐστὶ καὶ τὰ συγγράμματα τοῖς μαθηματικοῖς λόγοις καταπυκνώσας καὶ πανταχοῦ τὸ περὶ αὐτὰ θαῦμα τῶν φιλοσοφίας ἀντεχομένων ἐπεγείρων. ἐν δὲ τούτῳ τῷ χρόνῳ καὶ Λεωδάμας ὁ Θάσιος ἦν καὶ Ἀρχύτας ὁ Ταραντίνος καὶ Θεαίτητος ὁ Ἀθηναῖος, παρ' ὧν ἐπηυξήθη τὰ θεωρήματα καὶ προῆλθεν εἰς ἐπιστημονικώτεραν σύστασιν. Λεωδάμαντος δὲ νεώτερος ὁ Νεοκλείδης καὶ ὁ τούτου μαθητὴς Λέων, οἱ πολλὰ προσευπόρησαν τοῖς πρὸ αὐτῶν, ὥστε τὸν Λέοντα καὶ τὰ στοιχεῖα συνθεῖναι τῷ τε πλήθει καὶ τῇ χρείᾳ τῶν δεικνυμένων ἐπιμελέστερον, καὶ διορισμοὺς εὐρεῖν, πότε δυνατόν ἐστὶ τὸ ζητούμενον πρόβλημα καὶ πότε ἀδύνατον.

Εὐδόξος δὲ ὁ Κνίδιος, Λέοντος μὲν ὀλίγῳ νεώτερος, ἐταῖρος δὲ τῶν περὶ Πλάτωνα γενόμενος, πρῶτος τῶν καθόλου καλουμένων θεωρημάτων τὸ πλῆθος ἠὔξησεν καὶ ταῖς τρισὶν ἀναλογίαις ἄλλας τρεῖς προσέθηκεν καὶ τὰ περὶ τὴν τομὴν ἀρχὴν

λαβόντα παρὰ Πλάτωνος εἰς πλήθος προήγαγεν καὶ ταῖς ἀναλύσεσιν ἐπ' αὐτῶν χρησάμενος.

Φίλιππος δὲ ὁ Μενδαῖος, Πλάτωνος ὦν μαθητῆς καὶ ὑπ' ἐκείνου προτραπείς εἰς τὰ μαθήματα, καὶ τὰς ζητήσεις ἐποιεῖτο κατὰ τὰς Πλάτωνος ὑφηγήσεις καὶ ταῦτα προύβαλλεν ἑαυτῷ, ὅσα ᾤετο τῇ Πλάτωνος φιλοσοφίᾳ συντελεῖν. οἱ μὲν οὖν τὰς ἱστορίας ἀναγράψαντες μέχρι τούτου προάγουσι τὴν τῆς ἐπιστήμης ταύτης τελείωσιν.

Menon, Ἱατρικὴ συναγωγή

Εὐρ[υ]φῶν γ(άρ)τοι ὁ Κνίδιος οἶεται τὰς νόσους ἀποτελεῖσθαι τρόπῳ τοιούτῳ· ὅταν ἡ κοιλία, φ(ησίν), τὴν ληφθεῖσαν τροφὴν μὴ ἐκπέμπῃ, ἀπογεννᾶται περισσώματα, ἃ δὴ ἀνενεχθέντα ὡς τοὺς κ(ατὰ) τὴν κεφαλὴν τόπους ἀποτελεῖ τὰς νόσους· ὅταν μ(έν)τοι γε λεπτὴ καὶ καθαρὰ ὑ(πάρχη) ἡ κοιλία, δεόντως γίνεται ἡ πέψις· ὅταν δὲ μὴ ἢ τοιαύτη, συμβαίνει τὰ προκείμενα γί(νεσθαι)·

Ἰππ<ων> δὲ ὁ Κροτωνιάτης οἶεται ἐν ἡμῖν οἰκείαν εἶναι ὑγρότητα, καθ' ἣν καὶ αἰσθανόμεθα καὶ ἢ ζῶμεν· ὅταν μὲν οὖν οἰκείως ἔχη ἡ τοιαύτη ὑγρότης, ὑγιαίνει τὸ ζῶιον, ὅταν δὲ ἀναξηρανθῇ, ἀναισθητεῖ δὲ τὸ ζῶιον καὶ ἀποθνήσκει. διὰ δὲ τοῦτο οἱ γέροντες ξηροὶ καὶ ἀναισθητοί, ὅτι χωρὶς ὑγρότητος· ἀναλόγως δὲ τὰ πέλματα ἀναισθητα, ὅτι ἄμοιρα ὑγρότητος. καὶ ταῦτα μὲν ἄχρι τούτου φησίν. ἐν ἄλλῳ δὲ βυβλίῳ αὐτὸς ἀνὴρ λέγει τὴν κατωνομασμένην ὑγρότητα μεταβάλλειν δι' ὑπερβολὴν θερμότητος καὶ δι' ὑπερβολὴν ψυχρότητος καὶ οὕτως νόσους ἐπιφέρειν, μεταβάλλειν δὲ φησιν αὐτὴν ἢ ἐπὶ τὸ πλεῖον ὑγρὸν ἢ ἐπὶ τὸ ξηρότερον ἢ ἐπὶ τὸ παχυμερέστερον ἢ ἐπὶ τὸ λεπτομερέστερον ἢ εἰς ἕτερα, καὶ τὸ αἴτιον οὕτως νοσολογεῖ, τὰς δὲ νόσους τὰς γινομένας οὐχ ὑπαγορεύει.

THE CLASSICIST REVIVAL: PYTHAGORAS, PLATO, AND ARISTOTLE IN THE FIRST CENTURY B. C.

Anna Afonasin and Eugene Afonasin
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The round-table discussion will focus on various aspects of the phenomenon of the revival of interest to the classical philosophy in Late Republican period. We will, first, access the major sources indicating the revived interest to the Platonic dogmatism, so-called esoteric Aristotelian writings, and the Pythagorean tradition, and, secondly, trace their influence in the Imperial period. The questions to be discussed: the role of Antiochus of Ascalon in the revival of Academic dogmatism and Platonist's interest to exact sciences; the Pythagorean pseudoepigrapha and their cultural background; the rise of the Neopythagoreanism; the "Roman edition" of Aristotle, and, finally, the rise of the tradition of commentaries and encyclopedic summaries and their role in preserving and transforming of the classical science.

Suggested readings

The Pythagoreans and the Platonists

Basic

- Афонасина А. С. *Пифагорейские псевдоэпиграфы. Тимей Локрский о природе космоса и души*. Дисс. Новосибирск, 2012. **(attached)**
- Афонасин Е. В., ред. Неопифагорейцы. *ΣΧΟΛΗ*, 3.1 (2009), 9–65.
- Диллон Дж. *Средние платоники*. Пер. с англ. Е. В. Афонасина. СПб, 2002 (ch. 2–3).
- Диллон Дж. *Наследники Платона*. Пер. с англ. Е. В. Афонасина. СПб, 2005 (ch. 1).
- Baltes M. *Timaios Lokros: Über die Natur des Kosmos und der Seele*. Leiden, 1972.
- Marg W., Hg. *Timaeus Locrus. De natura mundi et animae*. Leiden, 1972.
- Thesleff H. *An Introduction to the Pythagorean Writings of the Hellenistic Period*. Åbo, 1961.
- Thesleff H., ed. *The Pythagorean texts of the Hellenistic Period*. Åbo, 1965.

Supplementary

- Bonazzi, M., Levy C., Steel C. eds. *Pythagoras, Platonism and Pythagoreanism in the Imperial Age*. Turnhout: Brepols, 2007.
- Burkert W. Zur geistesgeschichtlichen Einordnung einiger Pseudopythagorica, in: K. von Fritz (Hg.): *Pseudepigrapha I* (Genève 1971) 25-55 (Fondation Hardt. Entretiens sur l'antiquité classique. 18).
- Burkert W. *Lore and Science in Ancient Pythagoreanism*. Tr. by E. Minar. Cambridge, Mass., 1972.
- Cenrone B. The Theory of Principles in the Pseudopythagorica, in: K. Boudouris, ed. *Pythagorean Philosophy*. Athens, 1992, 90-97.
- Kahn Ch. H. *Pythagoras and the Pythagoreans. A Brief History*. Indianapolis, 2001.
- O'Meara D. *Pythagoras Revived: Mathematics and Philosophy in Late Antiquity*. Oxford, 1989.
- Thesleff H. On the Problem of the Doric Pseudo-Pythagorica, in: K. von Fritz (Hg.): *Pseudepigrapha I* (Genève, 1971) 59-101 (Fondation Hardt. Entretiens sur l'antiquité classique, 18).
- Zhmud L. *Pythagoras and Early Pythagoreans*. Oxford, 2012.

The Peripatetics

Basic

- Barnes, J. (1997). "Roman Aristotle," in J. Barnes and M. Griffin (eds.), *Philosophia Togata II* (Oxford: Clarendon Press).
- Menn, S. (1995). "The Editors of the *Metaphysics*," *Phronesis*, 40 (2), pp. 202–8.
- Tarán, L. (2001). "Aristotelianism in the First Century B.C.," in Tarán, *Collected Papers (1962–1999)* (Leiden: Brill), pp. 479–524.
- Gottschalk, H. B. (1990). "The Earliest Aristotelian Commentators," in R. Sorabji (ed.), *Aristotle Transformed: The Ancient Commentators and Their Influence* (London: Duckworth), pp. 55–82.

Supplementary

- Angier Tom, *Technē in Aristotle's Ethics: Crafting the Moral Life*. New York: Continuum International Publishing Group, 2010.
- Morau, P. (1973). *Der Aristotelismus bei den Griechen von Andronikos bis Alexander von Aphrodisias*, Band I-II (Berlin/New York: De Gruyter).

ANCIENT MUSIC

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In THE INTRODUCTORY PART (SPRING 2012) I have discussed Ancient musical practices, outlined the sources of the science of Harmonics in Classical Greece, and revealed the role of music in the society. The exposition was supplemented with a series of illustrations and a select bibliographic outline. Cf. <http://www.nsu.ru/classics/schole/6/6-1-af-itro.pdf>
<http://www.nsu.ru/classics/schole/6/schole-6-1-1.pdf>

On the present occasion I will focus on two topics:

1. THEOPHRASTUS ON MUSIC: The heir of Aristotle Theophrastus of Eresus (the head of Lyceum from 322 to c. 287 BCE) wrote voluminously on a great variety of subjects, including music. Unfortunately, not much survived intact, and for recovering his highly original approach to music we have to rely on a series of testimonies in later authors (fr. 714 ff. Fortenbaugh), and a relatively long extract from his treatise *On Music*, quoted by Porphyry in his *Commentary to Ptolemy's Harmonics*. He seems to be especially concerned with educational and therapeutic value of music and, most importantly, while criticising standard Pythagorean, Platonic and Peripatetic mathematical harmonics as well as contemporary acoustical theories, have proposed a new qualitative approach to music, based on a re-evaluation of common empirical considerations and a very problematic (due to the lack of sufficient evidence) theory of the psychological nature of musical consciousness, and special power of music, manifested in the movement productive of melody which occurs in the human soul when it reveals itself in a melodic voice. The fragments of Theophrastus' musical works are supplemented with other evidences, also quoted by Porphyry, such as the most important musical fragment of Archytas (fr. 1 DK), extracts from the Peripatetic *De audibilibus*, as well as quotes from such otherwise unknown musical writers as Panaetius, Heraclides, and Aelianus, all on the subject of Pythagorean harmonics and acoustic theory.

Cf. <http://www.nsu.ru/classics/schole/6/6-1-theoph.pdf>

2. PTOLEMAÏS OF KYRENE. *THE PYTHAGOREAN ELEMENTS OF MUSIC*: Extracts of the musical treatise of Ptolemaïis of Kyrene, the only female musical theorist in Antiquity, preserved by Porphyry in his *Commentary to Ptolemy's Harmonics*, are important, first of all, because, they belongs to those very scanty testimonies that witness continuous development of the musical science from the time of Aristoxenus to this of Nicomachus of Gerasa. In this respect the present study supplements two earlier our publications: the musical sections of *The Mathematics Useful for Understanding Plato* by Theon of Smyrna (the 2nd c. CE), which contain material taken from Thrasyllus (the beginning of the 1st c. CE) and Adrastus (the end of the 1st c. CE) [cf. Vol. 3.2 (2009) of the journal], and some passages from Heraclides the Younger (active in the time of Claudius and Nero), Didymus the Musician (active in the time of Nero), Panaetius the Younger (unknown date), and Aelianus (the end of the 2nd c.), preserved by Porphyry and translated as supplements to our study on Theophrastus [included in this volume]. Apparently Porphyry quotes Ptolemaïis on the basis of the work of Didymus and gives absolutely no information about her live. Most recently Levin (2009) speculated that this Ptolemaïis could be a woman of noble origin and live in Alexandria in the time of Eratosthenes (c. 275–194 BCE), which would be nice but cannot be proved. The extracts introduce the notion of the science of *kanonike* and

contribute to the famous polemics between the *mathematikoi* and the *mousikoi*, which lead to 'reason-based' Pythagorean and 'perception-based' Aristoxenian approaches to musical theory, and Ptolemaï's apparently prefers the latter despite the title of her work, given by Porphyry. Cf. <http://www.nsu.ru/classics/schole/6/6-1-ptol.pdf>

Recommended reading:

ΣΧΟΛΗ 6.1 (2012):

<http://www.nsu.ru/classics/schole/6/schole-6-1.pdf>

<http://www.nsu.ru/classics/schole/6/schole-6-1-1.pdf>

The issue is dedicated to Ancient Music and contains five articles and six translations. After a short systematic introduction and a bibliographic outline the authors develop Ancient musical theory from Pythagoras to Archytus, study the origins of the concept of 'harmony', and explore the history of ancient musical education as it is reflected in a treatise *De musica*, ascribed to the pen of Plutarch. The articles are followed by a series of new Russian translation of a number of Ancient musical works, including the *Problems, concerned with music* of the *Corpus Aristotelicum*, Pseudo-Euclidean *Sectio Canonis*, extracts from musical writings of Theophrastus and *The Pythagorean Elements of Music* by Ptolemaï's of Kyrene, a chapter from the musical compendium by Aristides Quintilianus, and an anonymous treatise, entitled *Ptolemy's 'Music'*, which along with two different translations of the *Manual of Harmonics* by Nicomachus of Gerasa in Vols. 2.2 (2008) and 3.1 (2009) of the journal and musical sections of *The Mathematics Useful for Understanding Plato* by Theon of Smyrna in Vol. 3.2 (2009) amounts to a good selection of Ancient musical sources in a new Russian translation.

A collection of the texts:

Barker, A. (1989) *Greek Musical Writings II, Harmonic and Acoustic Theory*. Cambridge.

On Theophrastus:

Sicking, C. M. J. (1998) 'Theophrastus on the nature of music', in van Ophuijsen and van Raalte (1998): 97–142.

Fortenbaugh, W. W., et al., eds. (1992) *Theophrastus of Eresus: Sources for his Life, Writings, Thought and Influence*, 2 vols. Leiden.

On Ptolemaï's of Kyrene:

Levin, F. R. (2009) *Greek Reflections on the Nature of Music*. Cambridge UP.

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Baltussen, H. (2000) *Theophrastus against the Presocratics and Plato*. Leiden.

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— (1984) *Greek Musical Writings I, The Musician and his Art*. Cambridge.

— (1985) 'Theophrastus on pitch and melody', in *Theophrastus of Eresus: on his Life and Work*, eds. W. Fortenbaugh et al. New Brunswick and Oxford: 289–324.

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- Glucker, J. (1998) 'Theophrastus, the Academy, and the Athenian philosophical atmosphere', in van Ophuijsen and van Raalte (1998): 299–316.
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- (1998) 'Theophrastus and the Peripatos', in Ophuijsen and Raalte (1998): 281–98.
- Landels, J. G. (1999) *Music in Ancient Greece and Rome*. London.
- Mathiesen, T. J. (1999) *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages*. Lincoln and London.
- Nagy, G. (2002) *Plato's Rhapsody and Homer's Music*. Cambridge, MA: Harvard University Press.
- Ophuijsen, J. M., van and M. van Raalte (eds.) (1998) *Theophrastus: Reappraising the Sources*. New Brunswick and London.
- West, M. L. (1992) *Ancient Greek Music*. Oxford.
- Wilkinson, L. P. (1938) "Philodemus on Ethos in Music," *CQ* 32, 174–81.

The Oxford Handbook of Engineering and Technology in the Classical World by John Peter Oleson ed. Oxford UP, 2008; review by Tracey E. Rihl <http://www.ircps.org/node/1212>

EUCLID'S OPTICS AND ANCIENT THEORIES OF VISION

Andrei Rodin

(Moscow, Institute of philosophy)

Lecture 1. Greek theories of vision: physical and mathematical approaches.

Reading:

A1) Sources:

Plato, *Timaeus*

Aristotle, *Sense and Sensibilia* (from *Parva Naturalia*)

Ptolemy, *Optics* (in Smith, M.A. (1996). *Ptolemy's Theory of Visual Perception: An English Translation of the Optics with Introduction and Commentary*. Philadelphia: The American Philosophical Society.)

B1) Secondary Literature:

O. Darrigol, *A history of optics from Greek Antiquity to the 19th century*. Oxford University Press 2012, ch. 1.

D.C. Lindberg, *Theories of Vision from al-Kindi to Kepler*, Chicago University Press, 1976; chapter 1

A.M. Smith, Ptolemy and the foundations of ancient mathematical optics: a source based guided study, American Philosophical Society 1999. Introduction and Sections 1-2

Lecture 2. Euclid's *Optics* and its significance in a modern perspective

Reading:

A2) Source: Euclid *Optics*

Greek: Heiberg, *Euclidis Opera Omnia*, Vol. 7; downloadable from

<http://www.wilbourhall.org/index.html#euclid>

English translation: Burton H.E. *The Optics of Euclid*, Journal of the Optical Society of America, Vol. 35, Iss. 5, pp. 357–357 (1945) (available by email request)

B2) Secondary Literature:

Heath Th.H. *A History of Greek Mathematics*. ch. 11, pp. 441-445

N.J. Wade *A Natural History of Vision*, MIT Press 2000

Ika Putri, *Ancient Theories of Vision and Al-Kindi's Critique of Euclid's Theory of Vision* (unpublished, available by email request)

Suppes, P. Is visual space Euclidean? *Synthese*, 35, pp. 397-421 (available by email request).

Note: All referred monographs are available electronically through GoogleBooks