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THESES OF A PHD DISSERTATION

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"Aristotle and the continuity – the deep structural agency of the concept of continuity in Aristotle's Physics and in the natural philosophy, which is reconstruct from it"

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The analyzed philosophical work is Aristotle's "Discourse on Natural Philosophy" (Φυσικὴ ἀκρόασις) from the 4th century BC. The aim of the dissertation is to find the relations and complexity of the concept of continuity. It's known, that Aristotle was the first who described the definition of the continuity with its relation to infinity, as "*continuous must be infinitely divisible*" (εἰς ἄπειρον γὰρ διαιρετὸν τὸ συνεχές **A**/2, 185 b10-11). This definition – not in an explicit way but in all Physics is present deep inside- is a basis to Aristotle's account of motion and change. This basis is unambiguously geometrical: the continuity of geometrical line represents the character of time and route of motion as continuous that is without any interruption, pause or stop. The subject of the inquiry is first of all the implicit, deep structural agency of continuity in Aristotle's natural philosophy. The analogy with geometrical line and point enables Aristotle to discuss the process of motion and change of the natural entities successfully and full in detail, moreover at the end of Physics he attains to the prime cause of the motion of all natural entities: the prime unmoved mover.
Nevertheless what new can we say about this problem? Well known, that Aristotle, despite his character of strict logical clearness, is apt to write in an elliptical way that is contrary to the requirements of our modern style in scientific works. The literal reading of the text of Physics can show many examples of contradiction even logical mistakes. Notwithstanding the collection of these aporias of interpretation is due to analytic researches in the history of philosophy. We must try to solve these aporias, so in our days in the research of Aristotle there is a growing demand to explain the text of Physics as a whole and to make correct, evi-

dent reconstructions of the arguments, supposing that the text has consistent and coherent train of thought despite its difficult reading.

In order to see the whole natural philosophical sense of the text of Physics we would evidently need a holistic, unified reading containing all books from **Α** to **Θ,** and this is what causes great difficulty to the commentators of Physics from late antiquity. The preconception of the interpretation in the present dissertation changes the traditional idea, so it doesn't hold the text of Physics readable in simple linear order. Aristotle's style is in one respect "holistic", inasmuch as the whole theory is always simultaneously beyond it, at least in the completeness of its fundamental, essential system. Therefore the text might be about any problem, the whole of the theory always has been considered, but it's only doing the deeper detailing with the aim of didactical explanation or it's enlarging and refining the essential kern of the theory according to the given particular problem.

In the other respect the organization of the text is "cyclic", because of the repeated return of the same subjects and while they're repeated, we get new and new information about them following the given concrete particular problem. Hence while the Aristotle's theory of natural philosophy is ready in consideration of its essence, he doesn't reveal his theory summarizing shortly and giving its basic theses, instead of it his fundamental notions and theses are again and again appearing in the flow of the text, and doing so they're always regarding from newer point of view, therefore we can always get to know a new information on the whole theory. Sometimes it gives us the impression as it would manifest in a collection of aporias. Consequently we have to reconstruct the idea beyond the survived flow of the text with its fundamental notions and theses, as if we were Aristotle's students and had to understand the master, namely we should interpret the text by thoroughly considering it and at the same time we should extract the ultimate theory from it. Although the text of the Physics had been written in a non-dialectical form, we should have to do exactly the same with it as with Plato's dramas: so we should let the master teach us, and we cannot believe that we are given a ready theory by the text of the Physics, and we only have to learn it. We have to think together with Aristotle and have to let him cause our understanding of the essence of his natural philosophy, and this way Aristotle's natural philosophy is a little bit our common work with Aristotle. However another aspect appears immediately beside the above noticed geometrical base another aspect; a metaphysical one. As we know the analysis of motion and change makes difficulties to Aristotle's predecessors, because of their incapability to solve the contrariety in it and the change of certain being and not-being. Aristotle' answer to this aporia was his own metaphysical theory: the potential (δυνάμει) and actual (ἐντελεχείᾳ or ἐνεργείᾳ) being, that we can name in short of δύναμις-theory.

Accordingly the subject of this dissertation is a special (hypothetic) reading of Physics, in which we can attempt to interpret Aristotle's kinematics as a product of the co-operation of the geometrical base with the supervening metaphysical theory. From the books of Physics there will be examined above all the reconstructions of the arguments of the book **Z**, namely the central kinematics. We will call the reconstruction of the short, connected arguments *microstructural* examination and the more distant connections in one book or between some books *macrostructural* examination. The most important contact themes of the book **Z** will be the books **Γ**, **Δ**, **E** and **Θ.**

The subject of the **first chapter** is the geometrical aspect of the continuity. We will discuss it primarily by a treatise of Hans-Joachim Waschkies (*Von Eudoxos zu Aristoteles*), and by the assistance of the works of Sir Thomas Heath, the classical researcher of the history of mathematics. Waschkies shows two different definitions of the geometrical continuity in the **Z**/1

and state that Aristotle could connect these two definitions through a mathematical argument. As we will see that it is difficult to prove the origin of this argument, but Waschkies concludes by reason of two other work, the one is Aristotle's "*On Generation and Perishing"*, the other is "*On the indivisible lines*", whose unknown writer could create it immediately after Aristotle, that it's such geometrical argument, whose creator had to argue the incomparability of all dimensions. Namely he stated that the points are without dimension, and had postulate that we can never construct a line from points. Waschkies held that this mathematician was *Eudoxus* of Cnidus, who was Arsitotle's contemporary and could have been in contact with the Athenian philosopher. The one of the great discoveries of Greek mathematics is the *general theory of proportion*, which is contained in Elements of Euclid, and it is the discovery of Eudoxus. The most important condition of the generalization of it was the *homogeneity of the dimensions*: so lines can measure only lines, planes only planes and bodies only bodies. Consequently the indispensable geometrical base to Aristotle's theory in Physics was the general theory of proportion by Eudoxus.
So the result of Waschkies' inquiry is significant not only from a history of mathematics' point of view but it's also relevant to the analysis of Physics. Nevertheless Waschkies wasn't engaged in the whole of the Aristotle's theory of motion, but he claims that the δύναμις-theory was its special innovation. After Waschkies, we can answer the question what new did Aristotle to the Eudoxus' geometrical base in **Z**/1 done, that he gave a very other definition of contact and higher level of the generalization too. That is to say Eudoxus' definition of contact was sufficient in the geometrical methods of coincidence: one point can connect with another all in one as the whole with the whole, and while the claim isn't about planes, we can speak rather of fusion of points. Generalization is as a matter of fact the definition of continuity, which Aristotle formulates in Physics several times and in various ways .
However it's evident, that a single, strong geometrical aspect doesn't cope with interpretation of Physics, so it isn't sufficient without the metaphysical aspect. It's undoubted, that Aristotle' definition hasn't only geometrical validity, as he uses it in the explanation of the motion, in a kinematical, or rather metaphysical theory. Therefore the difference is obviously ontological, that is metaphysical, and this is the plus that Waschkies' geometrical aspect can't give. While Aristotle adds to the geometer's viewpoint the reason, that the point is representing another thing than the line.
Aristotle's consideration is more than the geometer's not only in that he can see the full circle of the entities and the difference of it from the conceptual entities, but he what is more surpass him: while he uses geometry to another level of being, to the study of the proper natural entities. Hereby he set the geometrical base in the deep structure of the kinematical theory: the continuity of the geometrical line will represent for him the route and time of the motion of the natural entities, and the process of the motion. The geometrical analogy, the results of the general theory of proportion can serve the account of motion in that way, that they represent the factors of motion: the moving body, the route and the time of motion and various states of change. This is the plus Aristotle adds to the results of geometry.
We can try to examine this plus of the metaphysical viewpoint in some single points. (1) The complexity of the theory of continuity is revealed in that its definition includes the natural entities and all of their motions and changes. (2) Aristotle indeed contracts the two definitons of continuity and uses them together, it's evident for example from the argument of **Z**/3.
(3) Aristotel's kinematical and metaphysical definition of continuity has some ontological plus of course not only to the contemporary geometers, but it's differing from the modern mathematics too, so it isn't comparable to the Dedekind-continuity without conditions.

(4) The Plato's dialogue "Parmenides" is a more important source of Aristotle's inquiries, since Plato also proceeds to the problem of point-present (moment), even as the problem of the continuous division; though it hasn't an ultimate solution, but it remains a paradox. Therefore we don't think it right to claim that the antecedents of the theory of continuity could be only mathematical. Moreover Waschkies because of his viewpoint from history of mathematics can't consider that the definition of contact by Eudoxus – which is about the fusion of points - can agree in Aristotle's account with the stricter definition by Aristotle – which regards only the things that have expansion.
After all it's obvious, that we can divide the arguments and knowledge which belong to the mathematical region from those which belong to metaphysical one, but Aristotle's account of motion as natural philosophy can't be explained without the co-operation of geometry and metaphysics.
Notwithstanding the absolutely useful result of Waschkies' research is that there is a stark base of the theory of proportion in Physics. Therefore it's reasonable for us to attempt to adjoin to an explanation of motion by δύναμις-theory with a less known side of Aristotle's natural philosophy: with an explanation by the theory of proportion, which was maybe earlier than this, and which supports that in any case. We will see that it's a specially significant idea in the analysis of the book **Z**.

In the **second chapter** we will consider the metaphysical aspect of the continuity first through the work of Michael J. *White* "The Continuous and the Discrete". White investigates anachronistically by means of the modern logics and from anachronistic point of view, according to the state of modern science. However his preconception in the interpretation isn't anachronistic, in so far as he is conscious of it, that Aristotle thought in another scientific paradigm than we. So he tries to interpret Aristotle's account through analyses of using the modern logics. He want to explain Aristotle's kinematical-metaphysical model, but only in a metaphysical aspect, and through analyses of picking out some details. He collects some aporias on the interpretation, but he doesn't get the recognition, that we understand the δύναμις-theory only together with its geometrical roots.
We will initiate adjoining to White some other more recent researchers into our inquiry, who hold their principal job to reconstruct Aristotle's theory beyond the critique of him, and in order to be acceptable for the modern science. Nevertheless all of them indeed ignore the geometrical base of Physics from the theory of proportion.
In this chapter we will try to understand the aporias of the interpretation kinematics in the book **Z**, and try to use the theory of proportion in doing it. One of the hardest issue of it is the **Z**/4-8, where according to some recent interpretation we can find incompatibility from the definition of motion and the kinematical theory. In brief: if motion is in the same manner divisible into motion-segments, as the line, rather continuously, that is infinitely, then we come up against the aporia that one process of motion come to its end always at these segments. However in this case it won't be true that definition of motion according to motion is an actuality of a potential being as potential being. Though the aporia may be answered, if we take into consideration all of the macrostructural relations of the book **Z**, and keep in mind every theses Aristotle says. It will be clear, that Aristotle maintains that one continuous motion has one beginning and one end, in order to it accomplish one aim. Moreover we have to consider, that the kinematical arguments in **Z**/4-8 are written first to last through the theory of proportion: namely they compare the full motion and its other factors with the parts of motion and the parts of the others. The essence of the argumentation is everywhere, that the

parts together make out the whole. Therefore undoubtedly, through the theory of proportion we can't talk about the actualizing parts of motion in the parts of the line. It is sure that it’s simplier to speak of the process of motion through the δύναμις-theory of the book **Θ**: and claim the parts of the line only finish some potential motions, that is at the ends of them can stop the body but it doesn’t actually. Finally in the **third chapter** will follow the utilization of the collected information: we attempt to sum up the macrostructural order of arguments in the book **Z**. First we will once more survey those stylistic problems, which obstruct the understanding of the language of Physics. Such is for instance the trouble of the usage of the technical terms; since Aristotle sometimes is careless and uses the same term in one argument according to two different definitions.

The structure of the book **Z** gives evidence to the co-operation of the geometry with the metaphysics. While the subject of **Z**/1-3 is the point-present: for the indivisible (that is a point) doesn’t construct a continuum, and the motion (and its contradict the rest) is continuum, that’s why in the indivisible it is neither motion nor rest; only in the divisible, so in the phase of time.

The subject of **Z**/4-8 is the line-time; here because of the antecedents Aristotle’s theory has to answer the question what is the meaning of the infinity of the line-time, namely how is divisible the phase of time according to the motion and change of the natural entities.

In accordance with **Z**/4 it’s necessary that all the factors of the change be divisible into parts.

On the basis of the Z/5 it’s necessary that all the factors of the change be continuously divisible: the first πρῶτον is that there’s always a first point, in that the body has changed; and the second πρῶτον is still that there isn’t in any change an absolutely first point of division and part of the line. In consequence of all in the **Z**/6 he claims that the whole of change is a process (continuum), which is infinitely divisible on the analogy of the geometrical line and point: and the third πρῶτον is this primary time. In accordance with **Z**/7 the continuity of change corresponds to the infinity “by division”, according to it the factors of change stand in ratio, namely they’re commensurable with one another. Nevertheless they aren’t commensurable with the infinity “by addition”, since it hasn’t real boundary points, in accordance to which it could be divided. Moreover in **Z**/8 Aristotle maintains that there isn’t first time of coming to rest and the rest for they belong to the area of the definition of motion. Finally in **Z**/9-10 we will make it clear, how can some aporias of motion be answered which other thinkers consider in consequence of Aristotle’s theory that has previously expaunded. Because of it will be evident to what extent is better Aristotle’s theory.

After all we may declare attempt of interpretation to be successful that had the aim of applying the co-operation of geometry, kinematics and metaphysics to the explanation of Aristotle’s natural philosophy through the deep structure of continuity.