RCTHS

RESEARCH CENTRE FOR THEORY AND HISTORY OF SCIENCE

Special seminar of

RESEARCH CENTRE FOR THEORY AND HISTORY OF SCIENCE

with

Robert Hahn & Dirk L. Couprie

3rd March 2014
Sedláčkova 19, 306 14 Pilsen
room RJ-209

14:30–16:00

Did Thales Discover the Pythagorean Theorem?

Robert Hahn
Professor of Philosophy, Southern Illinois University Carbondale

16:30–17:30

Thales and the Solar Eclipse of 28th May 585 BC

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Did Thales Discover the Pythagorean Theorem?

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Throughout the 20th century there had been increasing doubts about the connection between Pythagoras (c. 570–495 BCE) and the famous geometrical theorem that bears his name. While there were late reports claiming Pythagoras was connected to the theorem, the little evidence from the 5th and 4th centuries became discredited, and the late reports lost their persuasive force. With the publication of Burkert's magisterial work in 1962 (English translation in 1972), the state of scholarship not only disconnected Pythagoras from this theorem but moreover with any contribution to mathematics at all. Since the last twenty years, however, Zhmud has been arguing for a review of Pythagoras in a variety of ways, including his contributions to mathematics and connection with the theorem. His recent book, *Pythagoras and the Pythagoreans* [Cambridge, 2012], has challenged these 20th century theories, and has re-opened the doorway to investigate Pythagoras and the theorem. If he had discovered, proved, or somehow had the mathematical intuitions about the connections between the sides of a right triangle, how might he have done it? And, perhaps more importantly, what does the theorem mean? And what could it have meant to a Greek of the 6th century BCE when there were no Greek texts in geometry, and in Hellas, geometry was in its infancy? What is it that someone would know if he or she knew the Pythagorean theorem? Could answering these questions, and taking this new approach with diagrams, lend a new window into this perplexing debate?

My project began when I realized that the evidence for Thales' forays in geometry were more clearly documented and the evidence more robust than for the legendary Pythagoras. So, I began there to see what picture forms about Thales' geometrical knowledge, and throughout I allowed my understanding of him to unfold in geometrical diagrams. If you look at the classic studies in early Greek philosophy by Zeller, Burnet, Kirk and Raven, Guthrie, and Barnes you will see hardly a geometrical diagram. Even O'Grady's recent book called *Thales of Miletus* has more than 300 pages but not a single diagram. So, this approach, so far as I have been able to determine, has never before been attempted, and certainly not in a full-length study. I call it *The Metaphysics of the Pythagorean Theorem*. I start by exploring what anyone would have had to imagine had they tried to measure the height of a pyramid both at a time of day when shadow length equals the height of the object that casts it, and also when the shadow is un-equal but proportional. We have reports that Thales used both techniques. And I recreated these measurements on the Giza plateau a few times with my students. Then, I place these diagrams side-by-side with what anyone must imagine to measure the distance of a ship at sea, another project in applied geometry attributed to Thales. And then I place all of them together with geometrical diagrams of the theorems with which he is associated. And after bringing all these diagrams together I ask a question that my colleagues have asked before but propose a new answer: What was Thales' doing with geometry? The usual reply is that he was a practical genius and took an interest in practical problem

solving. And in my opinion, there is something right about that answer. But what is missing is the metaphysical meaning and usefulness of geometrical techniques.

Once we see the metaphysics of the so-called Pythagorean theorem, and once we recall the geometrical diagrams that are connected with Thales, and add to them what we know about Thales' *metaphysical* project – water is the *archē* – we shall have a plausible, though of course speculative, case that Thales knew at least one interpretation – an areal interpretation – of the famous hypotenuse theorem. And furthermore, we have reports that, although late, are perfectly plausible that Pythagoras met with and studied with Thales and Anaximander. Since both Milesians are dead by 545 BCE, such meetings would have had to take place before then, not unlikely between 555 and 550, when young Pythagoras was more or less the age of our undergraduates. I propose that it was the *young* Pythagoras, not the elder statesman, who learned the hypotenuse theorem from Thales, but I will show why Thales missed the metric or numeric interpretation of it. And then I will go on to propose how young Pythagoras might have solved the metric interpretation in the process of his project of arithmetizing geometry. For this, I turn to a project in Samos – the digging of the tunnel of Eupalinos – that I now suspect was significantly earlier than the 530s when it is often dated, probably in the early 540s. Pythagoras might well have just returned from meeting the Milesians when he sought to confirm Eupalinos' hypothesis of the proposed lengths of each of the tunnel halves. Here we have a successful project that shows, above all else, that number reveals the hidden nature of things.

I regard the account by Pythagorean Timaeus in Plato's dialogue by that name to go back directly to Pythagoras, even in nascent form – the problem of constructing the cosmos out of triangles [53cff]. To see this thesis, my argument shows the metaphysical connection between ratios and proportions, the hypotenuse theorem, the theorem of the application of areas, and the construction of the regular solids from right triangles. *But this project was initiated by Thales who came to see the right triangle as the fundamental geometrical figure into which the whole cosmos reduced as its basic building block. Thales search in geometry shared the same strategy of inquiry as his search in nature: he was looking for the fundamental unity that underlies appearances*. Thales came to grasp an areal interpretation of the hypotenuse theorem in his search for the geometrical figure that was to *hudōr* as *hudōr* was to all other appearances, for this is part and parcel of what the hypotenuse theorem means. If everything is made of *hudōr*, how does it now appear fiery, and now airy, at one moment it flows like liquid and at another it is hard as stone. How does it do this? This is the Milesian problem of *transformational equivalence*; geometry offered a way to explain how one basic stuff can appear so divergently by transforming the building block of triangles into parallelograms and rectilinear figures of different shapes but with the same areas. That's how the cosmos is made of some single stuff and yet appears so divergently.

Thales and the Solar Eclipse of 28th May 585 BC

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It is told that Thales foretold a solar eclipse, and the most obvious candidate is that of 28th May 585 BC. Many scholars have wondered how he did the trick, but none of the several regular cycles of eclipses was able to produce the wanted result. I will show that the data of eclipses, gathered during Thales' lifetime, provided an apparent but accidental regularity that naturally lead to the prediction of the right date. Other scholars did not discover this because they made a silly mistake that prevented them from seeing the apparent cycle.

VÝZKUMNÁ SÍŤ
TEORIE A DĚJIN VĚDY

Special seminar
in Ancient Philosophy
with

Robert Hahn & **Dirk L. Couprie**

4th March 2014
Sedláčkova 19, 306 14 Pilsen
room RJ-209

14:30–15:30

Thales Monism, Transformational Equivalence, and Anaximenes' Material Felting

Robert Hahn
Professor of Philosophy, Southern Illinois University Carbondale

16:00–17:00

Anaxagoras and the Solar Eclipse of 17th February 478 BC

Dirk L. Couprie
Independent Researcher, Amsterdam

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Thales Monism, Transformational Equivalence, and Anaximenes' Material Felting

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The Ionian *phusiologoi* stand at the origins of western philosophy. According to the conventional view following Aristotle's lead in *Metaphysics A*, Thales and Anaximenes each postulated an original, primordial substance – *hudōr aer* – that transforms into diverse appearances without ceasing to be that original stuff. Thus all change must be ultimately and only alteration of "water," or "airy-mist." There can be nothing new that comes to be since all appearances are only different expressions of the original underlying substance: Material Monism [MM]. Daniel Graham, however, has argued recently that Aristotle got it wrong – as he has in other cases – and thus also all who have followed his lead, ancient and modern; while the Ionians did claim that in the beginning there was an original stuff, that original stuff perished in the process of generating other new things: Generating Substance Theory [GST]. And from this new interpretative starting point, Graham offers a new, fascinating reading of Presocratic philosophy whole cloth. In this paper I wish to focus only on Milesian beginnings, and not the consequences that Graham offers on the condition that his new reading is correct. Can the case be made that Aristotle's account of Milesian Material Monism is mistaken and that, instead, Thales and Anaximenes, and for that matter also Anaximander, were proponents of GST?

Graham offers what he regards to be arguments that are both "historically appropriate" and "philosophically coherent" to make his case, and while exploring his claims I wish to raise a new line of approach that I have opened in my last book *Archaeology and the Origins of Philosophy* [Ancient Philosophy Series, State University of New York Press, 2010] as to what *also* counts as "historically appropriate" and "philosophically coherent" that Graham never considers. Graham tends to pass over Thales because he regards the evidence as too exiguous. But it seems clear that he regards Thales as likely sharing the same approach as his Milesian compatriots. Anaximenes, and Anaximander, illuminate cosmic processes by appeal to material "felting" [*pilêsis*]; can archaeological resources lend support to or undermine Graham's thesis? And if archaeological resources can lend clarity to traditional debates in classical scholarship, what new light does this shed on what *also* counts as evidence that is "historically appropriate" and "philosophically coherent?"

When Graham examines the doxographical reports on Anaximander's cosmology, he understands that in the beginning was the *apeiron* and from that, by some quasi-biological process, a seed is generated, and from that seed comes the opposites – hot and cold, wet and dry – and in turn the "elements" that are comprised of them. Thus, hot and dry fire surrounds the cold and moist earth, like bark around a tree, and somehow gets separated off into concentric wheels of fire that we come to call the sun, moon, and stars. In Graham's take on the reports, the elements transform out of each other and perish into each other, but the *apeiron* does not seem to enter directly into these processes. Thus, in Graham's estimation,

Anaximander does not appear to be a Material Monist, and from this reading of him Anaximenes could not have inherited MM either. But, it should be noted that many commentators interpret the only surviving fragment to read that "when things have their origin, into that they have their perishing"; it is from the *apeiron* that plurality emerges and it is back into the *apeiron* that all diverse things return ultimately. Graham's reading that the interchange is between the elements has had support, but a substantial assembly of scholars has advocated the reading that origins from and perishing into finds as its locus the apeiron.[1]

On Graham's view, Anaximenes' embrace of *aer* as the originating substance allows it to continue in the resulting world (Graham, p. 83). Like Anaximander, according to Graham, Anaximenes' originating substance articulates into successor states, but Anaximenes describes the processes of condensation and rarefaction as the mechanism by means of which "he can at least adumbrate the laws that operate on physical objects and ultimately maintain cosmic scales in balance" (Graham, p. 83). Thus "Anaximenes' great achievement is to fill in the gaps of Anaximander's grand vision with details…" (Graham, p. 83).

How does Graham defend this interpretation? He claims that it is "historically appropriate" because it does not suppose a sophisticated ontology (Graham, p. 80). Had the Ionians been proponents of MM they would be positing an underlying substratum that persists throughout the changing appearance and Graham can find no evidence for this sophistication. And Graham presses this point further when he contends that GST is more "philosophically coherent" because MM requires an account of an ultimate reality beyond the sensible attributes that we perceive, and again, he can find no evidence for such an Ionian account. Moreover, Graham emphasizes that in the doxographical reports, Simplicius uses the term *gignesthai* and Hippolytus uses the term *apogonoi* in explaining Anaximenes' position; these terms suggest the kind of coming-to-be, more than mere alteration of a primordial stuff, that seems inconsistent with MM.

With Graham's thesis and its background debate in mind, I will turn to consider what the archaeological resources can supply about "felting" Can we assemble the evidence of what Anaximenes and his compatriots believably saw when they watched the process? When we isolate the evidence so far as possible can we understand better why this particular *technê* seemed appropriate to Anaximenes, and Anaximander, to describe and/or illuminate cosmic processes?

I tracked down craftsmen still working on the west coast of Turkey, in Tyre, a short distance from Miletus, and I photographed them making felt in what seems to be the same simple, traditional process in which felt was produced thousands of years ago. I will show this process as part of my Powerpoint presentation and let the audience decide if it adds clarity to this debate.

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[1]There are scholars who take an approach shared by Graham, for example Kahn, Schwabl, Vlastos, perhaps Heidel, while those like Nietzsche, Schmitz, Gadamer, Freudenthal, Stokes, Hoelscher, and Couprie adopt the "*Apeiron*" reading. An important issue to be resolved here is to explain 'why' Anaximander might have postulated the *apeiron* as the originative stuff if it played no further role in the explanatory narrative.

Anaxagoras and the Solar Eclipse of 17th February 478 BC

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Daniel Graham, in his latest book, argues that Anaxagoras had measured the size of the sun with the help of a solar eclipse. The idea was proposed earlier, but with other eclipses than that of 17 February 478 BC that went over the Peloponnesus and could be observed in Athens. I will show that Graham's attempt is based on assumptions of modern astronomy which do not hold for a flat earth, and that its execution yields insurmountable problems. An alternative method, proposed by me, Graham calls "excessively complicated". I will show that a rough and simpler version of the same method also leads to the desired result.