RCTHS
RESEARCH CENTRE FOR THEORY AND HISTORY OF SCIENCE

Special seminar of

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with

Robert Hahn & **Dirk L. Couprie**

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Did Thales Discover the Pythagorean Theorem?

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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.