The Greek Philosophers and the development of science. Will their influence also lead to the completion of science ?

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Abstract

In this paper it will be argued that Ancient Greek Philosophy, seen from the point of view of contemporary science is not only important but also of guiding influence. Many scholars are of the opinion that science has, in many aspects, reached its final success, that the truth has already been attained and further research in all the fields of science is not deemed necessary. The best that may happen is that very small modifications may occur, but still no new substantial discoveries could in principle be made because we have reached the limits of what is to be known. What is more, is that this possible dramatic event, even though far off in time from the the Greeks, may have something important to do with them. In this respect, a few questions will come under consideration such as: Were the basic scientific guidelines that came from the Greeks, ways of thinking which led science to this high mark and end limit? Could it be claimed that the influence on science is in all aspects related to the Greeks? What about so many other cultures and technological civilizations? What would the important influence of Greek thinking be on contemporary scientific thinking? Is it really the case that the Greek influence would bring science to its completion and end? These questions immediately brings two issues to the fore a) the possibility of other technological civilizations that influenced the development of science until today and bj the possible end of science. Although these two issues, are distinguishable issues, the first one is a necessary condition for the second one. The article is designed by faking this conditionality into account.

1. Introduction

The importance and relevance of Greek Philosophy seen from the vantage point of contemporary science, seems to be, time and again, of a guiding influence. Today the issue of the possibility that science is nearing its completion and end is becoming more widespread. It is a serious possibility considered by many scientists especially in the natural sciences. If this is to be the case, science would have fulfilled its project of research, would have

fulfilled its task of arriving at complete knowledge. It would have 'arrived' in an epistemological sense. The truth would have been attained and further research would not be deemed necessary. Only very small modifications may occur, but no new substantial discoveries could in principle be made because we have reached the limits of what is to be known. Science can in such an event "close its books!!" Science would have reached its final success. What is more, is that this possible dramatic event, even though far off in time from the the Greeks, may have something important to do with them. It is now asked whether the basic scientific guidelines as well as ideas coming from the Greeks, are ways of thinking which led science to this high mark and end limit.

This article would like to investigate this matter. To do this, the question must also be asked whether one could really claim that the mentioned influence on science was due only to the Greeks. What about so many other cultures and technological civilizations? What would the important influence of Greek thinking be on contemporary scientific thinking? Is it really the case that the Greek influence would bring science to its completion and end? For the purposes of this article we thus have two issues: a) the possibility of other technological civilizations that influenced the development of science until today and b) the possible end of science. Although these two issues are distinguishable issues, the first one is a neccessary condition for the second one. The article is designed by taking this conditionality into account.

Did the Greeks prepare the way for science or are there others too? To assess this matter, let us pay attention to the first great contribution of Greek thinking. The primary influence of Greek thinking was to "demythologize" the world. Greek explanations of the world and universe were not the first in the world. It is rather the way the explanations occurred. Myths were prevalent among all cultures in the world about the 6th and 7th C (including the Greeks themselves). Many myths also included explanations of phenomena. These explanations made sense to the adherents of such myths, in that it gave them a satisfactory explanation of strange and new phenomena, like earthquakes, falling stars, and many others. It helped them to relate to the world. It helped them to understand themselves and bonded them together. For one or other reason which is still inexplicable today, the Greeks were the first as far as we know who systematically started to break through the barriers of non-theoretical mythological explanation and come forward with rational-theoretical explanations of the world and universe.

Is it not possible that others outside Greece might have done the same? Is there not a possible Western prejudice in favour of the Greeks? What about superb technology among the Egyptians, Babylonians, Chinese, Incas, Toltecs,

and others? Did they not, in a similar way, do science and engage in rational thinking? How would the good astronomy of the Babylonians, and mathematics of the Egyptians be possible, without a likewise rational approach to the world? These questions are indeed important and relevant.

It would be no problem if these questions should be answered in the affirmative by new discoveries and insights coming from outside Greece. It would in fact say something wonderful about human rationality and inventiveness. It would also not minimize the Greek contribution, but rather confirm convergence in human rational endeavour.

There is increasing evidence that the Egyptians (and/or possible precursors?) displayed an astonishing amount of objectivity in studying certain phenomena, especially empirical issues. The technology underlying the building of the pyramids still baffles our comprehension on how this could be possible. (This apart from other buildings.)

It is sometimes claimed that Greek science is Babylonian and Egyptian in origin and thus not original. This claim about extra-Greek origin is not unfounded. However, the conclusion of non-originality does not follow from this. But does it change the Greek position in relation to modern and contemporary science? Let us look at this matter, as well as the possible imminent end of science, which is claimed by many scientists as a contemporary extension of Greek grand unifying theories, like Thales, Anaxtmander or Plato.

The Babylonian mathematics which initially used 60 as the key number was quite advanced from a modern point of view. They made use of fractions. The theorem of Pythagoras was known to them 1200 years before Pythagoras! Let us take a turn to the outside ie., extra-Greek world to assess the issue. Let us focus mainly on the example of the Chinese civilization.

2. Greek, as well as extra-Greek science and technology. Special reference to the Chinese civilisation as example.

One can take note of the fact that the Chinese, like the Greeks developed non-mythological explanations of nature. Their technology was very advanced and achieved much more than the discovery of gunpowder. However, we must distinguish technology from science. And also in this area there were advances in China. From time to time, mathematics (algebra, but not geometry) advanced. A good example of attempting a rational explanation of the world is the theory of the elements.

The theory of elements is better known in its Greek context. Empedocles of Agrigentum of the 5C BC is known to be the founder of the system of the four elements: fire, air, water and earth. To the elements he added the principles of friendship and hate. These two governed the combinations of the four. The elements thus could combine. Plato strived for an even more rational base for the elements and the same applies to Aristotle. Without knowing it, Plato began to talk in the same kind of language as is used in contemporary DNA and RNA theory in genetics, by understanding them in terms of letters *[Stoichea).* Just as in DNA and RNA the letters are not only carriers of information, but enhance the information, by combining to form words. Likewise Plato let the letters combine to form words. Unlike DNA and RNA, the focus here is not on information carried on further, but rather as ways of explaining the combinations of the elements. Plato used mathematical deductions to discuss the elements. He tried to confirm that the earth consisted of at least four elements using a ratio of the elements. He further deduced a further element which he called *aether.* This is based on correlations of the elements with regular *polyhedra.* This aether element played an important role in modern Newtonian theory and classical mechanics. Plato was not aware that even through the falsification of *aether* in modern times, it contributed to the birth of Einstein's Theory of Relativity. It *[aether]* was falsified by the crucial Michelson-Morley experiment at the end of the 1 9 century. In a way, this paved the way for the Theory of Relativity.

Aristotle's somewhat less mathematical approach than Plato, being more of a philosopher than Plato (an idealist Philosopher), used empirical and physical evidence to explicate the theory of elements. Aristotle once more came with the idea of a primal matter, but unlike the Pre-Socratic philosophers, he did not identify it with one element. He stated that the primary matter can only have appearance if it is combined with some kind of property, which he pointed out as heat over against cold, moistness and dryness. In a quite modern chemical way of thinking, the elements would be transformed into others, by changing the properties. One dominates the other in one of elements. Once more it is for physical, rather than mathematical reasons that he argued for the existence of the fifth element *aether.*

All this is clearly an attempt to explain the world rationally. The Chinese also came with a similar theory of five elements. Not *Stoichea* but *Wu-hsing.* ("Wu" means five, whereas "Hsing" seems to have meant powers, forces, or agents - thus the five powers). This was founded by Tsou Yen about 300 BC. He is regarded as the founder also of the opposing forces of nature the Yin and Yang. For many ages the elements as well as the Yin and Yang, are seen together as explanations of how the world operates, of how things fit together. The Chinese elements are fire, earth, water, metal and wood. Unlike the

Greek elements, these are not physical substances, but metaphysical forces operating in nature. Yet, it is a rational construct. Especially seasons and physical objects are governed by these elements or forces. The yellow dragon was the beast of the element earth. Like the Greek hate and love, the Chinese connected it with anger (wood), joy (fire), desire (earth), sorrow (metal), fear (water). It differed however from the Greek theory in an important way, in that it did not allow for a combination of the elements.

What we note here is that independently of the Greeks, the Chinese culture (examples from cultures elsewhere could surely also be supplied, e.g. Egyptian medical analysis which was even more objective-rational) also developed attempts at a rational explanation of nature. The Chinese philosophers with the system of five elements surely tried to steer away from a mythological explanation. It used observations to give ground to their non-mythological explanations to make sense of the world. Both the Greek *Stoichea* and Chinese *Wu-hsing* together with explanations, also tried to make predictions - a characteristic of modern science. The same human curiosity among the Greeks also appeared here. It is part of a common rationality. In the 4th C BC it nearly happened that the same development as that of Greece occurred in China, i.e. a rational-abstract-methodological way of thinking. Mo-tzu worked out methodology and discussed it. It became, for a time, the fundamental guideline and basics of Chinese natural science. In fact Mo-tzu and followers after him (the "Mohists") came very near to a comprehensive theory of method like that of Aristotle (Huff: 244).

But what happened? Mohist thinking, unlike that of Plato and Aristotle faded away in China and had no influence on scientific thinking (Huff:244). It was never systematically followed up by further and new thinking. Why? It could not only be the background of mythological thinking, because these examples indicated even an tendency, from time to time, to move away from mythological explanations. In fact, especially outside natural scientific areas, Chinese thinking occurred which can be called highly sophisticated-rational. This includes the thinking of Confucius, and Chu Hsi. The problem is that it is here where most evolving possible theoretical thinking remained stagnant (important as it is otherwise), namely human problems and needs. The focus was on practical wisdom, like Confucian virtues such as filial piety, loyalty and human kindness (Huff:254). One could say that China did not move away much from its own Socratic period. When it then comes to empirical sciences, it remained at sporadic insights and developments. Wen-yan Qian in his book "The great inertia: scientific stagnation in traditional China" claims that China was more efficient in practical and technological applications, but not in theoretical understanding. This, according to him, led to the "great inertia" of Chinese science (Ibid: 238).

We thus find no systematic scientific development of science in China. There is, I would say, continuity - an essential necessity for scientific development and so advance. If there there is no continuity, there could also not be discontinuity! Discontinuity is sometimes just as essential for the same scientific development. This seems to me to be absent in China, i.e. scientific revolutions or upsurges, like the heliocentric revolution. The Greeks were influenced by other civilizations. But this is an important point: Science grows through interacting influences. It is not a disadvantage. Science is by nature open-minded and open-ended. The Greeks did not see Egyptian and Babylonian influences as a threat, but assimilated these influences and redirected them in its own way. The result was innovation on an unprecedent scale in the West. In China, there were several foreign visitors and contact with other civilizations, for example, the Muslim Arab and Persian civilizations and later the West via the Jesuits. (Ironically the Jesuits at that stage brought astronomical and other knowledge to China, but withheld knowledge of the heliocentric Copernican theory!). These influences, especially before the Jesuits had no influence or effects. Even though Muslim astronomers were hired in the Chinese imperial court, their knowledge was never disseminated and integrated into Chinese science!

3. Inhibiting factors

Why was the knowledge not disseminated? There must have been inhibiting factors, whereas in Greece there must have been non-inhibiting factors and even factors that were conducive (to science), as well as facilitating factors.

Important inhibiting factors in China were political, legal and social situations. In the light of these, a necessary prerequisite for scientific thinking, namely a sphere of independent thinking, where there is no interference from political or whatever factors, was absent in China. Despite many brilliant scholars, Huff (238) contends that the lack of intellectual freedom and its effects caused the Chinese to lag behind in astronomy, physics, optics and mathematics. Chinese rulers developed a strong and powerful centralized administration of authority throughout China, especially from the Sung dynasty, since 960AC. Later it was so powerfully carried forward that centralized authority was invincibly lodged in the hands of the emperor: The power of the emperor extended down through an efficient chain of command to the village level of everyday life. While Europe was busy with a gradual decentralization program by separating the state and church powers and eventually the legislative, executive and judicial powers, China embarked upon this unprecedented centralizing program - a vast network of overlapping and countervailing officials served to guarantee the centralized

and later autocratic rulership of all of China. There was no legal space for the rise of autonomous cities, towns, universities and other institutions (Ibid:257, 258, 261). From this, one could deduce that disinterested and independent inquiry would be out of bounds and stifled.

Bodde (291, 292) is of the opinion that the Chinese alphabet and language was far from ideal for scientific communication, because of archaic usages, ambiguity, ancient lack of punctuation, ignoring paragraph indentations and lack of continuous pagination. Though there may be a point in this, I think this is debatable, since many other good works did come through quite effectively in Chinese. A stronger factor I would argue is rather that the Chinese verbatim taking over of previous thinkers and pasting them to the own work, inhibited critical-dialectical thinking. Bodde calls this a scissor and pasting technique (299). Brilliant Chinese astronomers like Shen Kua who came with original insights, left behind a scattered set of writings that lack theoretical acuteness and organization: Notices of the highest originality stand cheek by jowl with trivial didacticism, court anecdotes. and ephemeral curiosities, providing insight. He nowhere organized his observations into anything like a theory.

Bodde also argues that it is especially the Chinese tendency towards correlative thinking, characterized by the constant usage of paired dualities, that resulted in the empirical not being a guiding principle. According to him, this way of thinking was especially strong among the Chinese literate elite, and thus affected philosophical thinking in the sciences. This especially refers to the Yin Yang duality or polarity: The world at all levels is a balanced set of paired forces, units, or elements. The most elementary would be heat and cold, heaven versus earth. Under the Yang primal force there are the qualities of brightness, heat, dryness, hardness etc. Under the primal force of Yin there are the contained opposing qualitites such as darkness, wetness, cold, softness, etc. (Ibid 297).

Bodde concludes that the desire to create symmetry and centrality within the dualities displays a highly refined sense of harmony and balance. The desire to attain centrality of expression in thinking, is represented by the pairing of elements in such a fashion that the grouping is always placed at the centre of a linear or spatial sequence. The principle of symmetry implies a sense of absolute orientation of a sense of being related to a central point, namely the *axis mundi*(298).

Bodde's argument on the pairing and symmetry is not convincing. That this did play a strong role in Chinese thinking can be granted. His conclusion however, that this inhibited causal thinking and the development of scientific

thinking does not follow. In fact, the thinking in terms of dualities could be conducive to critical dialectical thinking, because the idea of opposites is accepted. The Greeks also frequently operated with the idea of opposites and the unity of opposites, although not in such a fundamental way at all times. The Greek basic concept of Cosmos is clearly also refers to fundamental symmetry, order and harmony. I would rather conclude that the argument concerning centralization and lack of independent thinking and enquiry, which was enforced by the emperor, strongly inhibited scientific progressive development. It also enforced mythological approaches.

The rational attempts of the Ancient Greeks since Thales of Miletus had an enormous advantage: The systematic character of its rational explanations. The basis thereof was demythologised to such an extent that it became a systematic way of doing things, of going around in the world, of explaining the world. For more than one reason the same did not occur in Chinese, Babylonian and Egyptian science and technology. Without trying to devalue the role and even importance of myths in human society, myths stand opposed to theoretical-scientific analysis and open-endedness in explanation. A myth also differs from legends. Because of the non-theoretical and sometimes irrational elements it includes, it could historically never develop into a basis for a systematic and so ongoing way of doing things by trial and error. In fact, even a rational attempt like the Chinese five elements was embedded in all kinds of myths. It so developed into a more closed, non-open-ended approach.

In the case of the Greeks, the rational way of communicating with the world also eventually developed into an explicit taking of a critical distance at the own way of communicating with the world. One can find this critical stance and distancing in the dialogues of Plato and the Physics of Aristotle and other works.

4. The change that theory brought about

It is not accidental that Greek philosophy and other sciences flourished in Athens. Athens was the city state which also was a democracy. There was a correlation between Solon's constitutional reforms in Athens and the advance of thinking and science in Athens. The constitution was designed to be transparent for all citizens. Unlike the emperor in China, there was a definite atmosphere of free inquiry and critical discussion. This is the reason why mathematics, astronomy, medicine and physics progressed systematically like never before or elsewhere - as far as we know. By 100AD, Ptolemy's astronomy reached such a level that the well-known Thomas Kuhn called it a

mature science, and that even now it cannot be understood fully if you do not have technical knowhow and theoretical knowledge. They opened the door for Geology to become a science: The science that studies the structure and morphology of the earth. Erastothenes made the first accurate measurement of the earth's diameter. He gave a rational explanation for earthquakes and volcanic activities which elsewhere always had a mythological explanation, e.g. the anger of the gods. Aristotle gave a rational geological explanation by claiming that volcanic activities are caused by the earth's own heat and heat from the sun. Volcanoes, he said, marked the points at which the winds inside the earth escaped from earth into the atmosphere. Perhaps not today's explanation, but the point is that it is a rational non-mythological explanation.

The same can be seen with regard to the biological sciences. Charles Darwin was quite original in his great contribution to science, namely the theory of evolution. His originality did not lie in the concept of evolution, but in developing it into a Newtonian style theory, with causality manifested in the causal mechanism of natural selection. The originality of the concept of evolution comes from the Greek philosopher Anaximander. Darwin studied these Greek philosophers. Anaximander and other Greeks wondered how things began, how they functioned, how they developed and whereto they were developing. Anaximander's answer to these questions was the concept of biological evolution: life originated as a result of water and heat interacting with each other (This is astonishingly contemporary: Post Darwinian evolutionary theory regards energy, water and organic molecules as the three pillars of the origin of biological life) which led to the first life forms. These evolved into fishes. They evolved into animals when they moved from sea to land (as in modern evolution theory) and eventually humans evolved.

Aristotle gave new modifications to the theory of evolution. This is a good example of how science grows so that one explanation when falsified, paves the way for another explanation. When there is a mythical explanation, the one explanation is not exchanged for another, because it as adhered to as a final truth. Not so in Greek science. Many important changes within astronomical explanation in Greek astronomy can be recorded, e.g. the epicycle explanation in the rotation of planets. The rational approach involved the usage of logic and methodology. Chinese astronomy was inhibited because it was tightly woven into the court of the Emperor. As part of Chinese outlook there was a strong connection between the "mandate of heaven" (i.e. the emperor) and all terrestrial and super-terrestrial events. The chief astronomers were the official Chinese bureau of astronomers, especially at the beginning of the Ming dynasty (Ibid:240). The astronomers were not even aware of the significance of the changes in geographical locations in the making of astronomical calculations. This is why Ho Pang-yoke wrote that any

change in astronomical instruments was only possible if allowed and ordered to by the Chinese emperor. Yes, nothing could be done in the realm of astronomy or astrology without the permission of the emperor. Astronomy was treated as a state secret due to the mentioned linkage between heaven and earth (Ibid). A strange, but powerful veil of secrecy prevailed not only in astronomy, but all other sciences. This is just the opposite of the requirements of good science. Chinese astronomy was based on an algebra-based point estimations system, which relied upon numerical calculations rather than geometrical analysis. Astronomy thus lacked the development of geometrical models (Ibid: 240).

Aristotle's substances and other structures could be called precursors of natural laws. Deduction and inductive generalizations were made in a very definite way. The Greeks intensively applied mathematics in architecture, e.g. the building of the Parthenon in Athens. No wonder that Greece became the cradle of Western and contemporary science. Technology among the Egyptians, Babylonians, Chinese and Incas were much more advanced than those of the Greeks. Yet, the Greeks founded the basis for doing technology within the parameters of scientific theory. They, for example, applied physics in the construction of buildings. This made technologies' systematic development dynamically possible. Today with some exceptions, theory and technology or science and technology can hardly be separated from each other. The Egyptians, Babylonians and Incas or Chinese had no systematic theory. The Greeks indeed drew very much from Egyptian and others' knowledge, but the Greeks, apart from own original discoveries, turned that knowledge into science as a rational enterprise.

Looking at Chinese mathematics, we find that Chinese civilization did make sporadic advances in mathematics, but unlike the above-mentioned Greeks, it also lacked a systematic theoretical development. Needham concluded that geometry as a systematic deductive system of proofs and argumentation and demonstration was virtually non-existent (trigonometry was non-existent). China never developed a theoretical geometry independent of quantitative magnitudes. They never relied solely on pure axioms and postulates as the basis of discussion (Ibid). Libbrecher argues similarly: "Chinese geometry cannot be compared with Greek geometry because the Chinese did not have the slightest conception of deductive systems. All we find in their mathematical handbooks are some practical geometrical problems concerning place areas (Ibid: 240).

The following must be noted. I took the Chinese as an example in comparison with the Greeks. But what about Babylonian, Egyptian, Inca, Maya or Toltech civilisations? Yes, surely they cannot be equated with Chinese

civilisation. The imperial court in China was not identical to that of the Maya court. Detail will differ. Yet, there are fundamental similarities. In all these civilisations, we have superb technological civilisation and advances - even better than the Chinese. But in all cases there is as yet no evidence of theoretical science, although as in China there were sporadic tendencies to breakthrough the myth structure, e.g. the Mayan calendar system. In all cases mythological explanations played an inhibiting role. Of course, the idea that further research may lead to other insights is not excluded.

5. Abstraction and counter-intuition

The Greeks' philosophy could be claimed as a necessary condition for the commencement and development of modern and contemporary science. They brought a distance between subject and object. Without this, no rationality in the scientific sense could be possible. It is a necessary condition, because when this distinction is not made, as in mythological cultures, abstract thinking in a scientific way is impossible. In a mythological society one cannot claim that the epistemological subject and object are totally identical, but the distinction is very blurred. In the case of technological civilizations like the Egyptians, where a mythological culture still prevailed, a distancing between subject and object also occurred, e.g. in medical science with its large degree of objective observations and analysis. We have seen in Chinese culture the exceptional divergences from mythological thinking. Yet, it never made it independent therefrom as in the case of the Greeks. In strong mythological cultures, the participatory relationship between subject and object can be very strong. Many taboos sometimes existed in several areas as "no go areas" (in an epistemological sense). This inhibits scientific thinking. However, looking to contemporary times, the distinction between subject and object can and is sometimes pushed too far to the other extreme, which is equally detrimental to science than a too close unity between the two.

It is an important requirement of modern and especially contemporary science that it must sometimes act counter-intuitively, especially in the case of innovations and so creative activities. This is to assume, in the form of a hypothesis, constructs which contradict everyday experience of long and widely accepted scientific views.

Heisenberg stated the uncertainty principle in quantum theory. He made the counter-intuitive step to state that causality does not exist in quantum levels and that connected with this, we can never be exactly certain of the velocity and positions of atoms and molecules. Only by probability. Such a non-causal world is indeed counter-intuitive. Shortly after stating the uncertainty postulate

(which in the nineties has been further confirmed). Heisenberg, who attended a conference of natural scientists in Athens in 1961, claimed that this uncertainty principle, which is something counterintuitive, is something we owe to the Greek thinking. Heisenberg himself studied Philosophy apart from Physics. He in fact studies Plato in the original Greek text!

6. The end of science? An ultimate unified theory

We can now safely conclude that the present day claim about the end of science does have links with Greeks and not extra-Greeks. Apart from bringing a rational way of explanation to the world, the Greek philosophers further explained rationality in a particular way: This is to find an ultimate key or principle of reality which could be the solution to the problems of where humans and the world come from, how everything is constituted, how everything works, whereto everything is going? Thales found this ultimate principle (the *archS)* in water, Anaximenes in the *apeiron* and Anximander in air. Plato found it in another way in the Ideas or Forms. If you could reach an ultimate explanation, it is a fundamental explanation upon which all other explanations depend. But is such a fundamental explanation or explanatory theory, the last and ultimate explanation? In 1999, it seems that many important scientists are of this opinion. It would be a grand and even unified theory of everything. They argue that science then would come to its completion and end. Further research would be unnecessary and science so can come to an end and will be completed.

In our times, it is especially the famous mathematician-physicist and cosmologist of Cambridge University, Stephen Hawkins, who made this view known in his book "A brief history of time", as well as in his lecture: "Is the end of theoretical physics in sight". It would be a final theory. Physics is on the verge of finding "The Answer".

Several other scientists felt that science as a unified, objective endeavour is on the imminent brink of its end. The molecular scientist, Gunther Stent, argues in this fashion:

> *"Unlike biology the physical sciences seem to probe more deeply into matter by smashing particles against each other with greater force, and astronomers can always strive to see further into the universe. But in their effort to gather data from ever more remote regimes, physicists will inevitably confront various physical, economic, and even cognitive limits... As we gain more dominion over nature, however, we may lose what Nietzsche called our "will to power"; we may become less motivated to pursue further research..." (HorganJ: 11).*

The eminent biologist and president of the American Association for the Advancement of Science, Bentley Glass, likewise argues that not only is science finite, but the end is in sight:

> *"We are like the explorers of a great continent who have penetrated to its margins in most points of the compass and have mapped the major mountain chains and rivers. There are still innumerable details to fill in, but the endless horizons no longer exist... After all, astronomers have already plumbed the farthest reaches of the universe; they cannot see what, if anything, lies beyond its borders. Moreover, most physicists think that the reduction of matter into smaller and smaller particles will eventually end, or many have already ended for all practical purposes. Even if physicists unearth particles buried beneath quarks and electrons, that knowledge will make little or no difference to biologists, who have learned that the most significant biological processes occur at the molecular level and above... there is a limit to biology there that you don't expect to be able to ever break through, just because of the nature of the constitution of matter and energy" (Horgan:24,25,26).*

It is exactly this nature of the constitution of matter which brings the Greeks back into the picture. The fact that these scientists could argue like this, is indicative of a scientific frame of mind which was set by the pre-Socratics, Plato and Aristotle. This search for such an ultimate key or principle, the motivation to do so, did not fall from the air - it came from the Greeks. Prof. Leon Lederman, Nobel Prize winner in physics in 1981 and director of a particle accelerator, stated recently in the film "The Greeks on fire" that the contemporary search in Physics for fundamental principles is nearing the end of science. The 6 leptons and 6 quarks are indeed the fundamental of matter. This would, if completed, be the ultimate principle of all matter. Science would have arrived at its last destination. You cannot go further than these. This why they are fundamental. Lederman indicates however that this would not necessarily apply to all areas in science, for example, in chemistry.

Other scientists like Sheldon Glashow joins in with similar views, but argues that the end of physics with a grand unified theory, is the end of all sciences, because "unified" means or covers all the sciences' areas. He sees in the superstring theory the possibility which would banish the possibility that there is no ultimate foundation of physical reality but only an endless succession of smaller and smaller particles, nestled inside each other like Russian Matuschka dolls. According to superstring theory there is a fundamental scale beyond which all questions concerning space and time become meaningless (Horgan:63). The particle physicist, Steven Weinberg, argues in his book "Dreams of a final theory" that particle physics is the culmination of an epic quest of the ancient (that is, the Greeks) search for those principles that cannot be explained in terms of deeper principles. The why-question of the Greeks has led physicists deeper and deeper into the

heart of nature. Eventually Weinberg contended that the convergence of explanations down to simpler and simpler principles would culminate in a final theory and that the superstring theory might well lead to that ultimate explanation (Ibid:72)

The theoretical physicist, David Bohm, also thought in terms of a deeper ultimate reality behind the quantum world, without falling upon Einstein's classical realist philosophy. This reality could be multi-dimensional. But, once again we here also would have to do with a grand unified theory. But Bohm, like Lederman, does not necessarily see in this the end of science, although his reasons are not all exactly the same as those of Lederman.

Bohm told Horgan that science is sure to evolve in totally unexpected ways, and expressed the hope that future scientists would be less dependent on mathematics for modelling reality and would draw on new sources of metaphor and analogy. He said that we have an assumption, and this is that mathematics is the only way to deal with reality in science. Because it has worked so well in the past, we assumed that it has to be that way in the future for ever. He further expects that science and art would someday merge and that the division of art and science is temporary. The ability to perceive or think differently is more important than the knowledge gained (Ibid:88). I am sure that both Aristotle and Plato would find this argument of Bohm intriguing!

7. Conclusion

Whether science will come to an end is in my view most debatable. The philosopher of science Nicolas Rescher is also negative about such a possibility. According to his way of thinking, future new insights and even revolutions would still be on the cards. I would also argue that the possibility of a grand theory in physics cannot be ruled out from an epistemological point of view. This is up to physicists to come to a conclusion. But when it should happen, I would not conclude therefrom that this is the end of science. The great Aristotle commentator, the Arab Averroes, claimed in the Middle Ages in a similar fashion that with Aristotle, the end of science had arrived. No one could go further than Aristotle! After Newton, the British physicist, Lord Kelvin likewise claimed that with Newton science had ended, except for few possible details and modifications. He even discouraged secondary school pupils to study physics after school, because it would no longer be necessary!

What makes things somewhat different today is an all comprehensive unified theory. Even so, humans remain finite and open-ended. Our finite minds are open ended in principle and will therefore always be nourished by

new appeals from an incomplete and always new world. And so are we open ended, or ought to be. Whatever the case may be, this remains a most important issue in the natural sciences. Lederman could not be more right to say that science owes this to the Greek philosophers. If this is the case, the Greeks played a necessary role at the dawn and beginning of science, but then also at the possible end of science !!

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