Quantum Mechanics and Political Philosophy
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Quantum mechanics has been utterly successful as a physical description of the sub-astronomic. It has led to unprecedented technological accomplishments, such as microprocessors, modern pharmaceuticals, and advanced materials. It has revealed compelling theoretical insights into nature, such as the reality of the atom and the understanding of its properties both isolated and as a part of compounds. It has introduced new concepts, which any educated person has at least a passing knowledge: the wavefunction, the uncertainty principle, and many-worlds to name a few. All countries, whatever their regime, respect quantum mechanics and all religions feel the need to demonstrate the consistency of their tenets with quantum mechanics. It has captured the hearts of the brightest of youths and continues to captivate the greatest of researchers as they mature. As such, it is more widespread than Christianity in its heyday. Despite these successes, the connection between quantum mechanics and political philosophy is far from obvious. This paper elucidates some of these connections and argues that it should be taken seriously by those interested in political philosophy.

I. The Origins and Development of Quantum Mechanics

[I wish] to explain as clearly as possible the real core of the theory. This can be done most easily by describing to you a new, completely elementary treatment through which one can evaluate – without knowing anything about a spectral formula or about any theory – the distribution of a given amount of energy over the different colours of the normal spectrum using one constant of nature only and after that the value of the temperature of this energy radiation using a second constant of nature.¹

Quantum Mechanics was developed in the first half of the 20th century as a response to certain inadequacies in 19th century physics. A poster child of these inadequacies is the so-called “ultra-violet catastrophe,” which is the failure of the Raleigh-Jeans law, called the “classical theory.” That failure is shown in Fig. 1 below, in which the classical theory falls miserably short of explaining the blackbody emission of radiation in the ultra-violet region of the spectrum. The classical theory works at high wavelengths, but starts to miss the mark at lower wavelengths and in the end diverges (goes to infinity) as the wavelength gets very small, a catastrophically absurd result.

At the turn of the century, Max Planck was able to develop a theory that fit the experimental data well and was consistent with the logical understanding that at low wavelengths the theory predicts no radiance and does not diverge. However, this theory incorporated the fact that the blackbody could only take on specific discrete energy levels, i.e. it was quantized. The significance of the quantization and acknowledgement thereof still took some years, but the seeds has been planted and a completely new flora was to grow across the earth.

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From these initial approaches to correct the classical theory with a transformed approach to understanding radiation, a new approach for describing all of nature was developed. Within a couple of decades, Paul Dirac could state that with quantum mechanics “The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known.”\(^{2}\) The principles of nature above the nuclear length-scale and below the astronomic length-scale, i.e. those that depend only on the electromagnetic force, had been found.\(^{3}\)

In the subsequent decades, quantum mechanics was expanded upon to develop a unified theory of three of the four fundamental forces, the weak nuclear, the strong nuclear, and the electromagnetic. This theory, quantum field theory, has been developed into the Standard Model, which is a comprehensive description of the “fundamental particles” of nature and considered to be a comprehensive description of the sub-astronomic.

During the same time in which quantum mechanics was developed, Einstein developed his theory of general relativity, which treats the astronomic, in which gravity, the fourth fundamental force, is important. The treatment of the very large with general relativity and the very small with quantum mechanics led to a search for a unified way to treat all length scales and forces, the Theory of Everything (TOE). Finding such a theory has hitherto eluded physicists. Nevertheless, physicists view quantum mechanics as part of the TOE, which is considered to be the comprehensive way of understanding nature, even though the TOE itself has not been articulated. Furthermore, the problems that quantum mechanics raises are fundamental in the sense that they deal with the building blocks that make up the manifest world. Those building blocks can be addressed with quantum mechanics without taking into account gravity, which is insignificantly weak in the microscopic world. Finally, despite billions of applications, there has


\(^{3}\) It is important to note that quantum mechanics does not lead to the introduction of new forces, but only a new way of treating forces.
never been found any instance in which quantum mechanics, when applied properly, fails. Quantum mechanics seems to be the true description of the sub-astronomic world.\textsuperscript{4}

For those reasons, it is justified to treat quantum mechanics separately, while never forgetting that it is a part of a more comprehensive theory that aims to describe everything. There are many studies that address quantum mechanics for a lay audience and that cover to greater or lesser degree the gamut from the physical to the philosophical.\textsuperscript{5} This paper does not aim to be comprehensive or to address adequately the physical features of quantum mechanics that makes it utterly successful (predictive, universally respected, correct in all given applications) on the one hand and utterly bizarre (e.g. irreducible randomness, non-locality, and antiparticles) on the other. It does aim to consider the significance of the key features of quantum mechanics (within the presumed framework of TOE) for political philosophy.

II. How the Quantum Mechanician Might Address Key Questions about Nature

Since, in all pursuits in which there are principles or causes or elements, it is by way of our acquaintance with these that knowing and understanding come to us.\textsuperscript{6}

If the key to nature is knowing and understanding principles, causes, and elements, one should investigate what insight quantum mechanics might provide. The manifest world consists of things that are made of very small elements, “fundamental particles,” that are indivisible.\textsuperscript{7} These elements are distinguishable by specific properties that can be characterized. They interact with one another via inviolable principles, which are manifest as patterns to the senses. The principles themselves can be expressed in specific mathematical terms, the equations of quantum mechanics, which contain within them a small number of unchanging constants, “universal constants.”

As these elements interact with each other, they combine and separate. When they combine, they form compounds which exhibit more complex patterns than the individual elements. They can combine to form large objects, macroscopic things, which are detectible by our senses. Our senses themselves are the results of interactions between us and other compounds or between various parts that constitute us, all of which are governed by quantum mechanics.

Such a picture leads to a fully consistent explanation of the world in terms of mechanical processes. It provides in principle\textsuperscript{8} answers to all questions about nature, and it has recently

\textsuperscript{4} Here I focus on the significance of quantum mechanics per se, while using a few of the insights of quantum field theory, such as the fundamental particles.

\textsuperscript{5} One is the charming \textit{Our Mathematical Universe} by Max Tegmark (2014), with a clarity of presentation in non-mathematical terms and an aim towards comprehensiveness. There is also a large bibliography in it, and a search would reveal many other studies.

\textsuperscript{6} Aristotle, \textit{Physics}, 184a1-2.

\textsuperscript{7} This is not to say that eventually these elements might not be found to themselves consist of smaller elements, but that within the framework of quantum mechanics as such, they are indivisible.

\textsuperscript{8} I write “in principle” because of course, not everything has been explained. There is a tremendous amount of work yet to do, but that work involves the application of quantum mechanical principles, not the development of new principles. Of course, modern physics cannot state with certainty that new principles governing the sub-astronomic will not be found, but with its billions of successful applications in explaining the hitherto unexplained, there is no reason to assume that new principles are needed. Having said that, it should also be emphasized that the “fundamental” forces and “universal” constants, not to mention the patterns in nature, cannot be explained as such. They must be taken as given, irreducible aspects of nature that simply are.
provided answers to many basic questions that were hitherto unanswerable. Why is there dew on grass in the morning? Because radiation dissipating from the grass cools it relative to the atmosphere and condenses the humidity in the air nearby. Why is the sky blue? Because the white light from the sun interacts with the atmosphere in ways that lead to blue light being separated out and reaching earth. Why are things hard or soft? Because electrons interact with each other and with atomic nuclei in ways that lead to different degrees of spatial response when macroscopic objects interact. Etc. All of these can be quantified with a tremendous degree of accuracy via quantum mechanics.

Quantum mechanics presumes space and time. Within these, fundamental particles move and interact, combine and separate. Moreover, they can come into existence and go out of existence. All of these processes occur via the laws of quantum mechanics, such that patterns form when many of these processes occur, but a given process takes place within an irreducible randomness. There is no void per se, because everything is everywhere, albeit in a temporally transient, particular non-uniform way following the principles of quantum mechanics. There are discrete things only because interactions between them are weak compared with the interactions within them. For this reason, we are separate from the air around us, but as we breathe and oxygen in the air is incorporated into our body, it becomes part of us. It (and we) are nevertheless everywhere at once, but because of all of the constant interactions around us, we practically occupy a given volume.

Things in the manifest world can be understood in terms of their parts via quantum mechanics. Those parts combine in ways that lead to things with completely new properties. For example, atoms, a combination of electrons, protons, and neutrons, have completely different properties than their constituents. Molecules, combinations of atoms, have completely different properties than their constituents. The same is for combinations of molecules, for example, H2O molecules combined to form water. Also, for rocks, hammers, and even for living things, plants and animals.

The motions (operations) of living things can be thought of as a consequence of “algorithms” in those things, analogous to computer algorithms. Those algorithms are a consequence of the organization of the fundamental particles that make up living things. Because of “decoherence,” i.e. the interaction of particles that leads to their quantum behavior being averaged out so that they exhibit classical behavior, these algorithms can lead to processes which do not appear to involve randomness. Nevertheless, there is always some degree of residual randomness in any process.

Living things, and in fact all things, interact with and react to their environment. In living things, those interactions can affect their algorithms via the senses. All of these physical encounters operate according to the principles of quantum mechanics, but the degree of complexity can be tremendous. For example, the physiological reaction to pain or pleasure involves so many interactions that enumerating them would take much, much longer than the lifetime of the universe. Particularly human things, beauty, justice, piety, etc. are a result of the workings of these complex algorithms which themselves are a product of interactions according to quantum mechanics.

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9 For example, by forming particle-antiparticle pairs or the reverse.
10 “Emergence” is a term that has developed to treat the qualitatively new properties that arise from the combination of smaller things.
11 Protons and neutrons are themselves composed of “fundamental particles,” quarks.
Consciousness is also a manifestation of these algorithms or something like them. It is currently far from being fully explained, but it ultimately results from quantum mechanical processes. As such, there is no fundamental difference between living and dead things (although clearly these things can be categorized differently). Just as the 19th century notion that there is a separate, irreducible “living force” faded away into the history of the useless, there is no reason not to think that any remaining notions that there is a separate, irreducible “mind” will suffer the same fate, unless “mind” is a just shorthand for the algorithm formed from the interactions of particles that constitute the brain.\textsuperscript{12}

Within the description of the world of quantum mechanics, something like all four Aristotelian causes are present. The material cause is a product of the properties of the compounds, which themselves are ultimately made of the fundamental particles, which themselves have specific properties. The efficient cause is the action of those complex algorithms that result from the combination of the fundamental particles. The formal cause is the pattern resulting from these combinations. The final cause is similarly in those specific properties and in the way in which they combine, especially in the complex algorithms that result. Plants grow, animals mature, and human beings strive for happiness. There is no natural place for non-living things, including the fundamental particles that move through the universe, but living things thrive in specific places conducive to them.

Regarding ethics and politics, they are important, but they are at best a necessary distraction from the essential work of studying the fundamentals of nature. Politics, in particular, is a necessary evil, but is tolerable as long as it is willing to support quantum mechanics in praise and in funding. Philosophy, literature, and the arts are important, particularly to the extent that they help bring out the full implications of quantum mechanics.\textsuperscript{13} Truth, however, is paramount, and the only way to obtain truth, certain truth is via quantum mechanics.\textsuperscript{14} Its success speaks for itself. Perhaps today, we need political philosophy to investigate final cause, but since in principle every thing in the sub-astronomic world can be explained via quantum mechanics, political philosophy is at best secondary.

\section*{III. A Response to the Quantum Mechanician}

\textit{About those at the top... it’s surely these who since their youth, first of all, don’t know the way to the marketplace, or where’s a court, councilhouse, or anything else that’s a common assembly of the city.}\textsuperscript{15}

The political things are in the manifest world, and thus, political philosophy, to the extent to which it focuses on investigation of the political things, tends away from the study of the microscopic and the astronomic. The “algorithms” of human thought and action which lead us to study ethics and politics, to address questions such as: How should we best live? and What is the best society?, even if ultimately the products of indivisible fundamental particles propagating

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\item[\textsuperscript{12}] I am well aware of the huge body of literature on quantum mechanics and consciousness and the much unsettled debates on this subject. The criterion of the ultimate success of modern physics is that it can explain everything based on the principles elucidated by the application of its method. To the extent that it cannot do that, it has not been successful. The best that we can say now is that the verdict is still out.
\item[\textsuperscript{14}] As noted above, I use quantum mechanics here as incorporating key insights from quantum field theory. I also focus on the microscopic. General relativity would lead to truth about the astronomic, and TOE about all scales.
\item[\textsuperscript{15}] Plato’s \textit{Theatetus} 173c7-d2.
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and interacting via the principles of quantum mechanics, are qualitatively different than their material constituents, so different that addressing these questions does not seem to necessitate understanding the microscopic processes and things that lead to these questions. Besides, although in principle those algorithms could be determined by solving the equations of quantum mechanics, a very rough and low estimate shows that it would require 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 years even to begin to determine them.\(^\text{16}\)

Quantum mechanics is the great-grandchild of the project of the mastery of nature, the Baconian-Cartesian project. It is therefore ultimately a product of political philosophy. That project itself is questionable, and instead of focusing on a thrice derivative product of the project, one should focus on the project itself, with the origins and with the arguments for and against the project presented by the greatest thinkers. That quantum mechanics has led to tremendous technologies that affect almost every aspect of our lives only demonstrates the success of the Baconian-Cartesian project, and therefore that one should understand the project. The true understanding of the technologies and their success is in understanding their origins.

Similarly, the theoretical underpinnings of quantum mechanics are tenuous at best. As a product of the modern scientific method, it is necessarily hypothetical. It cannot say, for example, that what it today considers to be the fundamental particles will never themselves be found to consist of parts. Despite the fact that religions feel the necessity to demonstrate their consistency with quantum mechanics, it cannot prove that religion per se, let alone any given religion, is false.

The success of quantum mechanics, i.e. understanding of the world via application of the Baconian-Cartesian method, only reinforces the original goal. It does not prove that the goal is the right goal or that the method can address all questions. Application of the method only leads to answers for questions which are suitable for the method to address. That the method can be used to elucidate the atom does not mean that the method can elucidate everything. In particular it does not mean that the method can elucidate the political things, aside from perhaps transforming them to something else than they are and applying the method to those new things. Moreover, such an approach leads to the danger of deprecating other realms.

Because quantum mechanics was explicitly developed to address the microscopic, its application to the manifest world is tenuous at best. Furthermore, even if the human “algorithms” that make us search for answers to problems about beauty, justice, and piety, and moreover the human good, ultimately emerge from quantum mechanical processes, our searching is necessarily more than just the product of mechanistic processes. For our searches to be real, they necessarily involve choices that are irreducible to mechanism and randomness. The development of quantum mechanics itself, if it truly has significance, cannot be a product of mechanism and randomness. If it did, quantum mechanics would need to be treated as having no more status than anything else, which no quantum mechanician would deign to do. Alternatively, quantum mechanics could be just an illusion, a trick of deterministic processes that result in patterns indicative of quantum mechanics and its irreducible randomness, but that are

\(^{16}\) I just made a very rough estimate by assuming a 70 kg person (a standard assumption in pharmaceuticals) composed of water. Using a 6-31\(\text{g}(2\text{d},2\text{p})\) with a DFT functional, an optimization of a water molecule took about 1 minute on my laptop. I assumed a \(10^6\) more powerful computer and \(N^2\) scaling. This number is 10 undecillion.
not really random. As such, quantum mechanics becomes an illusion, a cosmic joke on its practitioners and supporters.\textsuperscript{17}

There is at least one strong indication that quantum mechanics is not, in fact, the full picture of the microscopic world. This is because of its reliance on mathematics, which is intrinsically unable to generate randomness, only patterns that arise from a large number of presumably random processes.\textsuperscript{18} If mathematics is part and parcel with quantum mechanics, quantum mechanics cannot even describe what it promises to describe.

There is another problem within quantum mechanics. It leads to its amazing results while admitting that there are fundamental universal mysteries. The fundamental particles, the fundamental forces and their non-locality, and the universal constants cannot be explained. They simply are. Even if they could be explained, they would need to be explained in terms of other fundamental universal mysteries. Quantum mechanics can do much, but it has ultimate limitations, and quantum mechanicians must therefore be content in the end with limited understanding.

Above and beyond all of this, quantum mechanicians, no matter how successful they are, still need to answer the questions of political philosophy discussed above. Quantum mechanics cannot even justify why one should study quantum mechanics. Such a justification would need to come from outside of quantum mechanics. This is sufficient to show that the quantum mechanician’s scorn for the political things is rooted in unreflected upon and ultimately false opinion. Thus, the right approach to understand the world is the approach of political philosophy, not the approach of quantum mechanics.

IV. Understanding Quantum Mechanics

He said that true opinion with speech was knowledge, but true opinion without speech was outside of knowledge, and of whatever there is not a speech, these things are not knowable.\textsuperscript{19}

Given the success of quantum mechanics, it might be better to understand it than to dismiss it. Gaining such an understanding, however, is a challenge for many reasons, not the least of which is that it is unclear where to start. There is no key text of quantum mechanics which can reveal a deep understanding of its appeal, aims and promises. There are, however, speeches and writings of quantum mechanicians which can be studied to reveal insights into quantum mechanics. Understanding those speeches and writings requires working through them, including the complex mathematics which is an integral part of them. Learning this mathematics, however, takes time and effort, akin to learning a language. Nevertheless, this effort can be rewarded by understanding quantum mechanics’ almost magical power of prediction.

For example, shortly after Schrödinger’s posing of his eponymous equation in 1926, which led to an understanding for the first time of the hitherto elusive atom (including the ability

\textsuperscript{17} This is actually the solution to the problem of quantum mechanical measurements called superdeterminism. On the other side of the coin, quantum mechanics itself is just a product of random processes. Either way, mechanism implodes on itself.

\textsuperscript{18} Irrational numbers might seem like an exception (or the norm given that there is an infinite number of them for each rational number), since enumerated, they would create an infinity of randomness. However, there is no way to actually enumerate them within the realm of mathematics.

\textsuperscript{19} Plato’s Theaetetus 201D 1-4.
to calculate the quantized energy levels of the hydrogen atom, in addition to in principle those of any other atom or molecule), Dirac aimed to make Schrödinger’s equation consistent with Special Relativity. In doing so, he posed his own eponymous equation\(^{20}\):

\[
\left[ \left( -\frac{W}{c} + \frac{e}{c} A_0 \right)^2 + \left( -\mathbf{p} + \frac{e}{c} \mathbf{A} \right)^2 + m^2c^2 \right] \psi = 0
\]

The consequence of doing this is that the wavefunction, \(\psi\), must be a vector of specific \(4 \times 4\) matrices. This means that \(\psi\) contains the two spins of the electron (\(\uparrow, \downarrow\)), but each with both positive and negative energies. Negative energies seem impossible, however, like having a negative baseball. Thus, various explanations ensued that were not fully satisfactory, until four years later, the antielectron, the positron, was found experimentally. Thus, the fulfillment in solving a mathematical problem led to gaining an astounding new insight into the nature of the world. It is as if solving the equations of motion for a baseball led to the prediction of an antibaseball which was then found in the world, and which when it interacts with a baseball, cancels it out in flash of light.

Such success is seductive, for the principles of quantum mechanics are unmatched in their comprehensiveness, their insight, and their powers of prediction. The results are even more seductive because they are counter-intuitive and, perhaps, best described as bizarre. Aside from the result that things constantly come into and go out of existence, other results of quantum mechanics are that each thing can be described as having associated with itself a wavefunction which leads to all measurable properties but is itself unmeasurable, there is inherent, irreducible randomness that governs every process, actions occur non-locally, and macroscopic things are localized only because interactions lead to wavefunction collapse.

Quantum mechanicians, however, are not content with merely solving problems or gaining insight. They aim to understand the fundamental aspects of nature. The subtitles in the two references mentioned previously are: “My Quest for the Ultimate Nature of Reality”\(^{5}\) and “Finding Nature’s Deep Design.”\(^{13}\) That there might be ultimately limitations in this understanding is perhaps what simply needs to be accepted, not inherent limitations of the Baconian-Cartesian method. Similarly, the spirit of quantum mechanics can be found in two statements of Max Planck: “I had always regarded the search for the absolute as the loftiest goal of all scientific activity.”\(^{21}\) and “We may say that the characteristic feature of the actual development of the system of theoretical physics is an ever extending emancipation from the anthropomorphic elements.”\(^{22}\) In order to meet this goal of the absolute, the chains of the anthropomorphic elements need to be removed, striving for human perfection without the human.

Perhaps, however, this goal emerges from a deeper aim in the pursuit of modern physics. “Then we shall at once more correctly understand from that principle what we are seeking, both the source from which each thing can be made and the manner in which everything is done without the working of gods.”\(^{23}\) After all, ancient atomism and modern physics have in common

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that their approaches assume no divine action. Perhaps respect or prudence limits explicit statements of that aim, but modern physicists can make bold statements. Ludwig Boltzmann, for example, explicitly denigrates philosophy together with metaphysics on the one hand and belief in God on the other.\textsuperscript{24} In doing so, modern physics becomes a substitute not only for philosophy and metaphysics, but also for transcendence and providence.

V. Quantum Mechanics and Political Philosophy Within the Whole

*Philosophy, as quest for wisdom, is a quest for universal knowledge, for knowledge of the whole.*\textsuperscript{25}

The whole seems to consist of both political things and non-political things. However, the political and the non-political are not separable in a straight-forward way. Quantum mechanics, which at first sight may seem non-political has tremendous political consequences. On the other hand, quantum mechanics, as a key part of natural philosophy, might be able to demonstrate the primacy of natural philosophy over political philosophy. Beauty, justice, piety and other things of political philosophy could in fact be merely a result of mechanical processes described by quantum mechanics.\textsuperscript{26} That the consequences of mechanism might be devastating to political philosophy as the does not mean that it should be dismissed. That the political things might be reducible to the non-political should be taken seriously. The possibility that the whole might in the end be ultimately homogenous, a space-time continuum into and out of which things fluctuate, is a possibility that political philosophy must face with courage.

Even if quantum mechanics is a product of a certain stream of thought within political philosophy, the Baconian-Cartesian project, this does not mean that the products of quantum mechanics are fully reducible to political things. For there seem to be things within the whole that simply are, non-reducible to political things, and political philosophy would undermine itself if it asserted that those things are solely the product of political thought. Perhaps there is a world independent of human thought and therein independent of political things.

Philosophy addresses the whole; it addresses what each thing is within and including the whole. If political philosophy is that part of philosophy that addresses political things, it must do so within the whole. Yet, it is not obvious how the political and the non-political interact with one another. This mutual interaction is a subject of philosophy, the quest for knowledge of the whole.

Modern physics aims for a fully consistent, mechanistic view of the whole. It uses the tools of mathematics, but ideas that emerge from modern physics are not of themselves evidently purely mathematical. Physicists use words and concepts in articulating their results. Nevertheless, modern physics tends to subsume the political within it, for it treats political things as ultimately products of mechanical processes. As such, political things can at best be studied

\textsuperscript{24} See Ludwig Boltzmann’s lectures in *Theoretical Physics and Philosophical Problems*, ed. Brian McGuinness, D. Reidel Publishing Company, Boston: 1974, p. 13 and 32; p. 75; and the last paragraph of p. 198. Similarly, Hans Reichenbach, in his *Philosophic Foundations of Quantum Mechanics*, p. vii (1944) states, “the author has tried in the present book to develop a philosophical interpretation of quantum physics which is free from metaphysics.” It is unclear whether Reichenbach is equating metaphysics with divinity or lack of absolutism or both.


\textsuperscript{26} This example, itself, though implies that the otherwise non-political is more political than the otherwise political is non-political, for justice, even if considered a product of mechanism still retains its political significance, even if that significance is secondary to mechanism.
via the same method as fundamental particles and at worst ultimately, they cannot be studied with any degree of conclusiveness at all.

Given the universal success of modern physics, the lack of respect it dons on political philosophy, its great complexity, and its seeming limitations, it is natural that students of political philosophy might react by being dismissive of modern physics. However, modern physics is proven to be a marvelous and effective way of investigating nature. Moreover, the spirit of dismissiveness is not the spirit of political philosophy. Dogmatism of any sort should not be countered dogmatically.

After all, today the mainstream of speculative philosophy, the aim to understand the whole, is modern physics. If the Socratic approach is to consider “what is” each of the beings, Socrates would not exempt quantum mechanics from his analysis. Quantum mechanics is a key part of the success of natural science on the one hand, and it is itself a major political (or trans-political) phenomenon on the other. Socrates would investigate what quantum mechanics is.