

NEEDHAM, PAUL, *Macroscopic Metaphysics: middle-sized objects and longish processes*, Synthese Library Studies in Epistemology, Logic, Methodology, and Philosophy of Science, vol. 390, Springer International Publishing AG, Switzerland, 2017; pp. 224. ISBN 13: 978-3-319-70998-7

Many philosophers rightly view the natural sciences as a partner, taking the methods used in these sciences as a model. This attitude often assumes that, to explain a complex thing or situation, we should first explain the constituent parts and then merge these explanations into one. We assume that the complex thing or situation is reducible to its elemental building blocks and the relations between them. Needham's book, as the title indicates, goes against this trend. It seeks to rehabilitate macroscopic considerations, insisting that resorting to smaller and smaller subunits does not always help. In the introduction, he expresses this point clearly: "belief in reductionism seems more like a leap of faith" (p. 4). He is referring to the common assumption that an object like a table is just a collection of atoms and an event like the growth of a plant is just a collection of micro-occurrences. For him, reductionism of this kind has no satisfactory justification. In fact, current science itself undermines such reductionism because, if we continue going down to increasingly smaller scales, we arrive at quantum fluctuations and indeterminacy. The smaller the scale, the more difficult the explanations become. This book does not seek to clarify what happens at the quantum level. It looks rather in the other direction and deals with macro-objects and macro-intervals, those we are familiar with in everyday life. The project therefore resonates well with Aristotelian and Stoic considerations regarding parts, wholes, and intervals.

As one could expect, Needham draws his main inspiration from chemistry rather than physics. The first chapter offers an overview of mereology, the study of the relation between parts and wholes, such as the relation between the atoms and the molecules they constitute. In chapters 2, 3, and 4, Needham explores the idea of occupying space, related concepts like the idea of boundary, the relation of constitution, and spatial parts. In the following three chapters, he focuses on substance and matter, showing how traditional ideas have been refined via current scientific discoveries and philosophical analysis. We find here also a very interesting study of how macroscopic predicates (like "is water") relate to microstructure (like "is H<sub>2</sub>O"). In the final two chapters, he examines events, changes, processes and their parts, referring to our current knowledge of phase-changes like the one from ice to water, or from water to vapour. The book has many interesting contributions and a short review cannot do justice to all. Readers who are interested in formal logic will find the final sections of each chapter particularly helpful but there is more in the book than this. What I find most interesting

is the way it presents current views together with the history behind them, often referring to Aristotelian concepts and their development in the course of history.

For instance, as regards mereology, Needham recalls how Aristotle rejected atomism and claimed that the original substances from which a new compound is generated are not actually present in the compound any longer. We now hold however that the elements are indeed present within the compounds they constitute. Is the issue settled? Needham shows that it is not. In spite of scientific advances, Aristotle's position is still partly relevant especially in chemistry. We know that the relation between elements in the isolated state differs from their relation in the combined state. A mixture of hydrogen and oxygen before a spark differs from what results after a spark. For Aristotle, the actuality of each element after the spark does not persist. Its potentiality however does. In a sense therefore, a carbon atom that becomes part of my body through my digestion ceases to be a carbon atom. It is promoted to a higher level, as it were, by becoming, in its actuality, a part of me even though it remains a carbon atom potentially. As opposed to Aristotle, the Stoics prioritized the ontological status of the elements rather than that of the whole that they constitute. Nowadays, we follow Lavoisier and tend to favour the Stoics but we have not yet resolved all the inherent problems. Using logical formalization, Needham explores these ideas and shows that Aristotle's idea of a potential part is an interesting midway notion between two extreme untenable positions, between, that is, the idea that elements retain all their actuality within the compound and the opposite idea that they cease to exist within the compound.

Another example concerns the way Aristotle took homogeneity as the mark of a substance, holding for instance that when we say that water is a substance we are thereby saying also, among other things, that any part of water is water. In current literature, this position is questioned. For instance Quine observes that, according to current science, "water" does not apply to parts smaller than molecules. Needham grapples with this question and highlights its complexity, especially because of phase-changes. In the case of water in the liquid state, we now know that there are ongoing microscopic dynamic changes invisible at the macro-level. Water in fact is not just a collection of molecules without mutual interaction. It is rather a set of constantly changing multi-molecular species, combining and recombining with each other in various patterns via hydrogen bonding. It seems therefore that neither Aristotle nor Quine is telling the whole story. There are no clear boundaries determining where substance-predicates are applicable and where they are not.

These two examples give some idea of the issues that Needham discusses. The book is not an easy read. The writing style is dry and often excessively condensed. It represents nevertheless a valuable contribution. Needham provides the historical background for ontological topics that lie behind current theorizing in chemistry, examines these topics via formal analysis, and updates them carefully

with reference to current literature. The book will be appreciated mainly by specialists working in the area of formal ontology. The historical sections are valuable for historians of science who seek to know how fundamental ancient views on key concepts like substance, process, element and compound, have developed to arrive at the semantic role they have today.

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