Psillos, Stathis (2007). *Philosophy of Science A-Z.* Edinburgh: University of Edinburgh Press.

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Those who have their interests in philosophy of science cannot complain that there are not enough up-to-date reference books in the field. Several introductions ([Rosenberg, 2000], [Okasha, 2001], [Losee, 2001], [Ladyman, 2002], [Hitchcock, 2004]), two companions ([Newton-Smith, 2000], [Psillos & Curd, 2008]), an encyclopedia ([Sarkar & Pfeifer, 2006]) and an impressive 16-volume Handbook in philosophy of science[1] have been published during the last 10 years to respond to the interest of those who would like to learn more about the central concepts and issues in this philosophical discipline. What's the place of Stathis Psillos' *Philosophy of Science A-Z* in this apparent abundance of guides?

The fact that attracts the attention first is that despite its rather modest size (less than 300 pages) Psillos' "A-Z" philosophy of science book contains nearly 390 alphabetically ordered entries. This is, for example, four times more than the number of the entries of Newton-Smith's Companion (81 entries). And it is nearly three times more than the number of the entries of the two-volume *Philosophy of Science Encyclopedia of Routledge* ([Sarkar & Pfeifer, 2006], 132 entries), which has been represented upon its publication as "the first in-depth reference in the field."[2] Of course, the texts included in the "A-Z" book are significantly shorter than the papers written for the Routledge Encyclopedia and in this sense Psillos' book is more like a dictionary.[3] But the modest size of the entry texts does not take away from the fact that this reference book provides an impressive network of entries to the main terms and names which represents philosophy of science in a large historical and a contemporary perspective. Although approximately short in size, each entry is supplied with multiple bold-faced cross-references as well as with references to books for further reading.[4] If the reader decides to follow the paths through the text, pointed to by the indicated cross-references, she/he will have the pleasure of accessing to a surprisingly rich and at the same time a concise and comprehensible picture of the explored issue and its closest context. Let me support this by a short demonstration of how exactly the cross-reference system works.

Suppose you are not a professional philosopher but one who nevertheless keeps some sense of curiosity in philosophical matters. And let us suppose that one of the questions which has occupied your mind for some time is "the nature of mathematical objects": how do those things, which professional mathematicians recognize as their subject-matter, exist? You expect that there are maybe different answers to this question and discussions about them and you are keen to learn more about this stuff. You try first to look for information in the authoritative two-volume *Philosophy of Science Encyclopedia of Routledge* [Sarkar & Pfeifer, 2006] but you do not find any relevant entry there.[5]. Let's see how the "A-Z" dictionary can help you in your search. Indeed, there too you do not see any entry for "mathematical objects" but you find one for "numbers." And since numbers, in your perspective, are good instances of mathematical objects, you decide to explore the entry for numbers. At the beginning you are disappointed for a while that there is not a paper assigned to this entry but only references to other entries such as "abstraction principles," "fictionalism, mathematical," "Frege," and "Platonism, mathematical." But after that you say, well, let me see what I can get from this cross-references. You start your inquiry with the paper discussing "abstraction principles." Reading this paper you learn that the notion of ab-

[1] The 16-volume *Handbook of the Philosophy of Science* has been published by Elsevier, under the general edition of D. Gabbay, P. Thagard, and J. Woods. The different volumes devoted to different subfields of philosophy of science have their own editors: the volume on general philosophy of science, for example, has been edited by T. Kuipers [Kuipers, 2007].

[2] See the publisher's announcement at http://www.routledge-ny.com/ref/philosophyscience/

[3] And in fact its author calls it a "dictionary" in the *Introduction and Acknowledgements* part of the book [Psillos, 2007; x-xi].

[4] The list of all books suggested for further reading contains about 300 titles.

[5] Strange enough indeed, in the two-volume set of [Sarkar & Pfeifer, 2006] there are no entries related to philosophy of mathematics.

straction principles has been "introduced by **Frege** in an attempt to explain our capacity to refer to **abstract entities**" [Psillos, 2007; 6].[6] The way the abstraction principles work is illustrated by two examples and one of these examples, now you are happy, is about numbers. From this example you learn that "the concept of number (and numbers as abstract entities) can be introduced by a similar abstraction principle, namely: (N=) The number which belongs to the concept *F* is the same as the number which belongs to the concept *G* if and only if concept *F* can be in one–one correspondence with concept *G*. The notion of one–one correspondence is a logical relation and does not presuppose the concept of number. Hence, the right-hand side of (N=) does not assert something that is based on intuition or on empirical fact. Still, (N=) states necessary and sufficient conditions for two numbers being the same; hence, we are offered identity-conditions for the abstract entity *number*" [Psillos, 2007; 6-7]. This sounds tough and not quite clear, you think (remember, you have never read Frege before). Yes, there is a book [Fine, 2002] recommended for further reading but you decide that it is too early for you to study primary sources. You find more reasonable to keep looking through the "A-Z" dictionary, led this time by what you have already learnt about Frege's view of mathematical objects: that (1) they are abstract entities; and (2) they are somehow related to concepts, which are also abstract entities. Thus, the notion of abstract entity appears to you as crucial for the understanding of mathematical objects "qua abstract entities," so you decide to explore the entry for "abstract entities."

From the text assigned to this entry you learn that abstract entities are those entities which "do not exist in **space** and **time"** and which are "causally inert" [Psillos, 2007; 5]. This definition of abstract entities puzzles you immediately: if abstract entities do not exist in space and time, and if they are causally inert (i.e. they do not cause anything), *where, how exactly*, do they exist? And *how do we know* that they exist at all? Continuing reading the paper you learn that the difficulty in answering these two questions is the crucial problem for those who believe in the existence of abstract entities and in particular for those who believe that numbers are such entities. Now you realize that it is time to look for alternative views about the nature of numbers. Going back to the cross-references suggested under the entry for "numbers," you decide to check this time the entry on "mathematical fictionalism." Thus you learn that according to mathematical fictionalists, "numbers and other mathematical 'entities'" are nothing but "useful fictions" [Psillos, 2007; 93]. You learn also that "fictionalism is a kind of **instrumentalism** about mathematics" and that as a sub-species of **nominalism** it opposes to mathematical **Platonism.** But if numbers and other mathematical entities are mere fictions, you ask, how could they be "useful" in the study of the real world, which is not fictitious? This question is enough to inspire you to look for other alternative views. Next in the initial list of cross-references is the entry for Frege. There you learn that Frege defends his view of numbers as abstract entities against Kantian view of numbers as intuitions, against Mill's view of numbers as generalized properties of physical objects, and against Berkeley's view of numbers as subjective ideas. Now you feel that you have enough alternatives for the nature of numbers: abstract entities, fictions, intuitions, properties of physical objects, or subjective ideas. In order to decide on any of these alternatives, however, you need to continue your study, and maybe you should go to the original texts of their proponents.

Let's stop our imaginary story here: it is demonstrated already that the cross-reference system of the "A-Z" dictionary works. It allows readers of all educational backgrounds to orient themselves through the subject that interests them.

The prospective readers of the A-Z book might be interested in how large the area of the subjects covered by this dictionary is. The knowledge about the total number of entries is not enough to answer this question. We should know how many categories of subjects are covered and which these categories are.

A careful look through the list of entries reveals that the great number of them fall into one of the following categories:

(1) concepts which are part of the specific vocabulary of the philosophy of science (for example: ad-hoc hypotheses, covering-law model, underdetermination);

(2) concepts which are part of the general scientific language and in the same time of interest for philosophers of science (examples: theories, models, experiments);

(3) general philosophical concepts (a priori/a posteriori, knowledge, truth, reality);

(4) important philosophical doctrines (realism, empiricism, instrumentalism, Bayesianism);

[6] The bold-face everywhere in the cited texts means that there are entries in the dictionary for the bolded terms and names.

(5) paradigmatic scientific theories (theory of relativity, quantum mechanics, Euclidean geometry, non-Euclidean geometries);

(6) principal figures in history of science (Copernicus, Galileo, Newton, Darwin, Einstein, Bohr);

(7) principal figures in history of philosophy (Aristotle, Ockham, Bacon, Descartes, Kant);

(8) principal figures in philosophy of science (Carnap, Popper, Kuhn, Lakatos).

Of course, there are entries ("ethics of science" is an example) which do not belong to any of the categories (1)–(8) but their existence only strengthen the impression that the covered area of topics is indeed extremely large and that makes a search through the cross-reference really fruitful.

Two groups of entries deserve to be particularly stressed. The first is the category of the concepts, which belong to the specific vocabulary of philosophy of science. It is no surprise that this category is the most extensive one. But the fact that makes it a true merit for the dictionary is that here one can find entries (and thus inquire about notions) which are not present in any other reference book (to mention only the entries for "bootstrapping," "ceteris paribus laws," "consilience of induction," "laws of thinghood," "Markov condition," "novel prediction" etc.).

The second group of entries, which deserve special mention is the category of the principal figures in philosophy of science. Here, besides the names of classical scholars like Carnap, Schlick, Popper, Feyerabend, one can find entries for philosophers of science born in the 30s and 40s of the 20th century. This is the generation that shaped philosophy of science after the post-positivist turn, which Popper, Lakatos, Kuhn, and Feyerabend were credited with. This generation has not yet been given a common label, partially because it has not yet become a subject of a careful historical reflection. By giving entries to this provisional list of names of people who contributed a lot to the maturation of philosophy of science about the end of 20th century, Stathis Psillos has done an important work, which I am sure will be appreciated by the future historians of philosophy of science. One may say that the suggested list of names is too idiosyncratic (in the Introduction Psillos himself admits that the list, which he has produced using "some advice" is "conventional" [Psillos, 2007; xi]) Well, one may easily find reasons to claim that. But it is out of question that Psillos could be eventually blamed only for the omission of one or another name,[7] and not for giving credit to those whose names he has included in the dictionary. For there is no doubt that people like Peter Achinstein and Larry Laudan, David Lewis and Ian Hacking, Ronald Giere and John Earman, Clark Glymour and Nancy Cartwright have proven their influence on the filed in the last quarter of the 20th century and, therefore, well deserve their place in the "A-Z" book.

Looking at the different categories of entries in the dictionary, one could ask why there are no entries for the different sub-disciplines of philosophy of science: philosophy of physics, philosophy of biology, philosophy of mathematics etc. The answer is simple: it is difficult, if not impossible to provide a useful general outline of any of these sub-fields in 300-500 words (what is the average length of an entry note in the "A-Z" book). And this answer points to one of the main strengths of the dictionary: the achieved "golden balance" between the number of the entries, the length of the entry papers, and the level of categorization of the entry subjects.

For whom is this book written? In his Series Editor's Preface[8] Oliver Leaman states that it is for those who want "to orient themselves through the subject." I hope this brief review has provided evidence that *Philosophy of Science A-Z* successfully completes the series' aim. But for me it is important to stress that Stathis Psillos' dictionary suggests much more than mere "orientation in the subject." I am not going to convince you in that, I strongly recommend to find out what I mean for yourself. Last but not the least, it should be said that the "A-Z" dictionary is not just another reference book in the large and sophisticated field of philosophy of science. It is a really indispensable guide to the field for both novices and professionals.

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[7] I personally wonder at the lack of entries for Daniel Dennett (born 1942), Michael Ruse (born 1940), or Paul Benaceraf (born 1930).

[8] *Philosophy of Science A-Z* is one of the volumes of the series *Philosophy A-Z*, published by University of Edinburgh Press under the general editorship of Oliver Leaman. By now the series has issued 14 volumes including *Epistemology A-Z*, *Philosophy of Language A-Z*, *Philosophy of Mind A-Z*, *Ethics A-Z*, *Political Philosophy A-Z* etc.

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