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Notes on Books

Witold Wiszniewski, *Time Change and Imaginary Numbers. From Hamilton to Einstein in Search for Understanding of the Imaginary Numbers*, Saarbrücken: VDM Verlag Dr. Müller 2008, pp. 310, ISBN 978-3-8364-9954-5.

Imaginary numbers were introduced to mathematics by Gerolamo Cardano in the 16th century; the term "imaginary number" was invented by Descartes in 1637. The idea concerned the next extension of the concept of number, related to the problem of the square root of -1. Due to conceptual difficulties, imaginary numbers were not very popular among mathematicians until the fundamental theoretical works of Leonard Euler and Karl Friedrich Gauss; the label "imaginary numbers" clearly indicates a kind of puzzlement or embarrassment. The results of Euler and Gauss made it possible to give a consistent geometrical interpretation of imaginary numbers. The next important step in the development of the theory of these objects was achieved by William Rowan Hamilton, a British mathematician and physicist, who generalized the geometrical interpretation of imaginary numbers via the concept of imaginary quaternions. Today, imaginary numbers are fully recognized mathematical objects within the framework of the theory of complex numbers and find many significant applications in mathematics and physics. Yet philosophers frequently debate various problems concerning imaginary numbers and their relations to other ideas, scientific as well as philosophical.

Wiszniewski's book is a contribution to the history and theory of imaginary numbers. This work consists of six chapters. The chapters are as follows: 1. Preface; 2. Time; 3. Change; 4. Imaginary numbers; 5. Space synthesis; 6. Selection of A-type theories of time and final conclusions. There is also an appendix about Hamilton's algebra of pure time. Each chapter has an introduction and a summary (the last chapter ends with the final conclusions of the whole book instead of a chapter-summary). Chapters 2 and 4 are divided into the following parts: 2.1. Introduction; 2.2 Ancient account of change and time; 2.3. Topological aspects of time; 2.4. The question of *now* (present); 2.5. Temporal (a)symmetry; 2.6. McTaggart's proof of the unreality of time; 2.7. Kant on time and space;

2.8. Summary; 4.1. Introduction; 4.2. Imaginary numbers; 4.3. Elements of the foundations of mathematics; 4.4. The special theory of relativity and imaginary numbers; 4.5. Theory of imaginary numbers based on the special theory of relativity; 4.6. Theory of imaginary numbers based on quantum mechanics; Strict derivation of the *i*-equation and the proof of $i^2 = -1$; 4.8. Hamilton's secondary moments of time; 4.9. Summary. The book is very clearly written and organized. In particular, introductions and summaries considerably help in following the author's arguments and proposals. The lack of a bibliography is the only defect in this respect.

I reproduced the content of the two selected chapters of the reviewed book quite deliberately in order to show that Wiszniewski offers a synthesis of three lines of thought: mathematical, physical and philosophical. Moreover, these are elucidated systematically as well as historically. As Wiszniewski explains in his preface, the problem of "What is time?" directed him towards studies on imaginary numbers. More specifically, he came to the conclusion that the answer to this question is not as simple from the philosophical point of view as one might initially think, and actually requires fairly advanced considerations about various topics, like change, the (a)symmetry (of time), the present, endurance or objecthood. Wiszniewski develops the idea of dynamic time, for which the problem of change appears as the most relevant. In particular, his theory is based on the priority of change over time. Wiszniewski defines change as also possessing incompatible properties (p. 6 and Chap. 3, pp. 137-144). He explicitly notes that this view is not new and was defended with various degrees of radicalism by Heraclitus and Hegel, as well as some contemporary writers, like Georg Henrik von Wright, Graham Priest or Chris Mortensen The philosophical tradition is not sufficient for Wiszniewski. He intends to explain the contradictory character of change by mathematical and physical devices. This leads him to imaginary numbers as a tool for a formal theory of contradictions. As Wiszniewski writes: "change can be implemented into mathematics, provided that it is uncoupled from time and presented as quasi-temporal change, being the possession of incompatible properties at the same time" (p. 224). It is important to see that Wiszniewski considers contradictions as conceptual, not real. This is illustrated by physical applications of imaginary numbers in the special theory of relativity and quantum mechanics.

Of course, the priority of change has consequences for the understanding of the concept of time. Clearly, the label "dynamic" does not explain very much. Wiszniewski analyzes the so-called A-theories and B-theories. They are related to McTaggart's famous proof showing that time is unreal. Wiszniewski observes that McTaggart's demonstration applies to A-theory only. Since A-theory implies that time is dynamic, the defense of the reality of time appears as a very crucial task. Wiszniewski achieves this aim by

arguing that "McTaggart's contradiction can be reduced to the contradiction posed by change taken as the possession of incompatible properties" (p. 82). Time, according to Wiszniewski, has the following properties: one-dimensionality, continuity, openness, boundlessness and singularity. Finally, Wiszniewski argues that his account of time is consistent with the special theory of relativity and quantum mechanics. This completes the integration of mathematics, science and philosophy in the reviewed book.

I fully sympathize with Wiszniewski's methodology, because doing natural philosophy without appealing to science seems to me completely irrational. The main problem which I see in this interesting book concerns the question of whether change is real or not. Since contradictions are conceptual, change consists in possessing incompatible (contradictory) properties, and the answer to the question posed is not straightforward. The term "quasi-temporal change" does not explain very much, because "quasi" can indicate either "being conceptual" or "being real." On the other hand, Wiszniewski's work is a very interesting contribution to the contemporary discussion about time. Finally, let me observe that Wiszniewski did not yield to the temptation to quote St. Augustine's famous words, *Quid est tempus? Si nemo a me quaerat, scio, si quaerenti explicare velim, nescio!*, used almost by everyone who writes about time. I consider the lack of these, in fact, irrational words, in the reviewed book as adding to its merit.

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