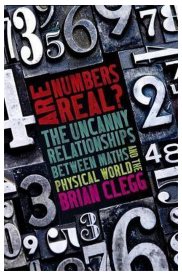
Are numbers real? by *Brian Clegg*, Little Brown UK, 2017 (304 p.), isbn: 9781472139764.





B. Clegg

'Is mathematics discovered or invented' is an old philosophical question, which has no yes or no answer. With the title of this book, Clegg tackles a subquestion about real numbers, and also here, the answer is not univocal. In search of an answer, he takes us on a journey through the history of mathematics from counting sheep to string theory to give in his last chapter a deeper discussion about the relation between science and mathematics.

Clegg is an experienced science writer with a PhD in physics. That, and the nature of the question he wants to answer, explains why the history of mathematics is explained in close connection with physics. This is also a book with almost no formulas avoiding as much as possible the technical details.

The history of mathematics has been told many times before and Clegg follows the same line of thoughts: the one-to-one relation between the number of sheep and the number of stones representing them is very real, it gains some abstraction when the same number is used to count goats or other things and when they are represented by a number system, they become separated from physical items.

In Greek antiquity mathematics became an independent discipline, but still the idea was that mathematics was only a model for reality which was supposed to be ideal, with nature intrinsically obeying the rules imposed by whole numbers and perfect circles. Zero and infinity did not find a natural counterpart in reality and thus, it took a longer time to be accepted. Roger Bacon (ca. 1214–ca. 1295) is singled out as the one to have promoted mathematics as a structured way of thinking, something that can be developed independently from nature.

Negative and imaginary numbers were introduced for solving equations, and studying on earth falling objects due to gravity and in the sky the motion in the solar system, and speed, as a change of motion, this triggered the development of ratios of change which resulted in derivatives and eventually calculus.

Probability was introduced to deal with problems of gambling, but it soon became a method to deal with a large number of events like molecules in a bottle and quantum particles. This is used as a pretext to move to more physical developments: the Maxwell equations and Schrödingers equation, and relativity theory. However, mathematical foundation also needed a revision: set theory was used to redefine the number system, Cantor learned us to deal with infinity, and Kurt Gödel showed the limitations of the mathematical system.

Relativity and quantum physics made us aware that reality is not as simple as it seemed to be. It was Emmy Noether's invariants and symmetry that guided the development in theoretical physics where the relation between nature and our mathematical model becomes the motor for the development of physics, even beyond experimental verification. The Higgs particle is at the boundary of what is currently (indirectly) observable and verifiable.

The history told in this book has some new facts and anecdotes that I had not seen before, so that is a nice feature. The last chapters on particle physics are a bit difficult to follow, but it is a difficult subject anyway if you're not a theoretical physicist.

This brings us to the last chapter which is the most interesting if you want an answer to the question in the title and the more general one mentioned in the beginning. Clegg's previous sketch of the history is used to argue that mathematics is a system in which things are either true or not, and it exists, without the need to verify with experiments. Science is a system in which one needs constantly refinements and corrections, and verification through experiments. Mathematics can evolve completely detached from reality, but it can come in handy to explain reality at a later stage when used in a model. However a model is not reality since it is always a simplification. Correlation does not mean causality and statistics cannot be applied to individuals. Numbers as used originally are real but most of mathematics is a fantasy world. Adhemar Bultheel