Elements of the Theory of Functions of a Complex Variable: With Especial Reference to the Methods of Riemann

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An excerpt from the Introduction.

The opinion that imaginary quantities are impossible has its true origin in mistaken ideas of the nature of negative, fractional and irrational quantities. For the application of these mathematical ideas to geometry, mechanics, physics, and partially even to civic life, presenting itself so readily and so spontaneously, and in many cases no doubt even giving rise to some investigation of these quantities, it came to be thought that in some one of these applications should be found the true nature of such ideas and their true position in the field of mathematics. Now, in the case of imaginary quantities, such an application did not readily present itself, and owing to insufficient knowledge of the same it was thought that they should be relegated to the realm of impossibility and their existence be doubted.

But thereby it was overlooked that pure mathematics, the science of addition, however important may be its applications, has in itself nothing to do with the latter; that its ideas, once introduced by complete and consistent definitions, have their existence based upon these definitions, and that its principles are equally true, whether or not they admit of any applications. Whether and when this or that principle will find an application cannot always be determined in advance, and the present time especially is rich enough in instances in which the most important applications — even those of far-reaching influence on the life of nations — have sprung from principles, at the discovery of which there was certainly no suggestion of such results. But so firm had the belief in the impossibility of imaginary quantities gradually become that, when the idea of representing them geometrically first arose in the middle of the last century, from the supposed impossibility of the same, was inferred conversely the impossibility of representing them geometrically.

To understand the position which imaginary quantities occupy in the field of pure mathematics, and to recognize that they are to be put upon precisely the same footing as negative, fractional and irrational quantities, we must go back somewhat in our considerations.

The first mathematical ideas proceeding immediately from the fundamental operation of mathematics, i.e., addition, are those which, according to the present way of speaking, are called positive integers.

If from addition we next pass to its opposite, subtraction, it soon becomes necessary to introduce new mathematical concepts. For, as soon as the problem arises to subtract a greater number from a less, it can no longer be solved by means of positive integers. From the standpoint in which we deal with only positive integers, we have therefore the alternative, either to declare such a problem impossible, insoluble, and thus to put a stop to all further progress of the science in this direction; or, on the other hand, to render the solution of the problem possible by introducing as new concepts such mathematical ideas as enable us to solve the problem. In this way negative quantities at first arise through subtraction as the differences of positive integers, of which the subtrahends are greater than the minuends. <u>Their existence and meaning for pure mathematics, then, is not based upon the opposition between right and left, forward and backward, affirmation and negation, debit and credit, or upon any other of their various applications, but solely upon the definitions by which they were introduced.</u>

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