

The Mathematics of Matter and the Mathematics of Mind

(Invited Talk)

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Abstract. It has been the rich body of continuous mathematics that has made possible the development of physical theories. In Newtonian mechanics, the theory of the electromagnetic field, general relativity and quantum electrodynamics, things are continuous. Were it not for the fact that things must be measured – no small consideration, of course – each theory could be formulated in a way that dispenses with numbers entirely. The rewards of continuity have been considerable. Quantum electrodynamics, is accurate to more than ten decimal places, and general relativity, under certain circumstances, accurate to more than thirteen. On the other hand, our reflections about mathematics have for more than sixty years been expressed in an entirely different language. In proof theory, model theory, recursion theory, and automata theory, things are discrete. Were it not for the fact that limits must occasionally be investigated – no small consideration, of course – each theory could be formulated in a way that dispenses with continuous functions entirely. What holds for meta-mathematics holds in a more general way for psychology. Our most sophisticated linguistic theory suggests that every human language is the expression of a unique computational system, one that is entirely discrete. What holds for linguistics is often claimed to hold for molecular biology as well; indeed, the analogies between linguistic and cellular computational systems have seemed as suggestive as they are elusive. The division of ordinary experience between material and mental objects thus finds itself mirrored in the division between continuous and discrete mathematics. In this talk, I should like to investigate the basis for the distinction, asking first whether the distinction may be expressed in terms of certain invariants, and second whether the distinction is itself an artifact, one resulting from the peculiar circumstances in which various sciences have been undertaken. I shall discuss minimalism in linguistics, the Smale-Shub theory of calculability, the use of K-theory in the evaluation of D-branes, and Stephen Wolfram’s recent work in cellular automata.