Abstract for General Public

December 1, 2020

Scientific theories, such as those in physics, engineering, chemistry, data science, economics and so on are routinely expressed in mathematical terms. The most successful of such theories have been not only corroborated experimentally, but have been profoundly successful in describing, accounting for and predicting phenomena, as well as providing countless technological applications.

In mathematical logic one studies the formal structure of theories. In philosophy, one is concerned with understanding certain concepts, and how these concepts are inter-related in our discourse and our best theories. Researchers have been able to carefully formalize the foundations of *pure mathematics* with great success, leading to a variety of foundational systems—set theory, higher-order logic, type-theory. But for *scientific* theories, comparable success has not yet been achieved, mainly due to the fact that the mathematicized scientific theories of interest assume a sophisticated geometric "infrastructure".

The primary research goals of this project are to improve our understanding of

(a) the formalization of mathematicized scientific theories; and
(b) the logical analysis of applied mathematics.

The proposed research project focuses on analysing the foundations of applied mathematics by constructing a flexible *applied mathematics base theory*, and then using this to construct *standard formalizations of mathematicized scientific theories*. With such a base theory in place, one may investigate and explore more general conceptual questions surrounding the applicability of mathematics, the possible dispensability of mathematics, mathematical explanation in science, mathematical representation in science and theoretical equivalence of scientific theories.

An important first step towards the research tasks of the project is taken in the project investigator's forthcoming paper "Foundations of Applied Mathematics I" (*Synthese*), which develops in detail a (many-sorted) system of set theory with atoms (ZFCA), over variable application signatures. The project aims to build on this preliminary work in a substantial way.