Implications of Einstein-Weyl Causality on Quantum Mechanics

David BenDaniel

Johnson School, Cornell University, USA
djb16@cornell.edu

ABSTRACT

A fundamental physical principle that has consequences for the topology of space-time is the principle of Einstein-Weyl causality. Borchers and Sen have rigorously investigated the mathematical implications of Einstein-Weyl causality and shown the denumerable space-time QxQ would be implied. They then embedded this space in a non-denumerable space but were left with important philosophical paradoxes regarding the nature of the physical real line E, e.g., whether $E = R$, the usual real line of mathematics. Alternatively, their initial result could otherwise suggest a constructible foundation. We have pursued such a program and find it indeed provides a dense, denumerable space-time and, moreover, a fundamental connection with quantum mechanics. This paper has three parts. We first introduce a constructible foundation and show it contains polynomial functions which are locally homeomorphic with a dense, denumerable metric space R* and are inherently quantized. Uniformly continuous functions can then be effectively obtained by computational iteration. Secondly, postulating a Lagrangian for fields in a compactified space-time, we obtain a general description of which the Schroedinger equation is a special case. Thirdly, from these results we can then prove that this denumerable space-time is relational (in the sense that space is not infinitesimally small if and only if it contains a quantized field) and, since Q is by definition embedded in R^*, it directly fulfills the mathematical requirements for Einstein-Weyl causality. Therefore, the theory predicts that $E = R^*$ and that quantum mechanics provides a possible empirical corroboration. Furthermore, since the theory suggests that polynomial functions are fundamental, this approach provides a connection between quantum and gravitational computational programs. Finally, we suggest other possible physical implications of these results, both on the QED scale and on the gravitational scale.