Title: Why is quantum theory complex?

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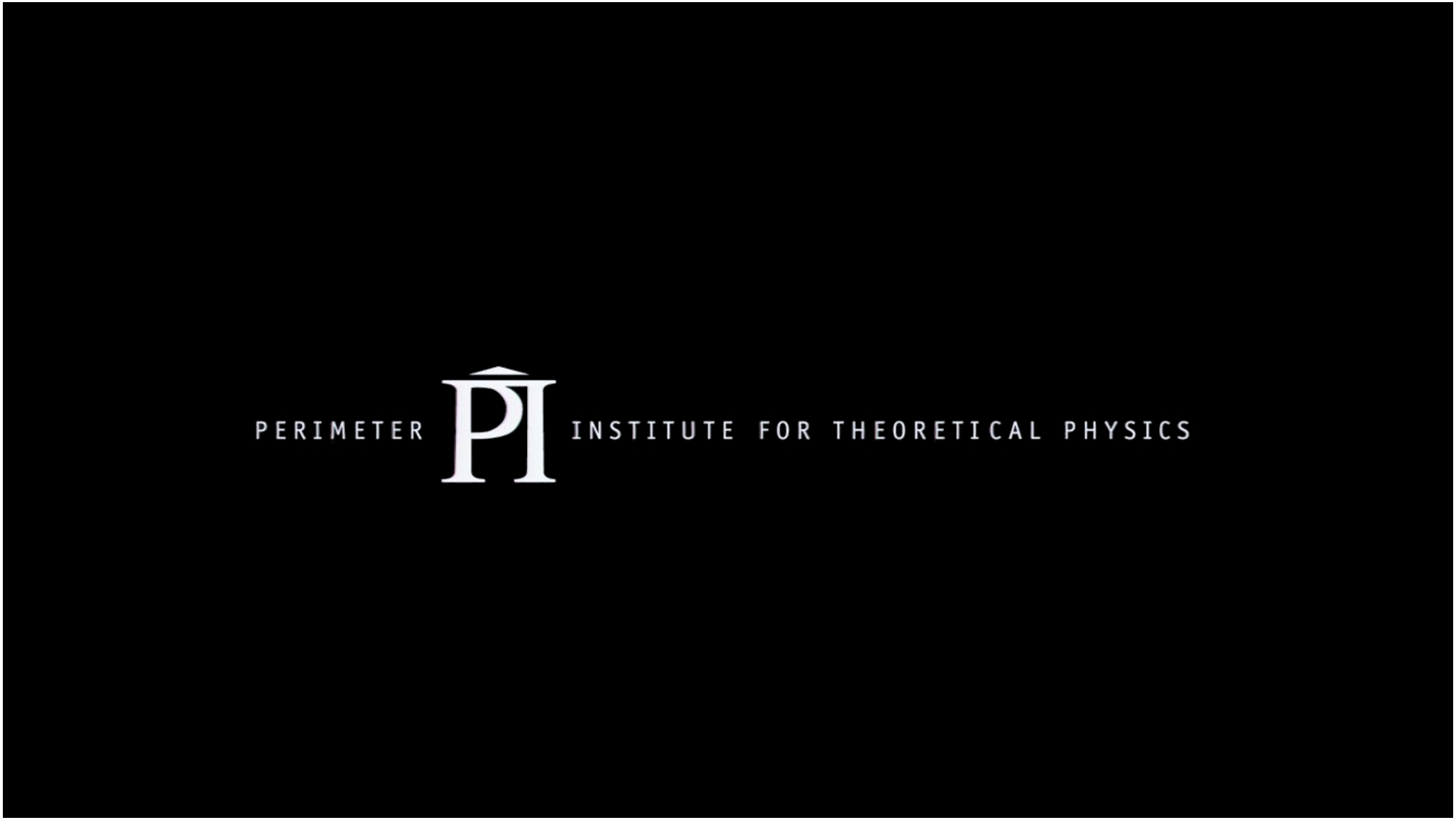
Abstract: Complex numbers are an intrinsic part of the mathematical formalism of quantum theory, and are perhaps its most mysterious feature. But what is their physical origin? In this talk, I show how it is possible to trace the complex nature of the quantum formalism directly to the basic symmetries associated with the basic operations which allow elementary experiments to be combined into more elaborate ones. In particular, I show that, by harnessing these symmetries, the Feynman rules of quantum theory can be derived from the assumption that a pair of real numbers is associated to each sequence of measurement outcomes, and that the probability of this sequence is a real-valued function of this number pair.

The derivation has numerous intriguing implications, such as pointing to a deep connection between the foundations of quantum theory and the foundations of number systems. It also demonstrates that, contrary to the rather prevalent working hypothesis that the structure of the quantum formalism has something essentially to do with nonlocality, the core of the quantum formalism in fact does not depend in any essential way on the properties of space.

Reference: "Origin of Complex Quantum Amplitudes and Feynman's Rules", Phys. Rev. A 81, 022109 (2010). Full text available at www.philipgoyal.org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