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Origin of Feynman's Rules of Quantum Theory and Complementarity PHILIP GOYAL, SUNY Albany — Complex numbers are an intrinsic part of the mathematical formalism of quantum theory, and are perhaps its most mysterious feature. If one considers how to combine experimental arrangements to generate new experimental arrangements, a set of five simple symmetries involving two binary operators naturally arises. Recently, I have shown that these symmetries, together with the probabilistic nature of measurement outcomes and the principle of complementarity (formalized in a novel way as the Principle of Information Duality) naturally lead to Feynman's rules of quantum theory (including their complex nature) [1]. In this paper, I present recent development of this work showing that the assumption of complementarity can be dropped, and, instead, a fundamental theorem from number theory—Frobenius' theorem—can be applied to show that the only formalism compatible with the experimental symmetries are real and complex quantum theory. I shall conclude with a discussion of physical principles which can be used to rule out real quantum theory.

[1] Origin of Complex Quantum Amplitudes and Feynman's Rules, P. Goyal, K. Knuth, J. Skilling, Phys. Rev. A 81, 022109 (2010)

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