A roll of the dice: Quantum mechanics researchers show that nature is unpredictable

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Many of the predictions we make in everyday life are vague, and we often get them wrong because we have incomplete information, such as when we predict the weather.

But in quantum mechanics, even if all the information is available, the outcomes of certain experiments generally can't be predicted perfectly beforehand.

This inability to accurately predict the results of experiments in quantum physics has been the subject of a long debate, going back to Einstein and co-workers, about whether quantum mechanics is the best way to predict outcomes.

Researchers from the University of Calgary's Institute for Quantum Information Science along with researchers from the Perimeter Institute in Waterloo and the Eidgenössische Technische Hochschule (ETH) in Zürich/Switzerland have published a paper in *Physics Review Letters* that suggests quantum theory is close to optimal in terms of its predictive power. The research in this paper looks at measurements on members of maximally entangled pairs of photons that are sent into Stern-Gerlach-type apparatus, in which each photon can take one out of two possible paths.

"In our experiment, we show that any theory in which there is significantly less randomness is destined to fail: quantum theory essentially provides the ultimate bound on how predictable the universe is," says Dr. Wolfgang Tittel, associate professor and GDC/AITFIndustrial Research Chair in Quantum Cryptography and Communicationat the University of Calgary.

Dr. Renato Renner, Professor at the ETH in Zürich adds: "In other words, not only does God 'play dice,' but his dice are fair."

Randomness in quantum theory is one of its key features and is widely known, even outside the scientific community, says Tittel. "Its appeal is its fundamental nature and broad range of implications: knowing the precise configuration of the universe at the big bang would not be sufficient to predict its entire evolution, for example, in contrast to classical theory."

More information: "An experimental bound on the maximum predictive power of physical theories" is by Terence E. Stuart,Joshua A. Slater, Roger Colbeck, Renato Renner and Wolfgang Tittel is available: prl.aps.org/abstract/PRL/v109/i2/e020402

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