



Almost Quantum Correlations

Opening a new avenue for generalizations of quantum theory?

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It is often suggested that to understand a concept in science one asks: "how could it be different?" In particular, if we were to alter a physical theory what are the consequences? Quantum theory is successfully tested in laboratories every day. However, and despite all its impressive predictive power, the theory has eluded consensual understanding even since its conception. This has motivated the search for models alternative to quantum theory that could offer a more intuitive explanation of the observed phenomena. The study of modifications of quantum theory has also been motivated by the difficulty in merging it with relativity, the hope being that alternative models may facilitate this task.

Unfortunately, until now, the existing alterations of quantum theory, even if a priori simple, have been problematic for fundamental reasons. For instance, they have been shown to imply a significant increase of the computational power of the theory, or predict violations of the no-signalling principle, one of the pillars of Einstein's relativity that states that

faster-than-light communication is impossible. In fact, it is very difficult to design a theory beyond quantum physics that remains compatible with the no-signalling principle. These results, among others, have led researchers to question whether quantum mechanics is special and represent "an island in theory space".

In a recent work entitled "Almost quantum correlations" published in *Nature Communications*, researchers from the Quantum Information Theory group led by ICREA Professor at ICFO Antonio Acín, in collaboration with Miguel Navascués, from University of Bilkent, and Yelena Guryanova, from Bristol, show that, at the level of correlations among different systems, quantum theory is not as special as initially expected. ICFO researchers have constructed a set of correlations, dubbed "almost quantum", and proven that it (i) is supra-quantum, as it predicts correlations that are impossible in the quantum formalism but (ii) does not lead to violations of the no-signalling principle and, more in general, is operationally equivalent to the quantum set for many information tasks. These results then demonstrate that it is possible to modify the structure of quantum correlations without running into any operational contradiction with quantum predictions. Intriguingly, the set of almost quantum correlations can also be derived within the history approach introduced in the context of quantum gravity. Researchers believe that these results could open a possible avenue for generalizations of quantum theory.