Link between quantum physics and game theory found

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(Phys.org) —A deep link between two seemingly unconnected areas of modern science has been discovered by researchers from the Universities of Bristol and Geneva.

While research tends to become very specialized and entire communities of scientists can work on specific topics with only a little overlap between them, physicist Dr Nicolas Brunner and mathematician Professor Noah Linden worked together to uncover a deep and unexpected connection between their two fields of expertise: game theory and quantum physics.

Dr Brunner said: "Once in a while, connections are established between topics which seem, on the face of it, to have nothing in common. Such new links have potential to trigger significant progress and open entirely new avenues for research."

Game theory—which is used today in a wide range of areas such as economics, social sciences, biology and philosophy—gives a mathematical framework for describing a situation of conflict or cooperation between intelligent rational players. The central goal is to predict the outcome of the process. In the early 1950s, John Nash showed that the strategies adopted by the players form an equilibrium point (so-called Nash equilibrium) for which none of the players has any incentive to change strategy.

Quantum mechanics, the theory describing the physics of small objects such as particles and atoms, predicts a vast range of astonishing and often strikingly counter-intuitive phenomena, such as quantum nonlocality. In the 1960s, John Stewart Bell demonstrated that the predictions of quantum mechanics are incompatible with the principle of locality, that is, the fact that an object can be influenced directly only by its immediate surroundings and not by distant events. In particular, when remote observers perform measurements on a pair of entangled quantum particles, such as photons, the results of these measurements are highly correlated. In fact, these correlations are so strong that they cannot be explained by any physical theory respecting the principle of locality. Hence quantum mechanics is a nonlocal theory, and the fact that Nature is nonlocal has been confirmed in numerous experiments.

In a paper published in *Nature Communications*, Dr Brunner and Professor Linden showed that the two above subjects are in fact deeply connected with the same concepts appearing in both fields. For instance, the physical notion of locality appears naturally in games where players adopt a classical strategy. In fact the principle of locality sets a fundamental limit to the performance achievable by classical players (that is, bound by the rules of classical physics).

Next, by bringing quantum mechanics into the game, the researchers showed that players who can use quantum resources, such as entangled quantum particles, can outperform classical players. That is, quantum players achieve better performance than any classical player ever could.

Dr Brunner said: "Such an advantage could, for instance, be useful in auctions which are well described by the type of games that we considered. Therefore, our work not only opens a bridge between two remote scientific communities, but also opens novel possible applications for quantum technologies."

More information: Paper: 'Connection between Bell nonlocality and

Bayesian game theory' by Nicolas Brunner and Noah Linden in *Nature Communications*. www.nature.com/ncomms/2013/130 … full/ncomms3057.html

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