
Speaker: Bob Coecke

Title: Picturing quantum informatics

Abstract: In quantum teleportation continuous data is transmitted while only using a two-bit classical channel. But where does the 'additional information' flow? The quantum formalism does not tell us this in an explicit manner. Clearly it has something to do with the nature of quantum entanglement, but, what exactly? This hidden nature of a magical 'flow of information' is probably the reason why this quite simple protocol was only discovered some 60 years after the creation von Neumann's quantum formalism. Wouldn't it be nice to have a quantum formalism in which inventing quantum teleportation would be a high-school exercise? Or, ... a kindergarten exercise?

Such a formalism actually does exist!

More precisely, there does exist a notion of quantum information-flow and Samson Abramsky and I showed how this quantum information-flow can be axiomatically characterized by a so-called strongly compact closed category. The kindergartenish nature arises due to the fact that such a strongly compact closed category admits a tangible purely graphical calculus. But most importantly, the very simple (graphical) axiomatics which captures quantum entanglement comes with almost all tools needed to do full-blown quantum mechanics e.g. scalar multiplication, external and internal trace, adjoint, unitarity, inner-product, Hilbert-Schmidt norm and inner-product, (eliminable) global phases, positivity of operations, projector, and also 'complete positivity' (a result due to Peter Selinger). Moreover, quantum information-theoretic notions such as all kinds of capacities and fidelities admit a simple uniform treatment in a formalism which combines the quantitative with the qualitative by introducing a high-level version of 'partiality of information', lifting domain-theoretic notions to the categorical.