Quantum physics as it is practised in the lab

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Quantum physics as it is practised in the lab can be given a purely category-theoretic axiomatics. We define both quantum and classical systems as structured objects within a symmetric monoidal category. Quantum measurements turn out be Eilenberg-Moore coalgebras relative to a comonad induced by a classical structure. In particular, the Eilenberg-Moore commuting square condition embodies von Neumann's projection postulate of quantum mechanics: when one repeats a measurement one obtains the same outcome in the second measurement as one obtained in the first one. This language provides an extremely powerful tool for the design and analysis of sophisticated quantum informatic protocols which involve highly non-trivial interaction between the quantum world and the classical world.

What is particularly appealing to the practising physicist is that this categorical language comes with an intuitive diagrammatic calculus. In fact, the graphical language for monoidal categories, quantum structures and classical structures is in fact a two-dimensional "correction" and "refinement" of the so-called Dirac-notation, which is very popular among physicists.

The category-theoretic background for this talk traces back to work by Kelly & Laplaza, Carboni & Walters, Joyal & Street and others. This talk is based on several papers which also include work by/with Abramsky, Duncan, Paquette, Pavlovic & Selinger. For papers and links please consult:
`http://se10.comlab.ox.ac.uk:8080/BobCoecke/Maintopic_en.html`