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Local measurement theory for quantum fields

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Many presentations of quantum mechanics include a postulate that the state of a system undergoes an instantaneous change following a measurement. This is clearly incompatible with special and general relativity and raises questions concerning the description of measurement in quantum field theory (QFT). Attempts to extend measurement postulates to QFT by hand have produced pathologies, such as the "impossible measurements" described long ago by Sorkin. I will present a recent operational approach to these questions, which models measurement of one quantum field (the system) by coupling it to another (the probe). This is all accomplished in a model-independent way within algebraic quantum field theory (AQFT). The resulting framework provides a description of measurement in QFT that is causal, covariant and consistent, and includes state update rules that are derived from the formalism, and works equally well in flat or curved spacetimes. As well as covering the basics of the formalism I will touch on some more recent developments, including asymptotic measurement schemes, and how one may describe Bell inequality violation in this framework.

The talk is mostly based on joint works with Rainer Verch, Henning Bostelmann, Maximilian Ruep and Ian Jubb.

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