Contribution ID: **20** Type: **not specified**

Quantum Tops: Quantum Information Meets High Energy Physics

Thursday 14 November 2024 14:00 (25 minutes)

The Standard Model of particle physics is a quantum field theory, based on quantum mechanics and special relativity. Therefore, it allows us to test fundamental properties of quantum mechanics. Top-quark pairs, which are generated at the LHC, are a unique high-energy system since their spin correlations can be measured. Thus, it is possible to study fundamental aspects of quantum mechanics such as entanglement and Bell non-locality using top-quark pairs, represented as two qubits. The environment provided by the LHC makes these studies especially attractive: the qubits are entangled through exotic interactions and are genuinely relativistic, at energies which are many orders of magnitude above conventional condensed-matter and optical experiments. In addition to the fundamental and interdisciplinary nature of these studies, quantum information observables can be used to develop new strategies to search for physics beyond the Standard Model. I will discuss the theoretical background, the first measurements of entanglement between top-quark pairs by the ATLAS and CMS collaborations, and the future prospect of the field.

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Session Classification: BSM