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Quantum simulations of loop quantum gravity

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One of the possible applications of quantum computers in the near future are simulations of physics. An example are quantum gravitational systems associated with the Planck scale physics. Such systems are expected to be of the many-body type, which justifies utility of quantum computations in the analysis of their complex quantum behaviour. In this talk, loop quantum gravity - a leading candidate for the theory of quantum gravitational interactions - is considered. In this case, quantum geometry of space is represented by the so-called spin networks, i.e. graphs with nodes associated with the “atoms of space”. A construction of quantum circuits which generate states of spin networks will be presented. Furthermore, a quantum algorithms which enable projection of states on physical subspace of Hilbert space and determination of amplitudes of transitions between different states of spin network are proposed. Results of implementation of the approach on IBM superconducting quantum computers will be presented. Obtained results provide building blocks for quantum simulations of complex spin networks, which can give insight into the Planck scale physics in the near future.

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