Marches quantiques et champs de jauge de synthèse

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Résumé

Discrete-time quantum walks (DTQWs) model spin-dependent transport on a lattice. They are universal building blocks of quantum algorithms, and can simulate transport in condensed matter. They have been implemented with several objects and setups, e.g. photons in optical networks or fibers, ions in optical traps, or cold atoms in optical lattices. When DTQWs decohere, they tend to classical random walks.

In the continuum limit, i.e. in the limit of weak spin-components coupling, large wavelengths and time periods with respect to the space and time steps, DTQWs reproduce a substantial branch of classical field theory, including couplings with (synthetic) electromagnetic and/or relativistic gravitational gauge fields. Several gauge invariances on the lattice have been exhibited, showing that the connexions between DTQWs and gauge theory are not a mere emergent property of the continuum limit, but exist at the discrete level.

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