A Hierarchy of Topological Tensor Network States

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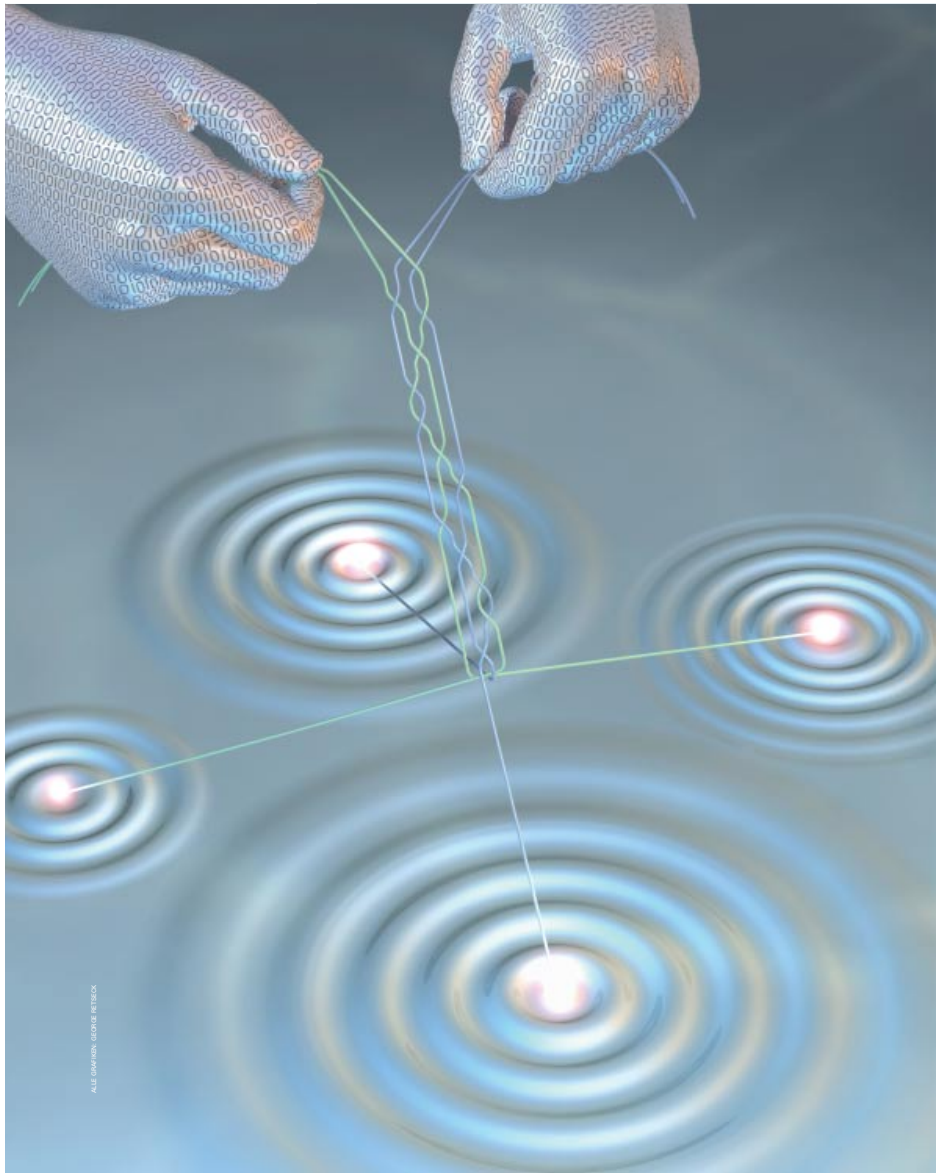
Zurich, Switzerland

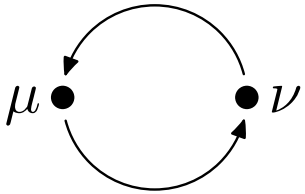
Quantum Engineering of States and Devices, Obergurgl 2010

Topological Order and Quantum Computation



Anyons

- Braiding in 2D



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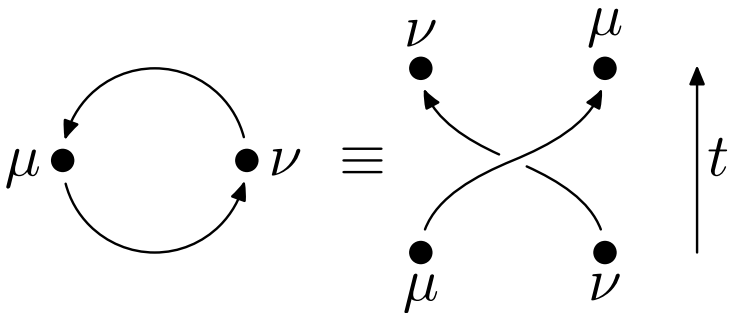

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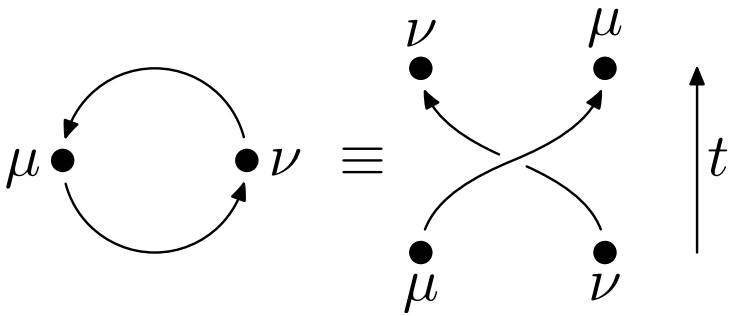

$$|\psi_{\mu\nu}\rangle \mapsto U\,|\psi_{\mu\nu}\rangle$$

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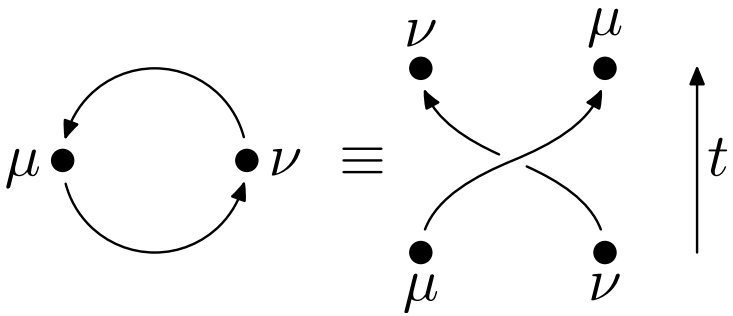

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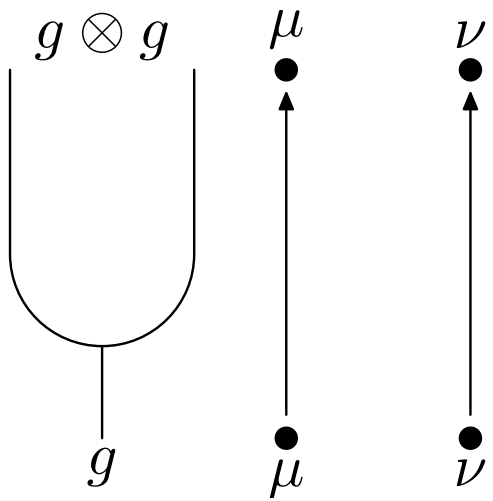
- Symmetry and Hopf algebras



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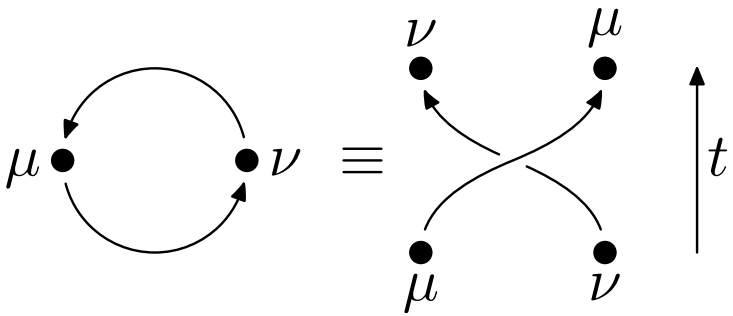

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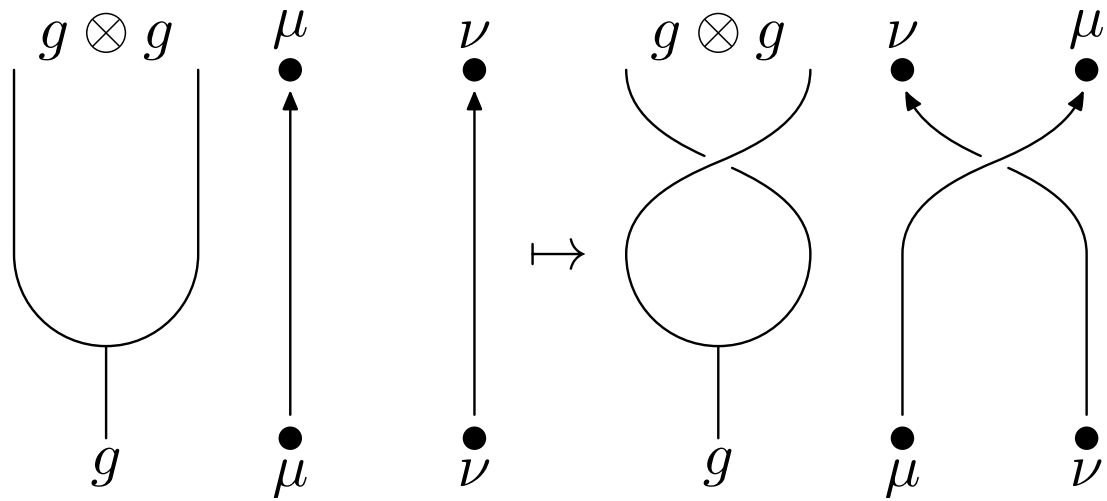

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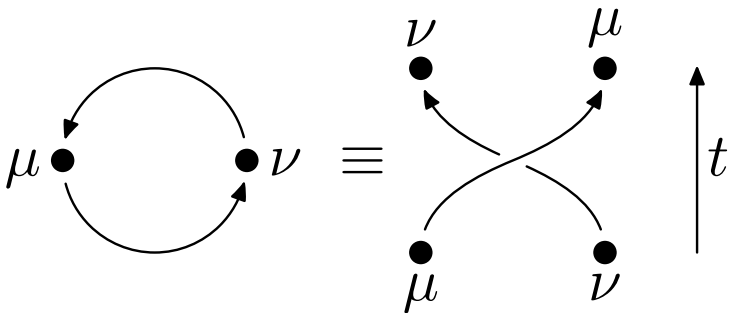

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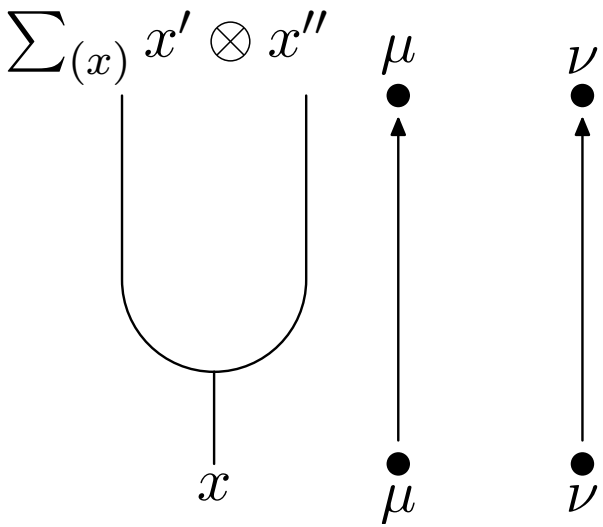

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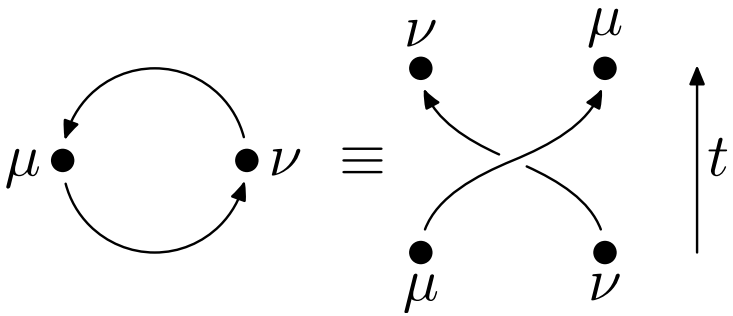

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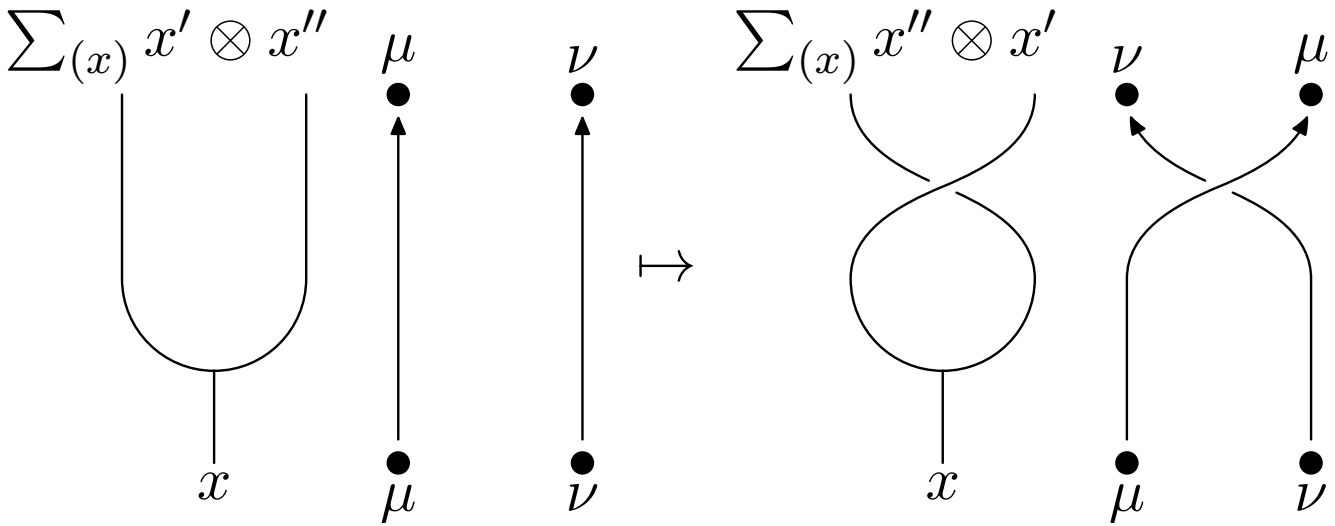
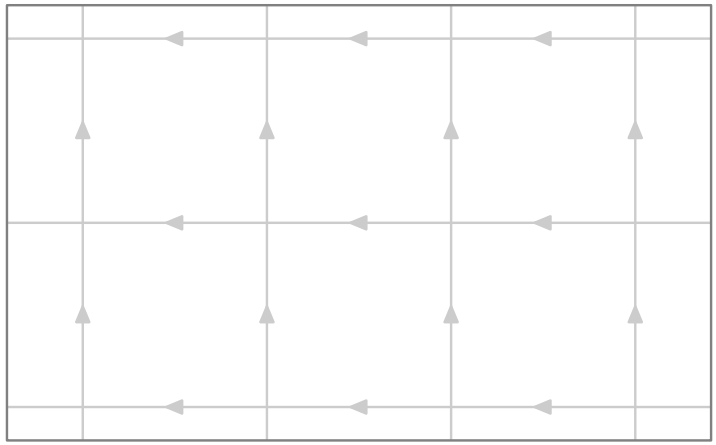


Tensor networks

- Traditional approach (AKLT, MPS, PEPS)



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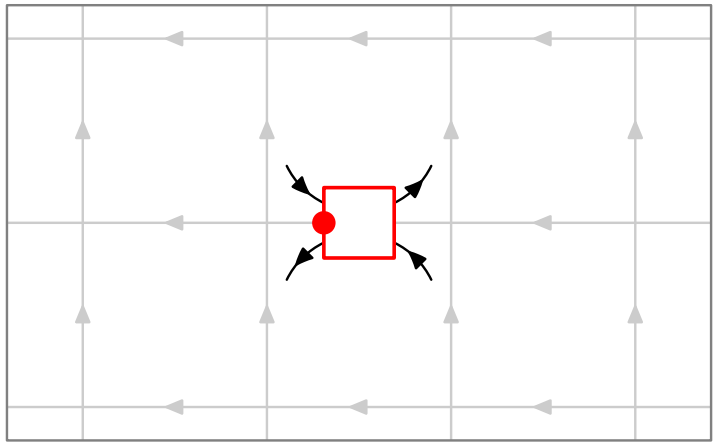

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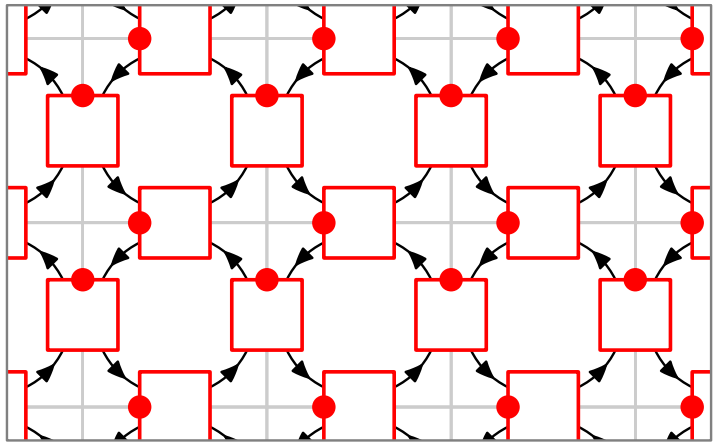
$$\langle g_1, \ldots, g_N | \psi \rangle =$$



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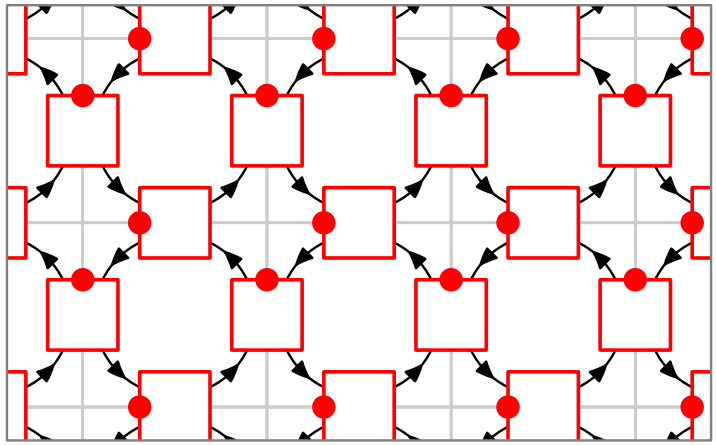

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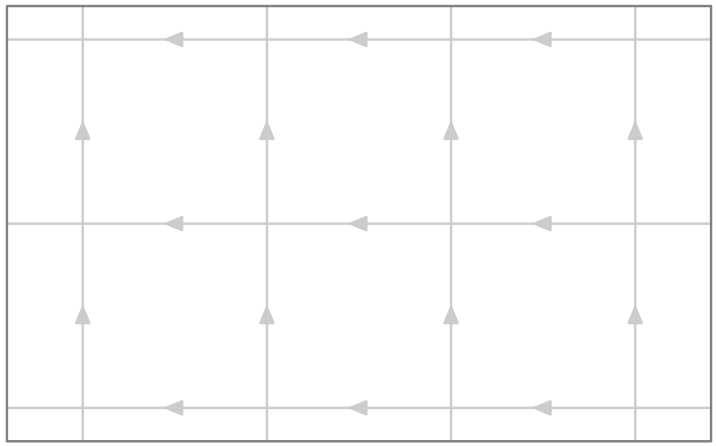

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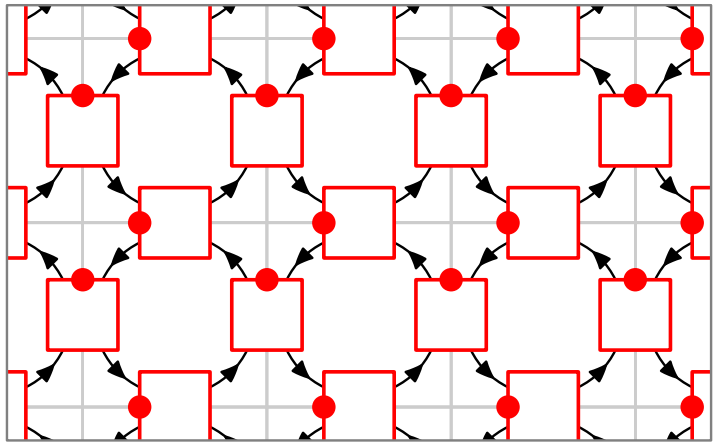

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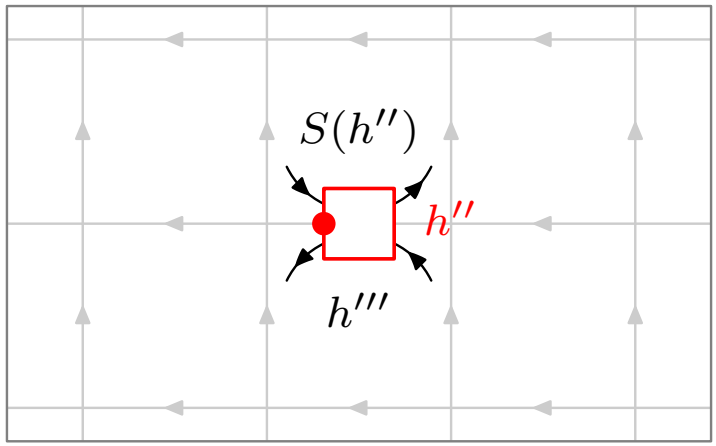
$$\sum_{(x)}$$



$$|x'\rangle$$

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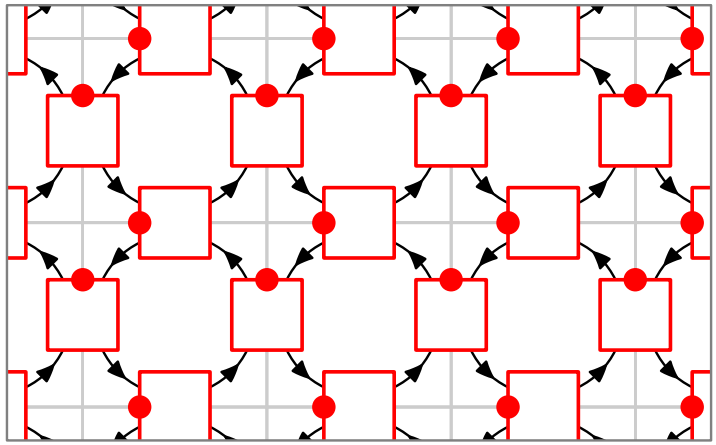
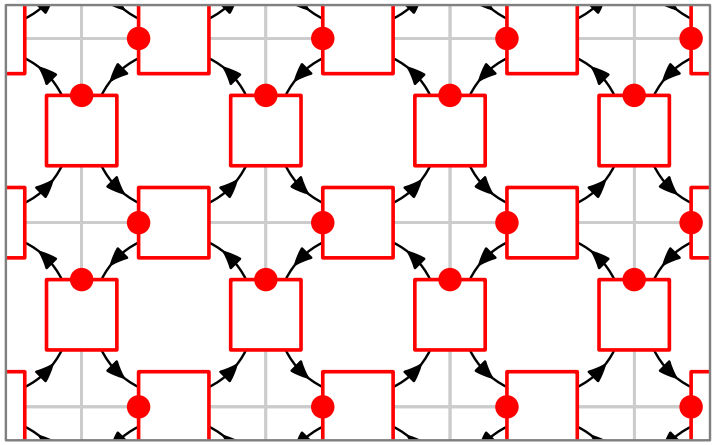


- Our approach

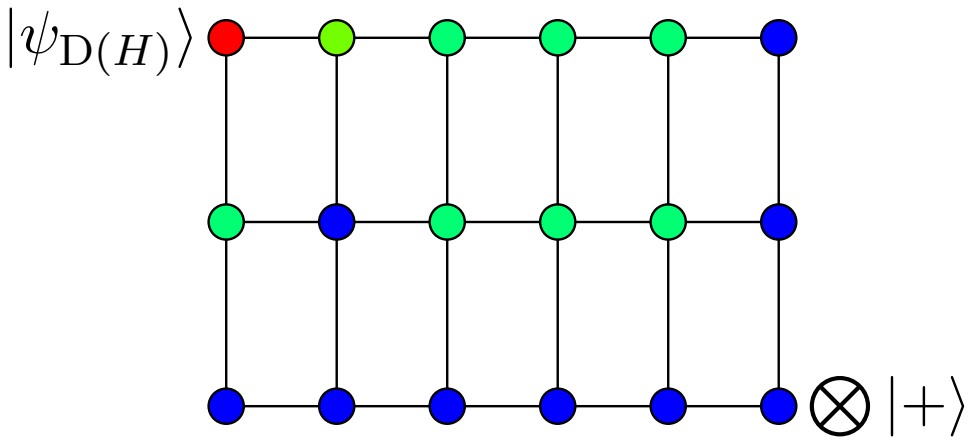
$$|\psi\rangle = \sum_{(x_i)}$$



$$\bigotimes_{i=1}^{N} |x_i'\rangle$$

Hierarchy of Topological TN States

- Quantum states from Hopf algebras



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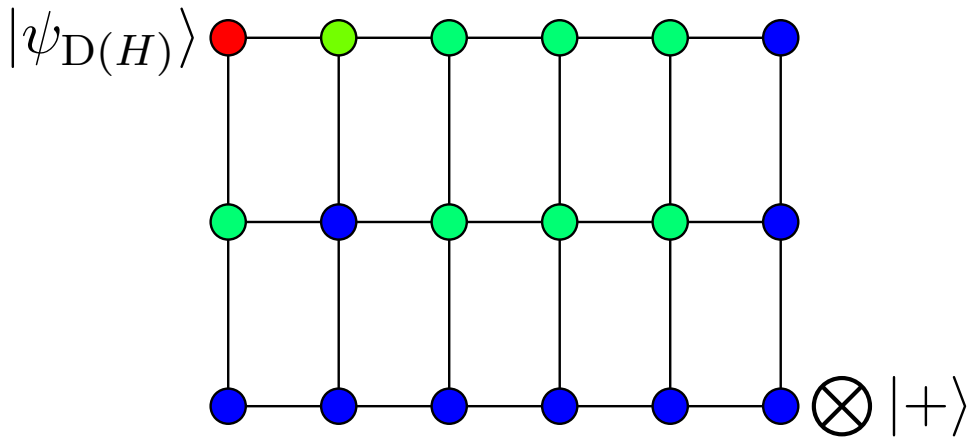
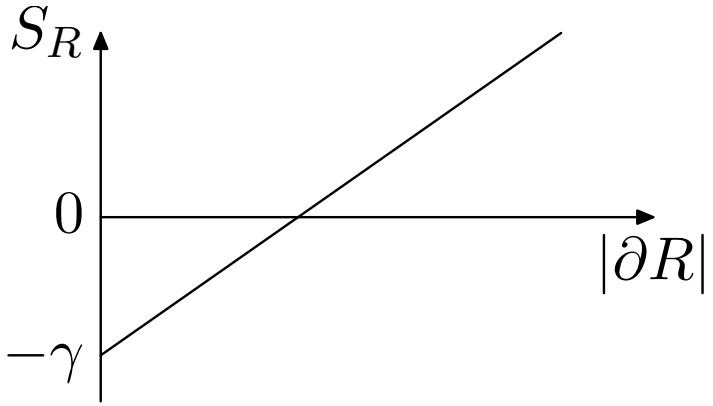


- Topological entanglement entropy



Summary

- Hopf algebras as natural tool to describe systems with topological order
- General framework for tensor network states based on Hopf algebras
- Hierarchy of topological states related by charge condensation