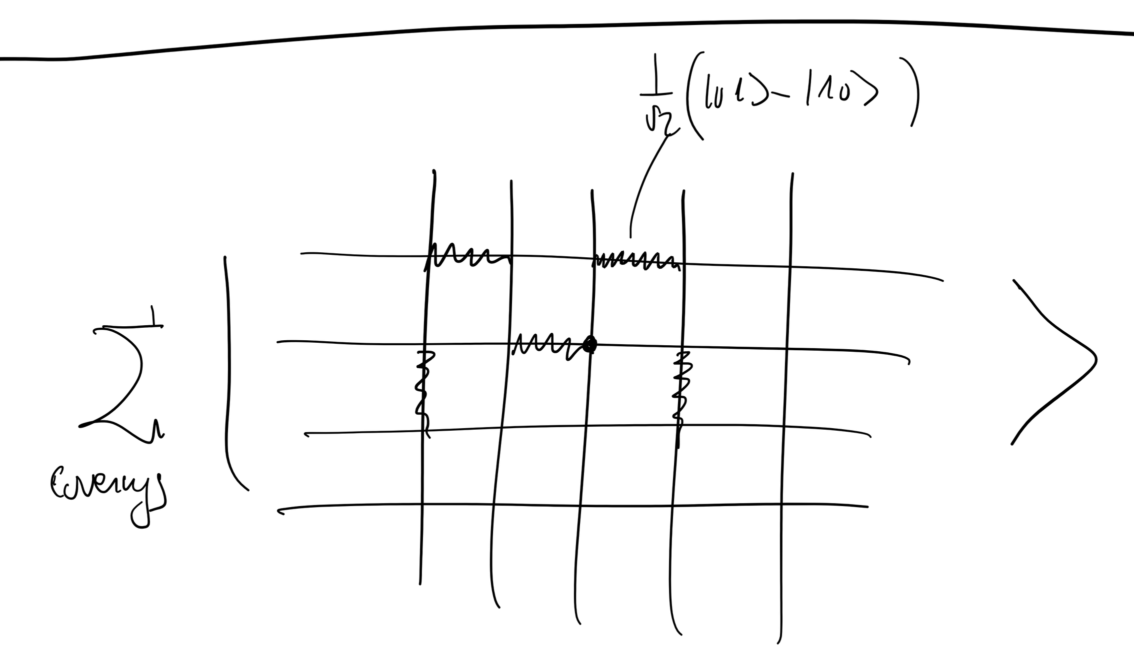
$\boxed{\text{Review about rigorous results on TN, RMP, Cirac, DPG, Schuch, Verstraete, 2021-2022.}}$

- Why are TN interesting (rigorous results)?
- what does working in TN formalism add? Why are TN useful?

Quantum Many Body

Interesting	Useful
$\boxed{GS \cong PEPS}$	Reduce the study of phases of matter to PEPS
Exotic examples are PEPS (representatives RFP of each gapped phase)	$\Updownarrow$
MERA $\cong$ 1D critical GS	Local characterization of global properties
	$\Updownarrow$
	Classification of phases of matter
	Hamiltonians for "free". RVB
	Ideas for better numerical methods



Q. computing

Interesting	Useful
(topological) codes	Lifetime estimates.
Quantum circuits $\cong$ TN.	Explicit examples of large complexity states.
1D QCA $\cong$ MPU	Index theorem. classify QCA.
MBQC (cluster state)	New universal resources.
measures $\rightsquigarrow$ Quantum circuit run in v.d.o.f.	Complexity theory.

Q. information

(uniform) MPS $\cong$ Quantum channels
$\Updownarrow$
$\boxed{\text{tp.cp}}$ map.

Quantum Wielandt theorem

$T: M_D \longrightarrow M_D$ linear.

trace preserving (tp)

$tr(T(x)) = tr(x) \quad \forall x \in M_D$

Completely positive. (cp)

$\mathbb{1}_k \otimes T: M_k \otimes M_D \longrightarrow M_k \otimes M_D$ positive preserving.

$\underset{M_k \otimes M_D}{\underset{\cap}{\rho}} \geq 0 \Rightarrow (\mathbb{1} \otimes T)(\rho) \geq 0 \quad \forall k \in \mathbb{N}.$

Stinespring

dim of environment.

T is a tpcp map $\Leftrightarrow \exists\, k \in \mathbb{N}$, U unitary s.t.

$T(\rho) = tr_E(U(\rho \otimes |0\rangle\langle 0|_E)U^\dagger)$

environment.

$\Leftrightarrow \exists\, (A_i)_i \subset M_D$ s.t.

Krauss operators.

$T(x) = \sum_i A_i x A_i^\dagger$

& $\sum_i A_i^\dagger A_i = \mathbb{1}$

transfer operator of an MPS in canonical form.

MPOs $\supseteq$ communication channels with memory.	complexity of computing the $\boxed{\text{Capacity}}$

Quantum gravity

Toy models	prove rigorously properties

AI

⋮