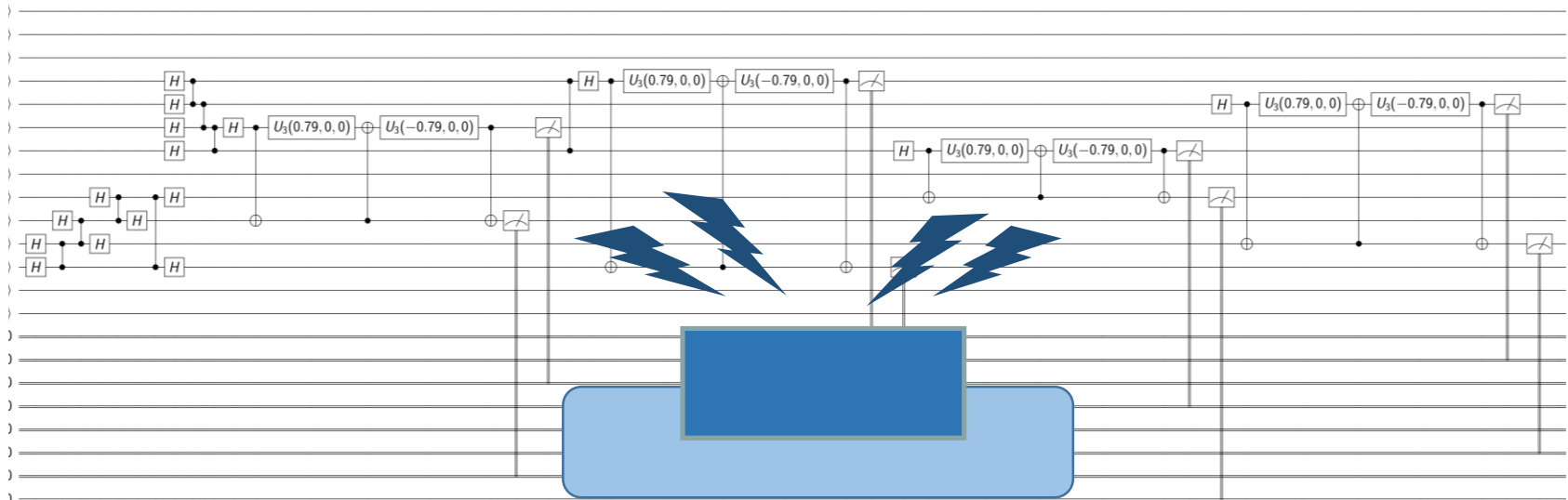


Symmetries and Noise

on an IBM Quantum Computer



Many-body quantum dynamics group



Mor Roses

Daniel Atzitz



Eran Sela
(TAU)

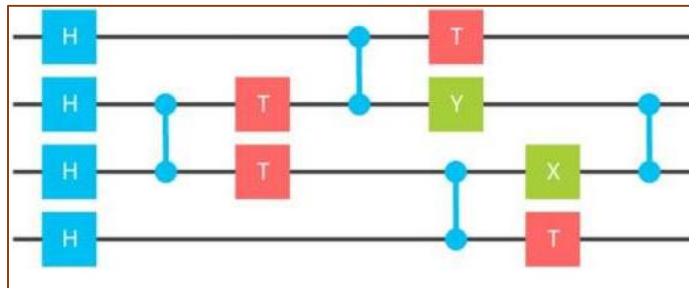


Yehuda Naveh
(IBM)



“The” challenge of quantum computing

Model : unitary gates

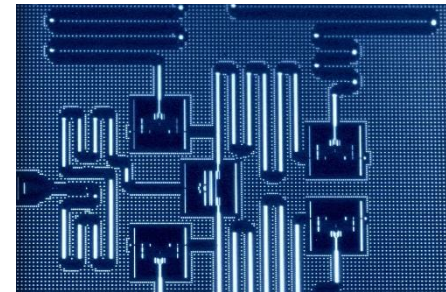


Reality : noisy QC

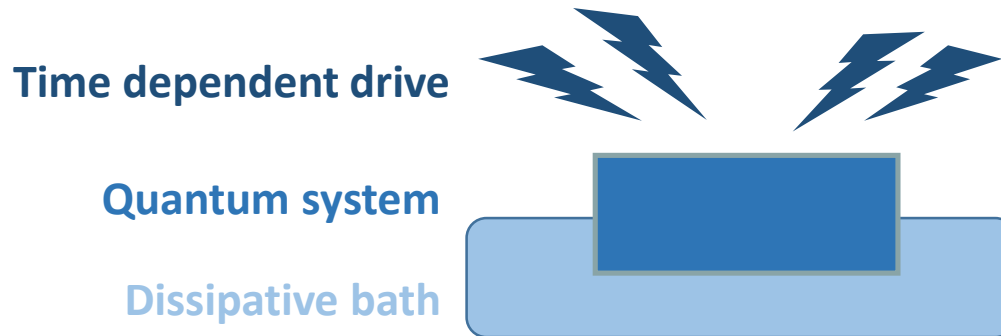
quantum error correction



open quantum systems



Open quantum systems



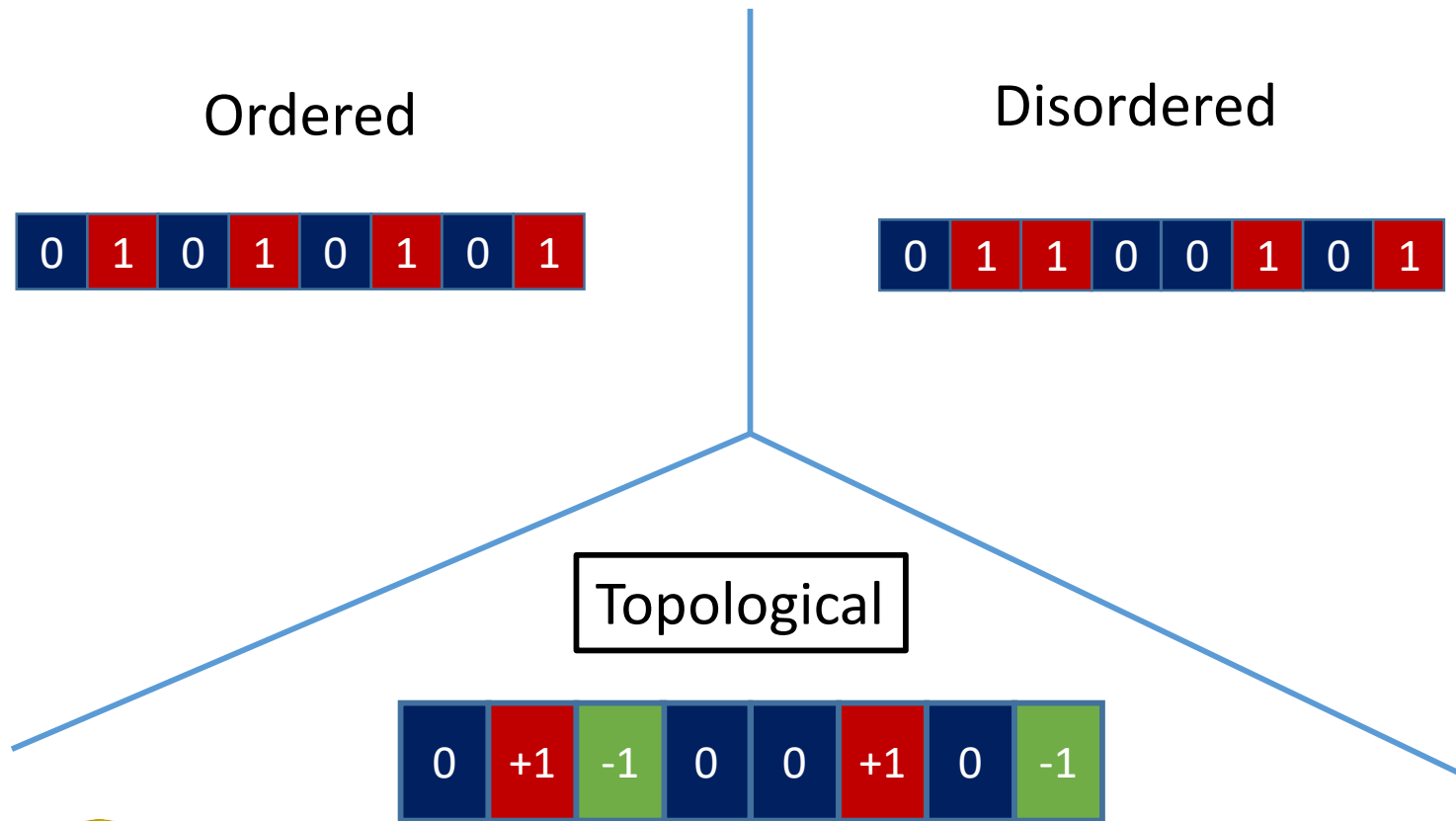
Floquet
engineering

Quantum bath
engineering

Nonequilibrium
universality

Symmetries and
topology

Introduction : phases of matter

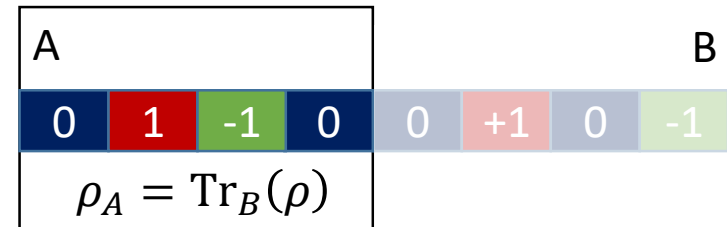


Haldane (1982), AKLT (1987), den Nijs&Rommelse (1989), ..., Dalla Torre, Berg&Altman (2012),

Symmetry protected topological phases

Subsystem probabilities:

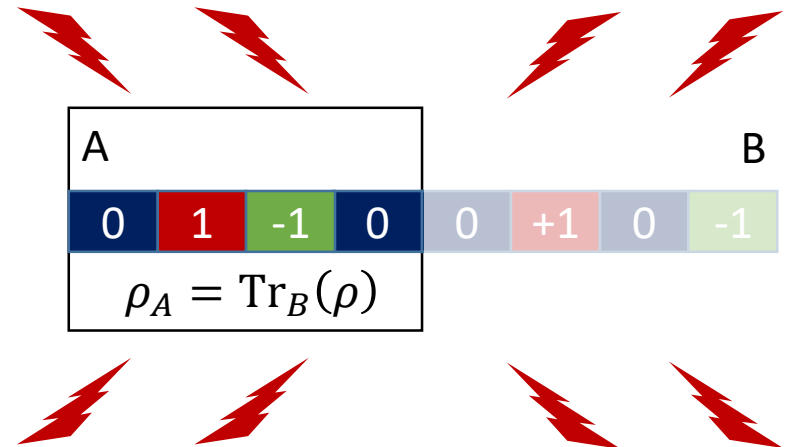
$$\text{Eigs}(\rho_A) = 0.3, 0.3, 0.15, 0.15, 0.05, 0.05, \dots$$



Pollmann, Turner, Berg, & Oshikawa (2010) Chen, Gu & Wen (2011)

Extension to open quantum systems ?

$$\text{Eigs}(\rho_A) = 0.25, 0.25, 0.1, 0.1, 0.03, 0.03, \dots ?$$



Atzitz, Sela, Dalla Torre (in preparation)

Noisy topological phases on a quantum computer

SPT on a quantum computer

Choo, von Keyserlingk, Regnault & Neupert (PRL, 2018)

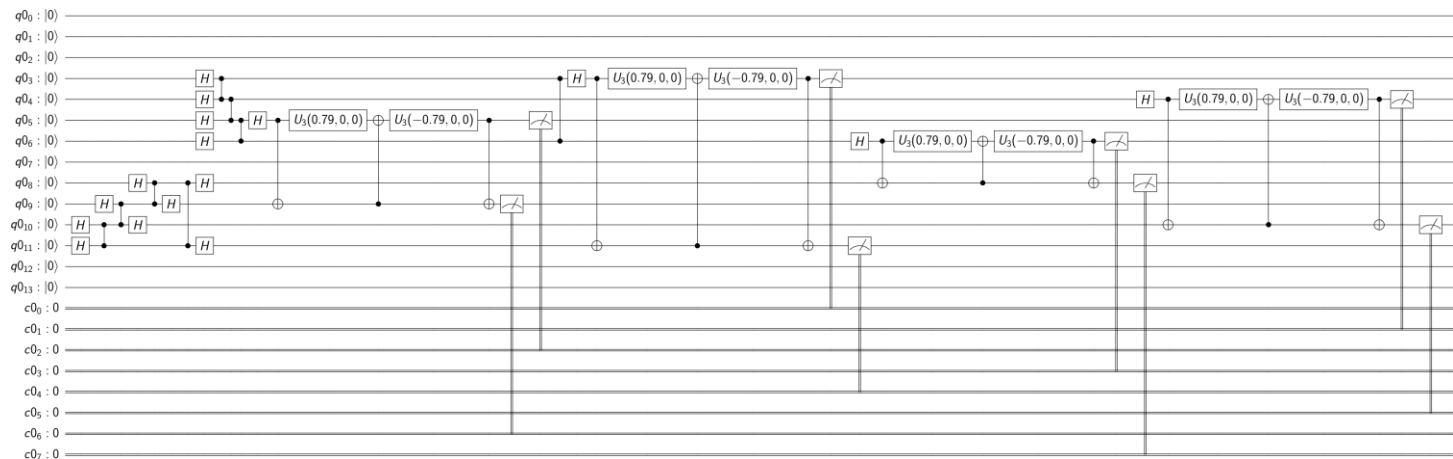
$$H = \sum_i \sigma_i^z \sigma_i^x \sigma_{i+2}^z$$

Symmetry-resolved purity

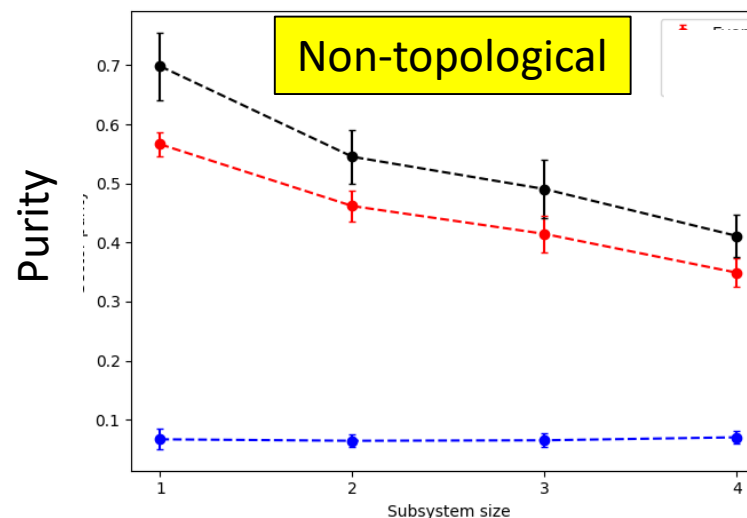
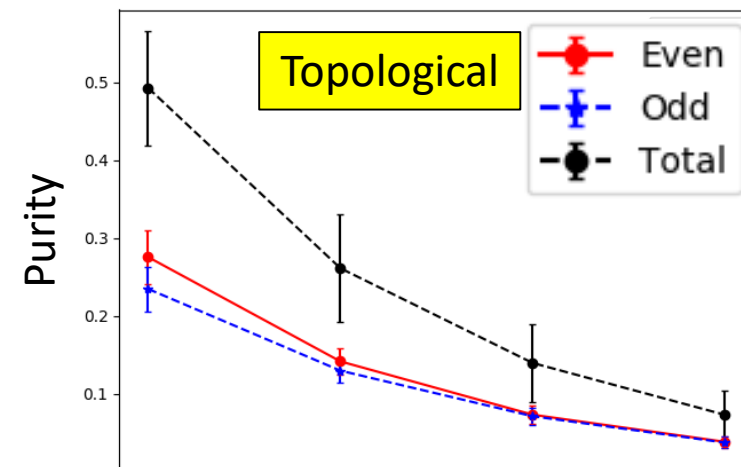
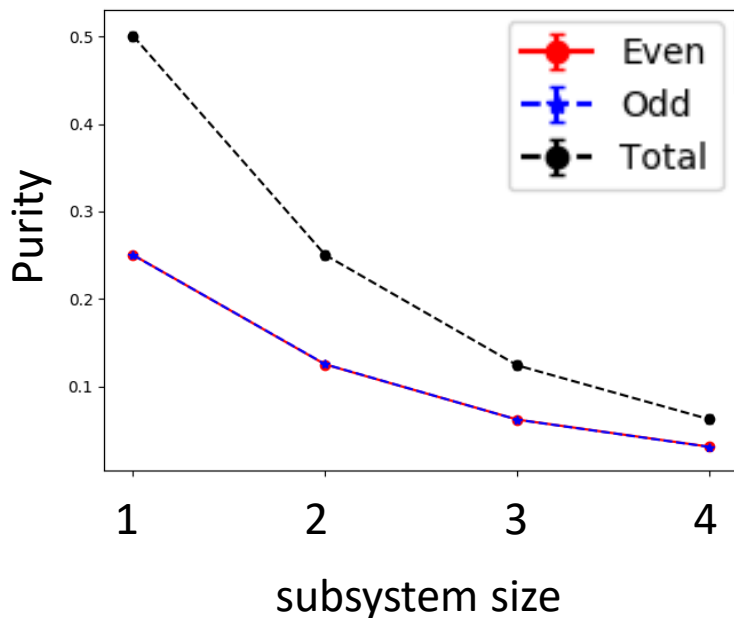
Daley, Pichler, Schachenmayer, Zoller (PRL, 2012),
Goldstein & Sela (PRL, 2018)

$$S_2^\pm = \sum_i (\lambda_i^\pm)^2$$

Our circuit:



Simulation vs. Experiment



Atzitz, Sela, Dalla Torre (in preparation)

Symmetries and Noise on an IBM Quantum Computer

1. **Psychology:**

addressing the “cognitive dissonance”

2. **Semiconductor industry (INTEL) :**

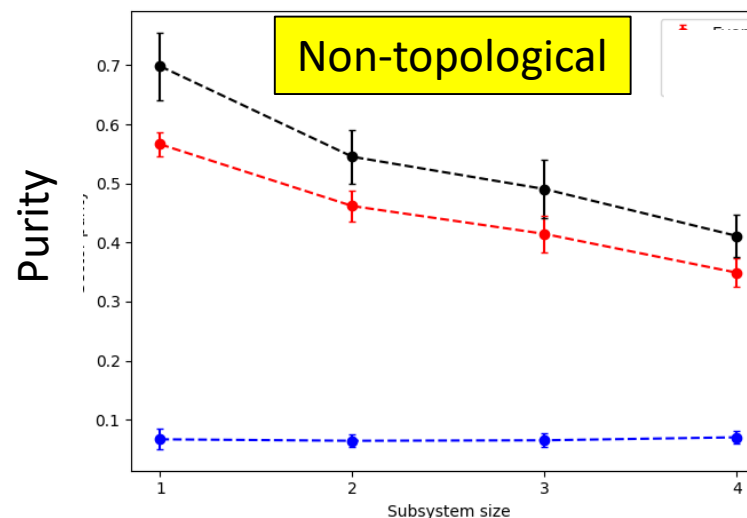
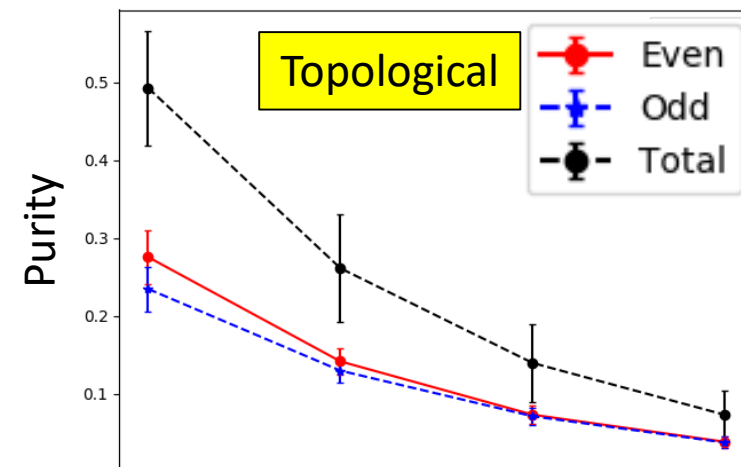
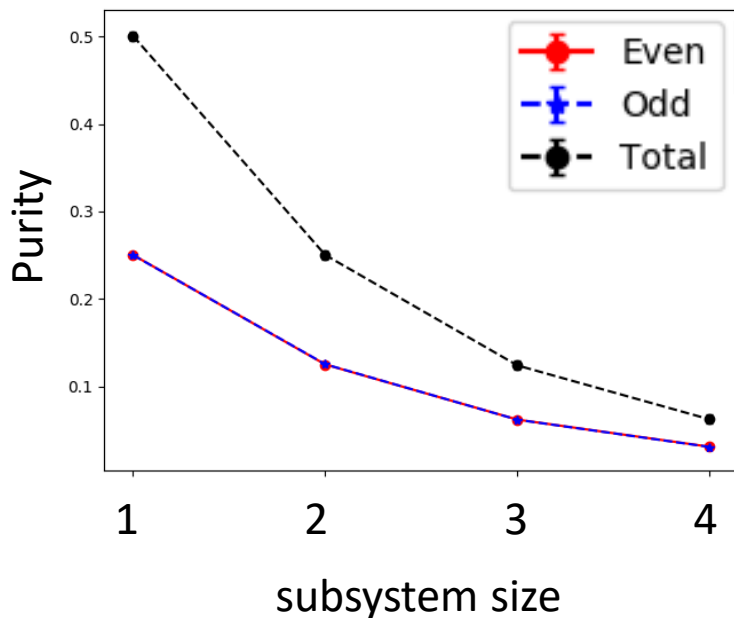
predictive power of noisy simulations

3. **Cond-mat and Stat-mech physics:**

f.e. “Introduction to mesoscopic physics” by Joe Imry z”l

4. ...

Simulation vs. Experiment



Atzitz, Sela, Dalla Torre (in preparation)

EXTRA SLIDES



"quantum computing dissonance" 

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