

Title: Quantum Information Review - Lecture 11

Date: Mar 01, 2011 09:00 AM

URL: <http://pirsa.org/11030000>

Abstract:

$$|0\rangle \rightarrow (|000\rangle + |111\rangle)^{\otimes 3}$$

$$|1\rangle \rightarrow (|000\rangle - |111\rangle)^{\otimes 3}$$

$$Z \otimes Z$$

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$$Z \otimes Z$$

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$$10) \rightarrow (1000 + 1111) \oplus 3$$

$$11) \rightarrow (1000 - 1111) \oplus 3$$

$$2 \oplus 2$$

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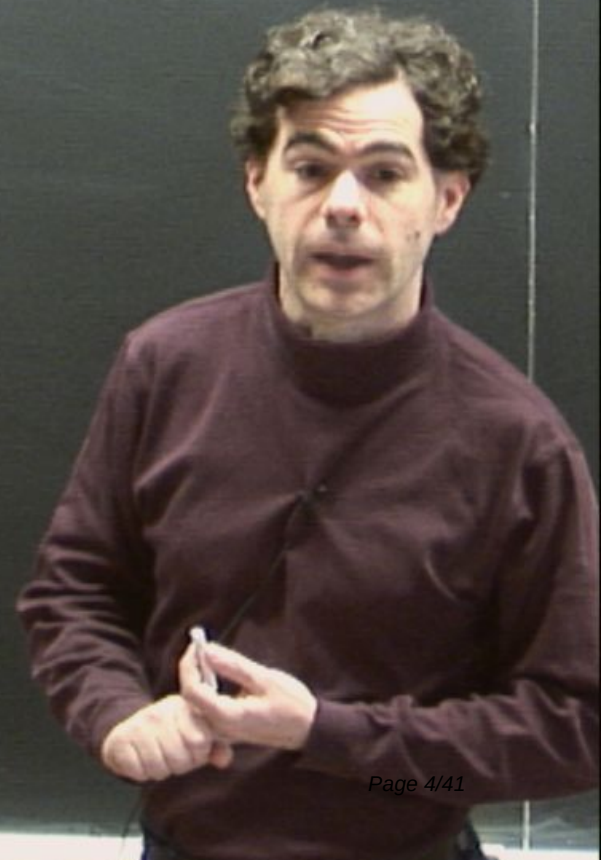
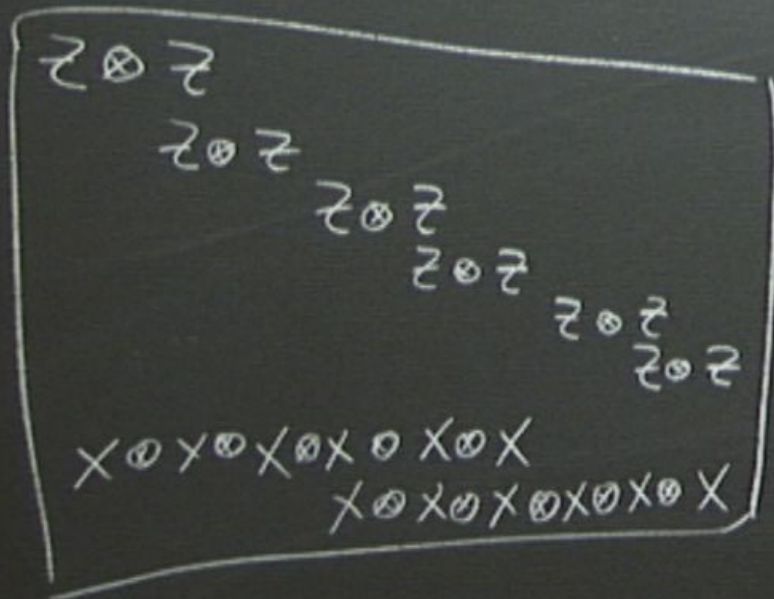
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$$X \oplus X \oplus X \oplus X \oplus X \oplus X$$

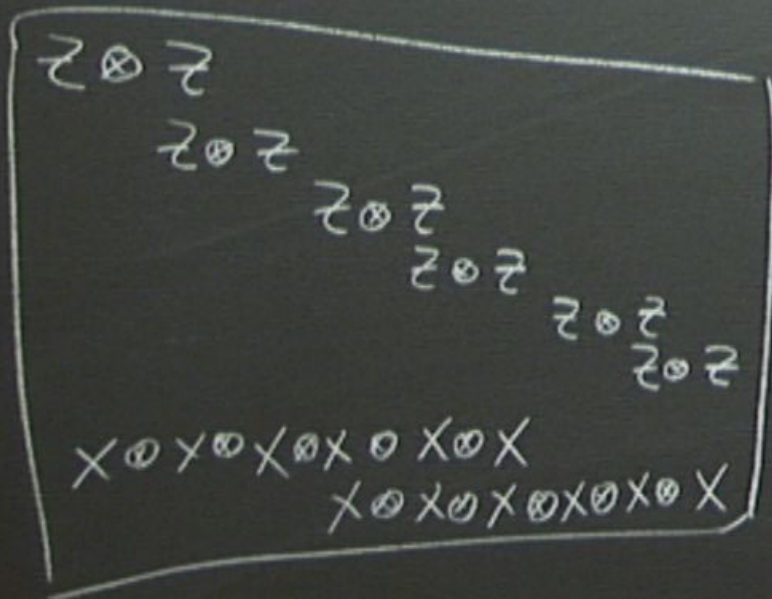
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$$M|4) = |4), N|4) = |4)$$

∀ codewords $|4)$

$$M N |4) = M |4) = |4)$$

$$\begin{aligned}
 |0\rangle &\rightarrow (|1000\rangle + |1111\rangle) \otimes 3 \\
 |1\rangle &\rightarrow (|1000\rangle - |1111\rangle) \otimes 3
 \end{aligned}$$

$$\begin{aligned}
 M|1\rangle &= |1\rangle, N|1\rangle = |1\rangle \\
 \forall \text{ codewords } |1\rangle
 \end{aligned}$$

$$M N |1\rangle = M |1\rangle = |1\rangle$$

Stabilizer of code

$$= \left\{ M \in \mathcal{P}_n \mid M|1\rangle = |1\rangle \quad \forall \text{ codewords } |1\rangle \right\}$$

$$\begin{array}{ccccccc}
 Z \otimes Z & & & & & & \\
 & Z \otimes Z & & & & & \\
 & & Z \otimes Z & & & & \\
 & & & Z \otimes Z & & & \\
 & & & & Z \otimes Z & & \\
 & & & & & Z \otimes Z & \\
 & & & & & & Z \otimes Z
 \end{array}$$

$$\begin{array}{cccccccc}
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 \end{array}$$

$|111\rangle^{\otimes 3}$
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$$M|\psi\rangle = |\psi\rangle, N|\psi\rangle = |\psi\rangle$$

$\forall$ codewords $|\psi\rangle$

$$MN|\psi\rangle = M|\psi\rangle = |\psi\rangle$$

Stabilizer of code

$$= \left\{ M \in \mathcal{P}_n \mid M|\psi\rangle = |\psi\rangle \forall \text{ codewords } |\psi\rangle \right\}$$

Pauli group $\mathcal{P}_n$ is group consisting of tensor products of I, X, Y, Z on n qubits w/ overall phase $\pm 1, \pm i$

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$\mathcal{P}_t$ (on t qubits) spans matrices on t qubits.

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Stabilizer of code

$$S = \left\{ M \in \mathcal{P}_n \mid M|\psi\rangle = |\psi\rangle \forall \text{ codewords } |\psi\rangle \right\}$$

X Pauli group \$\mathcal{P}_n\$ is group consisting of tensor products of \$I, X, Y, Z\$ on \$n\$ qubits w/ overall phase \$\pm 1, \pm i\$

\$-\mathcal{P}_n\$ (on \$n\$ qubits) spans matrices on \$2^n\$ qubits.

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$$\Rightarrow \mathcal{S} \text{ stabilizer Abelian}$$

Def.: Let $\mathcal{S} \subseteq \mathcal{P}_n$ with $\mathcal{S}$ an Abelian group, $-I \notin \mathcal{S}$.

$$\text{Let } T(\mathcal{S}) = \{|\psi\rangle \mid M|\psi\rangle = |\psi\rangle \forall M \in \mathcal{S}\}$$

Def. Let $S \subseteq \mathcal{P}_n$ with S an Abelian group, $-I \notin S$.

Let $T(S) = \{|\psi\rangle \mid M|\psi\rangle = |\psi\rangle \forall M \in S\}$.

Prop. If S has r generators,

on n physical qubits, then

$$\dim T(S) = 2^{n-r}$$

then
 $\{E, F\} = 0$.

$$\{Z\} = 0$$

$$= NM|\psi\rangle$$

$$= [M, N]|\psi\rangle = 0$$

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E, F have different error syndromes iff $E \& F$ commute w/ different subsets of S .

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Thm. $\mathcal{E}$ is set of possible errors. S is stabilizer. Then S corrects $\mathcal{E}$ iff

$$E^\dagger F \notin N(S) \setminus S \\ \forall E, F \in \mathcal{E}$$

M/N

$\forall$

M/N

$\sum$

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df tensor
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$$\text{e.g. } [E, F] =$$

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$$(MN)$$

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$$E^T F \in S \Rightarrow E^T F H Y = I Y$$

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E & F act the same
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If $E^\dagger F \in S$, the code is degenerate

Distance of S is minimum weight $N \in N(S) \setminus S$

of qubits where N is not identity

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Stabilizer code w/ n physical qubits, k logical qubits, distance d , then write this as $[[n, k, d]]$

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$$f(\gamma) = \gamma$$

γ

the same
corrected the

ect + qubit
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n physical qubits,
ce d , then

(d)

$$([5], 3)$$

$$X \otimes Z \otimes Z \otimes X \otimes I$$

$$I \otimes X \otimes Z \otimes Z \otimes X$$

$$X \otimes I \otimes X \otimes Z \otimes Z$$

$$Z \otimes X \otimes I \otimes X \otimes Z$$

Def. Let
group,
Let

Prop. I
on