Entanglement on demand
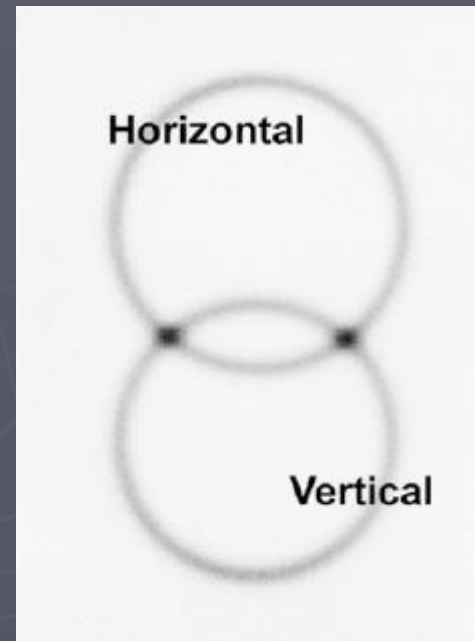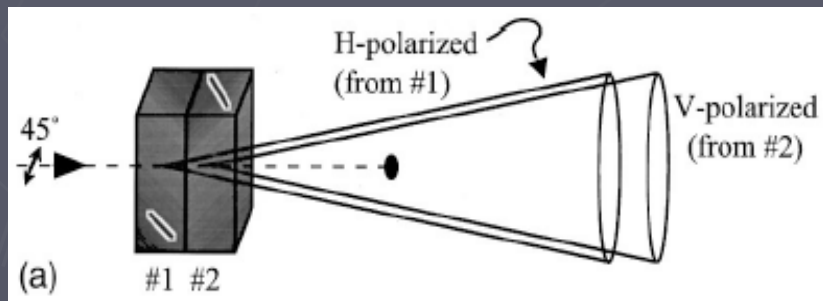

Akopian, Avron, Berlatzky, Gershoni, Lindner, Poem

On demand
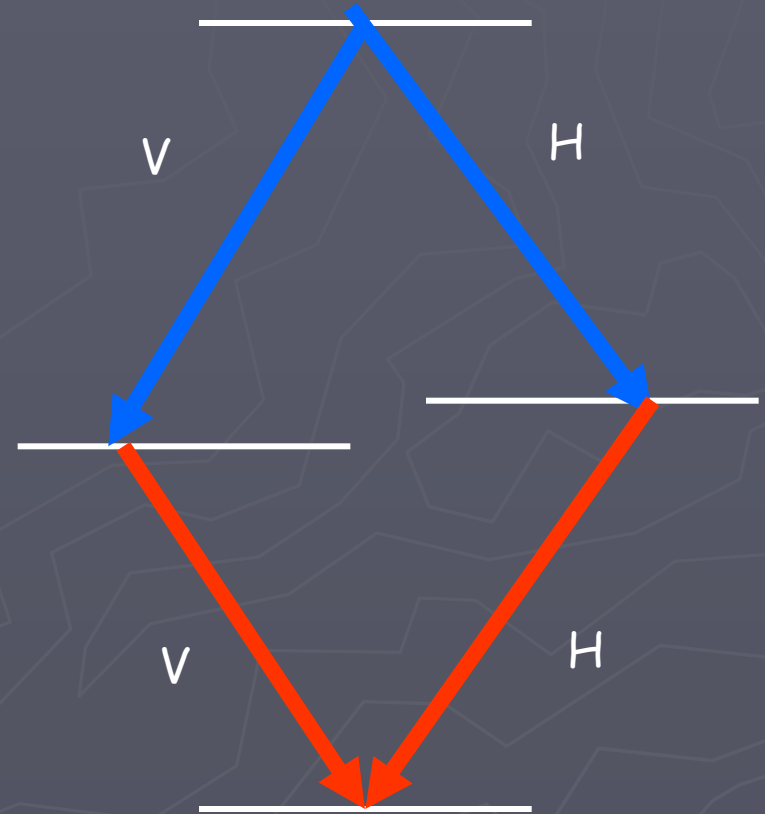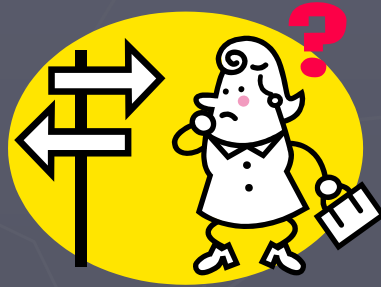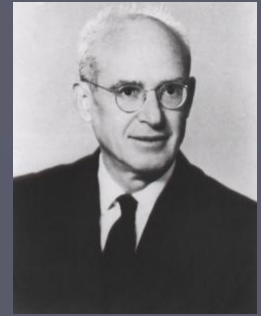

ε |entangled> + |junk>

Quantum dots
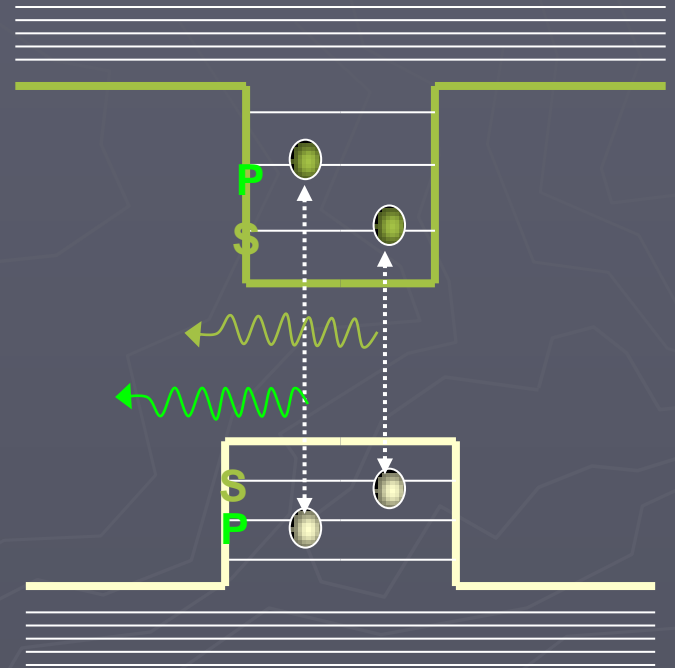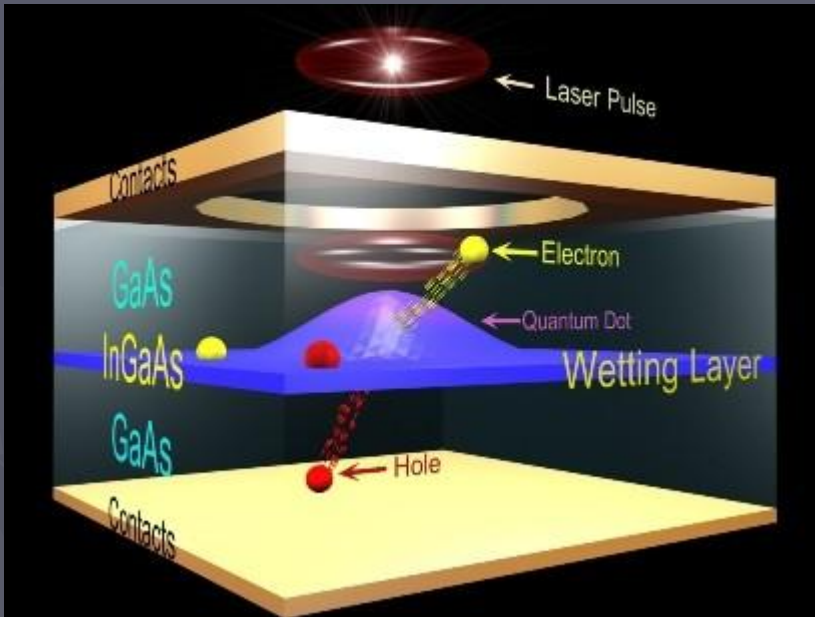
Which path and entanglement

classical correlations

Separable states

$$\rho_S = \sum p_j \, \rho_j^A \otimes \rho_j^B, \quad p_j > 0$$

Entangled states= Unseparable

Peres test

$$\rho = \begin{pmatrix} A & B \\ B^* & C \end{pmatrix}, \quad \rho^P = \begin{pmatrix} A & B^* \\ B & C \end{pmatrix}$$

If transform has negative eigenvalue state is entangled

$$\rho = \frac{1}{2} \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 \\ 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \quad \rho^P = \frac{1}{2} \begin{pmatrix} 0 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -1 & 0 & 0 & 0 \end{pmatrix}$$
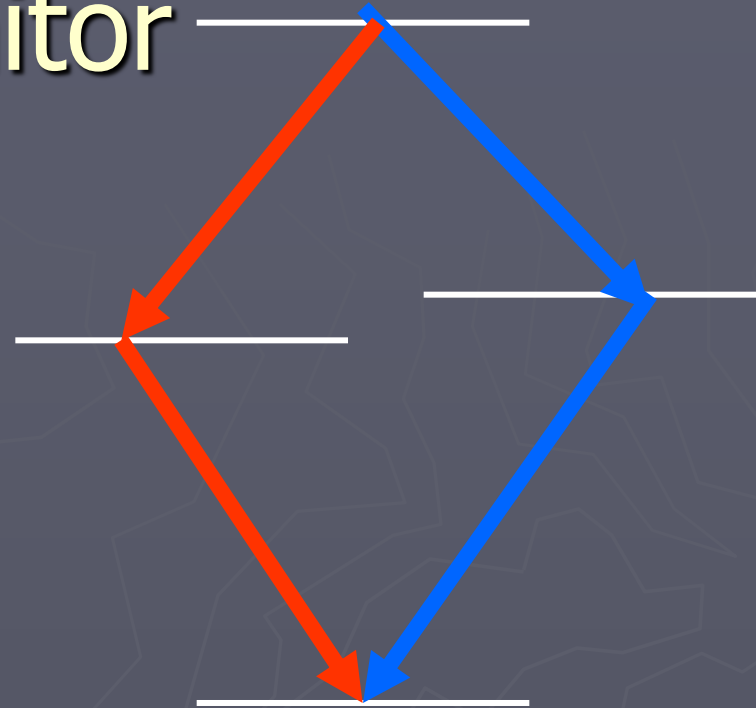
Color as path monitor

Photons wave packet

$$|\psi\rangle = \alpha\,|HH\rangle \otimes \overbrace{|p_H\rangle}$$
$$+\beta\,|VV\rangle \otimes |p_V\rangle$$

$$\rho = \begin{pmatrix} |\alpha|^2 & 0 & 0 & \gamma \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \gamma & 0 & 0 & |\beta|^2 \end{pmatrix}$$

$$\gamma = \alpha\bar{\beta}\langle p_H|p_V\rangle$$
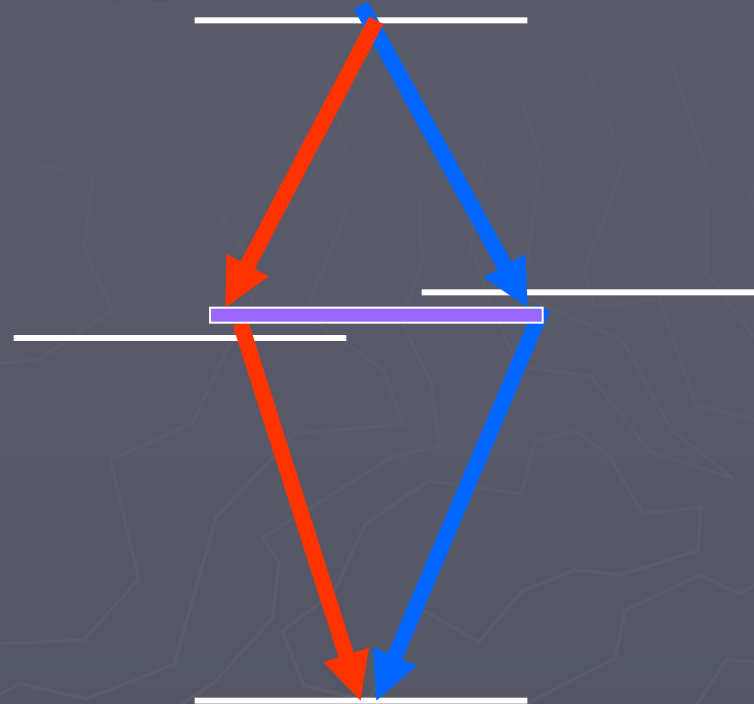
Monitors of the decay path kill the entanglement

Eliminating the monitor

$$|\psi\rangle$$

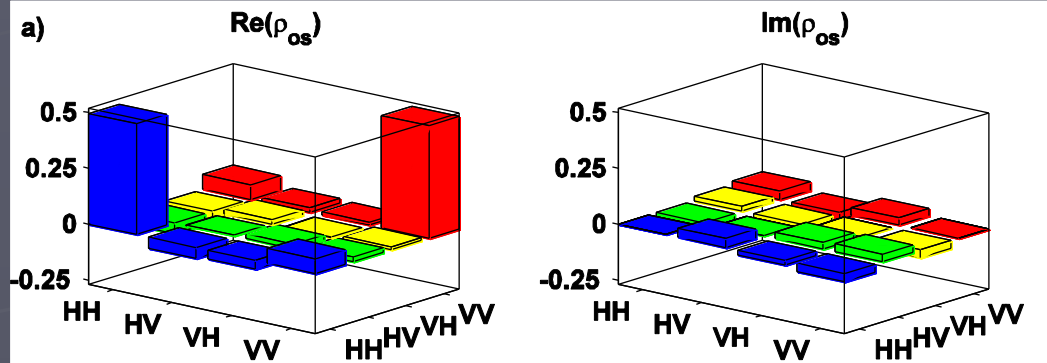$$\rightarrow \Big(|HH\rangle + |VV\rangle \Big) \otimes |p\rangle$$

$$\rho = \frac{1}{2} \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 \end{pmatrix}$$
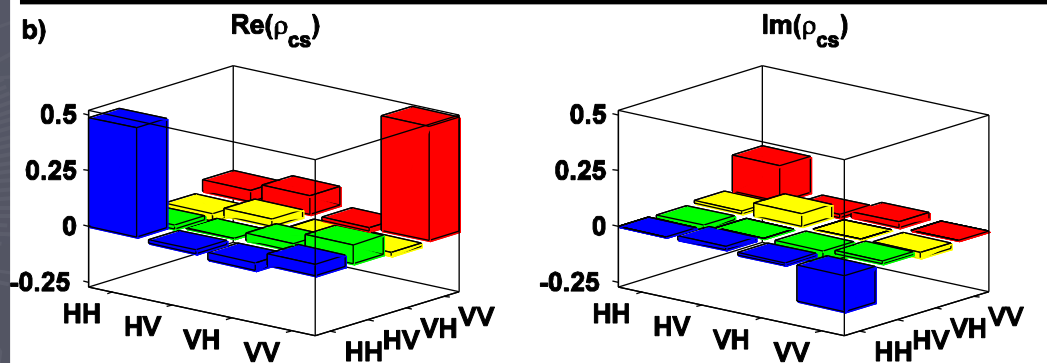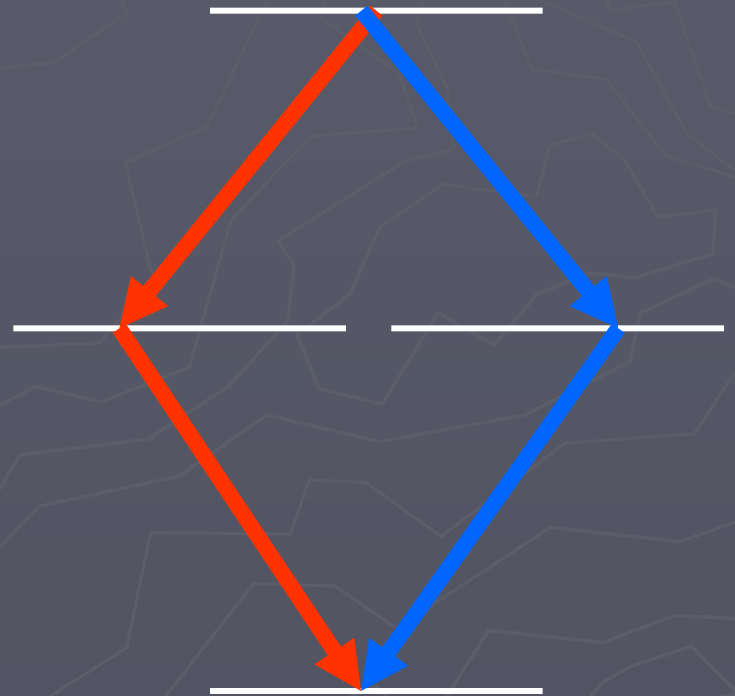
Entanglement at a price
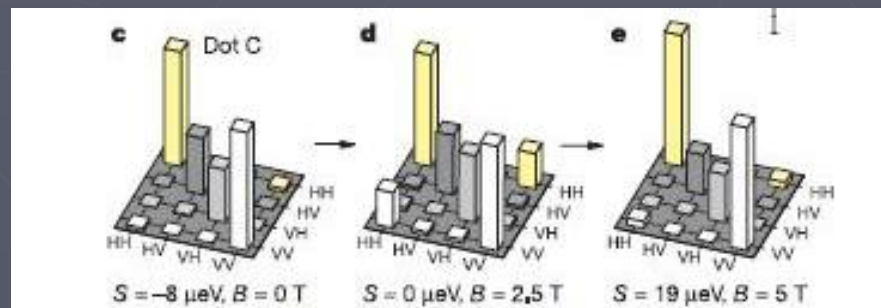
Tomography

Toshiba experiment

Forced degeneracy by annealing
And magnetic fields
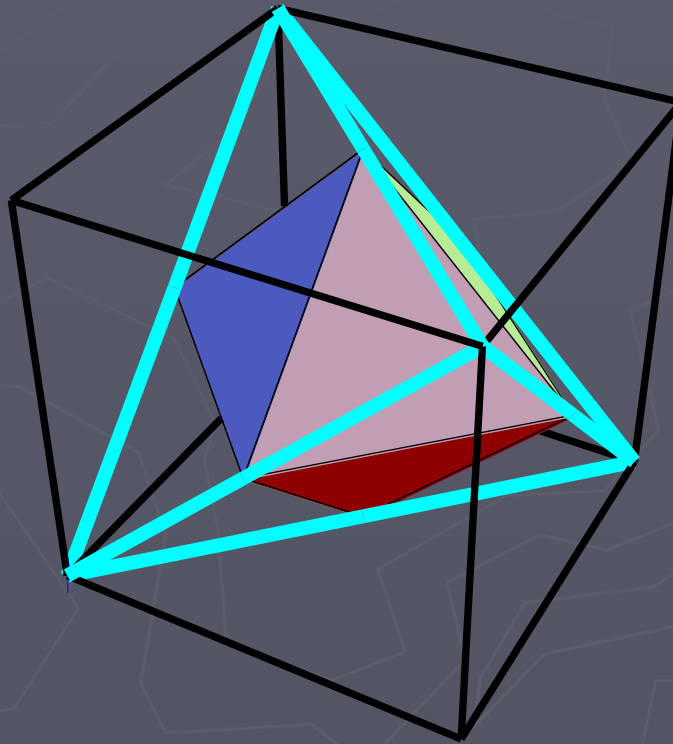
Is degeneracy sufficient?
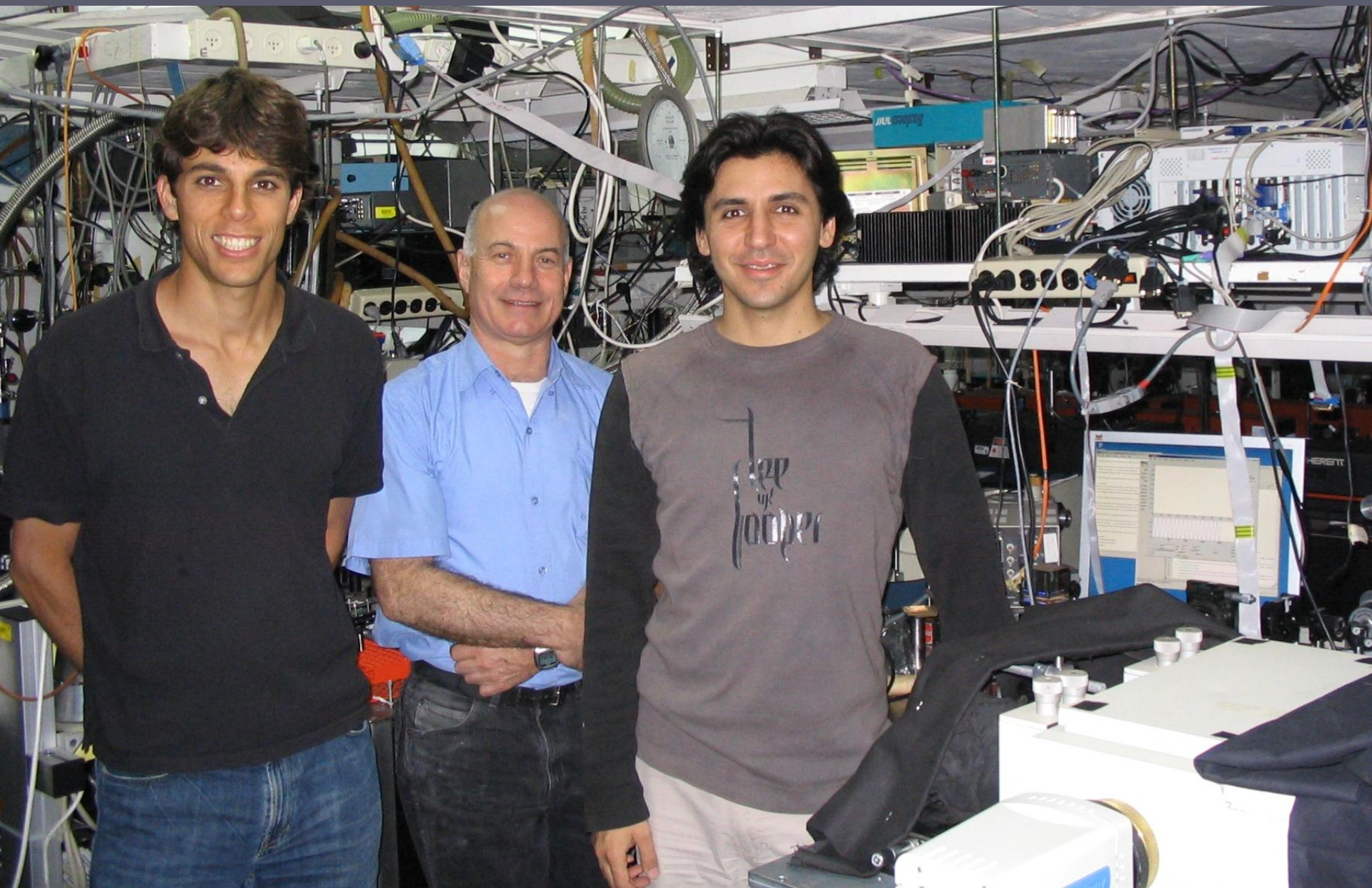

split

degenerate

split

Shields et. al. Nature 439 (2006)

Separable by Peres test

2 qubits Peres is iff

Leinaas Myrheim Uvrom, Kenneth Avron

Grad students Netanel Lindner and Nika Akopian
with Prof. Dudi Gershoni