Playing nonlocal games with quantum resources

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PNA 6

Based on joint works with Harry Buhrman, Troy Lee, Fernando de Oliveira-Filho, Ben Toner, Frank Vallentin and Thomas Vidick

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- OTHERWISE their answers must AGREE

Excellent framework for many interesting problems

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- **Making quantum key distribution protocols secure**

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- **If the quantum systems are entangled, their answers can be correlated in a "non-classical" way (Bell'64)**
- **An EPR pair (Einstein-Podolsky-Rosen'35)**

$$\frac{|0\rangle|0\rangle + |1\rangle|1\rangle}{\sqrt{2}}$$

can give a strict advantage over "classical" players

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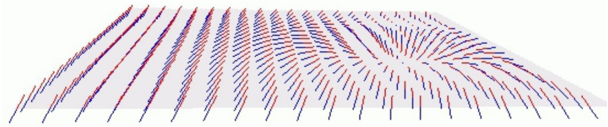
Quantifying the power of quantum entanglement




- Classical players can win the Dutch-or-Not game with prob. at most 0.75
- With an EPR pair, with prob. $\cos(\pi/8)^2 \approx 0.85$
- Nonlocal games can exhibit a key difference between classical and quantum physics: entanglement

Approximating ground state energies



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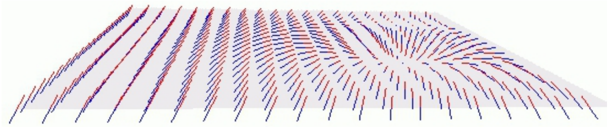

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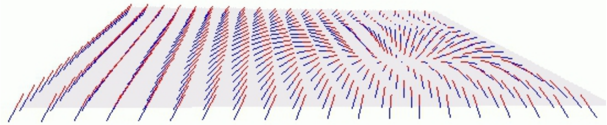

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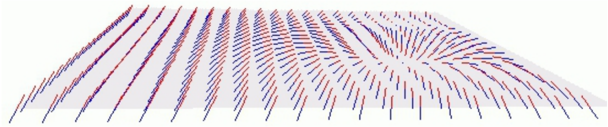

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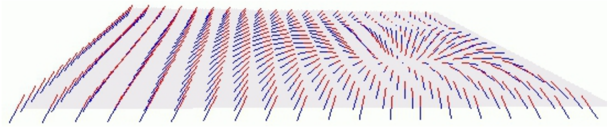

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- **Can be modeled by a nonlocal game**
- **Minimum winning probability gives ground state energy**
- **Computing this exactly is likely computationally hard**
- **In the context of nonlocal games, one can show that it can be approximated well efficiently!**

Thank you!

Nonlocal games: An excellent framework for many interesting problems