Quantum Mechanics & Quantum Computation

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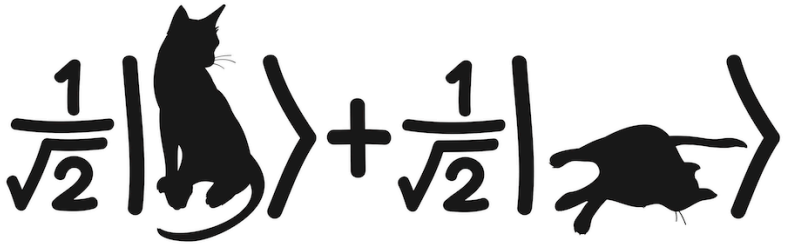


Lecture 4: Bell's Experiment

Bell's Experiment

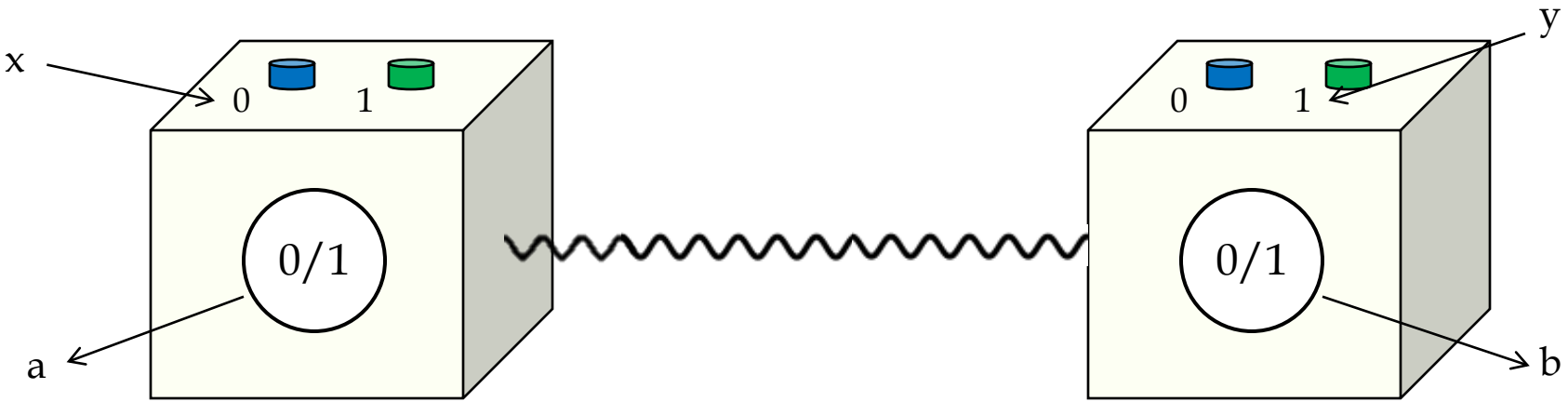
Bell's Experiment (1964)

John Bell devised a remarkable experiment with one of two outcomes:

- Outcome 1 ➔ Nature is inconsistent with quantum mechanics but might be better explained by some local hidden variable theory.

- Outcome 2 ➔ Nature is consistent with quantum mechanics but inconsistent with any local hidden variable theory.

Bell's Experiment Setup

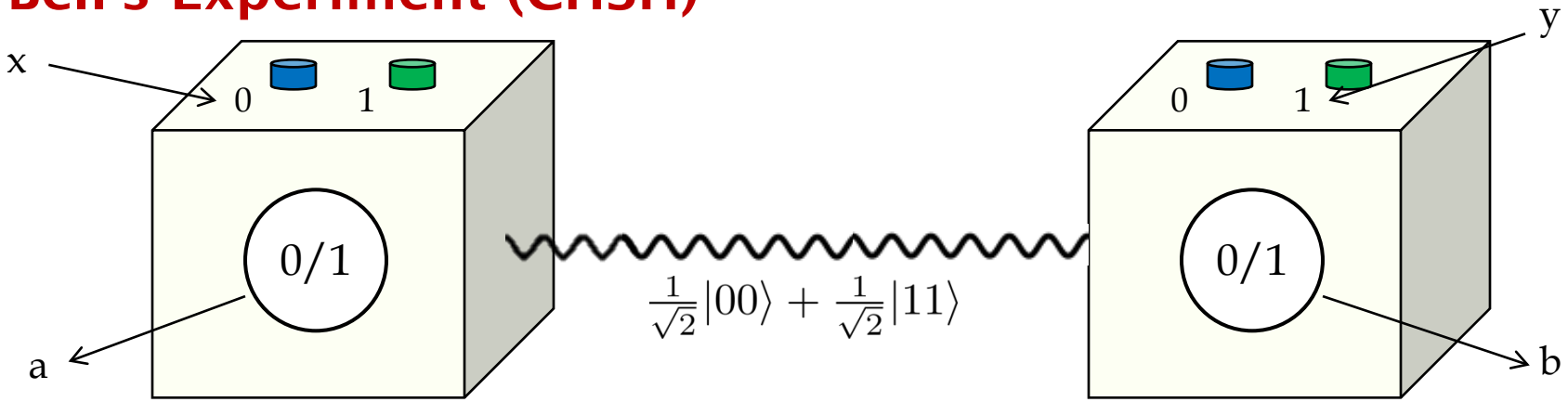


- Two boxes are very far apart.
- If both inputs are 1, want output bits to be different
  Otherwise, want outputs of the two boxes to be the same.

Boxes described by local hidden variables ➔ succeed with prob ≤ ¾ = .75

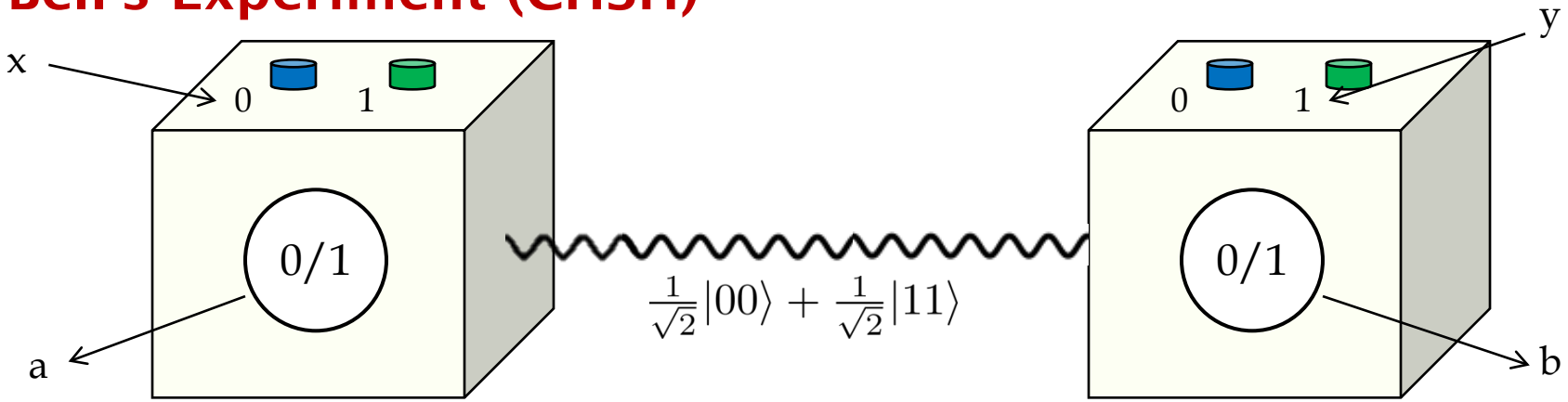
Boxes share a Bell state ➔ can succeed with prob as high as .85

Bell's Experiment (CHSH)



- If both inputs are 1 want output bits to be different; else same.

Bell's Experiment (CHSH)



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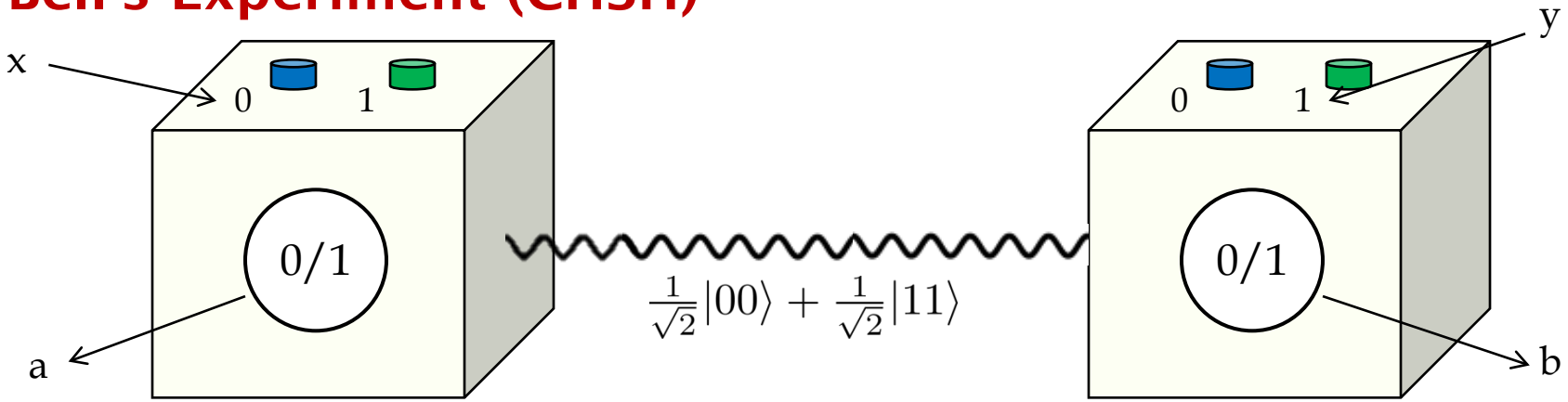
Bell's Experiment (CHSH)



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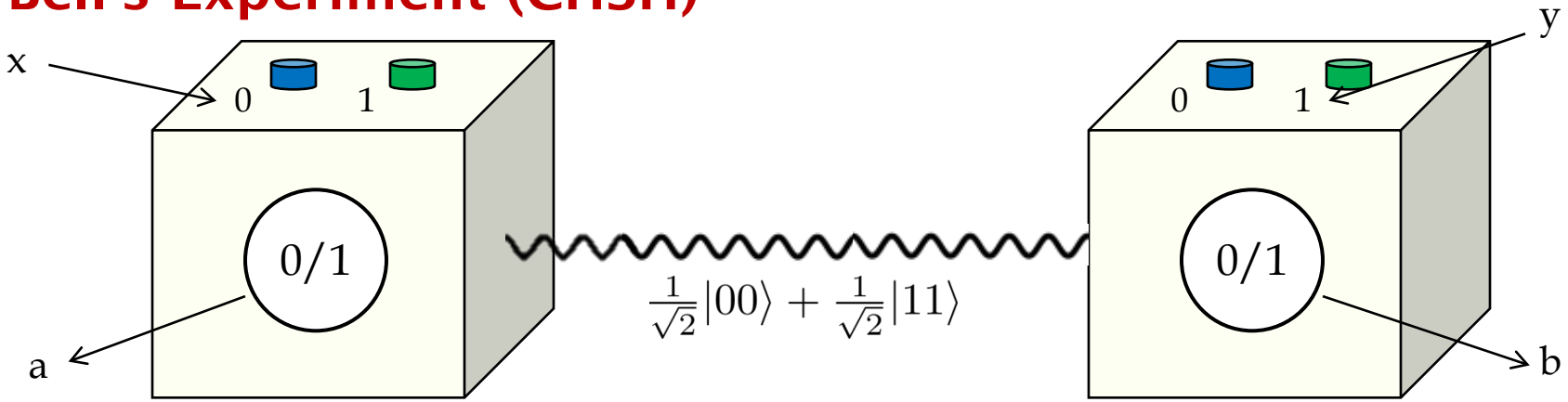
Bell's Experiment (CHSH)



- If both inputs are 1 want output bits to be different; else same.

Bell's Experiment (CHSH)

John Bell devised a remarkable experiment with one of two outcomes:

- Success probability ≤ ¾ ➔ Nature is inconsistent with quantum mechanics but consistent with some local hidden variable theory.

- Success probability > ¾ ➔ Nature is consistent with quantum mechanics and inconsistent with any local hidden variable theory.

The Bell experiment has been performed numerous times.
The results have always been consistent with quantum mechanics.