

QUANTUM CORRELATIONS AND CAUSAL EXPLANATION

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Project

- **Subject field:** philosophy of science
- **Project title:** Quantum correlations and causal explanation
- **Host institution:** Center for Philosophy of Science, University of Pittsburgh

Pittsburgh, PA



Cathedral of Learning



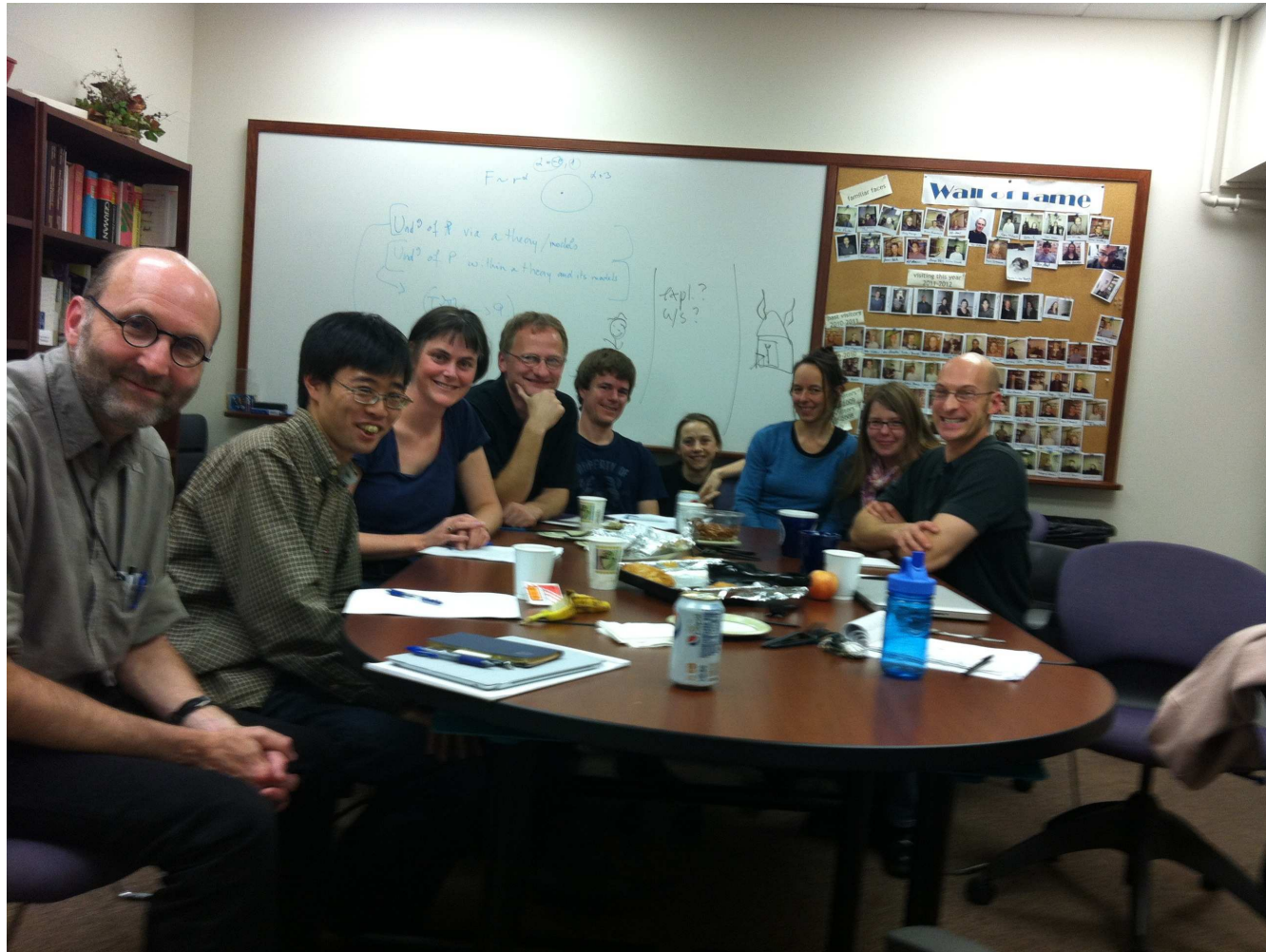
Hungarian Room



Center for Philosophy of Science



The reading group



Quantum correlations and causal explanation

Quantum correlations and causal explanation

Correlation:

A B

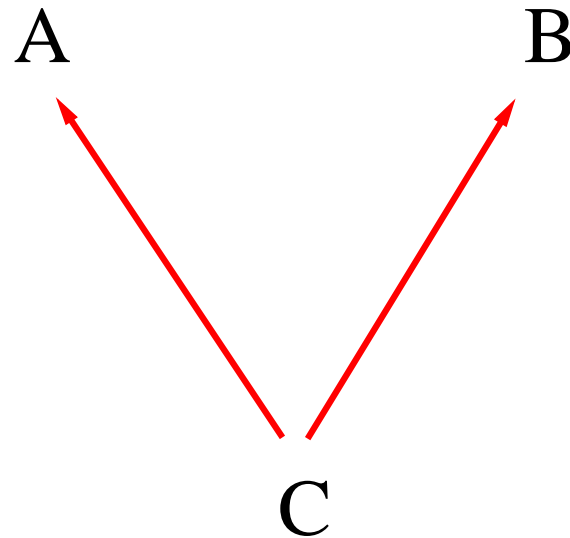
Quantum correlations and causal explanation

Direct causal relation:



Quantum correlations and causal explanation

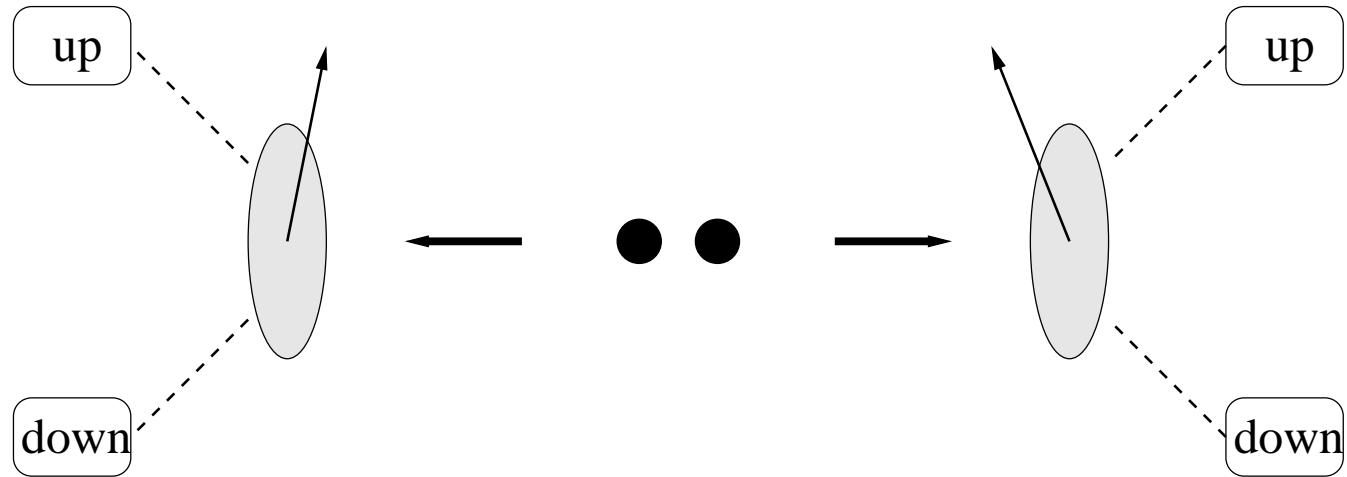
Common cause:



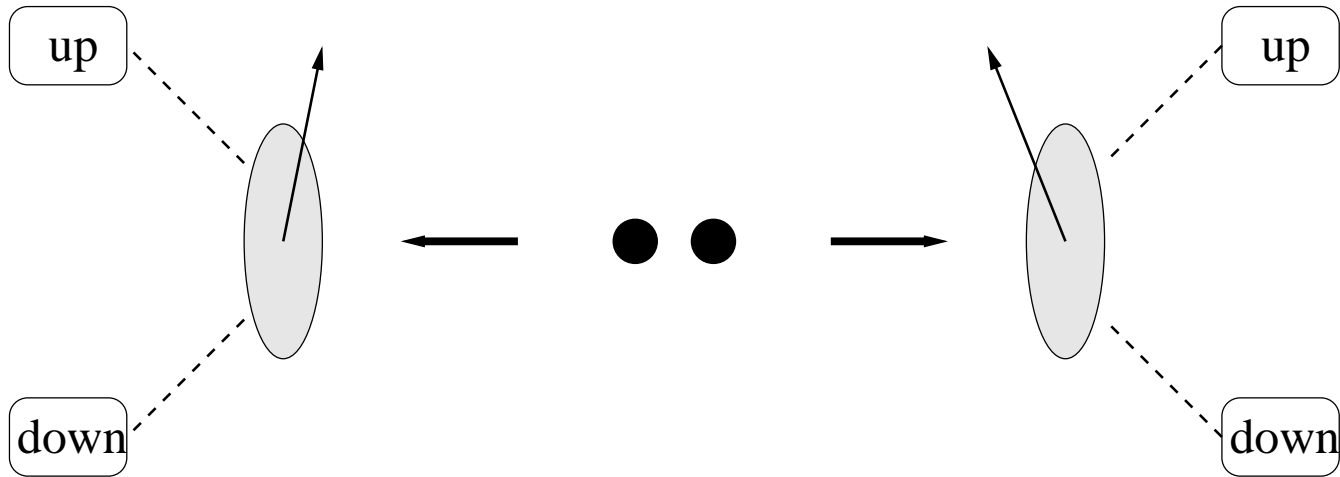
Common Cause Principle

Common Cause Principle: If there is a correlation between two events and a direct causal (or logical) connection between the correlated events can be excluded, then there exists a common cause of the correlation.

EPR correlations



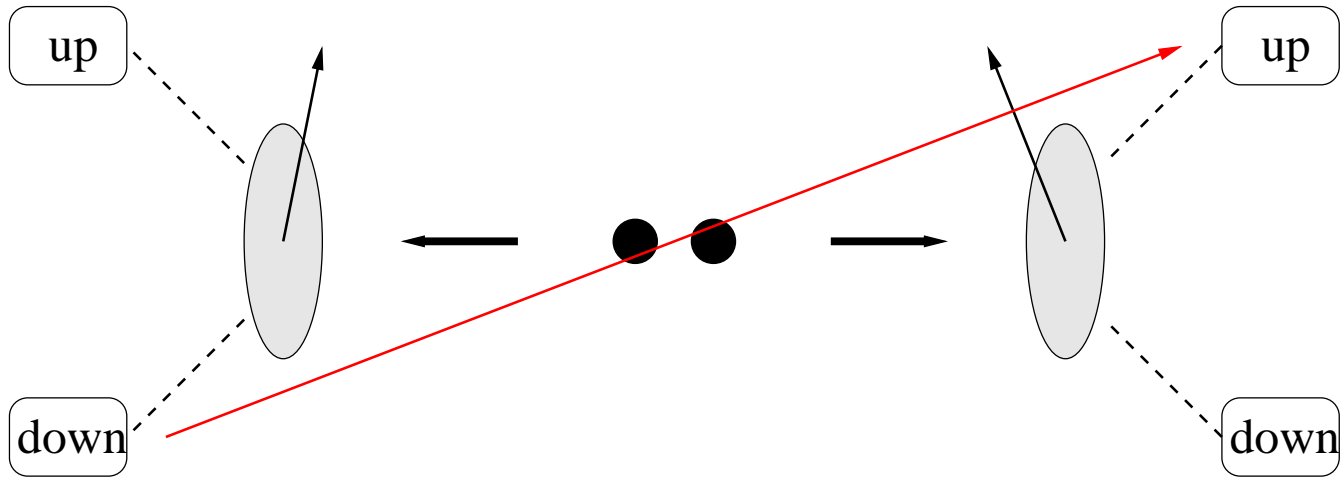
EPR correlations



Correlation:

$$p(A \& B) \neq p(A) p(B)$$

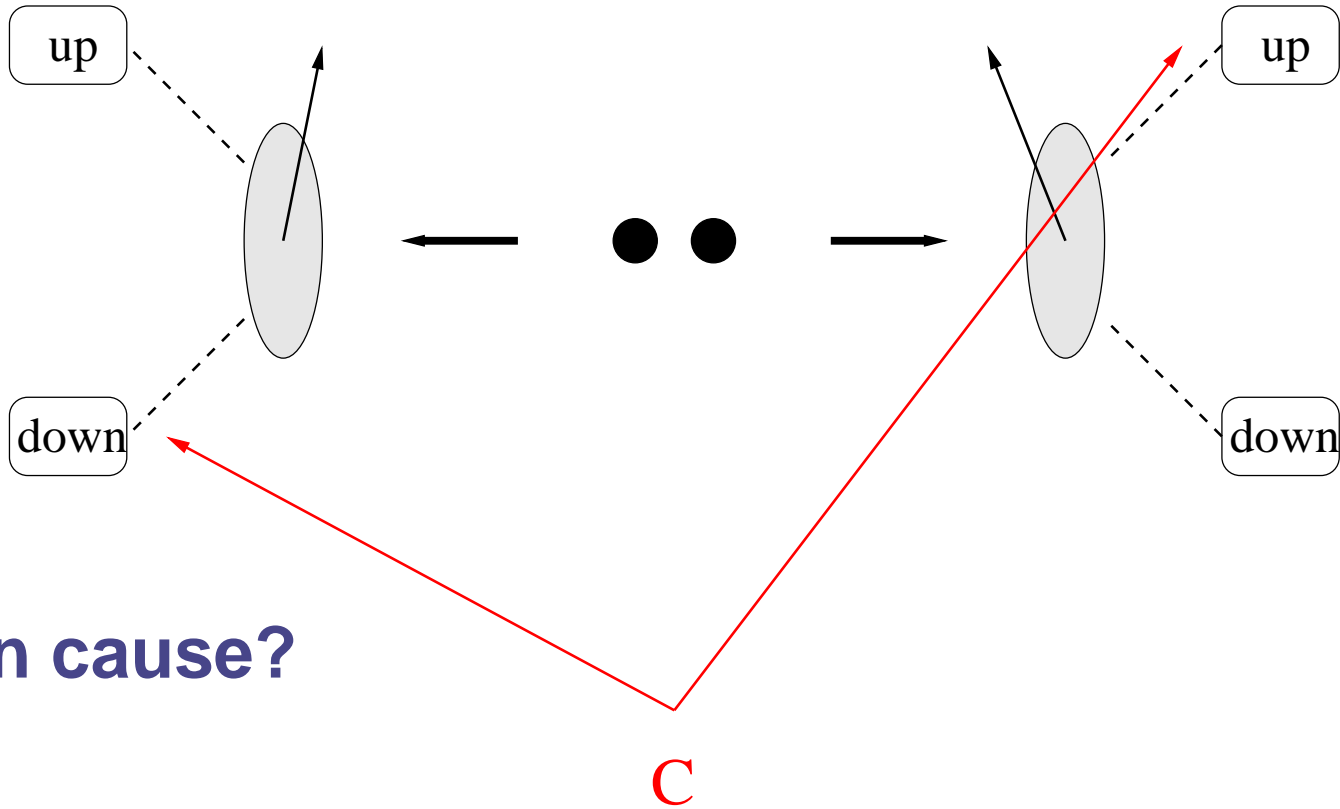
Causal explanation of correlations



Direct causal relation?

- Excluded by the theory of relativity!

Causal explanation of correlations



Bell inequality and joint common cause

Assumption 1

Assumption 2 \implies Bell inequality

Assumption 3

Bell inequality and joint common cause

Assumption 1

Assumption 2 \implies Bell inequality

Assumption 3

- Bell inequality is violated \implies EPR correlations *cannot* have a common causal explanation.

EPR correlations

Correlation:

A B

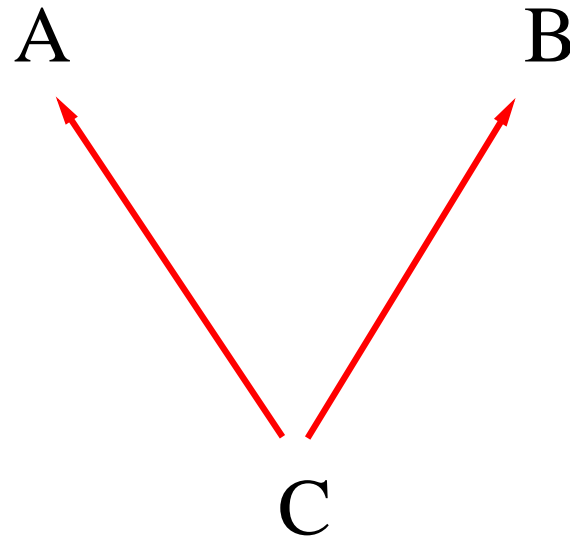
EPR correlations

No direct causal relation:



EPR correlations

No common cause:



Questions

What to do then?

- **Option 1:** Stick to our classical philosophical concept such as causality, probability and locality.
- **Option 2:** Go quantum and ...

Use both exits ...

