University of BRISTOL
School of Physics

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Teleportation of Post-Selected Quantum States

and how do I know an entangled state is what I think it is?

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Learn to see things backwards, inside out, and upside down

John Heider

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Post-Selection

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Post-Selection

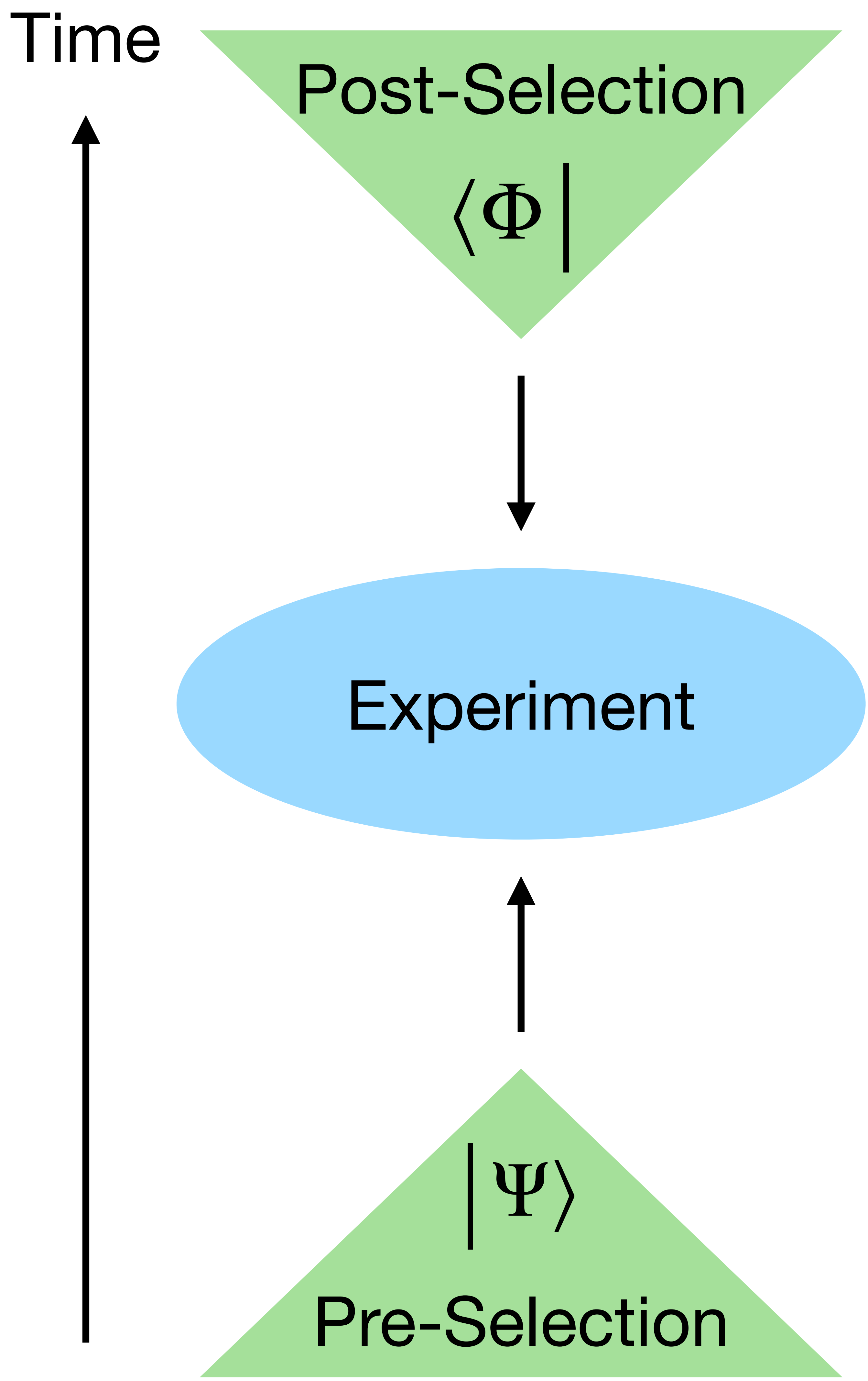
What is it, and why is it useful?

Post-Selection is conditioning on a final measurement giving a particular state.

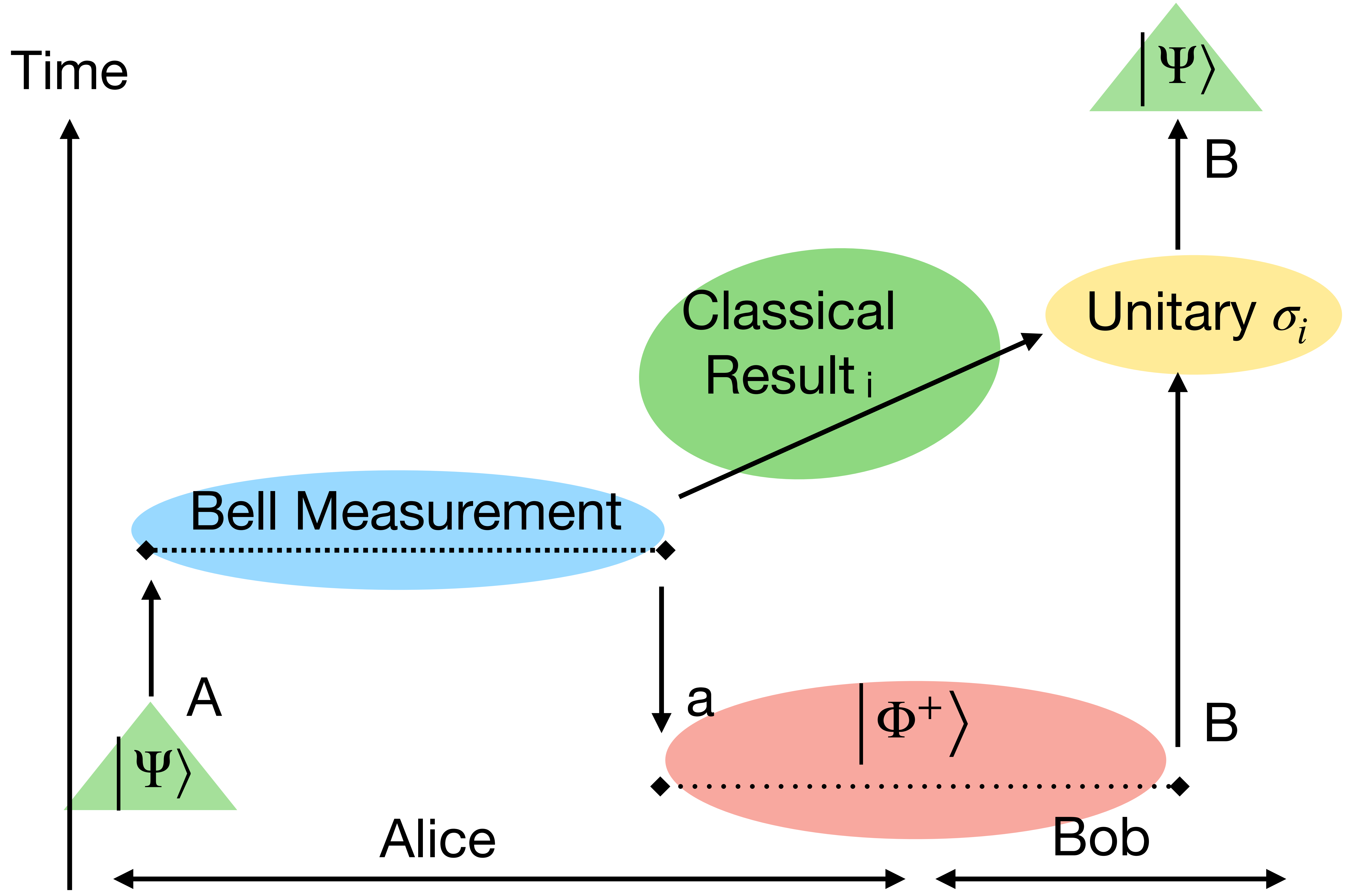
Natural in experiments with photon or particle detectors.

Gives more information about a system than any preparation, unlike classical deterministic mechanics.

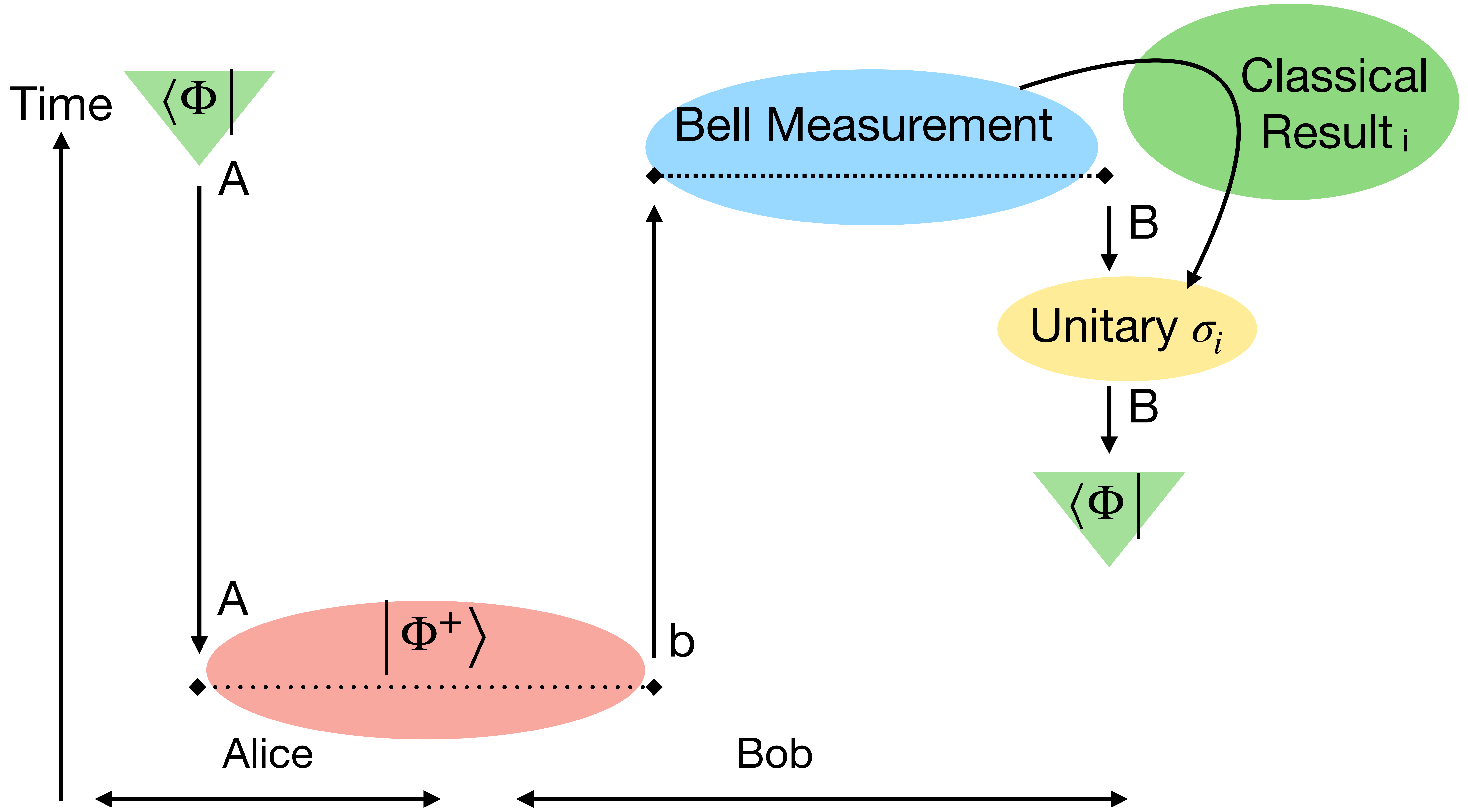
Classical reasoning breaks down.



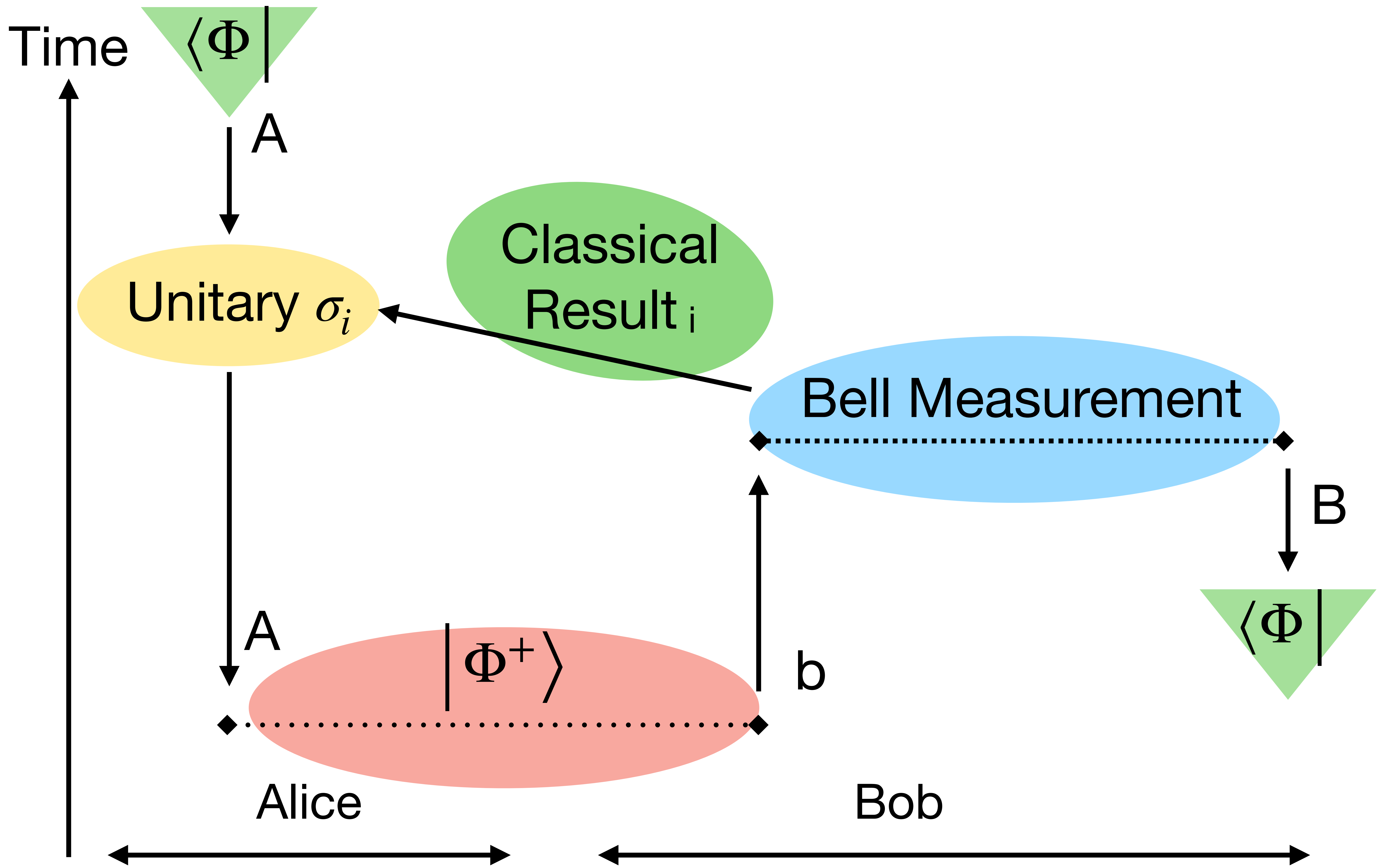
Regular Teleportation



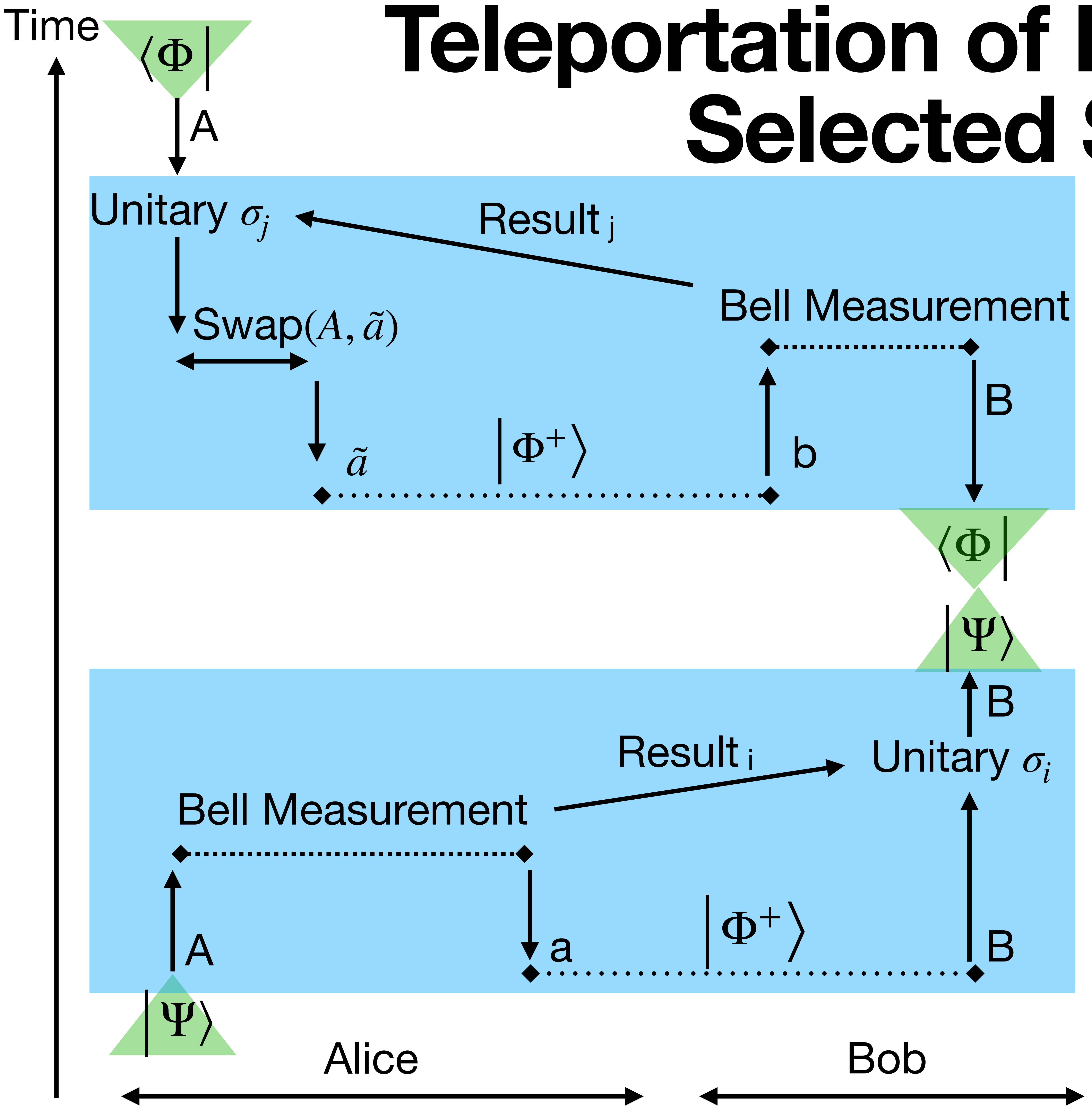
Teleportation of Post-Selected States 1st Try



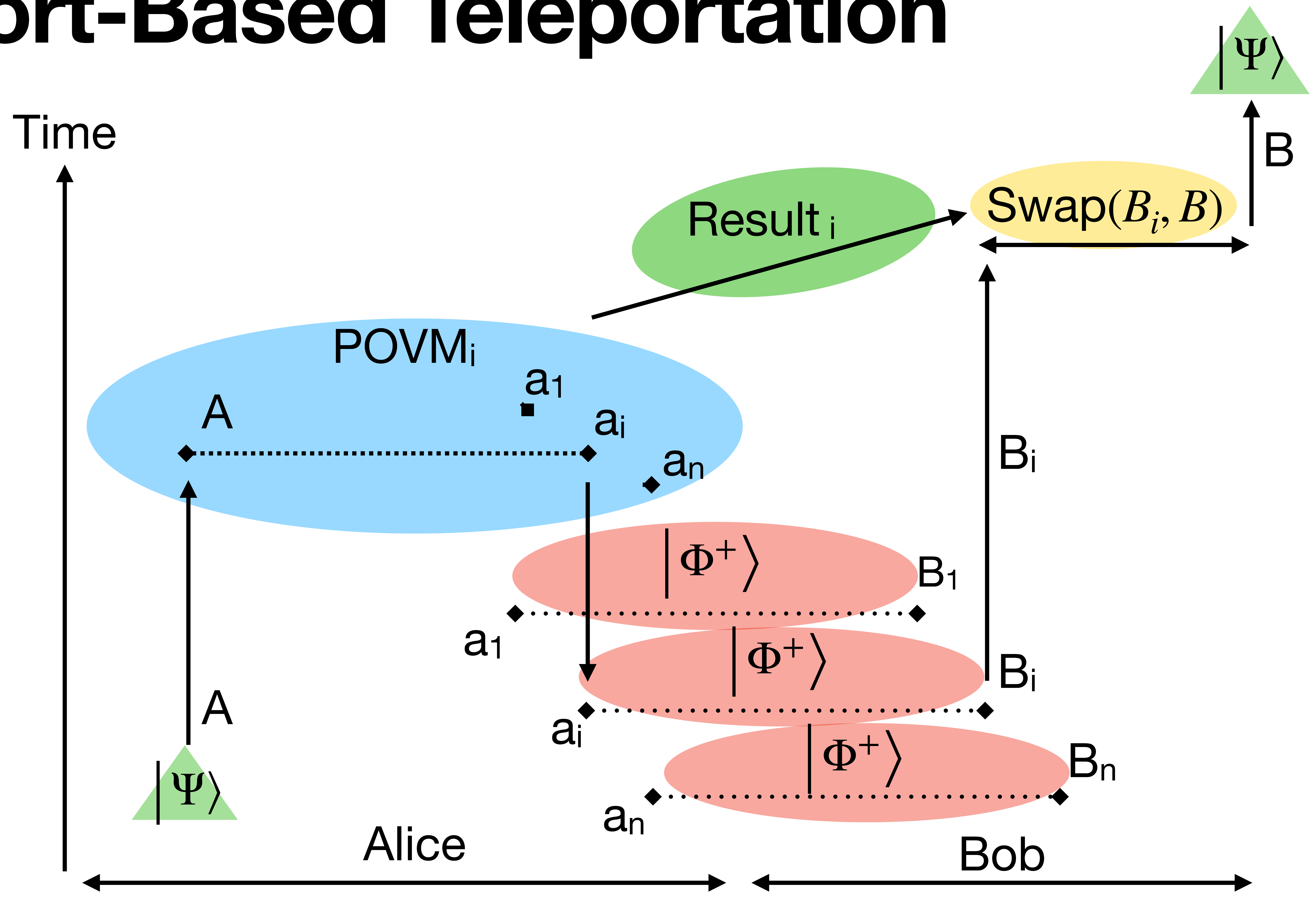
Teleportation of Post-Selected States



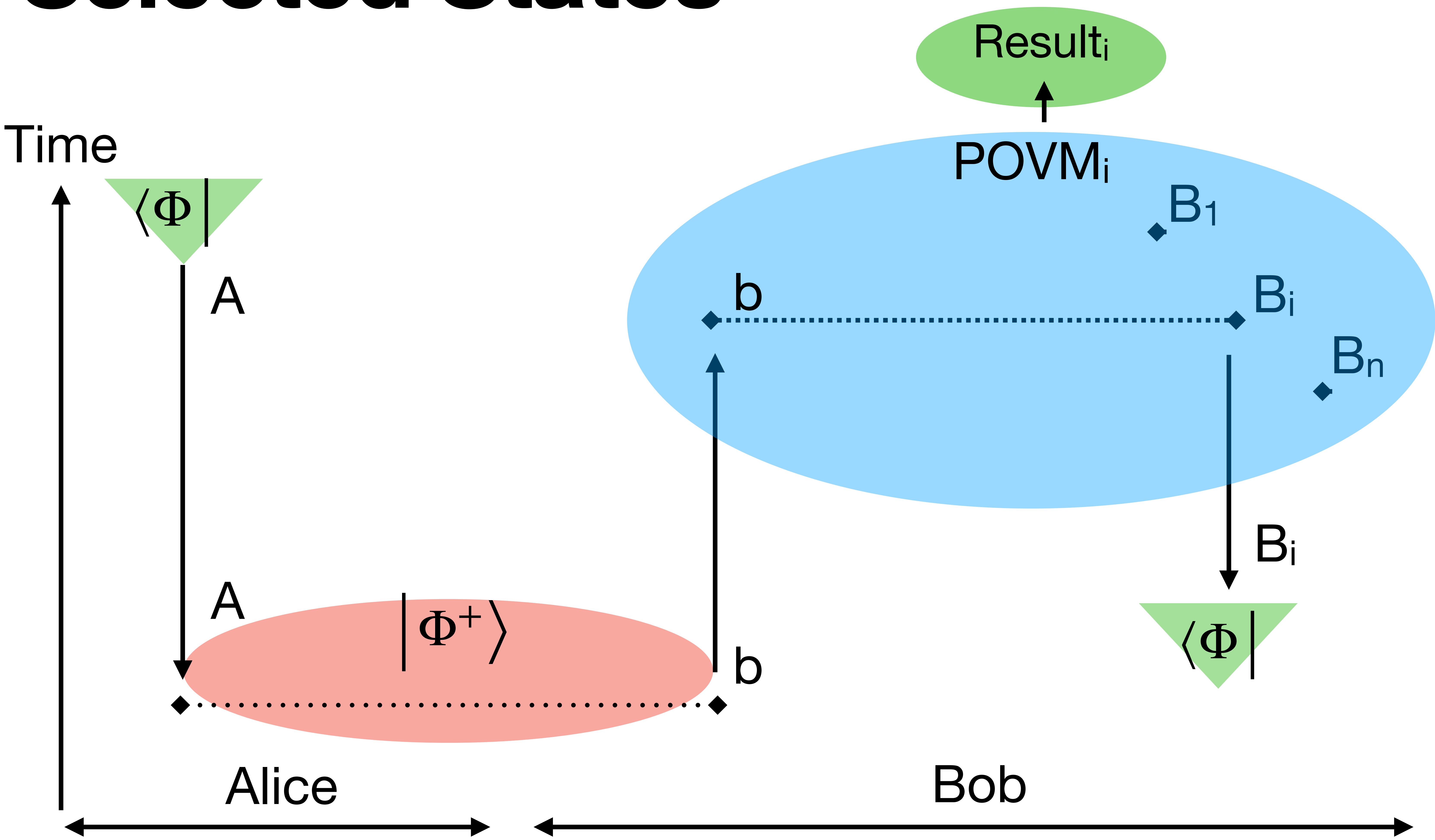
Teleportation of Pre and Post-Selected States



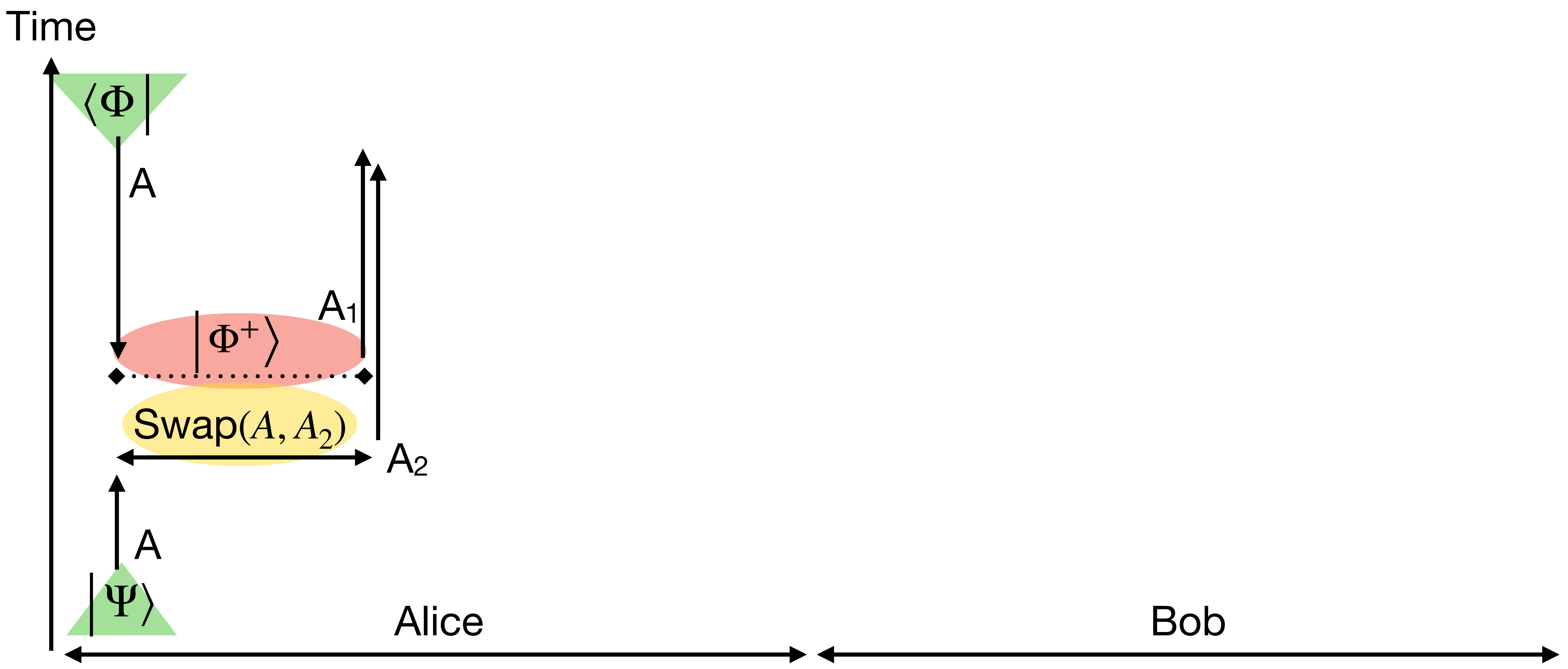
Port-Based Teleportation



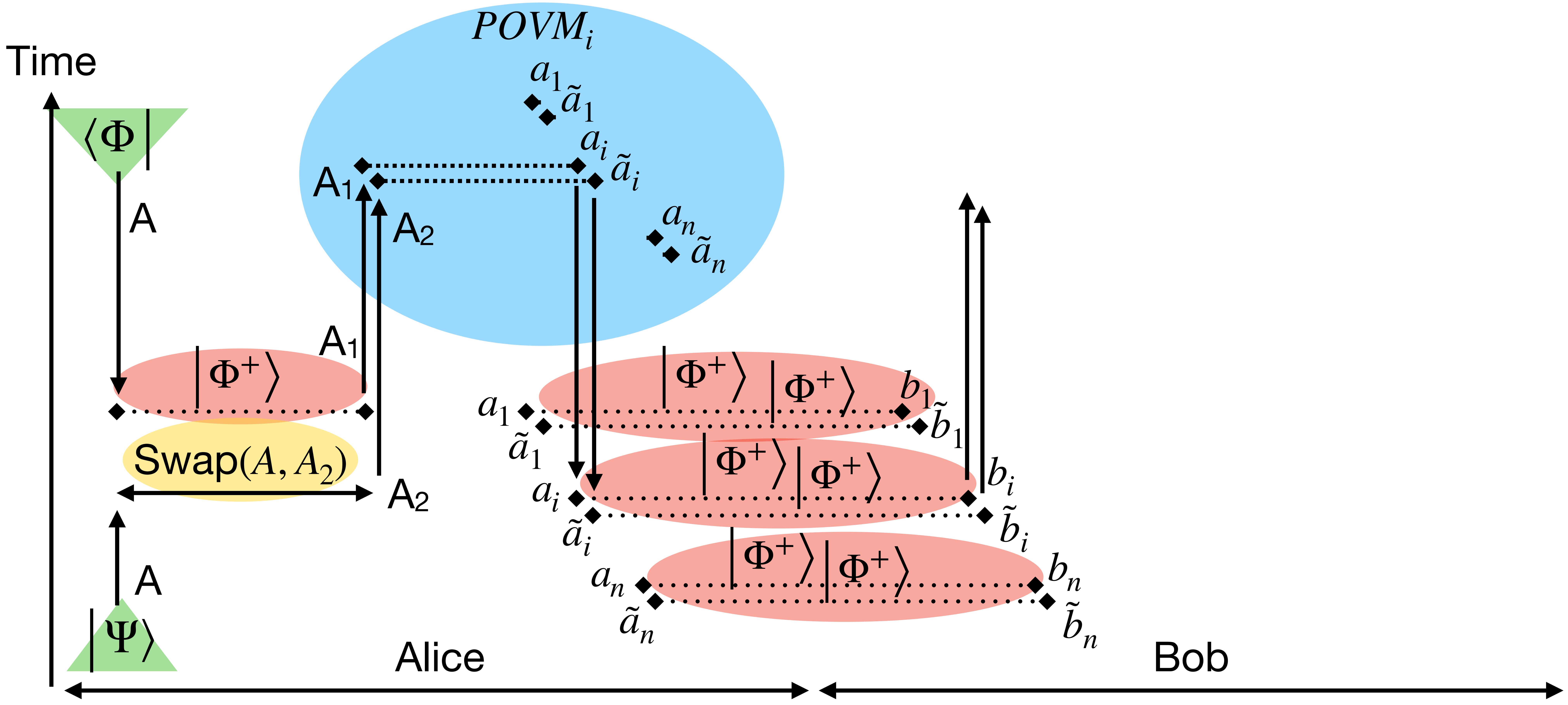
Port-Based Teleportation of Post-Selected States



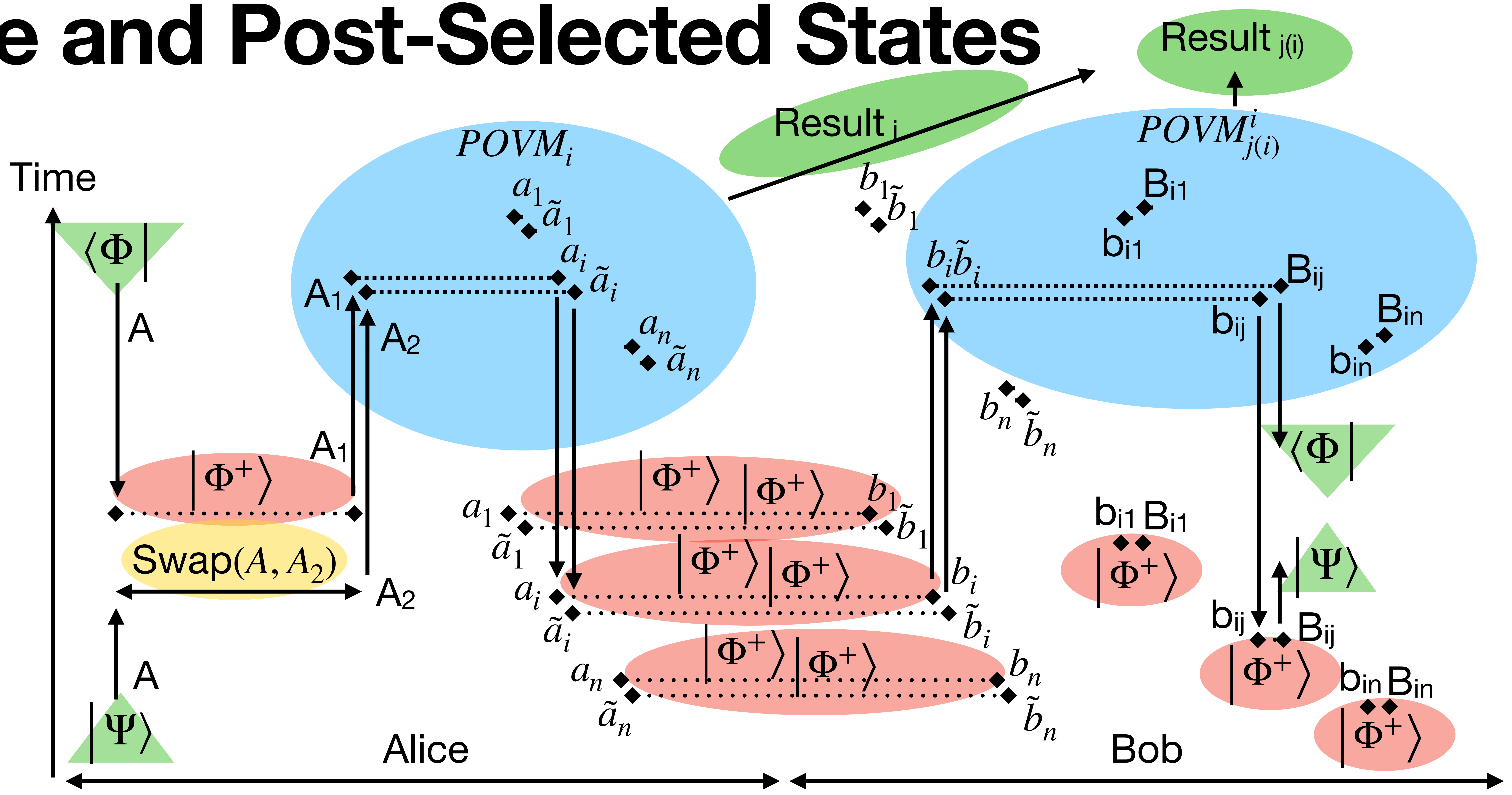
Port-Based Teleportation of Pre and Post-Selected States



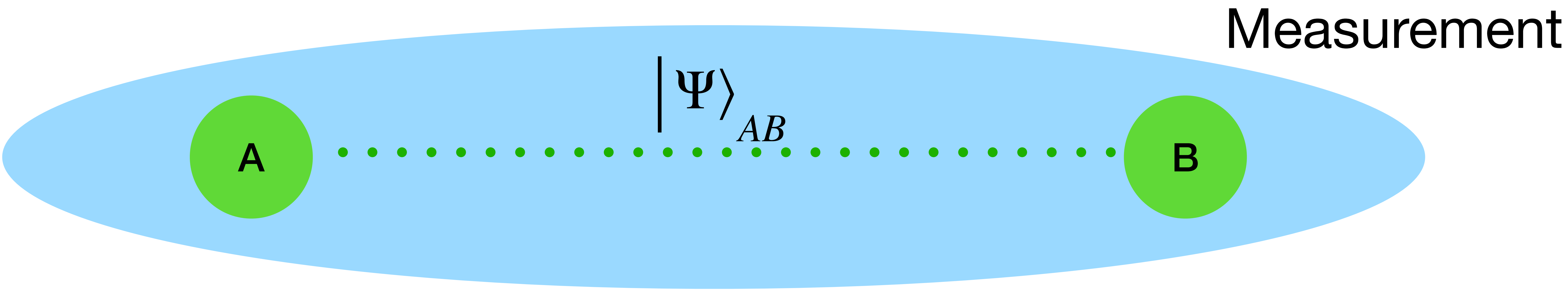
Port-Based Teleportation of Pre and Post-Selected States



Port-Based Teleportation of Pre and Post-Selected States



How do we know an entangled state is what we think it is?



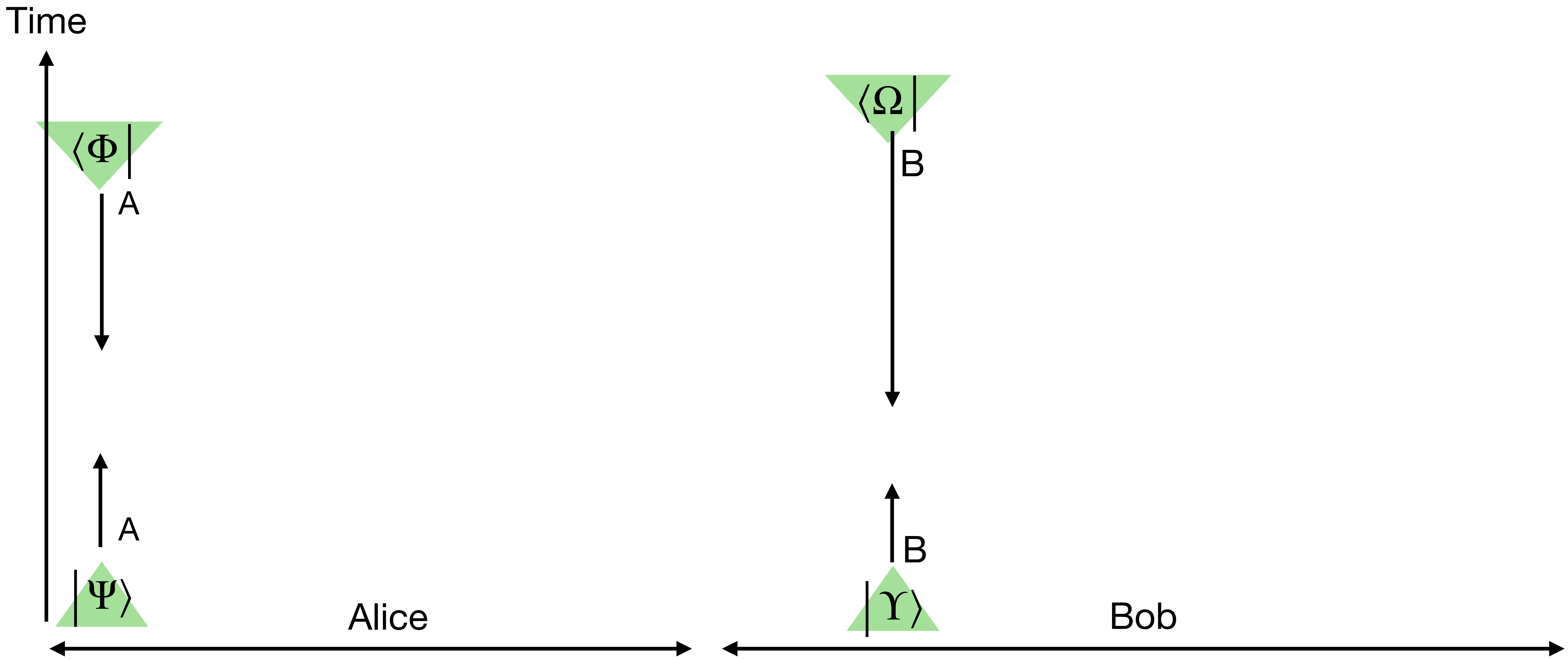
Can a measurement tell us: “a system is in a state at a certain time”?

We can’t perform arbitrary instantaneous Von Neumann measurements.

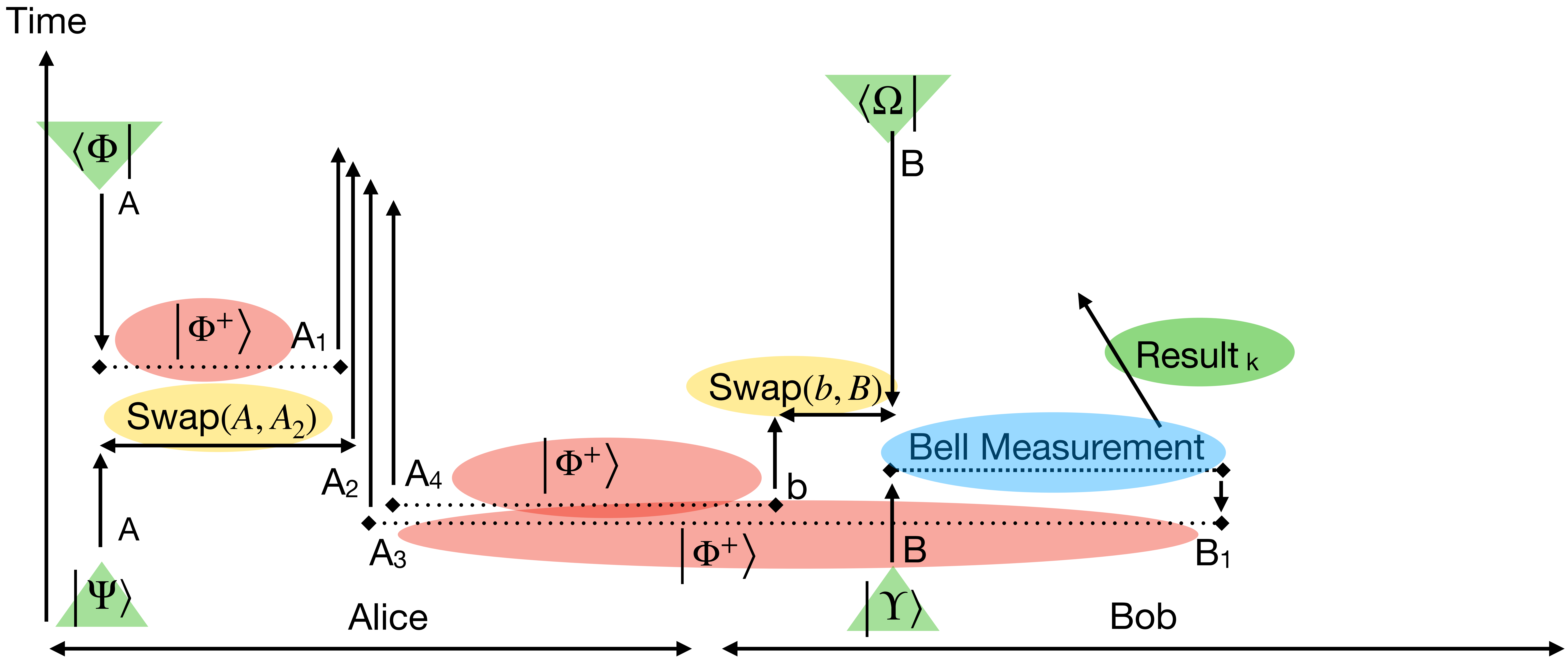
We can perform arbitrary instantaneous* verification measurements.

*instantaneous quantum followed by classical communication and processing.

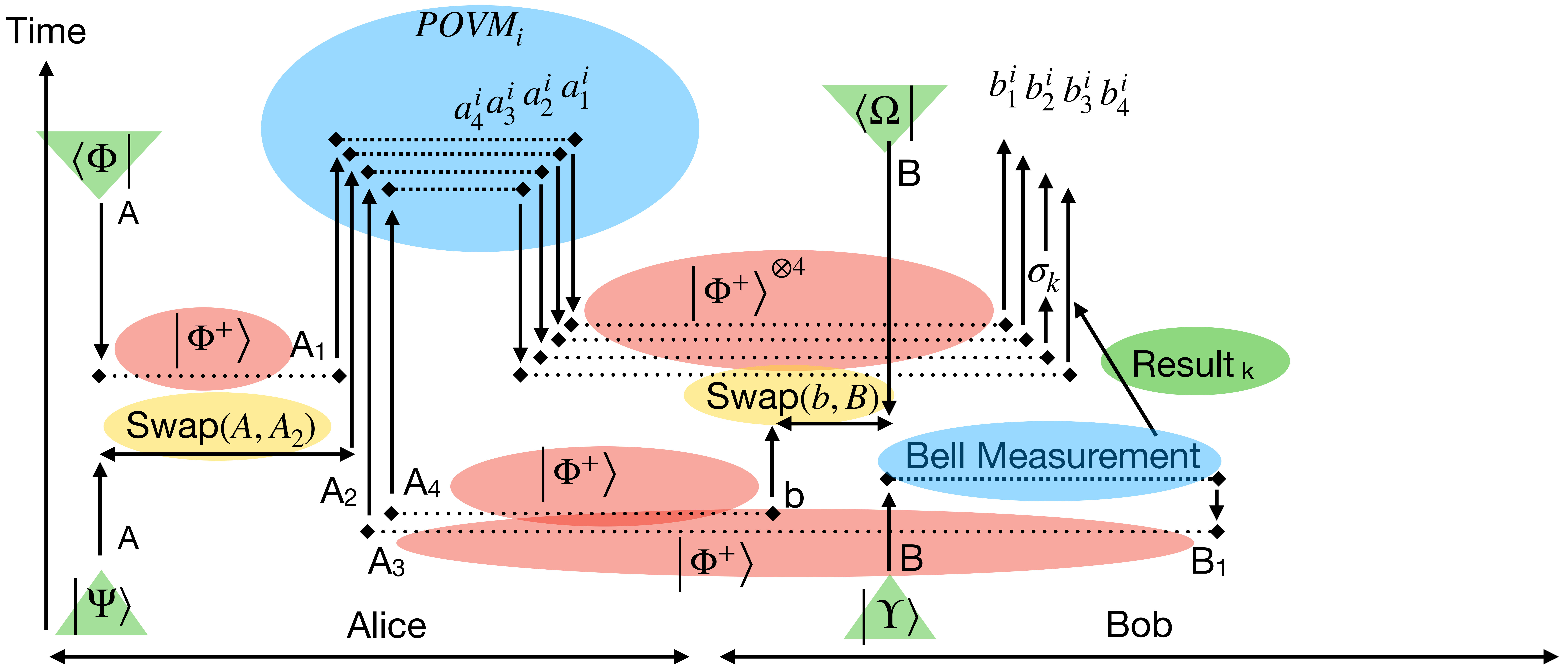
Instantaneous Measurement



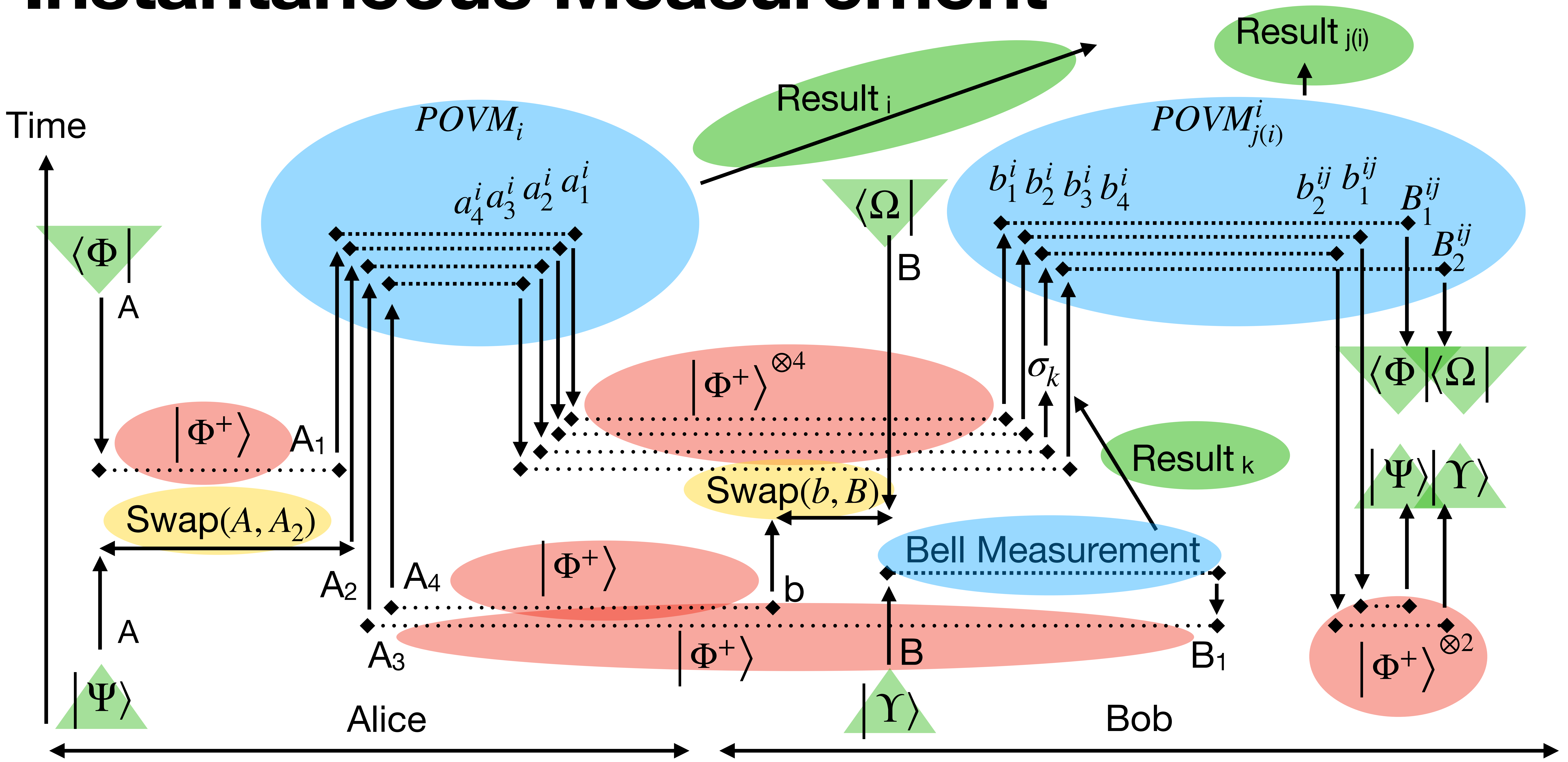
Instantaneous Measurement



Instantaneous Measurement



Instantaneous Measurement



Usage of Entanglement

- Instantaneously measure $\mathscr{M}_0$ on n pre and post-selected qubits for Alice and n for Bob.
- To quantify how close our teleportation protocol $\mathscr{M}_1$ is to $\mathscr{M}_0$ use the diamond norm $d_\diamond$.
- $d_\diamond = \max_\rho \|(\mathscr{M}_1 \otimes \mathbf{1})(\rho) - (\mathscr{M}_0 \otimes \mathbf{1})(\rho)\|_1$, where $\|\cdot\|_1$ is the trace norm, ρ is a density matrix.
- To get $d_\diamond < \epsilon$ using the original port-based protocol uses $2n\left(1 + \frac{2^{16n+5}}{\epsilon^2}\right)$ ebits.
- This can be reduced somewhat using one of the more recent protocols.

Summary

Teleportation of Post-Selected Quantum States: D. Collins, arXiv:2303.12456

Teleportation of pre and post-selected states.

Port-based teleportation of pre and post-selected states.

“Instantaneous” measurement of pre and post-selected states using exponentially less entanglement.

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