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# Observation of quantum entanglement in $\Lambda\bar{\Lambda}$ pair production via electron-positron annihilation

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We report the observation of quantum entanglement in $\Lambda\bar{\Lambda}$ pairs produced via electron-positron annihilation, specifically through the decay $J/\psi \to \Lambda\bar{\Lambda}$. By analyzing the angular correlations of the subsequent weak decays $\Lambda \to p\pi^-$ and $\bar{\Lambda} \to \bar{p}\pi^+$, we derive normalized observables $\mathcal{O}_i$ $(i = 0, 1, \ldots, 4)$ that distinguish entangled states from separable ones. Theoretical predictions for these observables are established, with violations of separable-state bounds serving as unambiguous signatures of entanglement. Experimental measurements at $\cos\theta_\Lambda = 0$ yield $\mathcal{O}_{1\text{min}}^{\text{Observed}} = -0.7374 \pm 0.0011 \pm 0.0016$, significantly exceeding the classical limit of $-0.5$ with a statistical significance of $124.9\sigma$. For $|\cos\theta_\Lambda| < 0.4883$, the observed $\mathcal{O}_1^{\text{Observed}}$ consistently exhibits $\mathcal{O}_1^{\text{Observed}} < -\frac{1}{2}$ with a statistical significance of at least $5\sigma$. Since $69.3\%$ of the decay events involving $\Lambda \to p + \pi^-$ and $\bar{\Lambda} \to \bar{p} + \pi^+$ are spacelike-separated, our results confirming the persistence of quantum entanglement in the $\Lambda\bar{\Lambda}$ system provide strong support for the non-locality of quantum mechanics. The findings are consistent with theoretical expectations under decoherence-free conditions, highlighting the potential of hyperon pairs as probes for fundamental quantum phenomena.

**Primary author(s) :** Dr PEI, Junle

**Presenter(s) :** Dr PEI, Junle

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