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From matrix algebras to Cuntz algebras: self-testing commuting operator correlations

An amalgamation of the matrix algebras $M_3(\mathbb{C})$ and $M_2(\mathbb{C})$, obtained by identifying a minimal projection in each, produces a corner isomorphic to the Cuntz algebra $\mathcal{O}_2$. A recent theorem of Sam Harris shows that just four prescribed moments uniquely determine a state on $\mathcal{O}_2 \otimes_{\max} \mathcal{O}_2$. In joint work with Simon Schmidt, we use these operator-algebraic ideas to construct a finite two-player nonlocal game whose optimal commuting operator correlation uniquely determines the underlying state. Remarkably, this state encodes an exact entanglement embezzlement protocol which cannot be realized in the local tensor-product model, even when the local spaces are allowed to be infinite dimensional (despite being approximable by finite-dimensional strategies). As a corollary, our nonlocal game gives the first genuine example of a commuting operator self-test. I will focus on the operator-algebraic structure behind the construction, particularly how finite-dimensional matrix algebras give rise to Cuntz algebras and how uniqueness of a state on a corner extends to the full algebra.