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There is no sum-of-squares certificate for positivity in tensor product of free algebras

In quantum information, the algebra $\mathbb{C}\mathbb{Z}_m^{*n} \otimes \mathbb{C}\mathbb{Z}_m^{*n}$ models a physical system with two spatially separated subsystems, where in each subsystem we can make n different measurements, each with m outcomes. The recent MIP$^* =$ RE result shows that it is undecidable to determine whether an element of $\mathbb{C}\mathbb{Z}_m^{*n} \otimes \mathbb{C}\mathbb{Z}_m^{*n}$ (for varying n and m) is positive in all finite-dimensional representations. In this poster, I will present joint work with Arthur Mehta and William Slofstra, in which we show that it is undecidable to determine whether an element of $\mathbb{C}\mathbb{Z}_2^{*n} \otimes \mathbb{C}\mathbb{Z}_2^{*n}$ (for some sufficiently large n) is positive in all representations. As a consequence, there is no sum-of-squares certificate for positivity in tensor product of free algebras.