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The limitations of nice mutually unbiased bases

Mutually unbiased bases of a Hilbert space can be constructed by partitioning a unitary error basis. We consider this construction when the unitary error basis is a nice error basis. We show that the number of resulting mutually unbiased bases can be at most one plus the smallest prime power contained in the dimension, and therefore that this construction cannot improve upon previous approaches. We prove this by establishing a correspondence between nice mutually unbiased bases and abelian subgroups of the index group of a nice error basis and then bounding the number of such subgroups. This bound also has implications for the construction of certain combinatorial objects called nets.

Joint work with Michael Aschbacher and Pawel Wocjan.