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Matrices associated with unitary representations of the modular group

Finite-dimensional irreducible unitary representations of the modular group–when viewed as the free product of cyclic groups of orders 2 and 3, respectively–give rise to certain pairs of complex matrices by way of noncommutative convex combinations of matrix pairs arising from such representations of the two canonical order-2 and order-3 generators of the modular group. It turns out that all matrix pairs occurring as such noncommutative convex combinations can be determined by a property of their joint numerical range. At the heart of this result, which may be understood to be a pairing of two classical dilation theorems (Halmos 1950; Mirman 1968), is a 4-dimensional complex vector space that shares some, but not all, of the defining features of an association scheme. Based on joint work with Roghayeh Maleki, Sofia Medina Varela, and Sushil Singla.