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On the smallest non-diagonalizable vertex-primitive digraphs

In 1980, Peter J. Cameron asked whether the adjacency matrices of arc-transitive digraphs are always diagonalizable. In 1985, Babai gave a negative answer to Cameron's question, and asked whether one can find vertex-primitive digraphs whose adjacency matrices are not diagonalizable. Recently, Li, Xia, Zhou, and Zhu gave an infinite family of such vertex-primitive digraphs. They further asked about the smallest such digraphs.

In this talk, I will show using the theory of commutative association schemes that the smallest vertex-primitive digraphs with non-diagonalizable adjacency matrices arise from the action of $\mathrm{PSL}_2(17)$ on the 2-subsets of the projective line $\mathrm{PG}_1(17)$, or equivalently on cosets of the dihedral group D_{16}.