Zero-Sum Flows on Graphs and Designs

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For an undirected graph $G$, a zero-sum flow is an assignment of non-zero real numbers to the edges, such that the sum of the values of all edges incident with each vertex is zero. By a zero-sum $k$-flow on a graph we mean a zero-sum flow with assignments from \{\pm 1, \pm 2, \ldots, \pm (k - 1)\}. It has been conjectured that if a graph $G$ has a zero-sum flow, then it has a zero-sum 6-flow. We generalize the concept of zero-sum flows to 2-designs. More precisely, by a zero-sum flow for a 2-design, we mean a nowhere-zero vector in the null space of its incidence matrix. We show that every non-symmetric 2-design admits a zero-sum flow.

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