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Delsarte designs in finite groups

Let G be a finite group with d non-trivial conjugacy classes and let $\{\chi_0, \chi_1, \ldots, \chi_d\}$ be the full set of irreducible characters of G where χ_0 is the trivial character. For $T \subseteq \{1, \ldots, d\}$ a *Delsarte T-design* in G (or, more precisely, in the conjugacy class association scheme of G) is a subset $C \subseteq G$ satisfying $\sum_{x,y \in C} \chi_j\left(xy^{-1}\right) = 0$ for all $j \in T$. A very interesting problem that is wide open in most cases is to characterize the T-designs in some standard family of finite groups and to find the most efficient (i.e., smallest) designs for various choices of T. In 2006, Bruce Sagan and I gave combinatorial characterizations of T-designs in the symmetric groups and showed that the smallest designs are typically much smaller than the smallest subgroups with the T-design property. In a recent preprint, Alena Ernst and Kai-Uwe Schmidt carried out a similar study for finite general linears groups, with rich results and difficult proofs. I aim to survey these results and, as time permits, give a preliminary report on the case of dihedral groups, an ongoing joint project with undergraduate students Benjaminh Brodeur and Sycamore Herlihy.