The classification of 2-\((v,k,\lambda)\) designs, with \(\lambda > 1\) and \((r,\lambda) = 1\), admitting a flag-transitive automorphism group.

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A classical subject in Theory of Designs is the study of 2-designs admitting an automorphism group fulfilling prescribed properties. Within this research area, it is of great interest the study of 2-(\(v,k,\lambda)\) designs \(\mathcal{D}\) admitting a flag-transitive automorphism group \(G\). Since they have been classified for \(\lambda = 1\) and \(G \not\approx A\Gamma L_1(q)\) by Buekenhout et al. (1990), a special attention is devoted to the general case \(\lambda > 1\). In this setting, a first natural generalization of the case \(\lambda = 1\) is represented by \(\lambda > 1\) and \(\gcd(r,\lambda) = 1\), where \(r\) is the replication number of \(\mathcal{D}\). Then \(G\) acts point-primitively on \(\mathcal{D}\) by a result of Dembowski (1968), and \(\text{Soc}(G)\), the socle of \(G\), is either an elementary abelian \(p\)-group for some prime \(p\), or a non abelian simple group by a result of Zeischang (1988). Starting from these two results, such 2-designs have been recently classified for \(G \not\approx A\Gamma L_1(q)\) by Biliotti et al. and by Alavi, Zhou et al. according to whether \(\text{Soc}(G)\) is an elementary abelian \(p\)-group or a non abelian simple group, respectively.

The aim of the talk is to survey the classification of 2-(\(v,k,\lambda)\) designs \(\mathcal{D}\), with \(\lambda > 1\) and \((r,\lambda) = 1\), admitting a flag-transitive automorphism group \(G\), mostly focusing on the constructions of the various examples contained in it.