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A new type of orthogonality for t-designs

Let t, k, v be integers with $0 \leq t \leq k \leq v$. A Steiner system, $\mathsf{S}(t,k,v)$ is a pair $(X,\mathcal{A})$ where X is a v-element set and $\mathcal{A}$ is a set of k-subsets of X, called blocks, with the property that every t-element subset of X is contained in precisely one block of $\mathcal{A}$. If the blocks $\mathcal{A}$ of a Steiner system $\mathsf{S}(t,k,v)$ defined on X can be partitioned into $\mathsf{S}(i,k,v)$, then the Steiner system is called i-resolvable. In this talk, I will introduce β-orthogonality for i-resolvable Steiner systems and the associated arrays called (t,i,β)-Kirkman squares. Orthogonal packings in projective space can be used to construct the first infinite class of $(3,2,\beta)$-Kirkman squares. These designs can be used to construct optimal doubly constant weight codes with perfect $(1,2)$ covers, thus answering a long open question on the existence of such codes. This work is closely connected to several interesting open problems in design theory and finite geometry.