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Symmetric designs, sets with two intersection numbers and Krein parameters of incidence graphs

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Abstract   Let $(\mathcal{P}, \mathcal{B}, \mathcal{I})$ be a symmetric (v, k, λ) block design. The incidence graph G of this design is distance-regular, hence belongs to an association scheme. In this paper, we use the algebraic structure of this association scheme to analyse certain symmetric partitions of the incidence structure.

A set with two intersection numbers is a subset $P_1 \subseteq \mathcal{P}$ with the property that $|B \cap P_1|$ takes on only two values as B ranges over the blocks of the design. In the special case where the design is a projective plane, these objects have received considerable attention. Two intersection theorems are proven regarding sets of this type which have a certain type of dual. Applications to the study of substructures in finite projective spaces of dimensions two and three are discussed.