Codes and Designs in Polar Spaces

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A finite classical polar space of rank n consists of the totally isotropic subspaces of a finite vector space equipped with a nondegenerate form such that n is the maximal dimension of such a subspace. In the first part of the talk, we will look at codes consisting of maximals in a polar space and derive upper bounds on the size of these codes. This is achieved by investigating the association schemes arising from the polar spaces and applying the powerful linear programming method from Delsarte. We will thereby see a remarkable resemblance between the bounds for codes in polar spaces and the bounds for codes in several other classical association schemes, such as the q-Johnson scheme and the affine schemes.

In the second part of the talk, we will use the derived bounds for codes to give an almost complete classification of t-Steiner systems in polar spaces. We will moreover look at t-(n, k, λ) designs in polar spaces of rank n with $k < n$. So far, nontrivial examples were only known for $t \leq 2$. We will show that these designs exist for all t. The proof of this existence result is nonconstructive and based on a probabilistic method due to Kuperberg, Lovett, and Peled.

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