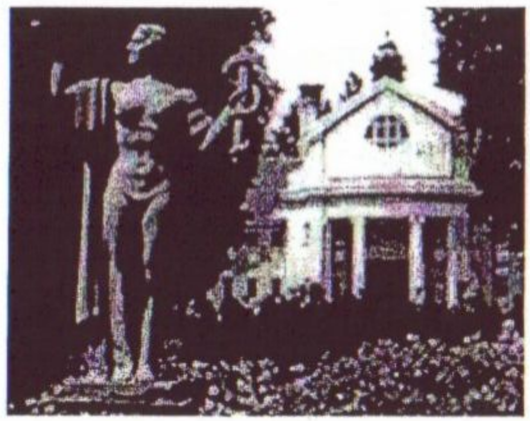
Annual Workshop

Coding Theory and Applications

Abstracts



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PREFACE

The Annual Workshop on Coding Theory and Applications is organized by the Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences. It is held in a spa resort near the town of Sofia from December 11 to December 15, 2002.

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Self-dual codes with an automorphism of order 25

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We apply a method for constructing binary self-dual codes having an automorphism of order 5^2 (see [1]).

Let C be a self-dual code of length 50 with an automorphism $\sigma = (1,2,\dots,25)(26,27,\dots,50)$ Then $C = C_\sigma \oplus E_\sigma$ where $C_\sigma = \{v \in C : \sigma(v) = v\}$ and $E_\sigma = \{v = (v_1, v_2, \dots, v_{50}) \in C : v_1 + \dots + v_{25} \equiv v_{26} + \dots + v_{50} \equiv 0 (mod\ 2)\}$. In our case $C_\sigma = \{00\dots0, 11\dots1\}$. Let us define the map $\phi : E_\sigma \to P, \phi(v) = (v_1 + v_2x + \dots + v_{25}x^{24}, v_{26} + v_{27}x + \dots + v_{50}x^{24}) \in P^2$ where P is the ring of even-weight polynomials in $F[2]/(x^5+1)$. We have $P = I_1 \oplus I_2$ where I_1 is a field with 16 elements and with identity $e_1 = x^{24} + x^{23} + \dots + x - x^{20} - x^{15} - x^{10} - x^5$, and I_2 is a field with 2^{20} elements and with identity $e_2 = x^{20} + x^{15} + x^{10} + x^5$. So $E_\sigma = M_1 \oplus M_2$ where M_1 is a linear [2,1] code over the field I_1, and M_2 is a linear [2,1] code over the field I_2. Up to equivalence, we can take $G_1 = (e_1\ e_1)$ as a generator matrix for M_1, and $G_2 = (e_2\ g(x))$ as a generator matrix for M_2 where $g(x) \in I_2$ and $g(x)g(x^{-1}) = e_2$. Hence we can take a generator matrix of C in the form

$G = (\phi^{-1}(G_1), \phi^{-1}(xG_1), \phi^{-1}(x^2G_1), \phi^{-1}(x^3G_1), \phi^{-1}(G_2), \phi^{-1}(xG_2), \dots, \phi^{-1}(x^{19}G_2), 111\dots11)^T$

References

[1] R. Doncheva, "Self-dual codes", *Dissertation*, Delft University, the Netherlands, 2002.

On the structure of some spherical designs

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The spherical designs were introduced in 1977 by Delsarte, Goethals and Seidel as a counterpart on the Euclidean sphere of the classicall combinatorial designs.

A spherical τ-design is a finite set $C \subset \mathbf{S}^{n-1}$ such that the equality

$$\frac{1}{\mu(\mathbf{S}^{n-1})} \int_{\mathbf{S}^{n-1}} f(x) d\mu(x) = \frac{1}{|C|} \sum_{x \in C} f(x)$$

(where $\mu(x)$ is the usual Lebesgue measure) holds for all polynomials $f(x) = f(x_1, x_2, \dots, x_n)$ of degree at most τ (i.e. the average of f over the set is equal to the average of f over $\mathbf{S}^{n-1}$).

An equivalent definition says that $C \subset \mathbf{S}^{n-1}$ is a spherical τ-design if and only if

$$\sum_{x \in W} f(\langle x, y \rangle) = |C| f_0 \qquad (1)$$

where $y \in \mathbf{S}^{n-1}$ is an arbitrary point, $f(t)$ is a real polynomial of degree at most τ, and f_0 is the first coefficient in the Gegenbauier expansion of $f(t) = \sum_{i=0}^k f_i P_i^{(n)}(t)$.

In this talk we show how (1) can be used for some special (with respect to the the design) points on $\mathbf{S}^n$ implying some restrictions on the structure of such designs. This gives new characterizations of spherical designs with small cardinalities.