ABSTRACTS

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Forbidden Configurations: A survey

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Forbidden configurations are a problem in Extremal Set Theory first described as a problem area in a 1985 paper. The subsequent work has involved a number of coauthors: Farzin Barekat, Laura Dunwoody, Ron Ferguson, Balin Fleming, Zoltan Füredi, Jerry Griggs, Nima Kamoosi, Steven Karp, Peter Keevash and Attila Sali but there are works of other authors (some much older, some recent) impinging on this problem as well. For example, the definition of VC-dimension uses a forbidden configuration.

The search for n-e.c. graphs and tournaments

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N-existentially closed (or *n*-e.c.) graphs have myriad applications in graph theory, logic, and even to models of real-world complex networks such as the web graph. For a positive integer n, a graph is *n*-e.c. if for all disjoint sets of vertices A and B so that the union of A and B has cardinality n, there is a vertex z not in A nor B joined to each vertex of A and no vertex of B. *N*-e.c. graphs were discovered by Erdos and Renyi, who proved that for a given n almost all graphs are *n*-e.c. Despite this fact, relatively few explicit constructions of *n*-e.c. graphs are known. Analogous results hold for *n*-e.c. tournaments (which are defined in a similar way to *n*-e.c. graphs).

In the last few years, several new explicit families of *n*-e.c. graphs and tournaments were discovered. Such families were defined using techniques from finite geometry, number theory, design theory, and matrix theory. We describe some new constructions of regular *n*-e.c. graphs and tournaments, and pose conjectures surrounding the asymptotics of the minimum orders of *n*-e.c. graphs and tournaments.

Divisible Design Graphs

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Divisible design graphs are graphs whose adjacency matrix can also be interpreted as the incidence matrix of a divisible design. They are a generalization of (v,k,λ) graphs. The concept is due to Hadi Kharaghani (private communication). We will present a start for some theory of these structures. This includes constructions, characterizations and necessary conditions for existence. (Joint work with Maaike Meulenberg.)

New series of strongly regular graphs

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In 1971 W.D. Wallis proposed a new construction of strongly regular graphs based on an affine design and a Steiner 2-design. Thirty years later D.G. Fon-Der-Flaass found how to introduce a sort of randomness into Wallis construction. He built a hyperexponentially many strongly regular graphs with the same parameters, but his construction covered only one case of Wallis construction, namely when the corresponding Steiner design has block size 2. The goal of this talk is twofold. First, I show how to modify Fon-Der-Flaass ideas in order to cover all the cases of Wallis construction. Second, it will be shown that a Steiner 2-design in the original Wallis construction may be replaced by a partial linear space with some additional properties. As a result new constructions of strongly regular graphs will be presented.

Skew Hadamard difference sets from commutative semifields and symplectic spreads

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Let G be a finite group of order v (written multiplicatively). A k-element subset D of G is called a (v,k,λ) *difference set* if the list of "differences" xy^{-1}, $x,y \in D$, $x \neq y$, represents each nonidentity element of G exactly λ times. Let q be a prime power congruent to 3 modulo 4. The set of nonzero squares of $GF(q)$ is a $(q, \frac{q-1}{2}, \frac{q-3}{4})$ difference set in $(GF(q),+)$. This construction dates back to 1933, and it is due to Paley. The difference sets coming from this construction are usually called *Paley difference sets*.

A difference set D in a finite group G is called *skew Hadamard* if G is the disjoint union of D, $D^{(-1)}$, and $\{1\}$, where $D^{(-1)} = \{d^{-1} \mid d \in D\}$. The Paley difference sets provide a family of examples of skew Hadamard difference sets. For more than 70 years, these are the only known examples in abelian groups. It was conjectured that no further examples in abelian groups can be found. This conjecture was disproved by Ding and Yuan in 2005. Subsequently, we found another construction using certain permutation polynomials from the Ree-Tits slice symplectic spreads in $PG(3,3^{2h+1})$. In this talk, we will discuss these developments and raise several questions about skew Hadamard difference sets.