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1 Complex-Valued Golay Pairs of Complementary Sequences

Two finite sequences (of the same length L) of unimodular complex numbers are said to form a complementary pair if their generating polynomials $P(z)$ and $Q(z)$ satisfy, for all z on the unit circle,

$$|P(z)|^2 + |Q(z)|^2 = \text{constant } (= 2L, \text{ necessarily}). \tag{1}$$

Two obvious origins of such pairs are the (totally unrelated) works of M. Golay and H.S. Shapiro [1949-1951], but their remote ancestry is much older: Hadamard, Fejér-Riesz... Examples of interesting and useful variations are: (A) All coefficients of $P(z)$ and $Q(z)$ are in a given subgroup (or subset) of the unit circle; (B) The variable z in (1) is restricted to a finite subgroup of the unit circle. Such variations often lead to combinatorics and to number theory, with the underlying non-commutative algebraic structures. I hope to present a fairly complete account of such PAIRS, including related Hadamard matrices. I will say little about complementary triples, quadruples, etc. The reason is that, while many straightforward properties of such pairs are readily extensible to m-tuples (hence the large published literature on such m-tuple extensions, although part of that literature is certainly nontrivial), some deeper properties are specific to PAIRS or at least are much harder to extend to m-tuples. On the other hand, pairs of complementary n-D arrays (generalizing such sequence pairs) are part of this talk.

2 Autocorrelations and Crosscorrelations of Functions on Finite Groups

Some aspects of the classical (commutative) correlation theory of finite sequences (or n-D arrays), for example the above topic, can be extended to non-abelian finite groups. Such extensions can be non-straightforward, not only because of representation theory, but also because non-abelian combinatorics, *e.g.* the theory of non-abelian (v, k, λ) difference sets, is fairly young and less explored. Concrete examples will be given.