various constructions and applications of Hadamard and weighing matrices

A. Goldberger Tau Tel-Aviv, Y. Strassler Danyishay and G.Dula* Nac Netanya. ISRAEL.

An $n \times n$ matrix H with terms in $\{\pm 1\}$ is called an Hadamard matrix if $HH^T = H^T H = nI_n$. A matrix W with terms in $\{\pm 1, 0\}$ is called a weighing matrix $W(n, w)$ if $WW^T = W^T W = wI_n$ for some natural number $w \leq n$. Every Hadamard matrix is a $W(n, n)$.
The subject of weighing matrices is growing fast and relates to other mathematical fields e.g. information theory, number theory, group theory and topology.
In the first part of this talk we will survey the early works of Sylvester, Walsh and of Hadamard on Hadamard matrices. These works relate to error correcting codes in various different ways. Nasa used Hadamard code to transmit images from Mars.
We will discuss the usage of (complex) Hadamard matrices to quantum random access codes. Then we will survey the construction of Payley that gave many new Hadamard matrices. The construction uses weighing matrices
Then we will survey the works of Koukouvinos and Seberry and of Harada and Munemasa which relate weighing matrices with optimal weighing designs, optical multiplexing and again with (self dual) codes.
In the second part of this talk we will survey some other classical results e.g Strassler, Craigen and Eliyahu and Kervaire
In the last part we will present the basic ideas that led to the solution of $W(23, 16)$ using shadow geometries.

Keywords: weighing matrix, geometry, local geometry