DISCOVERY OF AN HADAMARD MATRIX OF ORDER 92[1]

BY LEONARD BAUMERT, S. W. GOLOMB AND MARSHALL HALL, JR.

Communicated by F. Bohnenblust, December 29, 1961

An Hadamard matrix H is an n by n matrix all of whose entries are $+1$ or -1 which satisfies $HH^T = nI$, H^T being the transpose of H. The order n is necessarily 1, 2 or $4t$, with t a positive integer. R. E. A. C. Paley [3] gave construction methods for various infinite classes of Hadamard matrices, chiefly using properties of quadratic residues in finite fields. These constructions cover all values of $4t \leqq 200$, except $4t = 92, 116, 156, 172, 184, 188$. Further constructions have been given by J. Williamson [5; 6], A. Brauer [1], M. Hall [2] and R. Stanton and D. Sprott [4]. Williamson's first paper gave an Hadamard matrix of order 172, incorporating a special automorphism of order 3. The same method may be applied to 92, 116, 156, and 188, but Williamson did not do so, principally because of the amount of computation involved.

Williamson's method has been applied to $4t = 92$ using the IBM 7090 at the Jet Propulsion Laboratory. The matrix H has the form

$$H = \begin{vmatrix} A & B & C & D \\ -B & A & -D & C \\ -C & D & A & -B \\ -D & -C & B & A \end{vmatrix}$$

where each of A, B, C, D is a 23 by 23 symmetric circulant matrix. We give here the first row of each of A, B, C, D writing $+$ for $+1$ and $-$ for -1.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
A	+	+	−	−	−	+	−	−	−	+	−	+	+	−	+	−	−	−	+	−	−	−	+
B	+	−	+	+	−	+	+	−	−	+	+	+	+	+	+	−	−	+	+	−	+	+	−
C	+	+	+	−	−	−	+	+	−	+	−	+	+	−	+	−	+	+	−	−	−	+	+
D	+	+	+	−	+	+	+	−	+	−	−	−	−	−	−	+	−	+	+	+	−	+	+

REFERENCES

1. A. Brauer, *On a new class of Hadamard determinants*, Math. Z. **58** (1953), 219–225.

[1] The work reported in this paper was conducted at the Jet Propulsion Laboratory of the California Institute of Technology under a program sponsored by the National Aeronautics and Space Administration, Contract number NASw-6.