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Hadamard matrices related to orthogonal arrays

Let $n \equiv 3 \pmod{4}$ be a positive integer. The following statements are equivalent:

(i) There exists an Orthogonal Array $\mathrm{OA}(n+1, n)$ and an $n \times (n+1)$ partial Hadamard matrix.

(ii) There exists a balancedly multi-splittable $n^2 \times n(n+1)$ partial Hadamard matrix.

Additionally, the concept of balancedly multi-splittable Balanced Incomplete Block Designs will be introduced and discussed.

A joint work with Sho Suda and Yash Khobragade.