On the classification of unitals on 28 points of low rank

Alfred Wassermann
University of Bayreuth
alfred.wassermann@uni-bayreuth.de

Vladimir Tonchev
Michigan Technological University
tonchev@mtu.edu

Unitals are combinatorial 2-$(q^3+1, q+1, 1)$ designs. In 1981, Brouwer constructed 138 nonisomorphic unitals for $q = 3$, i.e. 2-$(28, 4, 1)$ designs. He observed that the 2-rank of the constructed unitals is at least 19, where the p-rank of a design is defined as the rank of the incidence matrix between points and blocks of the design over the finite field GF(p). In 1998, McGuire, Tonchev and Ward proved that indeed the 2-rank of a unital on 28 points is between 19 and 27 and that there is a unique 2-$(28, 4, 1)$ design, the Ree unital $R(3)$, with 2-rank 19. In the same year, Jaffe and Tonchev showed that there is no unital on 28 points of 2-rank 20 and there are exactly 4 isomorphism classes of unitals of rank 21.

Here, we present the complete classification by computer of unitals of 2-rank 22, 23 and 24. There are 12 isomorphism classes of unitals of 2-rank 22, 78 isomorphism classes of unitals of 2-rank 23, and 298 isomorphism classes of unitals of 2-rank 24.