Second International Conference “Mathematics Days in Sofia”
July 10–14, 2017, Sofia, Bulgaria

Constructing DNA Codes by Additive Self-dual Codes

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Coding theory has several applications in Genetics and Bioengineering. Every DNA molecule consists of two complementary strands which are sequences of four different nucleotide bases called adenine (A), cytosine (C), guanine (G) and thymine (T). The problem of designing DNA codes (sets of words of fixed length n over the alphabet $\{A, C, G, T\}$ that satisfy certain combinatorial constraints) has applications for reliably storing and retrieving information in synthetic DNA strands and designing of molecular barcodes.There are four certain constraints for DNA codes: the Hamming distance constraint, the reverse constraint, the reverse-complement (RC) constraint and the fixed GC-content constraint.

The studies on DNA codes so far have been focused mostly on codes of length up to 35. In [2] DNA code with $n = 36$ and $d = 10$ was constructed. Grassl and Harada [1] improved this result. They constructed additive circulant graph code (an additive circulant graph code is a code corresponding to graph with circulant adjacency matrix) with $n = 36$ and $d = 11$. In terms of quantum codes with good parameters, in [1] were also constructed additive circulant graph codes with the following n and d: $(56, 15)$, $(57, 15)$, $(58, 16)$, $(63, 16)$, $(67, 17)$, $(70, 18)$, $(71, 18)$, $(79, 19)$, $(83, 20)$, $(87, 20)$, $(89, 21)$ and $(95, 20)$. Using these codes and the method described in [2] we construct the following DNA codes with parameters n and d: $(56, 15)$, $(57, 15)$, $(58, 16)$, $(63, 16)$, $(67, 17)$, $(70, 18)$, $(71, 18)$, $(79, 19)$, $(83, 20)$, $(87, 20)$, $(89, 21)$, $(95, 20)$. Also, by some methods about shortening and lengthening of additive codes we obtain new results about DNA codes: $(55, 14)$, $(60, 16)$, $(62, 16)$, $(72, 18)$, $(82, 19)$ and $(88, 20)$.

References

[1] M. Grassl, M. Harada, New self-dual additive $F4$-codes constructed from circulant graphs, *Discrete Mathematics*, 2016.

[2] T. Todorov, Z. Varbanov, M. Hristova, A method for constructing DNA codes from additive self-dual codes over $GF(4)$, *ROMAI Journal, v.10(2)*, 203–211, 2014.