DISTINCTNESS OF THE "LIFTED" KLOOSTERMAN SUMS OVER THE PRIME FIELD $\mathbb{F}_p$

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Abstract. In this talk I consider the Kloosterman sums over the finite field $\mathbb{F}_q$ of characteristic p, defined by

$$\mathcal{K}_q(u) = \sum_{x \in \mathbb{F}_q^*} \omega^{\,Tr(x+ux^{-1})},$$

where $\omega = e^{\frac{2\pi i}{p}}$ is a primitive $p-$th root of unity, and $Tr(a)$ is the absolute trace of $a \in \mathbb{F}_q$ over $\mathbb{F}_p$.

The focus of special attention are the so-called "lifted" Kloosterman sums over $\mathbb{F}_q$ (see, [2]), i.e., $\mathcal{K}_{q^n}(u), u \in \mathbb{F}_q$, where $\mathbb{F}_{q^n}$ is the finite field of order $q^n, n > 1$.

It is well-known that the Kloosterman sums play an important role in algebraic coding theory and cryptography (see, e.g., the surveys [3]-[4]).

Firstly I clashed with them in the problem of enumerating the elements of a finite field having prescribed trace and co-trace:

https://arxiv.org/pdf/1711.08306.pdf

The issue of their distinctness is considered and partly solved for the first time by Benjamin Fisher in 1992 [5]. In particular, this author has proved that fact for the simplest sums, i.e., over the prime fields.

Recently, in a personal communication with us, Daqing Wan has announced that as a co-product of his research [6] (based on deep algebraic number theory such as Stickelberger's theorem) it follows the distinctness of "lifted" Kloosterman sums over any prime field $\mathbb{F}_p$ whenever the extension degree is not a multiple of p. This statement generalizes our result for the fields whose extension degree is a power of 2:

https://link.springer.com/article/10.1007/s12095-020-00443-1

The case $p = 3$ I considered in [1]. Here I give a complete proof that all "lifted" Kloosterman sums over each prime field of characteristic $p > 3$ and any extension degree, are distinct.

References

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