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# Davenport–Hasse’s Theorem for Polynomial Gauss Sums over Finite Fields

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## Abstract

In this paper, we study the polynomial Gauss sums over finite fields, and present an analogue of Davenport–Hasse’s theorem for the polynomial Gauss sums, which is a generalization of the previous result obtained by Hayes.

**2010 Mathematics Subject Classification:** Primary 11T55, 11T24, 11L05

**Key words:** Polynomial Gauss sums, Finite fields, Davenport–Hasse’s Theorem

## 1 Introduction

Let  $\mathbb{F}_q$  be a finite field with  $q = p^l$  elements, where  $p$  is a prime number. Let  $\mathbb{F}_{q^n}$  be a finite extension over  $\mathbb{F}_q$  of degree  $n$ , and  $\sigma$  be the Frobinus on  $\mathbb{F}_{q^n}$ , given by  $\sigma(a) = a^q$  for any elements  $a$  in  $\mathbb{F}_{q^n}$ . We have  $\sigma^n = 1$ , and  $\sigma$  generates the Galois group of  $\mathbb{F}_{q^n}/\mathbb{F}_q$ . The relative trace  $\text{tr}(a)$  and the norm  $N(a)$  of an element  $a$  in  $\mathbb{F}_{q^n}$  are defined by

$$\text{tr}(a) = \sum_{i=1}^n \sigma^i(a), \quad N(a) = \prod_{i=1}^n \sigma^i(a) \quad (1.1)$$

respectively. Let  $\psi$  be a (complex-valued) character of the additive group of  $\mathbb{F}_q$ , and  $\chi$  a character of the multiplicative group  $\mathbb{F}_q^*$  of  $\mathbb{F}_q$ . The Gauss sums on  $\mathbb{F}_q$  are defined by

$$\tau(\chi, \psi) = \sum_{a \in \mathbb{F}_q^*} \chi(a) \psi(a). \quad (1.2)$$

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