On pencils of cubics on the projective line over finite field of characteristic $> 3$

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Abstract

A cubic $C$ in $\text{PG}(1, q)$ is the zero locus of a homogenous polynomial $f(X_0, X_1)$ of degree 3 in $\mathbb{F}_q[X_0, X_1]$. The cubic forms on $\text{PG}(1, q)$ form a four-dimensional vector space $W$, and subspaces of the projective space $\text{PG}(W)$ are called linear systems of cubics. One-dimensional linear systems are called pencils.

In this talk, we mention combinatorial invariants of the equivalence classes of pencils of cubics on $\text{PG}(1, q)$, for $q$ odd and $q$ not divisible by 3. These equivalence classes are considered as orbits of lines in $\text{PG}(3, q)$, under the action of the subgroup $G \cong \text{PGL}(2, q)$ of $\text{PGL}(4, q)$ which preserves the twisted cubic $C$ in $\text{PG}(3, q)$. In particular, we determine the point orbit distributions and plane orbit distributions of all $G$-orbits of lines which, are contained in an osculating plane of $C$, have non-empty intersection with $C$, or are imaginary chords or axes.