

SEMINARIO DI GEOMETRIA E ALGEBRA

UNIBA - POLIBA

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On the geometry of $(q + 1)$ -arcs of $PG(3, q)$, q even

Abstract. Considered the projective space $PG(3, q)$ of dimension three over the finite field \mathbb{F}_q , for q a power of a prime, a $(q + 1)$ -arc of $PG(3, q)$ is a set of $q + 1$ points of $PG(3, q)$ such that no four of them are coplanar. In this talk we specialize to the case $q = 2^n$, in which a $(q + 1)$ -arc is projectively equivalent to

$$\mathcal{A} = \{P_t = (1, t, t^{2^h}, t^{2^{h+1}}) \mid t \in \mathbb{F}_q\} \cup \{(0, 0, 0, 1)\},$$

where $\gcd(n, h) = 1$ and it is also projectively equivalent to

$$\bar{\mathcal{A}} = \{(1, t, t^{2^{n-h}}, t^{2^{n-h+1}}) \mid t \in \mathbb{F}_q\} \cup \{(0, 0, 0, 1)\}.$$

For $q \geq 5$, the group that leaves \mathcal{A} invariant, denoted by G_h , is a subgroup of $PGL(4, q)$ isomorphic to $PGL(2, q)$.

In the case $h = 1$, the $(q + 1)$ -arc \mathcal{A} is called *twisted cubic*; it has been deeply studied in literature, and, in particular, so is the action of its group G_1 on points, lines and planes.

Besides being important from a geometrical point of view, it is relevant also because of its connection to coding theory, for example to asymptotically optimal multiple covering codes [1].

In this talk, we study the orbits of the group G_h on points, lines and planes of $PG(3, q)$. In particular, we show that, similarly to what happens for the case $h = 1$ of the twisted cubic, there are five orbits on points and planes. Moreover, the orbits on lines are $2q + 7 + \xi$, where $q \equiv \xi \pmod{3}$. This proves, in even characteristics, Conjecture 8.2 of [2].

We conclude examining the point-line incidence matrix for the case of the twisted cubic.

References

- [1] D. BARTOLI; A.A. DAVYDOV; S. MARCUGINI; F. PAMBIANCO, *On planes through points off the twisted cubic in $PG(3, q)$ and multiple covering codes*. Finite Fields Appl., 67 (2020), 101710.
- [2] A.A. DAVYDOV; S. MARCUGINI; F. PAMBIANCO, *Twisted cubic and orbits of lines in $PG(3, q)$ II*, arXiv 2112.14803v1, preprint, 2021.

