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PLANAR 2-COCYCLES OF FINITE GROUPS

by Yu Qing CHEN

Let G be a finite group and A a G -module. Recall [2] that a (normalized) 2-cocycle of G with coefficients in A is a function

$$f: G \times G \rightarrow A$$

satisfying

- (i) $f(g, 1) = f(1, g) = 0$, for all $g \in G$;
- (ii) $f(g, h) + f(gh, k) = gf(h, k) + f(g, hk)$ for all $g, h, k \in G$.

DEFINITION 24.1. A 2-cocycle of G with coefficients in A is called *planar* (the extension group acts on a finite projective plane as a collineation group [3], [4], [5]) if

- (i) $|G| = |A|$;
- (ii) for every $1 \neq g \in G$, the maps

$$f(g, \cdot): G \rightarrow A$$

and

$$f(\cdot, g): G \rightarrow A$$

are bijections.

EXAMPLE 24.2. Let $\mathbf{F}$ be a finite field. We can regard $\mathbf{F}$ as a trivial $\mathbf{F}$ -module. For any Galois automorphism σ , we define $f_\sigma: \mathbf{F} \times \mathbf{F} \rightarrow \mathbf{F}$ by

$$f_\sigma(x, y) = x\sigma(y).$$

The function f_σ is a planar 2-cocycle of the additive group of $\mathbf{F}$ with coefficients in the same group.

CONJECTURE 24.3. *If G has a planar 2-cocycle, then G is a p -group.*

REMARK 24.4. A more general conjecture is the so-called prime power conjecture, which asserts that the order of a finite projective plane is always a power of a prime ([1], [5]).

CONJECTURE 24.5 (Stronger version). *If G has a planar 2-cocycle with coefficients in a G -module A , then G and the underlying group of A are elementary abelian groups.*

REMARK 24.6. In the case when G is abelian and the cocycle is symmetric (i.e. $f(x, y) = f(y, x)$ for all x and y in G), which is equivalent to the extension group being abelian, Conjecture 24.3 is true [1] but we do not know whether the stronger version is also true.

REFERENCES

- [1] BLOKHUIS, A., D. JUNGnickel and B. SCHMIDT. Proof of the prime power conjecture for projective planes of order n with abelian collineation groups of order n^2 . *Proc. Amer. Math. Soc.* 130 (2002), 1473–1476.
- [2] BROWN, K. S. *Cohomology of Groups*. Graduate Texts in Mathematics 87. Springer-Verlag, Berlin, Heidelberg, New York, 1982.
- [3] GALATI, J. C. A group extension approach to relative difference sets. *J. Combin. Des.* 12 (2004), 279–298.
- [4] PERERA, A. A. I. and K. J. HORADAM. Cocyclic generalised Hadamard matrices and central relative difference sets. *Des. Codes Cryptogr.* 15 (1998), 187–200.
- [5] POTT, A. *Finite Geometry and Character Theory*. Lecture Notes in Mathematics 1601. Springer-Verlag, Berlin, Heidelberg, 1995.

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