

Zeitschrift: L'Enseignement Mathématique
Herausgeber: Commission Internationale de l'Enseignement Mathématique
Band: 54 (2008)
Heft: 1-2

Artikel: Planar 2-cocycles of finite groups
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DOI: <https://doi.org/10.5169/seals-109893>

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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, \): G \rightarrow A$$

and

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

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.

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