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Extensions of finite fields and some class of special p-groups

Olga Pyliavska

A finite p-group G is called special if the center $Z(G)$, the commutator subgroup G' and the Frattini subgroup $\Phi(G)$ coincide ([**4**]).

Special p-groups have nilpotency class 2. For these groups $Z(G)$ and G/G' are elementary abelian and exponent of G is p or p^2.

The special p-groups of exponent p admit some matrix presentation over the field $F_p = \mathbb{Z}/p\mathbb{Z}$ (see [**1**], [**5**], [**6**]), which gives possibility for their classification.

We define some class of special p-groups of exponent $\leq p^2$ which admit the calculation in the extension of F_{p^n} of finite field F_p. The groups of investigation has order p^{3n}, where $n = gcd(n, p-1)$ and $|G'| = p^n$.

For small n and arbitrary prime p are obtained

- full classification of these groups up to isomorphism and their enumeration;
- the structure of maximal abelian normal subgroups and corresponding factor-groups;
- automorphism groups.

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Some special p-groups and nearrings with identity

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Clearly every associative ring is a nearring and each group is the additive group of a nearring, but not necessarily of a nearring with identity. The question what group can be the additive group of a nearring with identity is far from solution.

We investigate p-groups with cyclic subgroup of index p as the additive groups of nearrings with identity.

In [**1**, Theorem 12.5.1] it was proved that there exist seven types of p-groups with cyclic subgroup of index p.

Theorem 1. *Let G be a group from* [**1**, Theorem 12.5.1]. *G is the additive group of a nearring with identity iff one of the following statement holds:*

(1) $G = \langle a|\ a^{p^n} = 1\rangle$, $n \geq 1$.
(2) $G = \langle a,\ b|\ a^{p^{n-1}} = 1,\ b^p = 1,\ ba = ab\rangle$, $n \geq 2$.
(3) $G = \langle a,\ b|\ a^{p^{n-1}} = 1,\ b^p = 1,\ ba = a^{1+p^{n-2}}b\rangle$, *$p$ is odd,* $n \geq 3$.
(4) G is a dihedral group of order 8.
(5) $G = \langle a,\ b|\ a^{2^{n-1}} = 1,\ b^2 = 1,\ ba = a^{1+2^{n-2}}b\rangle$, $n \geq 4$.

Denote by $n(G)$ the number of all non-isomorphic zero-symmetric nearrings with identity whose additive group R^+ is isomorphic to the group G.

So using [**3**, Theorem 7.1] and [**2**] we can easily conclude the following result:

Proposition 1. *Let G be a non-abelian group from Theorem 1. Then the following statements hold:*

(1) If $p = 2$ *and* $n = 3$, *then* $n(G) = 7$.
(2) If $p = 2$ *and* $n = 4$, *then* $n(G) = 32$.
(3) If $p = 2$ *and* $n > 4$, *then* $n(G) = 2^{n+2}$.
(4) If $p = 3$, *then* $n(G) = 3^{n-2}$.
(5) If $p > 3$, *then* $n(G) = p^{n-3}$.

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