International Journal of Mathematical Archive-6(8), 2015, 144-151
Available online through www.ijma.info ISSN 2229 – 5046

A NOTE ON B_1-NEAR-FIELD SPACES OVER REGULAR δ-NEAR-RINGS (B_1 - NFS-R-δ-NR)

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(Received On: 10-08-15; Revised & Accepted On: 31-08-15)

ABSTRACT

The aim of Dr N V Nagendram in this paper is to extend the concepts of B_1 near-rings and after in depth study to introduce the concepts of B_1 – near-field spaces and strong B_1 – near-field spaces. We say that a right near-field space N is a B_1 – near-field space if for every $a \in N$, there exists $x \in N^*$ where $N^* = N – \{0\}$, such that $N ax = N xa$. By way of generalization, we define N as a strong B_1 – near-field space if $N ab = N ba$ $\forall a, b \in N$. Dr. N. V. Nagendram discuss some of their properties and obtain a characterization and also a structure theorem.

Keywords: *B_1–near-ring, strong B_1–near-ring, near-field, near-field space, sub near-field space, B_1–near-field spaces, B_1 – sub near-field spaces.*

Subject Classification Code: *MSC (2010):16D25, 54G05, 54C40, 16Y30.*

SECTION 1: INTRODUCTION

Throughout, this paper N stands for a right near-field space (N, +, .), with at least two elements and "0" denotes the identity element of the near-field (N, +). Obviously $0n = 0$ $\forall n \in N$. If in addition, $n0 = 0$ $\forall n \in N$ then we say that N is zero symmetric near-field. A sub near-field space (M, +) of (N, +) is called an N- sub near-field space of N if $NM \subset M$ and an invariant N- sub near-field space of N if $MN \subset M$ as well. N is called weak commutative near-field space if $abc = acb$ $\forall a, b, c \in N$ (by G pilz [4]). N is said to be regular near-field space if for every $a \in N$ there exists $b \in N$ such that $a = aba$. An element a is said to be nilpotent if $a^k = 0$ for some positive integer k. N is called nil near-field space if every element of N is nilpotent. N is called integral near-field space if N has no non-zero zero divisors. N is called a P_k near-field space if there exists a positive integer k such that $x^kN = xNx$ $\forall x \in N$. For any sub near-field space A of near-field space N, we denote by A^* the set of all non-zero elements of A. In particular $N^* = N – \{0\}$. N is called a strong B_1 near-field space if $N^* = N_{B1}(a)$ $\forall a \in N$ where $N_{B1}(a) = \{x \in N^* / axa = xa\}$. For basic concepts and terms used but left undefined in this paper we refer to Gunter Pilz [4].

Near-field over a regular delta Near-Ring is a generalized structure of a near-field. Dr. N.V. Nagendram introduced the notion of B_1 – near-field spaces over a regular delta near-ring.

Dr. N.V. Nagendram after in depth study of near-rings, regular near-rings, regular δ-near-ring, various types of regular δ-near-rings, near-fields, semi near-fields and near-field space over regular delta near-rings extended the concept to B_1 – near-field spaces over a regular delta near-ring and characterization of B_1 – near-field spaces over a regular delta near-ring.

As in near-ring theory it is interesting to fuzzify some sub structures of near-field spaces over regular delta near-rings of a near-ring. Hence our aim in this paper is to study B_1– sub-near-field spaces and B_1 – near-field spaces.

The organization of this paper is as follows:

In section 2, some fundamental and preliminary definitions and results are given.

In section 3, B_1 – near-field spaces of a near-field over regular delta near-ring are defined and obtained some results in relation B_1 – near-field spaces.

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In section 4, Study of Strong B_1 – near-field spaces of a near-field over regular delta near-ring and are defined. Also obtain some results in relation Strong B_1 – near-field spaces.

Section 5 concludes the paper. In depth study of various types of near-fields [10], Dr. N V Nagendram extended the B_1 – near-fields and strong B_1–near-fields over regular delta near-ring in a near-field space by applying the topological applications making it into algebraic topology in modern and abstract algebra for large scale scope of applications in algebra of mathematics. Algebraic topology is a branch of mathematics that uses tools from abstract algebra to study topological spaces. The basic goal is to find algebraic invariants that classify topological spaces up to homeomorphism, though usually most classify up to homotopy equivalence. Although algebraic topology primarily uses algebra to study topological problems, using topology to solve algebraic problems is sometimes also possible. Algebraic topology, for example, allows for a convenient proof that any subgroup of a free group is again a free group.

SECTION 2: FUNDAMENTAL DEFINITIONS AND RESULTS

In this section we recall some fundamental definitions and results for the sake of completeness in the sense of topology:

2.1 Definition: zero symmetric near-field. N stands for a right near-field space (N, +,.), with at least two elements and "0" denotes the identity element of the near-field (N, +).

Obviously $0n = 0 \ \forall \ n \in N$. If in addition, $n0 = 0 \ \forall \ n \in N$ then we say that N is zero symmetric near-field.

2.2 Definition: sub near-field space. A sub near-field space (M, +) of (N, +) is called an N- sub near-field space of N if $NM \subset M$ and an invariant N- sub near-field space of N if $MN \subset M$ as well.

2.3 Definition: weak commutative near-field space [G Pilz4]. N is called weak commutative near-field space if $abc = acb \ \forall \ a, b, c \in N$.

2.4 Definition: regular near-filed space. N is said to be regular near-field space if for every $a \in N$ there exists $b \in N$ such that $a = aba$.

2.5 Definition: nil near-field space. An element a is said to be nilpotent if $a^k = 0$ for some positive integer k.

N is called nil near-field space if every element of N is nilpotent.

2.6 Definition: Integral near-field space. N is called integral near-field space if N has no non-zero zero divisors.

2.7 Definition: P_k near-field space. N is called a P_k near-field space if there exists a positive integer k such that $x^kN = xNx \ \forall \ x \in N$.

Here is an extension of the results from [3], [4] and [5] mentioned remarks as below:

2.8 Result: a B_1 – near-field space N has no non-zero nilpotent elements $\Leftrightarrow a^2 = 0 \Rightarrow a = 0 \ \forall \ a \in N$.

2.9 Result: a B_1 – near-field space N is zero symmetric $\Leftrightarrow$ left ideal of B_1 – N is an B_1 – N-sub near-field space of N.

2.10 Result: Let a B_1 – near-field space N be zero symmetric then the following are equivalent:

(i) a B_1 – near-field space N has no non-zero nilpotent elements
(ii) a B_1 – near-field space N is a sub direct product of integral near-fields say N_i for all i = 1,2,3,........

2.11 Result: If N is a strong B_1 – near-field space then N is zero symmetric.

2.12 Result: N is a strong B_1 – near-field space $\Leftrightarrow axa = xa \ \forall \ a, x \in N$.

SECTION 3: B_1 - NEAR-FIELD SPACES OVER REGULAR DELTA NEAR - RINGS

In this section, I discuss about a right near-field space N is said to be left bi-potent if $Na = Na^2 \ \forall \ a \in N$.

3.1 Definition: B_1 near-field space. A right near-field space N is said to be left nilpotent if $Na = Na^2 \ \forall \ a \in N$. Then N is a B_1 – near-field space if for every $a \in N$, there exists $x \in N^*$ such that $N\,ax = N\,xa$.

3.2 Example: Every constant near-field space is a B_1 – near-field space.

3.3 Example: The near-field space (Z_4, +,.) where (Z_4, +) is the group of integers modulo “4” and “.” is defined as follows (Scheme (4), p.407 of Gunter Pilz [4]).

.	0	1	2	3
0	0	0	0	0
1	0	0	1	0
2	0	0	3	0
3	0	0	2	0

This is a $B_{1\,-}$ near-field space over a regular δ-near-ring.

3.4 Theorem: Let N be a near-field space. Each of the following implies that N is a $B_{1\,-}$ near-field space over a regular δ-near-ring.

(i) N is a zero symmetric nil near-field space over a regular δ-near-ring.
(ii) N is a weak commutative.
(iii) N has identity “1”.
(iv) N is a near-field space over a regular δ-near-ring.

Proof: To prove (i): Let $a \in N$. if a = 0, then $\forall\, x \in N^*$, Nax = Nxa = N0 = {0}. If $a \in N^*$, since N is nil near-field space over a regular δ-near-ring, there exists a positive integer k such that $a^k = 0$. Put $x = a^{k-1} \neq 0$.

Now $Nax = Naa^{k-1} = Na^k = Na^{k-1}a = Nxa = N0 = \{0\}$, Thus N is a $B_{1\,-}$ near-field space over a regular δ-near-ring.

To prove (ii): Let $a \in N$. $\forall\, x \in N^*$, $y \in Nax \Rightarrow y = nax$ where $n \in N$. Since N is weak commutative, $y = nxa \in Nxa$. Therefore $Nax \subset Nxa$. Similarly we can show that $Nxa \subset Nax$ and (ii) follows.

To prove (iii): Follows by taking x = 1 in the definition 3.1.

To prove (iv): Follows from (iii).

This completes the proof of the theorem.

3.5 Theorem: Let N be a $B_{1\,-}$ near-field space over a regular δ-near-ring. If N is a strong $B_{1\,-}$ near-field space over a regular δ-near-ring without non-zero zero divisors then the following are true:

(i) Every non-zero N-sub near-field space over a regular δ-near-ring of N is a $B_{1\,-}$ near-field space over a regular δ-near-ring.
(ii) Every non-zero ideal of near-field space over a regular δ-near-ring N is an $B_{1\,-}$ near-field space over a regular δ-near-ring.

Proof: Since N is a strong $B_{1\,-}$ near-field space over a regular δ-near-ring, by result 2.11 N is zero symmetric near-field space and by result 2.12
$aba = ba \;\forall\, a, b, c \in N$ (1)

(i) Let M be an N- sub near-field space of N and let $m \in M$. If m = 0 then $\forall\, x \in N^*$, Nmx = N0 = {0} (Since N is zero symmetric near-field space) = N xm. For $m \neq 0$, since N is a $B_{1\,-}$ near-field space over a regular δ-near-ring, $\exists\, y \in N^*$ such that N my = N ym (2)

Let n = ym.
$\Rightarrow n \in M^*$. Now $Mmn = Mm(ym) \subset Nm(ym) \subset (Nmy)m = (Nym)m$ [by (2)]
$\Rightarrow$ $= N(mym)m$ [by (1)]
$\Rightarrow$ $= Nm(ym)m \subset M(ym)m = Mnm$.
i.e., $Mmn \subset Mnm$ (3)

In a similar fashion we get $Mnm \subset Mmn$ (4)
(3) and (4) $\Rightarrow$ Mmn = Mnm.
Consequently, M is a $B_{1\,-}$ near-field space over a regular δ-near-ring.
(ii) Since N is zero symmetric near-field space, by result 2.9 demands that every ideal of near-field space is an N-sub near-field space of Nand now (ii) follows from (i).
This completes the proof of the theorem.

3.6 Proposition: Let N be a B_{1-} near-field space over a regular δ-near-ring. Then for every a ∈ N, there exists x ∈ N^* such that the following are true.

(i) ∃ n ∈ N ∋ axa = nax.
(ii) Nax ⊂ Na ∩ Nx.
(iii) If N is a Boolean near-field space over a regular δ-near-ring then Naxa = Nxa.
(iv) If N is a strong B_{1-} near-field space over a regular δ-near-ring then ∃ n ∈ N ∋ xa = nax.

Proof: Let a ∈ N.
Since N is a B_{1-} near-field space over a regular δ-near-ring, ∃ x ∈ N^* ∋ Nax = Nxa (1)

(i) Since axa ∈ Nxa, by using (1) we get axa = nax for some n ∈ N and (i) follows.
(ii) (1) ⇒ Nax = Nxa ⊂ Na. Obviously, Nax ⊂ Nx.
∴ Nax ⊂ Na ∩ Nx.
(iii) When N is Boolean near-field space over a regular δ-near-ring, Nxa = Nxa^2 = (Nxa)a = (Nax)a [by (1)] and (iii) follows.
(iv) Since N is a strong B_{1-} near-field space over a regular δ-near-ring, the result follows from result 2.12 and (i). This completes the proof of proposition.

SECTION 4: STRONG B_1 - NEAR-FIELD SPACES OVER REGULAR DELTA NEAR-RINGS

In this section, By generalizing the concept of B_{1-} near-field space over a regular δ-near-ring, Dr. N.V. Nagendram introduce strong B_{1-} near-field space over a regular δ-near-ring. Also study some of its important properties, obtain a simple characterization under a condition and also a structure theorem.

4.1 Definition: strong B_1 near-field space. For any sub near-field space A of near-field space N, we denote by A^* the set of all non-zero elements of A. In particular N^*=N–{0}. N is called a strong B_1 near-field space if N^* =N_{B1}(a) ∀ a∈N where N_{B1}(a) = {x ∈ N^* / axa = xa}.

In other words, we say that N is a strong B_{1-} near-field space over a regular δ-near-ring if Nab = Nba ∀ a, b ∈ N.

4.2 Example: Every commutative near-field space over a regular δ-near-ring is a strong B_{1-} near-field space over a regular δ-near-ring.

4.3 Example: Consider the near-field space (N, +, .) where (N, +) is the Klein's four group {0, a, b, c} and "." Is defined as follows (scheme p.408 Gunter Pilz[4])

.	0	a	b	c
0	0	0	0	0
a	a	a	a	a
b	0	a	b	c
c	a	0	c	b

This is a strong B_{1-} near-field space over a regular δ-near-ring.

4.4 Proposition: Every strong B_{1-} near-field space over a regular δ-near-ring is a B_{1-} near-field space over a regular δ-near-ring.

Proof: Obvious.

4.5 Note: Converse of proposition 4.4 is not valid. For example we consider the near-field space (N, +, .) where (N, +) is the Klein's four group {0, a, b, c} and "." Is defined as follows (Scheme (14), p.408 of Gunter Pilz [4])

.	0	a	b	c
0	0	0	0	0
a	a	a	a	a
b	0	a	b	c
c	a	0	c	b

This is a B_{1-} near-field space over a regular δ-near-ring. But it is not a strong B_{1-} near-field space over a regular δ-near-ring since, N ac ≠ N ca.

4.6 Note: It is clear that the property of N being strong $B_{1\,-}$near-field space over a regular δ-near-ring is preserved under near-field homo-morphisms.

Consequently, the following theorem can be deduced.

4.7 Theorem: Every strong $B_{1\,-}$ near-field space over a regular δ-near-ring is isomorphic to a sub direct product of sub directly irreducible strong $B_{1\,-}$ near-field space over a regular δ-near-rings.

Proof: by theorem 1.62, p.26 of Gunter Pilz [4] we get, N is isomorphic to a sub direct product of sub directly irreducible near-fields N_i's, say, and each N_i is a homomorphic image of N under the usual projection map π_i. The desired result now follows from note 4.6. This completes the proof of the theorem.

4.8 Lemma: If N is a strong $B_{1\,-}$ near-field space over a regular δ-near-ring $\Leftrightarrow \forall$ a, b, c $\in$ N, $\exists$ n $\in$ N $\ni$ abc = ncb.

Proof: $\Rightarrow$(If part): Let a, b, c $\in$ N. Now abc $\in$ N bc.

Since N is a strong $B_{1\,-}$ near-field space over a regular δ-near-ring, N bc = N cb.
$\therefore$ abc $\in$ N cb.
$\Rightarrow$ abc = ncb for some n $\in$ N.

$\Leftarrow$(IFF Part): Let a, b, c $\in$ N.

Now abc $\in$ N bc.
$\exists$ n $\in$ N $\ni$ abc = ncb $\in$ N cb.
$\therefore$ N bc $\subset$ N cb.

In similar manner we get N cb$\subset$N bc. Thus N is a strong $B_{1\,-}$ near-field space over a regular δ-near-ring. This completes the proof of the lemma.

4.9 Theorem: Let N be a strong $B_{1\,-}$ near-field space over a regular δ-near-ring. If N is regular then we have the following:

(i) $\forall$ a $\in$ N, $\exists$ x $\in$ N such that $a = a^2x$.
(ii) N has no non-zero nilpotent elements.
(iii) Any two principal N-sub near-field spaces of N commute with each other.
(iv) N is a P_1 - near-field space over a regular δ-near-ring.
(v) N is left bi-potent.

Proof: Obvious.

4.10 Corollary: Let N be a zero symmetric strong $B_{1\,-}$ near-field space over a regular δ-near-ring. If N is regular near-field space then N is the sub-direct product of integral near-field spaces over a regular δ-near-ring.

4.11 Theorem: Let N be a strong $B_{1\,-}$ near-field space over a regular δ-near-ring. If N is Boolean near-field space over a regular δ-near-ring then the following are true:

(i) NaNb = Nab $\forall$ a, b $\in$ N.
(ii) All principal N-sub near-field spaces of N commute with one another.
(iii) Every ideal of N is a strong near-field space over a regular δ-near-ring.
(iv) Every N-sub near-field space of N is a strong near-field space over a regular δ-near-ring.
(v) Every N – sub near-field space of N is an invariant N-sub near-field space of N over a regular δ-near-ring.

Proof: Obvious.

Here the discussion with the following characterization of strong near-field space over a regular δ-near-ring.

4.12 Theorem: Let N be a Boolean B_1- near-field space over a regular δ-near-ring. Then N is a strong B_1- near-field space over a regular δ-near-ring $\Leftrightarrow$ Na $\cap$ Nb = Nab $\forall$ a, b $\in$ N.

Proof: $\Rightarrow$(If Part) Let y $\in$ Na $\cap$ Nb.
$\therefore$ y = na = n′b for some n, n′ $\in$ N.

Now by lemma 4.8, $\exists$ z $\in$ N $\ni$ y^2 = (na)(n′b) = (nan′)b = (zn′a)b = (zn′)ab $\in$ Nab.

Since, N is Boolean, this yields $y \in Nab$.

Thus $Na \cap Nb \subset Nab$ (1)

Since N is a strong B_1- near-field space over a regular δ-near-ring,
Nab = N ba.

But $N ba \subset Na$ and $N ab \subset N b$.

Hence, $N ab \subset Na \cap Nb$ (2)
(1), (2) ⇒ we get $Na \cap Nb = N ab$.

⇐(only IF Part): Let $a, b \in N$. now $N ab = Na \cap Nb = Nb \cap Na = Nba$. Thus N is a strong B_1- near-field space over a regular δ-near-ring.

This completed the proof of the theorem.

SECTION 5: CONCLUSION

Near-field space theory over regular delta near-rings under algebra of mathematics has many applications in the study of permutation groups, block schemes and projective geometry. Near-field spaces over regular delta near-rings provide a non-linear analogue to the development of Linear Algebra, combinatorial problems and useful for agricultural experiments. In this paper Dr. N.V. Nagendram presented the notion of B_1 - near-field spaces over regular delta near-rings and derived the properties and characterization of the strong B_1 - near-field spaces over regular delta near-rings.

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Source of support: Nil, Conflict of interest: None Declared