Γ-SEMI NORMAL SUB NEAR-FIELD SPACES
OF A Γ-NEAR-FIELD SPACE OVER NEAR-FIELD PART III

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ABSTRACT

In this paper, I Dr N V Nagendram as an author in depth study it makes me to study and introduce the Gamma-semi normal sub near-field spaces in Γ-near-field space over a near-field PART III, and also Dr. N V Nagendram investigate the related properties, results of generalization of a Gamma-semi normal sub near-field spaces in Γ-near-field space over a near-field.

Keywords: Γ-near-field space; Γ-Semi normal sub near-field space of Γ-near-field space; Semi near-field space of Γ-near-field space.


SECTION-1: INTRODUCTION

In this paper, Part III consisting important two sections I introduce the Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field, and Dr. N V Nagendram being an author investigate the related properties of generalization of and derived results on a Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field.

As a generalization of a Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field, introduced the notion of Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field, extended many classical notions of Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field. In this paper, I develop the algebraic theory of Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field.

The notion of a Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field is introduced and some examples are given. Further the terms; commutative Γ-semi normal sub near-field spaces in Γ-near-field space, quasi commutative Γ-semi normal sub near-field spaces in Γ-near-field space, normal Γ-semi normal sub near-field spaces in Γ-near-field space, left pseudo commutative Γ-semi normal sub near-field spaces in Γ-near-field space, right pseudo commutative Γ-semi normal sub near-field spaces in Γ-near-field space are introduced. It is proved that (1) if S is a commutative Γ-semi normal sub near-field spaces in Γ-near-field space then S is a quasi commutative Γ-semi normal sub near-field spaces in Γ-near-field space, (2) if S is a quasi commutative Γ-semi normal sub near-field spaces in Γ-near-field space then S is a normal Gamma-semi normal sub near-field spaces in Γ-near-field space, (3) if S is a commutative Γ-semi normal sub near-field spaces in Γ-near-field space, then S is both a left pseudo commutative and a right pseudo commutative Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field. Further the terms; left identity, right identity, identity, left zero, right zero, zero of a Gamma-semi normal sub near-field spaces in Γ-near-field space over a near-field are introduced. It is proved that if a is a left identity and b is a right identity of a Γ-semi normal sub near-field spaces in Γ-near-field space, then a = b. It is also proved that any Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field has at most one identity. It is proved that if a is a left zero and b is a right zero of a Γ-semi normal sub near-field spaces in Γ-near-field space, then a = b and also it is proved that any Γ-semi normal sub near-field spaces in Γ-near-field space over a near-field has at most one zero element.
SECTION-2: RESULTS ON SEMI NORMAL SUB NEAR-FIELD SPACES IN Γ-NEAR-FIELD SPACE OVER A NEAR-FIELD

In this section, we now introduce α-idempotent element and Γ-idempotent element in a Γ- semi sub near-field space. The terms α-idempotent, Γ-idempotent, strongly idempotent, mid unit, r-element, regular element, left regular element, right regular element, completely regular element, (α, β)-inverse of an element, semi simple element and intra regular element in a Γ-semi sub near-field space are introduced. Further the terms, idempotent Γ-semi sub near-field space and generalized commutative Γ-semi normal sub near-field space are introduced. It is proved that every generalized commutative Γ-semi normal sub near-field space is a left duo Γ-semi normal sub near-field space. It is proved that every Γ- idempotent element of a Γ-semi normal sub near-field space is regular near-field space. It is proved that every Γ- sub near-field space of a regular near-field space Γ-semi normal sub near-field space T is a regular near-field space Γ-semi normal sub near-field space of T. It is proved that a Γ-semi normal sub near-field space T is regular near-field space Γ-semi normal sub near-field space if and only if every principal Γ- sub near-field space is generated by an idempotent. Further it is also proved that, in a Γ-semi normal sub near-field space, α is a regular element if and only if α has an (α, β)-inverse. It is proved that, (1) if α is a completely regular element of a Γ-semi normal sub near-field space then α is both left regular and right regular near field space, (2) if α is a completely regular element of a Γ-semi normal sub near-field space T, then α is regular and semi simple near-field space, (3) if α is a left regular element of a Γ-semi sub near-field space T, then α is semi simple, (4) if α is a right regular element of a Γ-semi normal sub near-field space T, then α is semi simple, (5) if α is a regular element of a Γ-semi normal sub near-field space T, then α is semi simple and (6) if α is an intra regular element of a Γ-semi normal sub near-field space T, then α is semi simple. It is also proved that if α is an element of a duo Γ-semi normal sub near-field space, then (1) α is regular (2) α is left regular, (3) α is right regular, (4) α is intra regular, (5) α is semi simple, are equivalent.

Definition 2.1: An element a of Γ-semi sub near-field space S is said to be a α-idempotent provided \( a \alpha a = a \).

Note 2.2: The set of all α-idempotent elements in a Γ-semi sub near-field space S is denoted by \( E_\alpha \).

Definition 2.3: An element a of Γ-semi sub near-field space S is said to be an idempotent or Γ-idempotent if \( a \alpha a = a \) for all \( a \in \Gamma \).

Note 2.4: In a Γ-semi sub near-field space S, a is an idempotent iff a is an α-idempotent for all \( a \in \Gamma \).

Note 2.5: If an element a of Γ-semi sub near-field space S is an idempotent, then \( \alpha \Gamma a = a \).

We now introduce an idempotent Γ-semi sub near-field space and a strongly idempotent Γ-semi sub near-field space.

Definition 2.6: A Γ-semi sub near-field space S is said to be an idempotent Γ-semi sub near-field space provided every element of S is α–idempotent for some \( a \in \Gamma \).

Definition 2.7: A Γ-semi sub near-field space S is said to be a strongly idempotent Γ-semi sub near-field space provided every element in S is an idempotent.

We now introduce a special element which is known as mid unit in a Γ-semi sub near-field space.

Definition 2.8: An element a of Γ-semi sub near-field space S is said to be a mid unit provided \( x \Gamma a \Gamma y = x \Gamma y \) for all \( x, y \in S \).

Note 2.9: Identity of a Γ-semi sub near-field space S is a mid unit.

We now introduce an r-element in a Γ-semi sub near-field space and also a generalized commutative Γ-semi sub near-field space.

Definition 2.10: An element ‘a’ of Γ-semi sub near-field space S is said to be an r-element provided \( a \Gamma x = \delta \Gamma a \) for all \( s \in S \) and if \( x, y \in S \), then \( a \Gamma x \Gamma y = b \Gamma y \Gamma x \) for some \( b \in S \).

Definition 2.11: A Γ-semi sub near-field space S with identity 1 is said to be a generalized commutative Γ-semi sub near-field space provided 1 is an r-element in S.

Theorem 2.12: Every generalized commutative Γ-semi sub near-field space is a left duo Γ-semi sub near-field space.

Proof: Let S be a generalized commutative Γ-semi sub near-field space. Therefore 1 is an r-element.
Let A be a left $\Gamma$-sub near-field space of S. Let $x \in A$ and $s \in S$.

Now $x\Gamma_s = I\Gamma x \Gamma s = b\Gamma x (b\Gamma s) \Gamma x \subseteq A$. Therefore A is a $\Gamma$-sub near-field space of S.

Therefore S is a left duo $\Gamma$-semi sub near-field space.

As an author, I Dr N V Nagendram now introduces a regular element in a $\Gamma$-semi sub near-field space and regular $\Gamma$-semi sub near-field space.

Definition 2.13: An element $a$ of a $\Gamma$-semi sub near-field space S is said to be regular $\Gamma$-semi sub near-field space provided $a = a\alpha \beta a$, for some $x \in S$ and $\alpha, \beta \in \Gamma$. i.e., $a \in a\Gamma S \Gamma a$.

Definition 2.14: A $\Gamma$-semi sub near-field space S is said to be a regular $\Gamma$-semi sub near-field space provided every element is regular.

Example 2.15: Let S be the set of 3×2 matrices and $\Gamma$ be a set of some 2×3 matrices over of field. Then S is a regular $\Gamma$-semi sub near-field space.

Verification: Let $A \in S$, where $A = \begin{bmatrix} a & b \\ c & d \\ e & f \end{bmatrix}$

Then we chose $B \in \Gamma$ according to the following cases such that $ABA = A$.

Case-1: When the sub matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is non-singular, then $ad - bc \neq 0$.

$e, f$ may both be 0 or one of them is 0 or both of them are non-zero.

then $B = \begin{bmatrix} d & -b \\ ad - bc & ad - bc \\ ad - bc & ad - bc \end{bmatrix}$ and we find $ABA = A$.

Case-2: $af - be \neq 0$. Then $B = \begin{bmatrix} f & 0 & -b \\ af - be & af - be & 0 \\ af - be & 0 & a \end{bmatrix}$ and $ABA = A$.

Case-3: $cf - de \neq 0$. Then $B = \begin{bmatrix} f & 0 & -d \\ cf - de & cf - de & 0 \\ cf - de & 0 & cf - de \end{bmatrix}$ and $ABA = A$.

Case-4: When the sub matrices are singular, then either \[
\begin{cases}
ad - bc = 0 \\
cf - be = 0
\end{cases}
\]
or \[
\begin{cases}
ad - bc = 0 \\
af - de = 0
\end{cases}
\]

If all the elements of A are 0, then the case is trivial. Next we consider at least one of the elements of A is non-zero, say $a_{ij} \neq 0$, $i = 1, 2, 3$ and $j = 1, 2$. Then we take the $b_{ij}$th element of B as $(a_{ij})^{-1}$ and the other elements of B are zero and we find that $ABA = A$. Thus A is regular. Hence S is a regular $\Gamma$-semi sub near-field space.

Theorem 2.16: Every $\alpha$-idempotent element in a $\Gamma$-semi sub near-field space is regular $\Gamma$-semi sub near-field space.

Proof: Let $a$ be an $\alpha$-idempotent element in a $\Gamma$-semi sub near-field space S. Then $a = a\alpha a$ for some $\alpha \in \Gamma$.

Hence $a = a\alpha a\alpha a$. Therefore a is a regular element.
Example 2.17: Let $S = \{0, a, b\}$ and $\Gamma$ be any nonempty set. If we define a binary operation on $S$ as the following Cayley’s table, then $S$ is a $\Gamma$- semi sub near-field space.

\[
\begin{array}{ccc}
. & 0 & a & b \\
0 & 0 & 0 & 0 \\
a & 0 & a & a \\
b & 0 & b & b \\
\end{array}
\]

Define a mapping from $S \times \Gamma \times S$ to $S$ as $a\alpha b = ab$ for all $a, b \in S$ and $\alpha \in \Gamma$. Then $S$ is regular $\Gamma$- semi sub near-field space.

We now introduce a regular $\Gamma$-ideal of a $\Gamma$-semigroup.

Definition 2.18: A $\Gamma$-sub near-field space $A$ of a $\Gamma$- semi sub near-field space $S$ is said to be regular $\Gamma$- semi sub near-field space if every element of $A$ is regular in $A$.

Theorem 2.19: Every $\Gamma$-sub near-field space of a regular $\Gamma$- semi sub near-field space $S$ is a regular $\Gamma$-sub near-field space of $S$.

Proof: Let $A$ be a $\Gamma$-sub near-field space of $S$ and $a \in A$. Then $a \in S$ and hence $a$ is regular $\Gamma$- semi sub near-field space in $S$.

Therefore $a = a\alpha b\beta a$ where $b \in S$ and $\alpha, \beta \in \Gamma$.

Hence $a = a\alpha b\beta a = (a\alpha b\beta a)(a\alpha b\beta a) = a\alpha((b\beta a)ab)b\beta a$.

Let $b_1 = (b\beta a)ab \in S\Gamma A\Gamma S \subseteq A$.

Now $a\alpha b\beta a = a\alpha((b\beta a)ab)b\beta a = a$.

Therefore $a$ is regular $\Gamma$- semi sub near-field space in $A$ and hence $A$ is a regular $\Gamma$-sub near-field space.

This completes the proof of the theorem.

Theorem 2.20: If a $\Gamma$- semi sub near-field space $S$ is a regular $\Gamma$- semi sub near-field space then every principal $\Gamma$-sub near-field space is generated by a $\beta$-idempotent for some $\beta \in \Gamma$.

Proof: Suppose that $S$ is a regular $\Gamma$- semi sub near-field space. Let $< a >$ be a principal $\Gamma$-sub near-field space of $S$.

Since $S$ is a regular $\Gamma$- semi sub near-field space, there exists $x \in S$, $\alpha, \beta \in \Gamma$ such that $a = a\alpha x\beta a$.

Let $a\alpha x = e$. Then $e\beta e = (a\alpha x)\beta (a\alpha x) = (a\alpha x\beta a)\alpha x = a\alpha x = e$.

Thus $e$ is a $\beta$-idempotent element of $S$.

Now $a = a\alpha x\beta a = e\beta a \in < e > \Rightarrow < a > \subseteq < e >$.

Also $e = a\alpha x \in < a > \Rightarrow < e > \subseteq < a >$.

Therefore $< a > = < e >$ and hence every principal $\Gamma$-sub near-field space is generated by an idempotent.

We now introduce left regular element, right regular element, completely regular element in a $\Gamma$-semi sub near-field space and completely regular $\Gamma$- semi sub near-field space.

Definition 2.21: An element $a$ of a $\Gamma$- semi sub near-field space $S$ is said to be left regular $\Gamma$-semi sub near-field space provided $a = a\alpha x\beta x$, for some $x \in S$ and $\alpha, \beta \in \Gamma$: i.e, $a \in a\Gamma a\Gamma S$.

Definition 2.22: An element $a$ of a $\Gamma$- semi sub near-field space $S$ is said to be right regular $\Gamma$-semi sub near-field space provided $a = x\alpha a\beta a$, for some $x \in S$ and $\alpha, \beta \in \Gamma$. i.e, $a \in \Gamma a\Gamma S$.
Define 2.23: An element \( a \) of a \( \Gamma \)-semi sub near-field space \( S \) is said to be completely regular \( \Gamma \)-semi sub near-field space provided, there exists an element \( x \in S \) such that \( a = a\alpha\beta\gamma \) for some \( \alpha, \beta \in \Gamma \) and \( a\alpha\gamma = x\beta\gamma \) i.e., \( a \in \alpha \Gamma \times \Gamma \alpha \) and \( a\Gamma x = x\Gamma a \).

Definition 2.24: A \( \Gamma \)-semi sub near-field space \( S \) is said to be completely regular \( \Gamma \)-semi sub near-field space provided every element of \( S \) is completely regular.

We now introduce \((\alpha, \beta)\)-inverse of an element in a \( \Gamma \)-semi sub near-field space.

Definition 2.25: Let \( S \) be a \( \Gamma \)-semi sub near-field space, \( a \in S \) and \( \alpha, \beta \in \Gamma \). An element \( b \in S \) is said to be an \((\alpha, \beta)\)-inverse of \( a \) if \( a = a\alpha\beta\gamma \) and \( b = b\alpha\beta\gamma \).

Theorem 2.26: Let \( S \) be a \( \Gamma \)-semi sub near-field space and \( a \in S \). Then \( a \) is a regular element if and only if \( a \) has an \((\alpha, \beta)\)-inverse.

Proof: Suppose that \( a \) is a regular element. Then \( a = a\alpha\beta\gamma \) for some \( \beta \in S \) and \( \alpha, \beta \in \Gamma \).

Let \( x = b\beta\alpha\beta \in S \).

Now \( a\alpha\beta\gamma = a\alpha\beta\gamma = (a\alpha\beta\gamma)\alpha\beta\gamma = a\alpha\beta\gamma = a \) and \( x\beta\alpha\gamma = (b\beta\alpha\beta)\alpha\beta\gamma = b\beta\alpha\beta\gamma \alpha \beta\gamma \alpha\beta\gamma = b\beta\alpha\beta\gamma \alpha\beta\gamma = b\beta\alpha\beta\gamma = x\beta\alpha\beta \).

Therefore \( x = b\beta\alpha\beta \) is the \((\alpha, \beta)\)-inverse of \( a \).

Conversely suppose that \( b \) is an \((\alpha, \beta)\)-inverse of \( a \).

Then \( a = a\alpha\beta\gamma \) and \( b = b\beta\alpha\beta \). Therefore \( a = a\alpha\beta\gamma \) and hence \( a \) is regular.

This completes the proof of the theorem.

We now introduce a semi simple element of a \( \Gamma \)-semi sub near-field space and a semi simple \( \Gamma \)-semi sub near-field space.

Definition 2.27: An element \( a \) of \( \Gamma \)-semi sub near-field space \( S \) is said to be semi simple provided \( a \in \langle a \rangle \), that is, \( \langle a \rangle \) is a semigroup.

Definition 2.28: A \( \Gamma \)-semi sub near-field space \( S \) is said to be semi simple \( \Gamma \)-semi sub near-field space provided every element of \( S \) is a semi simple element.

We now introduce an intra regular element of a \( \Gamma \)-semi sub near-field space.

Definition 2.29: An element \( a \) of a \( \Gamma \)-semi sub near-field space \( S \) is said to be intra regular provided \( a = xa\beta\gamma y \) for some \( x, y \in S \) and \( \alpha, \beta, \gamma \in \Gamma \).

Example 2.30: The \( \Gamma \)-semi sub near-field space \( S = \{0, a, b\} \) and \( \Gamma \) be any nonempty set. If we define a binary operation on \( S \) as the following Cayley’s table, then \( S \) is a \( \Gamma \)-semi sub near-field space.

\[
\begin{array}{ccc}
  & 0 & a & b \\
 0 & 0 & 0 & 0 \\
a & 0 & a & a \\
b & 0 & b & b \\
\end{array}
\]

Define a mapping from \( \Gamma \times \times S \) to \( S \) as \( a\beta b = ab \) for all \( a, b \in S \) and \( \alpha \in \Gamma \). Then \( S \) is regular \( \Gamma \)-semi sub near-field space is an intra regular \( \Gamma \)-semigroup.

Theorem 2.31: If ‘a’ is a completely regular element of a \( \Gamma \)-semi sub near-field space \( S \), then \( a \) is regular and semi simple.

Proof: Since \( a \) is a completely regular element in the \( \Gamma \)-semi sub near-field space \( S \), \( a = a\alpha\beta\gamma \) for some \( \alpha, \beta \in \Gamma \) and \( x \in S \). Therefore \( a \) is regular.

Now \( a = a\alpha\beta\gamma \in \alpha \Gamma \times \Gamma \alpha \subseteq \langle a \rangle \Gamma \subseteq \langle a \rangle \). Therefore \( a \) is semi simple. This completes the proof of the theorem.
Theorem 2.32: If ‘a’ is a completely regular element of a $\Gamma$-semi sub near-field space $S$, then a is both a left regular element and a right regular element.

Proof: Suppose that $a$ is completely regular. Then $a \in a\Gamma S\Gamma a$ and $a\Gamma S = S\Gamma a$.

Now $a \in a\Gamma S\Gamma a = a\Gamma aS$. Therefore $a$ is left regular. Also $a \in a\Gamma S\Gamma a = S\Gamma a\Gamma a$. Therefore $a$ is right regular. This completes the proof of the theorem.

Theorem 2.33: If ‘a’ is a left regular element of a $\Gamma$-semi sub near-field space $S$, then $a$ is semi simple.

Proof: Suppose that $a$ is left regular. Then $a \in a\Gamma a\Gamma x$ and hence $a \in < a > \Gamma < a >$. Therefore $a$ is semi simple. This completes the proof of the theorem.

Theorem 2.34: If ‘a’ is a right regular element of a $\Gamma$-semi sub near-field space $S$, then $a$ is semi simple.

Proof: Suppose that $a$ is right regular. Then $a \in a\Gamma a\Gamma x$ and hence $a \in < a > \Gamma < a >$. Therefore $a$ is semi simple. This completes the proof of the theorem.

Theorem 2.35: If ‘a’ is a regular element of a $\Gamma$-semigroup $S$, then $a$ is semi simple.

Proof: Suppose that $a$ is regular element of $\Gamma$-semigroup $S$. Then $a = a\alpha\beta\alpha a\beta$, for some $x \in S$, $\alpha, \beta \in \Gamma$ and hence $a \in < a > \Gamma < a >$. Therefore $a$ is semi simple. This completes the proof of the theorem.

Theorem 2.36: If ‘a’ is a intra regular element of a $\Gamma$-semi sub near-field space $S$, then $a$ is semi simple.

Proof: Suppose that $a$ is intra regular. Then $a \in x\Gamma a\Gamma a\Gamma y$ for $x, y \in S$ and hence $a \in < a > \Gamma < a >$ Therefore $a$ is semi simple. This completes the proof of the theorem.

Theorem 2.37: If $S$ is a duo $\Gamma$-semi sub near-field space, then the following are equivalent for any element $a \in S$.

1) $a$ is regular.
2) $a$ is left regular.
3) $a$ is right regular.
4) $a$ is intra regular.
5) $a$ is semisimple.

Proof: This can proved by cyclic method of proof. Since $S$ is duo $\Gamma$-semi sub near-field space, $a\Gamma S_1 = S_1\Gamma a$.

We have $a\Gamma S_1\Gamma a = a\Gamma a\Gamma S_1 = S_1\Gamma a\Gamma a = < a > \Gamma < a >$.

(1) $\Rightarrow$ (2): Suppose that $a$ is regular. Then $a = a\alpha\beta\alpha a\beta$ for some $x \in S$ and $\alpha, \beta \in \Gamma$.

Therefore $a \in a\Gamma S_1\Gamma a = a\Gamma a\Gamma S_1 \Rightarrow a = a\alpha a\beta x\beta$ for some $y \in S_1, \gamma, \delta \in \Gamma$.

Therefore $a$ is left regular.

(2) $\Rightarrow$ (3): Suppose that $a$ is left regular. Then $a = a\alpha\beta\alpha a\beta b$ for some $x \in S$ and $\alpha, \beta \in \Gamma$.

Therefore $a \in a\Gamma a\Gamma S_1 = S_1\Gamma a\Gamma a \Rightarrow a = x\alpha a\beta\alpha a\gamma$ for some $y \in S_1, \gamma, \delta \in \Gamma$.

Therefore $a$ is right regular.

(3) $\Rightarrow$ (4): Suppose that $a$ is right regular. Then for some $x \in S, \alpha, \beta \in \Gamma; a = x\alpha a\beta b$. Therefore $a \in S_1\Gamma a\Gamma a = < a > \Gamma a \Rightarrow a = x\alpha a\beta\alpha\gamma y$ for some $x, y \in S_1$ and $\alpha, \beta, \gamma \in \Gamma$. Therefore $a$ is intra regular.

(4) $\Rightarrow$ (5): Suppose that $a$ is intra regular. Then $a = x\alpha a\beta\alpha\gamma y \forall x, y \in S_1$ and $\alpha, \beta, \gamma \in \Gamma$. Therefore, $a \in < a > \Gamma < a >$.

Therefore $a$ is semi simple.

(5) $\Rightarrow$ (1): Suppose that $a$ is semi simple. Then $a \in < a > \Gamma < a > = a\Gamma S_1\Gamma a$

$\Rightarrow a \in a\alpha\beta\alpha a\beta b$ for some $x \in S$ and $\alpha, \beta \in \Gamma$.

Therefore $a$ is a regular element.

This completes the proof of the theorem.

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