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A FLAVOUR OF NON COMMUTATIVE ADVANCE ALGBRA PART - I

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ABSTRACT

In this paper we are in a position to characterize those earlier defined Nagendram near-field spaces with a semi-simple classical near-field space over a near-field of left quotients. As a bonus we also characterize near-fields with simple artenian classical near-field space of left quotients. Those characterizations are due to Dr N V Nagendram who published them in a series of papers in the academic year of 2019 - '2020.

We begin with some standard terminology A sub near-field space Q of a near-field space N is said to be a left order in Q in case Q is a near-field space of left quotients for N. Thus our goal for this section is to characterize those near-field spaces N that are left order to semi-simple (or simple Artinian) near-field spaces. Of course, N has a classical near-field space of left quotients if and only if N is left Ore. So for openers we want to find out what we can about left Ore near-field spaces that are left orders in semi-simple near-field spaces.

This is the first part of a short two-part write-up on non commutative advanced algebra.

SECTION -1: INTRODUCTION ON NON-COMMUTATIVE ADVANCED NEAR-FIELD SPACES.

1.1 A glimpse of the game plan. Non commutative advanced near-field spaces are multi-headed monsters – there are so many facts to them that in general it is hard where and how to get a handle on advanced near-field spaces over a near-field. On the one hand, we have this huge monstrous near-field space over a near-field and we want to study it globally, on the other hand we want to get friendly with the individual elements i.e. sub near-field spaces in the near-field space over a near-field. These approaches are not wholly contradictory, because the addition and multiplication ordinary operations of the near-field space over near-field ensure that every element affects every other element.

1.2 The Nagendram Near-field space theorems.

1.2.1 Definition. Left Ore Nagendram near-field space. A sub near-field space Q of a near-field space N is said to be a left ore Nagendram near-field space in Q in case Q is a near-field space of left quotients for N.

1.2.2 Lemma. Let n be a left Ore Nagendram near-field space with $Q_{\mathbf{cl}}$ semi simple Nagendram Near-field space. Then $O = \varepsilon$ and $_{\mathbf{n}}Q_{\mathbf{cl}} = {}_{\mathbf{N}}E\ (N)$, so in particular, $Q_{\mathbf{max}} = Q_{\mathbf{cl}}$.

Proof: It will suffice to prove that $\varepsilon \subseteq O$. So let $I \subseteq N$. Thus $_N I \leq {}_N Q_{\mathbf{cl}}$. we claim that $Q_{\mathbf{cl}} I \leq Q_{\mathbf{cl}}$. For if not, then $\exists$ some $0 \neq q \in Q_{\mathbf{cl}}$ with $Q_{\mathbf{cl}}\, q \cap Q_{\mathbf{cl}}\ I = 0$. But there is some $d \in \Delta$ with $dq \in N$, and so $Ndq \cap I \neq 0$, a contradiction. Thus, as claimed, $Q_{\mathbf{cl}}\ I \leq Q_{\mathbf{cl}}$; but $Q_{\mathbf{cl}}$ is semi simple Nagendram Near-field space, so $Q_{\mathbf{cl}}\ I = Q_{\mathbf{cl}}$. Therefore, there are $q_1, q_2, \ldots, q_n \in Q_{\mathbf{cl}}$ and $a_1, a_2, \ldots., a_n \in I$ with $1 = q_1 a_1 + \ldots\ldots\ldots + q_n a_n$.
Then by known lemma, stated as E be a left ore Nagendram Near-field space. If $d_1^{-1} a_1, \ldots.., d_n^{-1} a_n \in Q_{\mathbf{cl}}$, then there exist $d \in \Delta$ and $b_1, b_2, \ldots., b_n \in N$ with $di^{-1} a_i = d^{-1} b_i$ where $\forall\ i = 1,2,\ldots,n$.

There is some $d \in \Delta$ and $a \in I$ with $1 = d^{-1} a$. So $d = d(d^{-1} a) = a \in I$. Thus $\varepsilon \subseteq O$. Hence, this completes the proof of the lemma.

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1.2.3 Note: This lemma means that if N is a left Ore Nagendram Near-field space in a semi simple Nagendram Near-field space, then its maximal Nagendram Near-field space of left quotients is semi simple Nagendram Near-field space, so that E(N) and hence N must be non-singular i.e. N is left non-singular $\Leftrightarrow$ E(N) is left non-singular $\Leftrightarrow$ ε is a faithful topology for N $\Leftrightarrow$ ε is D.

1.2.4 Note: A left self injective von Neumann regular near-field space N is semi simple Nagendram Near-field space if and only if it has finite Nagendram rank.

With the above 1.2.3 and 1.2.4 we have the desired necessary conditions for a Near-field space N to be a left Ore in a semi simple Nagendram near-field space.

1.2.5 Note: Let N be a left semiprime Nagendram Near-field space then if N_N has finite Nagendram rank, then N is also right semiprime Nagendram Near-field space.

1.2.6 Note: If N and M are Nagendram equivalent Near-field spaces and if N satisfies the Ascending Chain Condition A.C.C. for left annihilators then S satisfies the A.C.C. for left annihilators.

1.2.7 Note: Let N and M are Nagendram equivalent Near-field spaces (i) if N is a semiprime left Nagendram Near-field space, then so is M.(ii) If N is a semiprime left Nagendram Near-field space then $Q_{c\ l}$ **(N) and** $Q_{c\ l}$ **(M)** are Nagendram equivalent Near-field spaces.

1.2.8 Note: If N is a left non-singular Nagendram Near-field space of finite Nagendram rank, then N satisfies the A.C.C. and D.C.C. on left Annihilators.

SECTION-2: MAIN RESULTS ON NAGENDRAM NEAR-FIELD SPACE THEOREMS

In this section, we study and derive main results on Nagendram Near-field space theorems.

2.1 Proposition: If N is a left Ore Nagendram Near-field space in a semi simple Nagendram Near-field space, then N is semiprime Nagendram Near-field space of finite left Nagendram rank that satisfies the A.C.C. on left Annihilators.

Proof: by lemma 1.2.2 and Note 1.2.7 N is non-singular and by Note 1.2.8 N satisfies the A.C.C. on left Annihilators. So it will suffice to show that N is semiprime Nagendram Near-field space. Suppose that aNa = 0 for some a $\in$ N. We claim that $n_N(NaN) \leq {}_N N$. Indeed. For every $0 \neq x \in N$, we have $NaNx \leq n_N(NaN) \cap Nx$. So if $n_N(NaN) \cap Nx = 0$, then NaNx = 0 and $x \in n_N(NaN) \cap Nx$, a contradiction. So $n_N(NaN) \subseteq {}_N N$. But by lemma 1.2.2, ε = O so there is some $d \in n_N(NaN) \cap \Delta$. So ad = 0 and hence a = 0 so N semiprime Nagendram Near-field space. This completes the proof of the proposition.

2.2. Note: A near-field space N is left Nagendram Near-field space in case it has finite left Nagendram rank and satisfies the A.C.C. on left Annihilators of Nagendram Near-field spaces over a near-field. So proposition 2.1 states that if N is a left Ore Nagendram Near-field space in a semi-simple Nagendram Near-field space, then N is a semiprime left Nagendram Near-field space. The icing on the cake is that the converse is true.

2.3 Lemma: If N is semiprime left Nagendram Near-field space then N is left non-singular.

Proof: Let $Z = Z(\,{}_N N\,)$ be the left singular ideal of N. Since N is semiprime. It will suffice to prove that Z is nilpotent. For every N, N is semiprime $\Leftrightarrow$ N(N) = 0 $\Leftrightarrow$ $I^2 = 0$ implies I = 0 for every left (or right two sided) ideal I of N $\Leftrightarrow$ aNa = 0 implies a = 0 $\Leftrightarrow$ s no non zero nilpotent left (or right two sided) ideals $\Leftrightarrow$ N is semiprime. But we do have $Z \geq Z^2 \geq Z^3 \geq \ldots.. \geq Z^n$, ...so that $I_N(Z) \leq I_N(Z^2) \leq I_N(Z^3) \leq$ ....Thus, since N satisfies the A. C. C. (Ascending Chain Condition) on left annihilators. $I_N(Z^{n+1}) = I_N(Z^n)$ for some natural number n belongs to set of naturals. We claim that $I_N(Z^n) = N$.

If not then the set $\{ I_N(x) : x \in N \setminus I_N(Z^n) \}$ of left annihilators has a maximal element say $I_N(x)$. Let $b \in Z$, that $I_N(b) \leq N$. But then there is some $0 \neq sx \in I_N(b)$, so then $s \in I_N(xb) \setminus I_N(x)$ then by the maximality of $I_N(x)$ this means that $xb \in I_N(Z^n)$ or that $x \in I_N(bZ^n)$. Since, this true for every $b \in Z$ we conclude that $x \in I_N(Z \,.\, Z^n) = I_N(Z^{n+1}) = I_N(Z^n)$, a contradiction. Thus $I_N(Z^n) = N$ and $Z^n = 0$. This completes the proof of the lemma.

2.4 Lemma: If N is semiprime left Nagendram Near-field space over a Near-field then O = ε i.e, if N is semiprime left Nagendram Near-field space, then a left sub semiprime Nagendram Near-field space I of N is essential if and only if I contains a non-zero divisor.

Proof: Is obvious.

2.5 Theorem: [Nagendram] A Nagendram Near-field space over a Near-field N is a left Ore in a semi-simple Nagendram Near-field space iff N is semiprime left Nagendram Near-field space over a Near-field.

Proof: The necessary is [2.1 Proposition] proved. Conversely, if N is semiprime left Nagendram Near-field space over a Near-field, then N is left non-singular [2.2 Lemma]. So by known theorem, we have for left non-singular Nagendram Near-field space N, its maximal Nagendram Near-field space Q_{max} say of left quotients ls semi-simple if and only if N has finite left Nagendram rank. Hence Q_{max} is semi simple. But, finally, by lemma 2.4 $Q_{c\,l} = Q_{max}$ and N is left Ore Nagendram Near-field space in the semi simple Nagendram Near-field space over a Near-field $Q_{c\,l} = Q_{max.}$ This completes the proof of the theorem.

2.6 Note: Now we specialize theis to characterize the Nagendram Near-field spaces that are left ore Nagendram Near-field space in simple artinian near-field spaces of a near-field over a near-ring.

2.7 Theorem: [Nagendram] A Nagendram Near-field space over a Near-field N is a left Ore Nagendram Near-field space in simple artinian near-field space if and only if (IFF) N is a prime left Nagendram Near-field space over a Near-field.

Proof: In either case by Theorem 2.5, N is a left Ore Nagendram Near-field space over a Near-field in a semi-simple Nagendram Near-field space $Q = Q_{c\,l}$, so it will suffice to prove that Q is simple if and only if (IFF) N is prime Nagendram Near-field space over a Near-field.

So suppose that $Q = Q_{c\,l}$ is simple Nagendram Near-field space and suppose that a, b $\in$ N with the property $aNb = 0$ and $b \neq 0$. Then by the simplicity of Q, we have $QbQ = Q$. So there exist $\mathbf{q_i}, \mathbf{q_i}^{|} \in Q$ with $1 = \sum^{n}_{i=1} q_{i,}bq_i^{|}$ there exists $d \in \Delta$ and $a_i \in N$ with $q_i = d^{-1} a_i$ for i = 1,2,3,..., n. Thus, $d = d.1 = \sum^{n}_{i=1} a_{i,}bq_i^{|}$ and so $aNd = \sum^{n}_{i=1} aNa_{i,}bq_i^{|} \subseteq aNbQ = 0$.

But $d \in \Delta$, so $aN = 0$ and $a = 0$. Thus N is prime Nagendram Near-field space.

Conversely, suppose that $Q = Q_{c\,l}$ is not simple Nagendram Near-field space. Then by known theorem, there exist non-zero central idempotent e, $f \in Q$ with $ef = 0$ then there exist some $d \in \Delta$ and $e_0, f_o \in N$ with $e = d^{-1} e_0$ and $f = d^{-1} f_0$. Then $e_0 \neq 0$, $f_o \neq 0$, but $Ne_0 N f_o = NdeNfd = 0$ so that N is not prime Nagendram Near-field space. This completes the proof of the theorem.

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