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Results on Homomorphism of a Vague Γ-Nearring

S Ragamayi, Y Bhargavi, N Konda Reddy

***Abstract:** In this article, we originate and inspect the idea of homomorphism of a Vague Γ- NR and prove that the vague pre-Homomorphic-image and Homomorphic-image of a VΓ − NR of M is also a Vague Γ- NR of M. Also we introduce Vague characteristic-set. We established one-one correspondence between vague characteristic Γ- Nearring of M and crisp characteristic Γ − NR of M.*

***Keywords:** Vague characteristic set, Vague set, Vague Γ-NR, Homomorphism of a vague Γ-NR.*

I. INTRODUCTION

The theory of fuzzy Γ-NRs has been introduced and developed by Bh.Satyanarayana[1] and G.L.Booth. Later D.J.Buehrer [20] introduced vague sets as generalization of fuzzy sets. Further S.Ragamayi ([12],[17]) has introduced and studied the notion of Normal Vague Γ- NR and Normal Vague Ideals of a Γ- NR. Also she proved some interesting results on it. Earlier, Ranjit Biswas[4] had introduced the notion of vague homomorphism in groups. Now we study the notation of homomorphism in vague Γ-NR. We show that the vague pre-Homomorphic-image and Homomorphic-image of a ***VΓ − NR*** of M is a VΓ- NR of M. Later, we show that pre-Homomorphic -image and it's image of a VΓ- NR possessing Supremum property is a **VΓ- NR** possessing Supremum property. Furthermore, we show that if P is a ***VC*** Ã − ***NR*** of M then it's (ó, è) - cut, $P_{(ó,è)}$ is also a ***CS***Ã − ***NR*** of M and vice versa.

Notations: Throughout this article, we use the following notations.

1) Ã − ***NR*** stands for Γ-NR.
2) ***V***Ã − ***NR*** stands for Vague Γ-NR.
3) **M** stands for Zero-Symmetric Γ-NR.
4) ***S***Ã − ***NR*** stands for Sub Γ-NR.
5) ***VC***Ã − ***NR*** stands for Vague characteristic Γ-NR.
6) ***CS***Ã − ***NR*** stands for Characteristic Sub Γ-NR
7) **H-image** stands for Homomorphic-image.
8) ***Aut***(***M***) is the set of all automorphisms of M

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* Correspondence Author
S Ragamayi, Department of Mathematics, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India.
Y Bhargavi, Department of Mathematics, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India.
Dr. N Konda Reddy, Department of Mathematics, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India.

II. PRELIMINARIES

Definition 2.1: A triple (M, +, Γ) is called Zero-Symmetric Ã − *NR*, if

(i) M is a group with '+'.
(ii) (M, +, γ) is a nearring ∀ γ ∈ Γ, where Γ is a non-empty set of binary operators on M
(iii) m γ_1 (n γ_2 p) = (m γ_1 n) γ_2 p, for all m, n, p ∈ M and $\gamma_1, \gamma_2 \in \Gamma$.
(iv) m γ_1 0 = 0 for every m ∈ M, $\gamma_1 \in \Gamma$

Definition 2.2: A nonempty subset 'E' of M is said to be ***S***Ã − ***NR*** if

i) m − n ∈ E
ii) m α n ∈ E , for each α ∈ Γ and m, n ∈ M.

Definition 2.3: A Fuzzy subset µ of M is a Fuzzy ***S***Ã − ***NR*** of M if

1) µ(m − n) ≥ min{µ(m), µ(n)}
2) µ(m α n) ≥ min{µ(m), µ(n)}for all m, n ∈ M, α ∈ Γ.

Definition 2.4: A vagueset P in the universe of discourse U is a pair (t_P , f_P), where

t_P, f_P :U → [0, 1] are mappings in such a way that $t_P(a) + f_P(a) \leq 1$, ∀ a ∈ U. The functions

t_P and f_P are called true and false membership functions.

Definition 2.5: The interval [$t_P(a)$, 1-$f_P(a)$] is said to be the vague value of 'a' in P is defined as

$V_P(a) = [t_P(a), 1-f_P(a)]$, ∀ a ∈ U.

Definition 2.6: For given vague sets P and Q, P ⊆ Q if and only if $V_P(a) \leq V_Q(a)$ i.e., $t_P(a) \leq t_Q(a)$ and $1-f_P(a) \leq 1-f_Q(a)$, ∀ a ∈ U.

Definition 2.7: We can say that two vague sets P and Q are equal, P = Q, if and only if P ⊆ Q and Q ⊆ P i.e., $V_P(a) \leq V_Q(a)$ and $V_Q(a) \leq V_P(a)$, ∀ a ∈ U.

Definition 2.8: The union of vague sets P and Q is a vagueset R, is represented by

R = P∪Q then it's truth membership function is $t_R = \max\{t_P, t_Q\}$and false membership function $1-f_R = \max\{1-f_P, 1-f_Q\} = 1-\min\{f_P, f_Q\}$.

Definition 2.9: The intersection of two vague sets P and Q is a vagueset R =P∩Q, whose truth membership function is $t_R = \min\{t_P, t_Q\}$ and false membership function is $1-f_R = \min\{1-f_P, 1-f_Q\} = 1-\max\{f_P, f_Q\}$.

Definition 2.10: The intersection and union of a family {P_i/ i ∈ ∆} of vague sets of U are defined by

$$V_{\cup_{i\in\Delta} P_i}(r) = \sup_{i\in\Delta} V_{P_i}(r), \forall r \in U$$

$$V_{\cap_{i\in\Delta} P_i}(r) = \inf_{i\in\Delta} V_{P_i}(r), \forall r \in U$$

Definition 2.11: The vaguecut or (ó, è) - cut of a vagueset P of a universeset U is defined for every ó, è ∈ [0,1] with ó ≤ è as $P_{(ó,è)}$) = {r ∈ U/ $V_P(r) \geq$ [ó, è]}where $P_{(ó,è)}$ = {r ∈ U/ $t_P(r) \geq$ ó , $f_P(r) \leq$ è } is the crisp subset of U.

Definition 2.12: The ó-cut of a vagueset P of a universe U is defined by Pσ = {x ∈ U/ $t_P(r) \geq$ }.

Definition 2.13: Consider g : X → Y be homomorphism. Let P be a vagueset in X whose vaguevalue V_P. Then the H-image of P, g(P) is the vagueset on Y described as

$$V_{g(P)}(n) = \begin{cases} \sup_{r\in g^{-1}(n)} V_P(r) & if\ g^{-1}(n) \neq 0 \\ [0,0] & Otherwise \end{cases}$$

For all n ∈ Y, where g^{-1} (n) = {l/g(x) = n}.
If Q is a vagueset in Y then the pre-H-image of Q, g^{-1}(Q) is the vagueset on X by

$$V(l) = V_{g^{-1}(Q)}(l) = V_{(Q)}(g(l)), \forall l \in X.$$

Definition 2.14: A vagueset P of possessing the Supr. property if S ⊆X,
$\exists\ \alpha_0 \in S \ni V_p(\alpha_0) = \sup_{á\in S} V_P(á)$

Definition 2.15: If g is homomorphism from X → Y then

$$g(m\gamma_1 n) = g(m)\, \gamma_1\, g(n), \forall\ m, n \in X; \gamma_1 \in \Gamma_1.$$

Definition 2.16: A vagueset P = (t_P, f_P) of M is said to be a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ if for every r,m ∈ M and α ∈ Γ,

1) $V_P(t\text{-}m) \geq \min\{V_P(t), V_P(m)\}$ and 2) $V_P(t\alpha m) \geq \min\{V_P(t), V_P(m)\}$

i.e., (i). $t_P(t\text{-}m) \geq \min\{t_P(t), t_P(m)\}$, $1\text{-}f_P(t\text{-}m) \geq \min\{1\text{-}f_P(t), 1\text{-}f_P(m)\}$ and

(ii). $t_P(t\alpha m) \geq \min\{t_P(t), t_P(m)\}$, $1\text{-}f_P(t\alpha m) \geq \min\{1\text{-}f_P(t), 1\text{-}f_P(m)\}$.

III. VAGUE HOMOMORPHISM OF A Γ-NR

In the following section, we invented the notion of vague homomorphism of a $\tilde{A} - \boldsymbol{NR}$. We shown that the pre-H-image and H-image of a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of **M** is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of **M**. Later, we prove that the pre-H-image and H-image of a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ having Supremum property is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ possess Supremum property.

Definition 3.1: If g : M →N be homomorphism and P be a vagueset on M whose vaguevalue V_P then the image of P, g(P) is the vagueset on N defined as

$$V_{g(P)}(n) = \begin{cases} \sup_{r\in g^{-1}(n)} V_P(r) & if\ g^{-1}(n) \neq \emptyset \\ [0,0] & Otherwise \end{cases}$$

∀ n ∈ N, g^{-1} (n) = {m/g(m) = n}.
Let Q be a vagueset on N. Then the pre-H-image of Q, g^{-1}(Q) is the vagueset on M by

$$V_{g^{-1}(Q)}(m) = V_Q(g(m)), \forall\ m \in M.$$

Definition 3.2: If ∃ m_0 ∈ S in such a way that $V_P(m_0) = \sup_{m\in S} V_P(m)$, then we say that the vagueset P of M is having Supr. Property , ∀S ϵ M.

Definition 3.3: Let P and Q be two $\tilde{A} - \boldsymbol{NRs}$ and if 'g' is homomorphism from P into Q then

$$g(m\gamma_1 n) = g(m)\, \gamma_1\, g(n), \forall\ m, n \in P; \gamma_1 \in \Gamma_1.$$

Theorem 3.4: If 'g' is homomorphism from $\tilde{A} - \boldsymbol{NR}$,M into $\tilde{A} - \boldsymbol{NR}$, N and if Q is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of N, then it's pre-H-image of Q, g^{-1}(Q) is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of M.

Proof. : ∀ t,r ∈ M; β ∈ Γ_1,

1. $V_{g^{-1}(Q)}(t\text{-}r) = V_Q(g(t\text{-}r)) = V_Q(g(t)\text{-}g(r)) \geq \min\{V_Q(g(t)), V_Q(g(r))\} = \min\{V_{g^{-1}(Q)}(t), V_{g^{-1}(Q)}(r)\}$

2. $V_{g^{-1}(Q)}(t\,\beta\, r) = V_Q(g(t\,\beta\, r)) = V_Q(g(t)\,\beta\, g(r)) \geq \min\{V_Q(g(t)), V_Q(g(r))\} = \min\{V_{g^{-1}(Q)}(t), V_{g^{-1}(Q)}(r)\}$.

hence, g^{-1}(Q) is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of M.

Theorem 3.5: If 'g'is a homomorphism of $\tilde{A} - \boldsymbol{NR},$ M onto $\tilde{A} - \boldsymbol{NR},$ N. If 'P' is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of M possess Supr. property, then the H-image of P, g(P) is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of N.

Proof: Let m, n ∈ N; β ∈ Γ.

If either $g^{-1}(m) = \emptyset$ or $g^{-1}(n) = \emptyset$ then the proof is obviously true.

Let's have a Supposition, i.e., neither $g^{-1}(m) \neq \emptyset$ nor $g^{-1}(n) \neq \emptyset$.

Let $m_0 \in g^{-1}(m)$ and $n_0 \in g^{-1}(n)$ be $\ni V_p(m_0) = \sup V_p(a)$ where $a \in g^{-1}(m)$

and $V_p(n_0) = \sup V_p(b)$ where $b \in g^{-1}(n)$

1) $V_{g(P)}(m\text{-}n) = \sup_{r\in g^{-1}(m-n)} V_P(r) \geq V_P(r), r \in g^{-1}(m - n)$
$= V_P(m_0 - n_0) \geq \min\{V_P(m_0), V_P(n_0)\}$
$= \min\{V_{g(P)}(m), V_{g(P)}(n)\}$

2) $V_{g(P)}(m\gamma_2 n) = \sup_{r\in g^{-1}(m\gamma 2n)} V_P(r) \geq V_P(r), r \in g^{-1}(m\gamma_2 n)$
$= V_P(m_0\gamma_1 n_0), \gamma_1 \in \Gamma_1 \geq \min\{V_P(m_0), V_P(n_0)\}$
$= \min\{V_{g(P)}(m), V_{g(P)}(n)\}$.

Hence we have shown that g(P) is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of N.

Theorem 3.6: Let g be an epimorphism from a $\tilde{A} - \boldsymbol{NR}$,M onto a $\tilde{A} - \boldsymbol{NR}$, N. Let P be $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of M possessing Supr. property. Then the H-image g(P) of a vagueset P, is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of N possessing Supr. property.

Proof. : From theorem: 3.5, g(P) is a $\boldsymbol{V}\tilde{A} - \boldsymbol{NR}$ of N.

Now, we prove that g(P) possess sup. property.

Let S ⊆ M_2.
Since g is epimorphism $g^{-1}(S) \neq \emptyset$.

According to definition, $V_{g(P)}(s) = \sup\{V_P(m)/ m \in g^{-1}(s)\}$.

Since P possess sup. property and $g^{-1}(S) \subset M$, $\exists\ m_0 \in g^{-1}(S) \ni$
$V_P(m_0) = \sup\{V_P(m)/ m \in g^{-1}(S)\}$.............(1).

Also,

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$\sup\{V_{g(P)}(s)/ s \in S\} = \sup\{\sup\{V_P(m)/ m \in g^{-1}(s)\}/ s \in g^{-1}(S)\}$

$= \sup\{V_P(m)/ m \in g^{-1}(S)\}$............(2).

From (1) and (2), $V_P(m_0) = \sup\{V_{g(P)}(s)/ s \in S\}$.
Let $s_0 \in S$.
Since g is epimorphism, we have $m_0 \in M_1 \ni s_0 = g(m_0)$.
Now,we have $V_{g(P)}(s_0) = \sup\{V_P(m)/ m\in g^{-1}(s_0)\}$.
But $m_0 \in g^{-1}(s_0) \subseteq g^{-1}(S)$.
So, $\sup\{V_P(m)/ m \in g^{-1}(S)\} \geq \sup\{V_P(m)/ m \in g^{-1}(s_0)\}$.
Thus $V_P(m_0) = \sup\{V_P(m)/ m \in g^{-1}(S)\} \geq \sup\{V_P(m)/ m \in g^{-1}(s_0)\} \geq V_P(m_0)$ is not possible.
Therefore $V_P(m_0) = \sup\{V_P(m)/ m \in g^{-1}(s_0)\}$.
Now, $V_{g(P)}(s_0) = \sup\{V_P(m)/ m \in g^{-1}(s_0)\} = V_P(m_0) = \sup\{V_{g(P)}(s)/ s \in S\}$.
i.e., $V_{g(P)}(s_0) = \sup\{V_{g(P)}(s)/ s\in S\}$.
Hence g(P) possess Sup. property.

Theorem 3.7: If g:M →N is a homomorphism onto and Q be a $\boldsymbol{V\tilde{A} - NR}$ of N possessing Supr. property. Then the pre-H-image $g^{-1}(Q)$ of Q, is a $\boldsymbol{V\Gamma - NR}$ of M possess Supr. property.

Proof. : From theorem: 3.4, $g^{-1}(Q)$ is a $\boldsymbol{V\Gamma - NR}$ of M.
we will prove that $g^{-1}(Q)$ possess Supremum- property.
Let $T\subseteq M_1$. By definition, $V_{g^{-1}(Q)}(m) = V_Q(g(m))$, ∀ m ∈ T.
Since Q possesing sup. property, $\exists\, l_0 \in g(T) \ni$
$V_Q(l_0) = \sup\{V_Q(l)/ l \in g(T)\}$......... (1).
Also, $\sup\{V_{g^{-1}(Q)}(l)/ l \in T\} = \sup\{V_Q(g(l))/ l \in T\} = \sup\{V_Q(l)/ l \in g(T)\}$.............(2).
From (1) and (2), $V_Q(l_0) = \sup\{V_{g^{-1}(Q)}(l)/ l \in T\}$.
Now, $l_0 \in g(T)$ which implies $\exists\, l_0 \in T$ in such a way that $l_0 = g(m_0)$.
Thus $V_{g^{-1}(Q)}(m_0) = V_Q(g(m_0)) = V_Q(l_0) = \sup\{V_{g^{-1}(Q)}(m)/ m \in T\}$.
Hence proved that $g^{-1}(Q)$ possessed Sup. property.

Definition 3.8: If g(P) = P, ∀ g ∈ $\boldsymbol{Aut(M)}$ then a $\boldsymbol{S\tilde{A} - NR}$, P of M is said to be $\boldsymbol{CS\tilde{A} - NR}$.

Definition 3.9: If $V_P(g(l)) = V_P(l)$, ∀ l ∈ M, g ∈ Aut(M) then a $\boldsymbol{V\tilde{A} - NR}$, P of M is said to be $\boldsymbol{VC\tilde{A} - NR}$.

Lemma 3.10: Let $P = (t_P, f_P)$ be a $\boldsymbol{V\tilde{A} - NR}$ of M and let m ∈ M. Then $V_P(m) = [\alpha, \beta]$ if and only if $m \in P_{(\alpha,\beta)}$ and $m \notin P_{(\gamma,\delta)}$, ∀ $[\gamma, \eta] > [\alpha, \beta]$, where $\gamma, \eta \in [0, 1]$.
Proof. : The proof of lemma is clear.

Theorem 3.11: Let $P = (t_P, f_P)$ be a $\boldsymbol{V\tilde{A} - NR}$ of M. Then P is $\boldsymbol{VC\tilde{A} - NR}$ of M if and only if it's vaguecut of P or (ó, è) -cut, $P_{(ó,è)}$, where ó, è ∈ [0, 1] is a $\boldsymbol{CS\tilde{A} - NR}$ of M.

Proof. : Let P be a $\boldsymbol{VC\tilde{A} - NR}$ of M.
$\rightarrow P_{(ó,è)}$ is a $\boldsymbol{VC\tilde{A} - NR}$ of M.
Let g∈ Aut(M).
We have to prove that $g(P_{(ó,è)}) = P_{(ó,è)}$.
Let $n \in g(P_{(ó,è)})$
$\rightarrow$ n = g(m), for some m∈ $P_{(ó,è)}$.
Now, $V_P(n) = V_P(g(m)) = V_P(m) = [ó, è] \Rightarrow n \in P_{(ó,è)}$.
So, $g(P_{(ó,è)}) \subseteq P_{(ó,è)}$.
Let $n \in P_{(ó,è)}$.
because g is automorphism on M, we have n = g(m), for some p ∈ M.
Now, $[ó, è] \leq V_P(n) = V_P(g(m)) = V_P(m)$.
$\Rightarrow m \in P_{(ó,è)} \Rightarrow n\in g(P_{(ó,è)})$
So, $P_{(ó,è)} \subseteq g(P_{(ó,è)})$.
$\rightarrow P_{(ó,è)} = g(P_{(ó,è)})$.
Thus, $P_{(ó,è)}$ is a $\boldsymbol{CS\tilde{A} - NR}$ of M.

By Converse, we have a supposition that $P_{(ó,è)}$ is a $\boldsymbol{CS\tilde{A} - NR}$ of M.
Consider g ∈ (M) , m ∈ M.
Let $V_P(m) = [ó, è]$.
This implies $m \in P_{(ó,è)}$, $m \notin P_{(ô,ö)}$ ∀ [ô , ö] > [ó, è].
Let $V_P(g(m)) = [ô, ö]$
if it is possible [ô, ö] > [ó, è].
Then $g(m) \in P_{(\tau,\varphi)} = g(P_{(\tau,\varphi)}) \Rightarrow m \in P_{(\tau,\varphi)}$ is contradiction.
$\rightarrow P_{(\tau,\varphi)} = [ó, è]$.
So, $V_P(g(m)) = V_P(m)$.
Thus P is a $\boldsymbol{VC\tilde{A} - NR}$ of M.

Definition 3.12: Let $P = (t_P, f_P)$ and $Q = (t_Q , f_Q)$ be $\boldsymbol{V\tilde{A} - NR}$s of M. If $\exists\, \vartheta \in$ Aut(M) ∋
$V_P(m) = V_Q(\vartheta(m))$, ∀ m ∈ M. i.e., $t_P(m) = t_Q(\vartheta(m))$ and $f_P(m) = f_Q(\vartheta(m))$, then P and Q are said to be homologous $\boldsymbol{V\tilde{A} - NR}$s of M.
If P and Q are homologous then Q , P are also homologous.

Theorem 3.13: Consider $Q = (t_Q , f_Q)$ be a $\boldsymbol{V\tilde{A} - NR}$ of M and $\vartheta \in$ Aut(M). If $P = (t_P, f_P)$ is a vagueset of M ∋ $V_P(m) = V_Q(\vartheta(m))$, ∀ m ∈ M, then P and Q are homologous $\boldsymbol{V\tilde{A} - NR}$s of M.

Proof. : Let t, r ∈ M; $\gamma_1 \in \Gamma$.

1. $V_P(t-r) = V_Q(\vartheta(t-r))$
$= V_Q(\vartheta(t)- \vartheta(r))$
$\geq \min\{V_Q(\vartheta(t)), V_Q(\vartheta(r))\}$
$= \min\{V_P(t), V_P(r)\}$

2. $V_P(t\gamma_1 r) = V_Q(\vartheta(t\gamma_1 r))$
$= V_Q(\vartheta(t)\gamma_1 \vartheta(r))$
$\geq \min\{V_Q(\vartheta(t)), V_Q(\vartheta(r))\}$

Therefore P is a $\boldsymbol{V\tilde{A} - NR}$ of M.
Thus P and Q are homologous $\boldsymbol{V\tilde{A} - NR}$s of M.

Theorem 3.14: Let $P = (t_P, f_P)$ be a $\boldsymbol{V\tilde{A} - NR}$ of M and let g be an onto homomorphism from M into itself. Then the vagueset $P^f = (t_P^g, f_P^g)$ defined by $V_P\, g\,(m) = V_P(g(m))$, ∀ m ∈ M is a $\boldsymbol{V\tilde{A} - NR}$ of M.

Proof. : Let m, n ∈ M; $\gamma_1 \in \Gamma$.

1. $V_P{}^g(t-r) = V_P(g(t-r))$
$= V_P(g(t)-g(r))$
$\geq \min\{V_P(g(t)), V_P(g(r))\}$
$= \min\{V_P{}^g(t), V_P{}^g(r)\}$.

2. $V_P{}^g(t\gamma_1 r) = V_P(g(t\gamma_1 r))$
$= V_P(g(t)\gamma_1 g(r))$
$\geq \min\{V_P(g(t)), V_P(g(r))\}$
$= \min\{V_P{}^g(t), V_P{}^g(r)\}$.

Hence P is a $\boldsymbol{V\tilde{A} - NR}$ of M.

IV. CONCLUSION

In this research article, the idea of vague homomorphism of a $\boldsymbol{\tilde{A} - NR}$ has been introduced and proved some interesting results on it. We proved that the homomorphic Pre- image and image of a $\boldsymbol{V\tilde{A} - NR}$ of M is a $\boldsymbol{V\tilde{A} - NR}$ of M. Also, we proved that pre-H-imageand image of a $\boldsymbol{\tilde{A} - NR}$ possessing Sup. property is a $\boldsymbol{V\tilde{A} - NR}$ possessing Sup. property. Moreover, we proved that if P is a $\boldsymbol{VC\tilde{A} - NR}$ of M then it's (á, â) – cut, $P_{(\alpha,\beta)}$ is also a $\boldsymbol{CS\tilde{A} - NR}$ of M and vice versa.

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