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Mohsin Khalid

Neha Andaleeb Khalid

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T-MBJ NEUTROSOPHIC SET UNDER M-SUBALGEBRA

Mohsin Khalid[1], Neha Andaleeb Khalid[2]

[1]Department of Mathematics and Statistics, The University of Lahore, 1Km Raiwind Road, Lahore, 54000, Pakistan. mk4605107@gmail.com

[2]Department of Mathematics, Lahore collage for women University, Lahore, Pakistan. nehakhalid97@gmail.com

*Correspondence: mk4605107@gmail.com;

Abstract. In this paper, the idea of T-MBJ neutrosophic set is introduced in which MBJ-neutrosophic set is used to present this new set called T-MBJ neutrosophic set. furthermore the notion of T-MBJ neutrosophic M-subalgebra on G-algebra is also introduced and provide the conditions for T-MBJ neutrosophic M-subalgebra. The word M in the term M-subalgebra, represents the initial of author's first name Mohsin. We study the T-MBJ neutrosophic set through different characteristics and also prove some results for better understanding of newly define T-MBJ neutrosophic set.

Keywords: G-algebra; T-MBJ neutrosophic set; T-MBJ neutrosophic M-subalgebra.

1. Introduction

Smarandacha [3, 4] extented the intuitionistic fuzzy set to neutrosophic set. Barbhuiya [22] wrote in detailed about t-intuitionistic fuzzy using the concept of subalgebra and different other characterstics. Takallo et al. [5] extensively explained the BMBJ-neutrosophic subalgebra. Senapati et al. [27] used cubic set and applied it to subalgebras, ideals and closed ideals of B-algebra. Imai and Iseki [7, 28] defined the BCK-algebra and BCI-algebra. Bandaru et al. [21] first time introdued the G-algebra. Zadeh [8, 9] introduced unique sets called fuzzy set and interval-valued fuzzy set. Saeid [1] studied interval-valued fuzzy subalgebra of B-algebra. Khalid et al. [10] defined T-neutrosophic cubic set and explained this set with important results. Senapati et al. [25] studied L-fuzzy G-subalgebra of G-algebra. Lots of work on BG-algebras [2] have been done by the researchers [26]. Khalid et al. [11] investigated neutrosophic soft cubic subalgebra. Khalid et al. [12] studied translation and multiplication of intuitionistic fuzzy set through some theorems. Khalid et al. [13] first time done the magnification of translation of set MBJ-neutrosophic and proved the results to explain the magnification. Khalid et al. [14]

studied MBJ-neutrosophic T-ideal on B-algebra. Khalid et al. [15] wrote the extensively important results for multiplicative interpretation of neutrosophic cubic set. Takallo et al. [16] discussed the application of MBJ-neutrosophic set. Neggers et al. [6] studied the fundamental theorem of B-homomorphism for B-algebra. Biswas [23] investigated the membership function of interval valued fuzzy set. Ahn [24] proved different results for fuzzy subalgebra. Jun et al. [29] deeply studied neutrosophic cubic set with different characteristics. Basset et. al [17] done the detailed study on hybrid neutrosophic multiple criteria group decision making approach for project selection. Hemavati et. al [20] investigated the β-subalgebra using the interval valed fuzzy set. Surya et. al [18] worked on MBJ neutrsophic β-subalgebra. Basset et. al [19] worked on novel group decision making model based on neutrsophic set for the heart disease.

This paper is presented to define the T-MBJ neutrosophic set and provide the condition for T-MBJ neutrosophic set [T-MBJ NS] to be a T-MBJ neutrosophic M-subalgebra on G-algebra. We also investigate some properties and proved some results for T-MBJ neutrosophic M-subalgebra [T-MBJ NMSU].

2. **Preliminaries**

Here, some basic definitions are written that are helpful to present this paper.

Definition 2.1. A nonempty set Y with a constant 0 and a binary operation $*$ is said to be G-algebra [21] if it fulfills these axioms:
G1: $t_1 * t_1 = 0$
G2: $t_1 * (t_1 * t_2) = t_2$, for all $t_1, t_2 \in Y$.

A G-algebra is denoted by $(Y, *, 0)$.

Definition 2.2. A nonempty set Y with a constant 0 and a binary operation $*$ is said to be B-algebra [6] if it fulfills these axioms:
B1: $t_1 * t_1 = 0$
B2:$t_1 * 0 = t_1$ B2: $(t_1 * t_2) * t_3 = t_1 * (t_3(0 * t_2)$, for all $t_1, t_2, t_3 \in Y$.

Definition 2.3. Let S be a subset of G-algebra is called a subalgebra [21] of Y if $t_1 * t_2 \in S$ $\forall\ t_1, t_2 \in S$.

Definition 2.4. Function $f \mid Y \to X$ of B-algebra is called homomorphic [6] if $f(t_1 * t_2) = f(t_1) * f(t_2)\ \forall\ t_1, t_2 \in Y$. If $f \mid Y \to X$ is a $B-$homomorphic, then $f(0) = 0$.

Definition 2.5. Let C be a fuzzy set [8] in Y is defined as $C = \{< t_1, \vartheta_C(t_1) > \mid t_1 \in Y\}$, where $\vartheta_C(t_1)$ is called the existence ship value of t_1 in C and $\vartheta_C(t_1) \in [0, 1]$.

For a fuzzy set's family $C_i = \{< t_1, \vartheta_{C_i}(t_1) > | \ t_1 \in Y\}$ in Y, where $i \in H$ and H is index set, Join ($\vee$) and meet ($\wedge$) are defined as follow:

$$\vee_{i \in H} C_i = (\vee_{i \in H} \vartheta_{C_i})(t_1) = sup\{\vartheta_{C_i} \mid i \in H\},$$

and

$$\wedge_{i \in H} C_i = (\wedge_{i \in H} \vartheta_{C_i})(t_1) = inf\{\vartheta_{C_i} \mid i \in H\}$$

respectively, $\forall \ t_1 \in Y$.

Definition 2.6. [23] Let two elements $D_1, D_2 \in D[0,1]$. If $D_1 = [(t_1)_1^-, (t_1)_1^+]$ and $D_2 = [(t_1)_2^-, (t_1)_2^+]$, then $rmax(D_1, D_2) = [max((t_1)_1^-, (t_1)_2^-), max((t_1)_1^+, (t_1)_2^+)]$ which is denoted by $D_1 \vee^r D_2$ and $rmin(D_1, D_2) = [min((t_1)_1^-, (t_1)_2^-), min((t_1)_1^+, (t_1)_2^+)]$ which is denoted by $D_1 \wedge^r D_2$. Thus, if $D_i = [((t_1)_1)_i^-, ((t_1)_2)^+] \in D[0,1]$ for $i = 1, 2, 3, \ldots,$ then they defined $rsup_i(D_i) = [sup_i(((t_1)_1)_i^-), sup_i(((t_1)_1)_i^+)]$, *i.e.*, $\vee_i^r D_i = [\vee_i((t_1)_1)_i^-, \vee_i((t_1)_1)_i^+]$. In the same way they defined $rinf_i(D_i) = [inf_i(((t_1)_1)_i^-), inf_i(((t_1)_1)_i^+)]$, *i.e.*, $\wedge_i^r D_i = [\wedge_i((t_1)_1)_i^-, \wedge_i((t_1)_1)_i^+]$. Now they called $D_1 \geq D_2 \iff (t_1)_1^- \geq (t_1)_2^-$ and $(t_1)_1^+ \geq (t_1)_2^+$. Similarly they defined the relations $D_1 \leq D_2$ and $D_1 = D_2$.

Ahn et al. [24] defined fuzzy subalgebra, which is defined below.

Definition 2.7. A nonempty set $C = \{\langle t_1, \vartheta_C(t_1)\rangle \mid t_1 \in Y\}$ is called a fuzzy subalgebra [24] of Y if $\vartheta_C(t_1 * t_2) \geq min\{\vartheta_C(t_1), \vartheta_C(t_2)\} \ \forall \ t_1, t_2 \in Y$.

Definition 2.8. For any $\mathcal{C}_i = (\rho_i, \lambda_i)$ [29] where $\rho_i = \{\langle t_1; \rho_{iE}(t_1), \rho_{iI}(t_1), \rho_{iN}(t_1)\rangle \mid t_1 \in Y\}, \lambda_i = \{\langle t_1; \lambda_{iE}(t_1), \lambda_{iI}(t_1), \lambda_{iN}(t_1)\rangle \mid t_1 \in Y\}$ for $i \in H$, P-union, P-inersection, R-union and R-intersection is defined respectively by **P-union**$\underset{i\in H}{\cup_P} \mathcal{C}_i = (\underset{i\in H}{\cup} \rho_i, \underset{i\in H}{\vee} \lambda_i)$, **P-intersection** $\underset{i\in H}{\cap_P} \mathcal{C}_i = (\underset{i\in H}{\cap} \rho_i, \underset{i\in H}{\wedge} \lambda_i)$, **R-union** $\underset{i\in H}{\cup_R} \mathcal{C}_i = (\underset{i\in H}{\cup} \rho_i, \underset{i\in H}{\wedge} \lambda_i)$, **R-intersection:** $\underset{i\in H}{\cap_R} \mathcal{C}_i = (\underset{i\in H}{\cap} \rho_i, \underset{i\in H}{\vee} \lambda_i)$, where

$$\underset{i\in H}{\cup} \rho_i = \{\langle t_1; (\cup_{i\in H}\rho_{iE})(t_1), (\cup_{i\in H}\rho_{iI})(t_1), (\cup_{i\in H}\rho_{iN})(t_1)\rangle \mid t_1 \in Y\},$$
$$\vee_{i\in H}\lambda_i = \{\langle t_1; (\vee_{i\in H}\lambda_{iE})(t_1), (\vee_{i\in H}\lambda_{iI})(t_1), (\vee_{i\in H}\lambda_{iN})(t_1)\rangle \mid t_1 \in Y\},$$
$$\cap_{i\in H}\rho_i = \{\langle t_1; (\cap_{i\in H}\rho_{iE})(t_1), (\cap_{i\in H}\rho_{iI})(t_1), (\cap_{i\in H}\rho_{iN})(t_1)\rangle \mid t_1 \in Y\},$$
$$\wedge_{i\in H}\lambda_i = \{\langle t_1; (\wedge_{i\in H}\lambda_{iE})(t_1), (\wedge_{i\in H}\lambda_{iI})(t_1), (\wedge_{i\in H}\lambda_{iN})(t_1)\rangle \mid t_1 \in Y\}.$$

Definition 2.9. Let $B = (\vartheta_B, \nu_B)$ be an IFS of BG-algebra Y and $t \in [0,1]$, then the IFS B^t is said to be t-intuitionistic fuzzy subset [1] of Y w.r.t B and is defined as $B^t = \{< t_1, \vartheta_{B^t}(t_1), \nu_{B^t}(t_1) > | \ t_1 \in Y\} =< \vartheta_{B^t}, \nu_{B^t} >$, where $\vartheta_{B^t}(t_1) = min\{\vartheta_B(t_1), t\}$ and $\vartheta_{B^t}(t_1) = max\{\nu_B(t_1), 1-t\} \ \forall \ t_1 \in Y$.

Definition 2.10. Let $B^t = (\vartheta_{B^t}, \nu_{B^t})$ be a t-IFS of BG-algebra Y and $t \in [0,1]$ then B^t is said to be t-IFSU [23] of Y if it fulfills these axioms.

(i) $\vartheta_{B^t}(t_1 * t_2) \geq min\{\vartheta_{B^t}(t_1), \vartheta_{B^t}(t_2)\}$ and
(ii)$\nu_{B^t}(t_1 * t_2) \leq max\{\nu_{B^t}(t_1), \nu_{B^t}(t_2)\}\ \forall\ t_1, t_2 \in Y$.

Definition 2.11. A MBJ-neutrosophic set [16] in Y is a structure of the form $C = \{\langle M_C t_1, \hat{B}_C t_1, J_C t_1\rangle \mid t_1 \in Y\}$, where M_C and J_C are fuzzy sets in Y and M_C is a truth membership function, J_C is a false membership function and $\hat{B}$ is an indeterminate interval valued membership function.

3. T-MBJ Neutrosophic M-Subalgebras

Definition 3.1. A nonempty set of the from $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ is called a T-MBJ neutrosophic set (**T-MBJ NS**) of Y, where $\mathcal{C}^t = \{< t_1, M^t(t_1), \hat{B}^t(t_1), J^t(t_1) >\mid t_1 \in Y\} =< M^t, \hat{B}^t, J^t >$ with two independent components is defined as $M^t(t_1) = \{min(M, t)(t_1)\}$, $\hat{B}^t = \{rmin(\hat{B}, t')(t_1)\}$ and $J^t(t_1) = \{max(J, 2-t-t')(t_1)\}\ \forall\ t, t', 2-t-t' \in [0,1]$, where M^t is truth membership function, $\hat{B}$ is an indeterminate interval valued membership function and J^t is a false membership function.

Definition 3.2. Let $\mathcal{C}^t = (M^t, \hat{B}, J^t)$ be a T-MBJ neutrosophic set. Then $\mathcal{C}^t$ is T-MBJ NMSU under binary operation $*$, where $t_1, t_2, t, t', 2-t-t', \aleph, \Re \in [0,1]$ if it satisfies the following three conditions: N1:

$$min(M((t_1 * \aleph) * (t_2 * \Re)), t) = M^t((t_1 * \aleph) * (t_2 * \Re)) \succeq min\{M^t(t_1 * \aleph), M^t(t_2 * \Re)\}$$
$$min(\hat{B}((t_1 * \aleph) * (t_2 * \Re)), t') = \hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) \succeq rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_2 * \Re)\}$$
$$min(J((t_1 * \aleph) * (t_2 * \Re)), 2-t-t') = J^t((t_1 * \aleph) * (t_2 * \Re)) \preceq max\{J^t(t_1 * \aleph), J^t(t_2 * \Re)\}.$$

For our simplicity we replace the $2-t-t'$ with $\Im$.

Example 3.3. Let $Y = \{0, t_1 * \aleph, t_2 * \Re\}$ be a G-algebra with the following Cayley table.

$\circledast$	0	$t_1 * \aleph$	$t_2 * \Re$
0	0	$t_1 * \aleph$	$t_2 * \Re$
$t_1 * \aleph$	$t_1 * \aleph$	0	$t_2 * \Re$
$t_2 * \Re$	$t_2 * \Re$	$t_1 * \aleph$	0

A T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}, J^t)$ of X is defined by

	0	$t_1 * \aleph$	$t_2 * \Re$
${M^t}_T$	0.4	0.6	0.6

	0	$t_1 * \aleph$	$t_2 * \Re$
$\hat{B}^t$	[0.1,0.2]	[0.3,0.5]	[0.6,0.9]

	0	$t_1 * \aleph$	$t_2 * \Re$
J^t	0.2	0.4	0.8

.

It is the routine work to check that set is T-MBJ neutrosophic M-subalgebra.

Proposition 3.4. *Let $\mathcal{C}^t = \{\langle t_1, M^t(t_1), \hat{B}^t(t_1), J^t(t_1)\rangle\}$ be a T-MBJ NMSU of Y, then $\forall$ $t_1 \in Y$, $M^t(0 * \aleph) \succeq M^t(t_1 * \aleph)$, $\hat{B}^t(0 * \aleph) \succeq \hat{B}^t(t_1 * \aleph)$ and $J^t(0 * \aleph) \preceq J^t(t_1 * \aleph)$. Thus, $M^t(0*\aleph)$, $\hat{B}^t(0*\aleph)$ and $J^t(0*\aleph)$ are the upper bounds and lower bounds of $M^t(t_1*\aleph)$, $\hat{B}^t(t_1*\aleph)$ and $J^t(t_1 * \aleph)$ respectively.*

Proof. $\forall\ t_1 \in Y$, we have $M^t((0*\aleph)) = min(M((0*\aleph)),t) = min(M((t_1*\aleph)*(t_1*\aleph)),t) \succeq min\{min(M((t_1*\aleph)),t), min(M(t_1*\aleph),t)\} = min(M(t_1*\aleph),t) = M^t((t_1*\aleph)) \Rightarrow M^t((0*\aleph)) \succeq M^t((t_1*\aleph))$, $\hat{B}^t(0*\aleph) = rmin(\hat{B}(0*\aleph),t') = rmin(\hat{B}((t_1*\aleph)*(t_1*\aleph)),t') \succeq rmin\{rmin(\hat{B}(t_1*\aleph),t'), rmin(\hat{B}(t_1*\aleph),t')\} = rmin(\hat{B}(t_1*\aleph),t') = \hat{B}^t(t_1*\aleph) \Rightarrow \hat{B}^t(0*\aleph) \succeq \hat{B}^t(t_1*\aleph)$ and $max(J(0*\aleph),\Im) = max(J((t_1*\aleph)*(t_1*\aleph)),\Im) \succeq max\{max(J(t_1*\aleph),\Im), max(J(t_1*\aleph),\Im)\} = max(J(t_1*\aleph),t) = J^t(t_1*\aleph) \Rightarrow J^t(0*\aleph) \preceq J^t(t_1*\aleph)$. □

Theorem 3.5. *Let* $\mathcal{C}^t=\{\langle(t_1), M^t(t_1), \hat{B}^t(t_1), J^t(t_1)\rangle\}$ *be a T-MBJ NMSU of* Y. *If there exists a sequence* $\{(t_1*\aleph)_n\}$ *of* Y *such that* $\lim_{n\to\infty} M^t((t_1*\aleph)_n) = 0$, $\lim_{n\to\infty} \hat{B}^t((t_1*\aleph)_n) = [1,1]$ *and* $\lim_{n\to\infty} J^t((t_1*\aleph)_n) = 0$. *Then* $M^t(0) = 0$, $\hat{B}^t(0) = [1,1]$ *and* $J^t(0) = 0$.

Proof. Using Proposition 3.4, $M^t(0*\aleph) \succeq M^t(t_1*\aleph)\ \forall\ t_1 \in Y$, then $M^t(0*\aleph) \succeq M^t((t_1*\aleph)_n)$ for $n \in \mathbf{Z}^+$. Consider, $0 \succeq M^t(0*\aleph) \succeq \lim_{n\to\infty} M^t((t_1*\aleph)_n) = 0$. Hence, $M^t(0*\aleph) = 0$. Using Proposition 3.4, $\hat{B}^t(0*\aleph) \succeq \hat{B}^t(t_1*\aleph)\ \forall\ t_1 \in Y$, so therefore $\hat{B}^t(0*\aleph) \succeq \hat{B}^t((t_1*\aleph)_n)$ for $n \in \mathbf{Z}^+$. Consider, $[1,1] \succeq \hat{B}^t(0*\aleph) \succeq \lim_{n\to\infty} \hat{B}^t((t_1*\aleph)_n) = [1,1]$. Hence, $\hat{B}^t(0*\aleph) = [1,1]$. Again, using Proposition 3.4, $J^t(0*\aleph) \preceq J^t(t_1*\aleph)\ \forall\ t_1 \in Y$, so therefore $J^t(0*\aleph) \preceq J^t((t_1*\aleph)_n)$ for $n \in \mathbf{Z}^+$. Consider, $0 \preceq J^t(0*\aleph) \preceq \lim_{n\to\infty} J^t((t_1*\aleph)_n) = 0$. Hence, $J^t(0*\aleph) = 0$. □

Theorem 3.6. *The R-intersection of any set of T-MBJ NMSU of* Y *is also a T-MBJ NMSU of* Y.

Proof. Let $\mathcal{C}_i^t = \{\langle t_1, M_i^t, \hat{B}_i^t, J_i^t\rangle \mid t_1 \in Y\}$ where $i \in k$, be a set of T-MBJ NMSU of Y and $t_1, t_2 \in Y$ and $t, \aleph, \Re \in [0,1]$. Then

$$\begin{aligned}
(\vee(M^t)_i)((t_1*\aleph)*(t_2*\Re)) &= \vee(min(M_i,t)((t_1*\aleph)*(t_2*\Re))) \\
&= sup(min(M_i,t)((t_1*\aleph)*(t_2*\Re))) \\
&\succeq sup\{min\{(min(M_i,t)(t_1*\aleph)), (min(M_i,t)(t_1*\Re))\}\} \\
&= min\{sup(min(M_i,t)(t_1*\aleph)), sup(min(M_i,t)(t_1*\Re))\} \\
&= min\{sup(M_i^t)(t_1*\aleph), sup(M_i^t)(t_1*\Re)\} \\
&= min\{\vee(M_i^t)(t_1*\aleph), \vee(M_i^t)(t_1*\Re)\} \\
\Rightarrow \vee(M_i^t)((t_1*\aleph)*(t_2*\Re)) &\succeq min\{\vee(M_i^t)(t_1*\aleph), \vee(M_i^t)(t_1*\Re)\}
\end{aligned}$$

and

$$\begin{aligned}(\cap(\hat{B}^t)_i)((t_1*\aleph)*(t_2*\Re)) &= \cap(rmin(\hat{B}_i,t')((t_1*\aleph)*(t_2*\Re)))\\ &= rinf(rmin(\hat{B}_i,t')((t_1*\aleph)*(t_2*\Re)))\\ &\succeq rinf\{rmin\{(rmin(\hat{B}_i,t')(t_1*\aleph)),(rmin(\hat{B}_i,t')(t_1*\Re))\}\}\\ &= rmin\{rinf(rmin(\hat{B}_i,t')(t_1*\aleph)),rinf(rmin(\hat{B}_i,t')(t_1*\Re))\}\\ &= rmin\{rinf(\hat{B}^t_i)(t_1*\aleph),rinf(\hat{B}^t_i)(t_1*\Re)\}\\ &= rmin\{\cap(\hat{B}^t_i)(t_1*\aleph),\cap(\hat{B}^t_i)(t_1*\Re)\}\\ \Rightarrow \cap(\hat{B}^t_i)((t_1*\aleph)*(t_2*\Re)) &\succeq rmin\{\cap(\hat{B}^t_i)(t_1*\aleph),\cap(\hat{B}^t_i)(t_1*\Re)\},\end{aligned}$$

and

$$\begin{aligned}(\vee(J^t)_i)((t_1*\aleph)*(t_2*\Re)) &= \vee(max(J_i,\Im)((t_1*\aleph)*(t_2*\Re)))\\ &= sup(max(J_i,\Im)((t_1*\aleph)*(t_2*\Re)))\\ &\preceq sup\{max\{(max(J_i,\Im)(t_1*\aleph)),(max(J_i,\Im)(t_1*\Re))\}\}\\ &= max\{sup(max(J_i,\Im)(t_1*\aleph)),sup(max(J_i,\Im)(t_1*\Re))\}\\ &= max\{sup(J^t_i)(t_1*\aleph),sup(J^t_i)(t_1*\Re)\}\\ &= max\{\vee(J^t_i)(t_1*\aleph),\vee(J^t_i)(t_1*\Re)\}\\ \Rightarrow \vee(J^t_i)((t_1*\aleph)*(t_2*\Re)) &\preceq max\{\vee(J^t_i)(t_1*\aleph),\vee(J^t_i)(t_1*\Re)\},\end{aligned}$$

which show that R-intersection of $\mathcal{C}^t_i$ is a T-MBJ NMSU of Y. □

Theorem 3.7. *Let $\mathcal{C}^t_i=\{\langle t_1,(M^t_i),(\hat{B}^t_i),(J^t_i)\rangle \mid t_1\in Y\}$ be a set of T-MBJ NMSU of Y, where $i\in k$ and $t\in[0,1]$. If $inf\{min\{(M^t_i)(t_1*\aleph),(M^t_i)(t_1*\aleph)\}\}=min\{inf(M^t_i)(t_1*\aleph),inf(M^t_i)(t_1*\aleph)\}$ and $inf\{max\{(J^t_i)(t_1*\aleph),(J^t_i)(t_1*\aleph)\}\}=max\{inf(J^t_i)(t_1*\aleph),inf(J^t_i)(t_1*\aleph)\}$ $\forall\ t_1\in Y$, then P-intersection of $\mathcal{C}^t_i$ is also a T-MBJ NMSU of Y.*

Proof. Suppose that $\mathcal{C}^t_i=\{\langle t_1,(M^t_i),(\hat{B}^t_i),(J^t_i)\rangle \mid t_1\in Y\}$ where $i\in k$, is a family of sets of T-MBJ NMSU of Y such that $inf\{min\{(M^t_i)(t_1*\aleph),(M^t_i)(t_1*\aleph)\}\}=min\{inf(M^t_i)(t_1*\aleph),inf(M^t_i)(t_1*\aleph)\}$ and $inf\{max\{(J^t_i)(t_1*\aleph),(J^t_i)(t_1*\aleph)\}\}=max\{inf(J^t_i)(t_1*\aleph),inf(J^t_i)(t_1*$

$\aleph)\} \ \forall\ t_1, t_2 \in Y$ and $t \in [0,1]$. Then

$$\begin{aligned}
(\wedge(M^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \wedge(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re))) \\
&= inf(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re))) \\
&\succeq inf\{min\{(min(M_i, t)(t_1 * \aleph)), (min(M_i, t)(t_1 * \Re))\}\} \\
&= min\{inf(min(M_i, t)(t_1 * \aleph)), inf(min(M_i, t)(t_1 * \Re))\} \\
&= min\{inf(M_i^t)(t_1 * \aleph), inf(M_i^t)(t_1 * \Re)\} \\
&= min\{\wedge(M_i^t)(t_1 * \aleph), \wedge(M_i^t)(t_1 * \Re)\} \\
\Rightarrow \wedge(M_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq min\{\wedge(M_i^t)(t_1 * \aleph), \wedge(M_i^t)(t_1 * \Re)\}
\end{aligned}$$

and

$$\begin{aligned}
(\cap(\hat{B}^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \cap(rmin(\hat{B}_i, t')((t_1 * \aleph) * (t_2 * \Re))) \\
&= rinf(rmin(\hat{B}_i, t')((t_1 * \aleph) * (t_2 * \Re))) \\
&\succeq rinf\{rmin\{(rmin(\hat{B}_i, t')(t_1 * \aleph)), (rmin(\hat{B}_i, t')(t_1 * \Re))\}\} \\
&= rmin\{rinf(rmin(\hat{B}_i, t')(t_1 * \aleph)), rinf(rmin(\hat{B}_i, t')(t_1 * \Re))\} \\
&= rmin\{rinf(\hat{B}_i^t)(t_1 * \aleph), rinf(\hat{B}_i^t)(t_1 * \Re)\} \\
&= rmin\{\cap(\hat{B}_i^t)(t_1 * \aleph), \cap(\hat{B}_i^t)(t_1 * \Re)\} \\
\Rightarrow \cap(\hat{B}_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq rmin\{\cap(\hat{B}_i^t)(t_1 * \aleph), \cap(\hat{B}_i^t)(t_1 * \Re)\},
\end{aligned}$$

and

$$\begin{aligned}
(\wedge(J^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \wedge(max(J_i, \Im)((t_1 * \aleph) * (t_2 * \Re))) \\
&= inf(max(J_i, \Im)((t_1 * \aleph) * (t_2 * \Re))) \\
&\preceq inf\{max\{(max(J_i, \Im)(t_1 * \aleph)), (max(J_i, \Im)(t_1 * \Re))\}\} \\
&= max\{inf(max(J_i, \Im)(t_1 * \aleph)), inf(max(J_i, \Im)(t_1 * \Re))\} \\
&= max\{inf(J_i^t)(t_1 * \aleph), inf(J_i^t)(t_1 * \Re)\} \\
&= max\{\wedge(J_i^t)(t_1 * \aleph), \wedge(J_i^t)(t_1 * \Re)\} \\
\Rightarrow \wedge(J_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\preceq max\{\wedge(J_i^t)(t_1 * \aleph), \wedge(J_i^t)(t_1 * \Re)\},
\end{aligned}$$

which show that P-intersection of $\mathcal{C}_i^t$ is a T-MBJ NMSU of Y. □

Theorem 3.8. *Let* $\mathcal{C}^t{}_i = \{\langle t_1, (M_i^t), (\hat{B}_i^t), (J_i^t)\rangle \mid t_1 \in Y\}$ *where* $i \in k$*, be a family of sets of T-MBJ NMSU of* Y*. If* $sup\{min\{(M_i^t)(t_1*\aleph), (M_i^t)(t_1*\Re)\}\} = min\{sup(M_i^t)(t_1*\aleph), inf(M_i^t)(t_1*\Re)\}$ *and* $rsup\{rmin\{(\hat{B}_i^t)(t_1 * \aleph), (\hat{B}_i^t)(t_1 * \Re)\}\} = rmin\{rsup(\hat{B}_i^t)(t_1 * \aleph), rsup(\hat{B}_i^t)(t_1 * \Re)\}$

and $sup\{max\{(J_i^t)(t_1 * \aleph), (J_i^t)(t_1 * \Re)\}\} = max\{sup(J_i^t)(t_1 * \aleph), sup(J_i^t)(t_1 * \Re)\}\ \forall t_1, t_2 \in Y$, *then P-union of* $\mathcal{C}_i^t$ *is also a T-MBJ NMSU of* Y.

Proof. Let $\mathcal{C}_i^t = \{\langle t_1, (\hat{B}_i^t), (J_i^t)\rangle \mid t_1 \in Y\}$ where $i \in k$, be a family of sets of T-MBJ NMSU of Y such that $sup\{min\{(M_i^t)(t_1 * \aleph), (M_i^t)(t_1 * \Re)\}\} = min\{sup(M_i^t)(t_1 * \aleph), sup(M_i^t)(t_1 * \Re)\}$ and $rsup\{rmin\{(\hat{B}_i^t)(t_1 * \aleph), (\hat{B}_i^t)(t_1 * \Re)\}\} = rmin\{rsup(\hat{B}_i^t)(t_1 * \aleph), rsup(\hat{B}_i^t)(t_1 * \Re)\}$ and $sup\{max\{(J_i^t)(t_1 * \aleph), (J_i^t)(t_1 * \Re)\}\} = max\{sup(J_i^t)(t_1 * \aleph), sup(J_i^t)(t_1 * \Re)\}\ \forall\ t_1, t_2 \in Y$. Then for $t_1, t_2 \in Y$, and $t \in [0, 1]$.

$$\begin{aligned}
(\vee(M^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \vee(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re))) \\
&= sup(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re))) \\
&\succeq sup\{min\{(min(M_i, t)(t_1 * \aleph)), (min(M_i, t)(t_1 * \Re))\}\} \\
&= min\{sup(min(M_i, t)(t_1 * \aleph)), sup(min(M_i, t)(t_1 * \Re))\} \\
&= min\{sup(M_i^t)(t_1 * \aleph), sup(M_i^t)(t_1 * \Re)\} \\
&= min\{\vee(M_i^t)(t_1 * \aleph), \vee(M_i^t)(t_1 * \Re)\} \\
\Rightarrow \vee(M_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq min\{\vee(M_i^t)(t_1 * \aleph), \vee(M_i^t)(t_1 * \Re)\}
\end{aligned}$$

and

$$\begin{aligned}
(\cup(\hat{B}^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \cup(rmin(\hat{B}_i, t')((t_1 * \aleph) * (t_2 * \Re))) \\
&= rsup(rmin(\hat{B}_i, t')((t_1 * \aleph) * (t_2 * \Re))) \\
&\succeq rsup\{rmin\{(rmin(\hat{B}_i, t')(t_1 * \aleph)), (rmin(\hat{B}_i, t')(t_1 * \Re))\}\} \\
&= rmin\{rsup(rmin(\hat{B}_i, t')(t_1 * \aleph)), rsup(rmin(\hat{B}_i, t')(t_1 * \Re))\} \\
&= rmin\{rsup(\hat{B}_i^t)(t_1 * \aleph), rsup(\hat{B}_i^t)(t_1 * \Re)\} \\
&= rmin\{\cup(\hat{B}_i^t)(t_1 * \aleph), \cup(\hat{B}_i^t)(t_1 * \Re)\} \\
\Rightarrow \cup(\hat{B}_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq rmin\{\cup(\hat{B}_i^t)(t_1 * \aleph), \cup(\hat{B}_i^t)(t_1 * \Re)\}
\end{aligned}$$

and

$$\begin{aligned}
(\vee(J^t)_i)((t_1 * \aleph) * (t_2 * \Re)) &= \vee(max(J_i, \Im)((t_1 * \aleph) * (t_2 * \Re))) \\
&= sup(max(J_i, \Im)((t_1 * \aleph) * (t_2 * \Re))) \\
&\preceq sup\{max\{(max(J_i, \Im)(t_1 * \aleph)), (max(J_i, \Im)(t_1 * \Re))\}\} \\
&= max\{sup(max(J_i, \Im)(t_1 * \aleph)), sup(max(J_i, \Im)(t_1 * \Re))\} \\
&= max\{sup(J_i^t)(t_1 * \aleph), sup(J_i^t)(t_1 * \Re)\} \\
&= max\{\vee(J_i^t)(t_1 * \aleph), \vee(J_i^t)(t_1 * \Re)\} \\
\Rightarrow \vee(J_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\preceq max\{\vee(J_i^t)(t_1 * \aleph), \vee(J_i^t)(t_1 * \Re)\},
\end{aligned}$$

which show that P-union of $\mathcal{C}_i^t$ is a T-MBJ NMSU of Y. □

Theorem 3.9. *Let $\mathcal{C}_i^t = \{\langle t_1, (\hat{B}_i^t), (J_i^t)\rangle \mid t_1 \in Y\}$ where $i \in k$, be a family of sets of T-MBJ NMSU of Y. If $inf\{min\{(M_i^t)(t_1 * \aleph), (M_i^t)(t_1 * \Re)\}\} = min\{inf(M_i^t)(t_1 * \aleph), inf(M_i^t)(t_1 * \Re)\}$ and $inf\{max\{(J_i^t)(t_1 * \aleph), (J_i^t)(t_1 * \Re)\}\} = max\{inf(J_i^t)(t_1 * \aleph), inf(J_i^t)(t_1 * \Re)\}$ and $rsup\{rmin\{(\hat{B}_i^t)(t_1 * \aleph), (\hat{B}_i^t)(t_1 * \Re)\}\} = rmin\{rsup(\hat{B}_i^t)(t_1 * \aleph), rsup(\hat{B}_i^t)(t_1 * \Re)\}$ $\forall$ $t_1 \in Y$, and $t \in [0,1]$ then R-union of $\mathcal{C}_i^t$ is also a T-MBJ NMSU of Y.*

Proof. Let $\mathcal{C}_i^t = \{\langle t_1, (M_i^t), (\hat{B}_i^t), (J_i^t)\rangle \mid t_1 \in Y\}$ where $i \in k$, and $t \in [0,1]$ be a family of sets of T-MBJ NMSU of Y such that $inf\{min\{(M_i^t)(t_1 * \aleph), (M_i^t)(t_1 * \Re)\}\} = min\{inf(M_i^t)(t_1 * \aleph), inf(M_i^t)(t_1 * \Re)\}$ and $inf\{max\{(J_i^t)(t_1 * \aleph), (J_i^t)(t_1 * \Re)\}\} = max\{inf(J_i^t)(t_1 * \aleph), inf(J_i^t)(t_1 * \Re)\}$ and $rsup\{rmin\{(\hat{B}_i^t)(t_1 * \aleph), (\hat{B}_i^t)(t_1 * \Re)\}\} = rmin\{rsup(\hat{B}_i^t)(t_1 * \aleph), rsup(\hat{B}_i^t)(t_1 * \Re)\}$ $\forall$ $t_1 \in Y$, and $t \in [0,1]$. Then for $t_1, t_2 \in Y$ and $t \in [0,1]$.

$$\begin{aligned}
(\wedge(M_i^t))((t_1 * \aleph) * (t_2 * \Re)) &= (\wedge(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re))) \\
&= inf\{(min(M_i, t)((t_1 * \aleph) * (t_2 * \Re)))\} \\
&\succeq inf\{min\{min(M_i, t)(t_1 * \aleph), min(M_i, t)(t_1 * \Re)\}\} \\
&= min\{inf(min(M_i, t)(t_1 * \aleph)), inf(min(M_i, t)(t_1 * \Re))\} \\
&= min\{inf((M_i^t)(t_1 * \aleph)), inf((M_i^t)(t_1 * \Re))\} \\
&= min\{\wedge(M_i^t)(t_1 * \aleph), \wedge(M_i^t)(t_1 * \Re)\} \\
\Rightarrow \wedge(M_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq min\{\wedge(M_i^t)(t_1 * \aleph), \wedge(M_i^t)(t_1 * \Re)\},
\end{aligned}$$

and

$$\begin{aligned}
(\cup(\hat{B}^t{}_i))((t_1 * \aleph) * (t_2 * \Re)) &= (\cup(rmin(\hat{B}_i, t'))((t_1 * \aleph) * (t_2 * \Re)) \\
&= rsup\{rmin(\hat{B}_i, t')((t_1 * \aleph) * (t_2 * \Re))\} \\
&\succeq rsup\{rmin\{rmin(\hat{B}_i, t')(t_1 * \aleph), rmin(\hat{B}_i, t')(t_1 * \Re)\}\} \\
&= rmin\{rsup(rmin(\hat{B}_i, t')(t_1 * \aleph)), rsup(rmin(\hat{B}_i, t')(t_1 * \Re))\} \\
&= rmin\{rsup((\hat{B}_i^t)(t_1 * \aleph)), rsup((\hat{B}_i^t)(t_1 * \Re))\} \\
&= rmin\{\cup(\hat{B}_i^t)(t_1 * \aleph), \cup(\hat{B}_i^t)(t_1 * \Re)\} \\
\Rightarrow \cup(\hat{B}_i^t)((t_1 * \aleph) * (t_2 * \Re)) &\succeq rmin\{\cup(\hat{B}_i^t)(t_1 * \aleph), \cup(\hat{B}_i^t)(t_1 * \Re)\},
\end{aligned}$$

and

$$\begin{aligned}(\wedge(J_i^t))((t_1*\aleph)*(t_2*\Re)) &= (\wedge(max(J_i,\Im))((t_1*\aleph)*(t_2*\Re))\\ &= inf\{max(J_i,\Im)((t_1*\aleph)*(t_2*\Re))\}\\ &\preceq inf\{max\{max(J_i,\Im)(t_1*\aleph), max(J_i,\Im)(t_1*\Re)\}\}\\ &= max\{inf(max(J_i,\Im)(t_1*\aleph)), inf(max(J_i,\Im)(t_1*\Re))\}\\ &= max\{inf((J_i^t)(t_1*\aleph)), inf((J_i^t)(t_1*\Re))\}\\ &= max\{\wedge(J_i^t)(t_1*\aleph), \wedge(J_i^t)(t_1*\Re)\}\\ \Rightarrow \wedge(J_i^t)((t_1*\aleph)*(t_2*\Re)) &\preceq max\{\wedge(J_i^t)(t_1*\aleph), \wedge(J_i^t)(t_1*\Re)\},\end{aligned}$$

which show that R-union of $\mathcal{C}_i^t$ is a T-MBJ NMSU of Y. □

Proposition 3.10. *If a T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y is a TMBJ-netrosophic M-subalgebra, then $\forall\ t_1 \in Y$, $M^t(0*t_1) \succeq M^t(t_1*\aleph)$ and $\hat{B}^t(0*t_1) \succeq \hat{B}^t(t_1*\aleph)$ and $J^t(0*t_1) \preceq J^t(t_1*\aleph)$.*

Proof. $\forall\ t_1 \in Y$, $M^t(0*t_1){=}min(M(0*t_1),t) \succeq min\{min(M(0),t), min(M(t_1*\aleph),t)\} = min\{min(M(t_1*t_1),t), min(M(t_1*\aleph),t)\} \succeq min\{min\{min(M(t_1*\aleph),t), min(M(t_1*\aleph),t)\}, min(M(t_1*\aleph),t)\} = min(M(t_1*\aleph),t) = M^t(t_1*\aleph)$ and $\hat{B}^t(0*t_1){=}rmin(\hat{B}(0*t_1),t') \succeq rmin\{rmin(\hat{B}(0),t'), rmin(\hat{B}(t_1*\aleph),t')\} = rmin\{rmin(\hat{B}(t_1*t_1),t'), rmin(\hat{B}(t_1*\aleph),t')\} \succeq rmin\{rmin\{rmin(\hat{B}(t_1*\aleph),t'), rmin(\hat{B}(t_1*\aleph),t')\}, rmin(\hat{B}(t_1*\aleph),t')\} = rmin(\hat{B}(t_1*\aleph),t') = \hat{B}^t(t_1*\aleph)$ and $J^t(0*t_1){=}max(J(0*t_1),\Im) \preceq max\{max(J(0),\Im), max(J(t_1*\aleph),\Im)\} = max\{max(J(t_1*t_1),\Im), max(J(t_1*\aleph),\Im)\} \preceq max\{max\{max(J(t_1*\aleph),\Im), max(J(t_1*\aleph),\Im)\}, max(J(t_1*\aleph),\Im)\} = max(J(t_1*\aleph),\Im) = J^t(t_1*\aleph)$ □

Lemma 3.11. *If a T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y is a T-MBJ neutrosophic M-subalgebra, then $\mathcal{C}^t((t_1*\aleph)*(t_2*\Re)) = \mathcal{C}^t((t_1*\aleph)*(0*(0*(t_2*\Re))))\ \forall\ t_1, t_2 \in Y$.*

Proof. Let Y be a G-algebra and $t_1, t_2 \in Y$. Then we know by lemma that $t_2*\Re = 0*(0*(t_2*\Re))$. Hence, $M^t((t_1*\aleph)*(t_2*\Re)) = M^t((t_1*\aleph)*(0*(0*(t_2*\Re))))$ and $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) = \hat{B}^t((t_1*\aleph)*(0*(0*(t_2*\Re)))$ and $J^t((t_1*\aleph)*(t_2*\Re)) = J^t((t_1*\aleph)*(0*(0*(t_2*\Re)))$. Therefore, $\mathcal{C}^t((t_1*\aleph)*(t_2*\Re)) = \mathcal{C}^t((t_1*\aleph)*(0*(0*(t_2*\Re))))$ □

Proposition 3.12. *If T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y is a T-MBJ NMSU, then $\forall\, t_1, t_2 \in Y$, $M^t((t_1*\aleph)*(0*(t_2*\Re))) \succeq min\{M^t(t_1*\aleph), M^t(t_1*\Re)\}$ and $\hat{B}^t((t_1*\aleph)*(0*(t_2*\Re))) \succeq rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_1*\Re)\}$ and $J^t((t_1*\aleph)*(0*(t_2*\Re))) \preceq max\{J^t(t_1*\aleph), J^t(t_1*\Re)\}$.*

Proof. Let $t_1, t_2 \in Y$. Then we have $M^t((t_1*\aleph)*(0*(t_2*\Re))) = min(M((t_1*\aleph)*(0*(t_2*\Re))), t) \succeq min\{min(M(t_1*\aleph), t), min(M(0*(t_2*\Re)), t)\} \succeq min\{min(M(t_1*\aleph), t), min(M(t_2*\Re), t)\} = min\{M^t(t_1*\aleph), M^t(t_2*\Re)\}$ and $\hat{B}^t((t_1*\aleph)*(0*(t_2*\Re))) = rmin(\hat{B}((t_1*\aleph)*(0*(t_2*\Re))), t') \succeq rmin\{rmin(\hat{B}(t_1*\aleph), t'), rmin(\hat{B}(0*(t_2*\Re)), t')\} \succeq rmin\{rmin(\hat{B}(t_1*\aleph), t'), rmin(\hat{B}(t_2*\Re), t')\} = rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_2*\Re)\}$ and $J^t((t_1*\aleph)*(0*(t_2*\Re))) = max(J((t_1*\aleph)*(0*(t_2*\Re))), \Im) \preceq max\{max(J(t_1*\aleph), \Im), max(J(0*(t_2*\Re)), \Im)\} \preceq max\{max(J(t_1*\aleph), t), max(J(t_2*\Re), \Im)\} = max\{J^t(t_1*\aleph), J^t(t_2*\Re)\}$ by Definition and Proposition. □

Proposition 3.13. *If T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y fulfills the following statements, then $\mathcal{C}^t$ refers to a T-MBJ NMSU of Y.*

(1) $M^t(0*t_1) \succeq M^t(t_1*\aleph)$ *and* $\hat{B}^t(0*t_1) \succeq \hat{B}^t(t_1*\aleph)$ *and* $J^t(0*t_1) \preceq J^t(t_1*\aleph)\ \forall\ t_1 \in Y$.

(2) $M^t(t_1*(0*t_2)) \succeq min\{M^t(t_1*\aleph), M^t(t_1*\Re)\}$ *and* $\hat{B}^t(t_1*(0*t_2)) \succeq rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_1*\Re)\}$ *and* $J^t(t_1*(0*t_2)) \preceq max\{J^t(t_1*\aleph), J^t(t_1*\Re)\}\ \forall\ t_1, t_2 \in Y$ *and* $t \in [0,1]$.

Proof. Let T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y fulfills the above statements (1 and 2). Then by Lemma 3.11, we have $M^t((t_1*\aleph)*(t_2*\Re)) = \{min(M((t_1*\aleph)*(t_2*\Re)), t)\} = \{min(M(t_1*(0*(0*t_2))), t)\} \succeq min\{min(M(t_1*\aleph), t), min(M(0*t_2), t)\} \succeq min\{min(M(t_1*\aleph), t), min(M(0*t_2), t)\} = min\{M^t(t_1*\aleph), M^t(t_1*\Re)\}$ and $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) = \{rmin(\hat{B}((t_1*\aleph)*(t_2*\Re)), t')\} = \{rmin(\hat{B}(t_1*(0*(0*t_2))), t')\} \succeq rmin\{rmin(\hat{B}(t_1*\aleph), t), rmin(\hat{B}(0*t_2), t')\} \succeq rmin\{rmin(\hat{B}(t_1*\aleph), t), rmin(\hat{B}(0*t_2), t')\} = rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_1*\Re)\}$ and $J^t((t_1*\aleph)*(t_2*\Re)) = \{max(J((t_1*\aleph)*(t_2*\Re)), \Im)\} = \{max(J(t_1*(0*(0*t_2))), \Im)\} \preceq max\{max(J(t_1*\aleph), t), max(J(0*t_2), \Im)\} \preceq max\{max(J(t_1*\aleph), \Im), max(J(0*t_2), \Im)\} = max\{J^t(t_1*\aleph), J^t(t_1*\Re)\}\ \forall\ t_1, t_2 \in Y$. Hence, $\mathcal{C}^t$ is T-MBJ NMSU of Y. □

Theorem 3.14. *The T-MBJ neutrosophic set $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ of Y is a T-MBJ NMSU of $Y \iff M^t$ and $\hat{B}^{t-}, \hat{B}^{t+}$ and J^t are fuzzy subalgebra of Y.*

Proof. Suppose M^t, $\hat{B}^{t-}, \hat{B}^{t+}$ and J^t are fuzzy subalgebra of Y and $t_1, t_2 \in Y$ and $t, t', \Im \in [0,1]$. Then $M^t((t_1*\aleph)*(t_2*\Re)) = \{min(M((t_1*\aleph)*(t_2*\Re)), t)\} \succeq min\{min(M(t_1*\aleph), t), min(M(t_1*\Re), t)\} = min\{M^t(t_1*\aleph), M^t(t_1*\Re)\}$ and $\hat{B}^{t-}((t_1*\aleph)*(t_2*\Re)) = \{rmin(\hat{B-}((t_1*\aleph)*(t_2*\Re)), t')\} \succeq rmin\{rmin(\hat{B}(t_1*\aleph), t'), rmin(\hat{B}(t_1*\Re), t')\} = rmin\{\hat{B}^{t-}(t_1*\aleph), \hat{B}^{t-}(t_1*\Re)\}$ and $\hat{B}^{t+}((t_1*\aleph)*(t_2*\Re)) = \{rmin(\hat{B}((t_1*\aleph)*(t_2*\Re)), t')\} \succeq rmin\{rmin(\hat{B+}(t_1*\aleph), t'), rmin(\hat{B+}(t_1*\Re), t')\} = rmin\{\hat{B}^{t+}(t_1*\aleph), \hat{B}^{t+}(t_1*\Re)\}$ and $J^t((t_1*\aleph)*(t_2*\Re)) = \{max(J((t_1*\aleph)*(t_2*\Re)), \Im)\} \preceq max\{max(J(t_1*\aleph), \Im), max(J(t_1*\Re), \Im)\} = max\{J^t(t_1*\aleph), J^t(t_1*\Re)\}$. Now, $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) = [\hat{B}^{t-}((t_1*\aleph)*(t_2*\Re)), \hat{B}^{t+}((t_1*\aleph)*(t_2*\Re))] = [rmin(\hat{B-}((t_1*\aleph)*(t_2*\Re)), t'), rmin(\hat{B+}((t_1*\aleph)*(t_2*\Re)), t')] \succeq$

$[rmin\{rmin(\hat{B-}(t_1 * \aleph), t'), rmin(\hat{B-}(t_1 * \Re), t')\}, rmin\{rmin(\hat{B+}(t_1 * \aleph), t'), rmin(\hat{B+}(t_1 * \Re), t')\}] = [rmin\{\hat{B}^{t-}(t_1 * \aleph), \hat{B}^{t-}(t_1 * \Re)\}, rmin\{\hat{B}^{t+}(t_1 * \aleph), \hat{B}^{t+}(t_1 * \Re)\}] \succeq rmin\{[\hat{B}^{t-}(t_1 * \aleph), \hat{B}^{t+}(t_1 * \Re)],[\hat{B}^{t-}(t_1 * \aleph), \hat{B}^{t+}(t_1 * \Re)]\} = rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_1 * \Re)\}$. Therefore, $\mathcal{C}^t$ is T-MBJ NMSU of Y.

Conversely, assume that $\mathcal{C}^t$ is a T-MBJ NMSU of Y. For any $t_1, t_2 \in Y$, $M^t((t_1 * \aleph) * (t_2 * \Re)) = \{min(M((t_1*\aleph)*(t_2*\Re)), t)\} \succeq min\{min(M(t_1*\aleph), t), min(M(t_1*\Re), t)\}$=min$\{M^t(t_1*\aleph), M^t(t_1 * \Re)\}$ and $[\hat{B}^{t-}((t_1 * \aleph) * (t_2 * \Re)), \hat{B}^{t+}((t_1 * \aleph) * (t_2 * \Re))] = \hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) = \{rmin(\hat{B}((t_1 * \aleph) * (t_2 * \Re)), t')\} \succeq rmin\{rmin(\hat{B}(t_1 * \aleph), t'), rmin(\hat{B}(t_1 * \Re), t')\} = rmin\{[rmin(\hat{B-}(t_1*\aleph), t'), rmin(\hat{B+}(t_1*\aleph), t'), rmin(\hat{B-}(t_1*\Re), t'), rmin(\hat{B+}(t_1*\Re), t')]\}$= $[rmin\{rmin(\hat{B-}(t_1 * \aleph), t'), rmin(\hat{B-}(t_1 * \Re), t')\}, rmin\{rmin(\hat{B+}(t_1 * \aleph), t'), rmin(\hat{B+}(t_1 * \Re), t')\}]$=$[rmin\{\hat{B}^{t-}(t_1*\aleph), \hat{B}^{t-}(t_1*\Re)\}, rmin\{\hat{B}^{t+}(t_1*\aleph), \hat{B}^{t+}(t_1*\Re)\}]$. Thus, $\hat{B}^{t-}((t_1*\aleph)*(t_2*\Re)) \succeq min\{\hat{B}^{t-}(t_1*\aleph), \hat{B}^{t-}(t_1*\Re)\}$, $\hat{B}^{t+}((t_1*\aleph)*(t_2*\Re)) \succeq min\{\hat{B}^{t+}(t_1*\aleph), \hat{B}^{t+}(t_1*\Re)\}$ and $J^t((t_1*\aleph)*(t_2*\Re)) = \{max(J((t_1*\aleph)*(t_2*\Re)), \Im)\} \preceq max\{max(J(t_1*\aleph), \Im), max(J(t_1*\Re), \Im)\}$=max$\{J^t(t_1 * \aleph), J^t(t_1 * \Re)\}$. Hence M^t and $\hat{B}^{t+}, \hat{B}^{t-}$ and J^t are fuzzy subalgebra of Y. □

Theorem 3.15. *Let $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ be a T-MBJ NMSU of Y. Then the sets I_{M^t}, $I_{\hat{B}^t}$ and I_{J^t} which are defined as $I_{M^t} = \{t_1 \in Y \mid M^t(t_1 * \aleph) = M^t(0)\}$, $I_{\hat{B}^t} = \{t_1 \in Y \mid \hat{B}^t(t_1 * \aleph) = \hat{B}^t(0)\}$ and I_{J^t}=$\{t_1 \in Y \mid J^t(t_1 * \aleph) = J^t(0)\}$ are T-MBJ neutrosophic M-subalgebra of Y.*

Proof. Let $t_1, t_2 \in I_{M^t}$. Then $M^t(t_1*\aleph) = M^t(0) = M^t(t_1*\Re)$ and so, $M^t((t_1*\aleph)*(t_2*\Re)) = \{min(M((t_1*\aleph)*(t_2*\Re)), t)\} \succeq$ min$\{(min(M(t_1*\aleph), t)), (min(M(t_1*\Re), t))\}$ =$M^t(0)$. By using Proposition 3.4, as we know that $M^t((t_1*\aleph)*(t_2*\Re)) = M^t(0)$ or equivalently $(t_1*\aleph)*(t_2*\Re) \in I_{M^t}$.

Now we let $t_1, t_2 \in I_{\hat{B}^t}$. Then $\hat{B}^t(t_1 * \aleph) = \hat{B}^t(0) = \hat{B}^t(t_1 * \Re)$ and so, $\hat{B}^t((t_1 * \aleph) * (t_2 * \Re))$=$\{rmin(\hat{B}((t_1 * \aleph) * (t_2 * \Re)), t')\} \succeq$ rmin$\{(rmin(\hat{B}(t_1 * \aleph), t')), (rmin(\hat{B}(t_1 * \Re), t'))\}$ =$rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_1 * \Re)\} = \hat{B}^t(0)$. By using Proposition 3.4, as we know that $\hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) = \hat{B}^t(0)$ or equivalently $(t_1 * \aleph) * (t_2 * \Re) \in I_{\hat{B}^t}$.

Again we let $t_1, t_2 \in I_{J^t}$. Then $J^t(t_1 * \aleph) = J^t(0) = J^t(t_1 * \Re)$ and so, $J^t((t_1 * \aleph) * (t_2 * \Re)) = \{max(J((t_1 * \aleph) * (t_2 * \Re)), t)\} \succeq$ max$\{(max(J(t_1 * \aleph), t)), (max(J(t_1 * \Re), t))\}$ =$J^t(0)$. Again by using Proposition 3.4, as we know that $J^t((t_1 * \aleph) * (t_2 * \Re)) = J^t(0)$ or equivalently $(t_1 * \aleph) * (t_2 * \Re) \in I_{J^t}$. Hence the sets I_{M^t} $I_{\hat{B}^t}$ and I_{J^t} are subalgebra of Y. □

Definition 3.16. Let $\mathcal{C}^t = \{M^t, \hat{B}^t, J^t\}$ be a T-MBJ neutrosophic set of Y. For $[s_1, s_2] \in D[0, 1]$ and $t_1, t_2 \in [0, 1]$, the set $U(M^t \mid \acute{t})$=$\{t_1 \in Y \mid M^t(t_1 * \aleph) \succeq \acute{t}$ is called upper t_1-level of $\mathcal{C}^t$ and the set $U(\hat{B}^t \mid [s_1, s_2])$ =$\{s_1, s_2 \in Y \mid \hat{B}^t(t_1 * \aleph) \succeq [s_1, s_2]$ is called upper $[s_1, s_2]$-level of $\mathcal{C}^t$ and $L(J^t \mid \acute{t})$ =$\{t_1 \in Y \mid J^t(t_1 * \aleph) \preceq \acute{t}$ is called lower $(t_1 * \aleph)$-level of $\mathcal{C}^t$.

Theorem 3.17. *If $\mathcal{C}^t = (M^t, \hat{B}^t, J^t)$ is T-MBJ NMSU of Y, then the upper $\acute{t}$-level, upper $[s_1, s_2]$-level and lower $\acute{t}$-level of $\mathcal{C}^t$ are subalgebra of Y.*

Proof. Let $t_1, t_2 \in U(M^t \mid \acute{t})$. Then $M^t(t_1 * \aleph) \succeq \acute{t}$ and $M^t(t_2 * \Re) \succeq \acute{t}$. It follows that $M^t((t_1*\aleph)*(t_2*\Re)) = \{min(M((t_1*\aleph)*(t_2*\Re)), t)\} \succeq min\{min(M(t_1*\aleph), M(t_2*\Re), t)\} = min\{min(M(t_1*\aleph), t), min(M(t_2*\Re), t)\} = min\{M^t(t_1*\aleph), M^t(t_2*\Re)\} \succeq \acute{t} \Rightarrow (t_1*\aleph)*(t_2*\Re) \in U(M^t \mid \acute{t})$. Hence $U(M^t \mid \acute{t})$ is a subalgebra of Y. Let $t_1, t_2 \in U(\hat{B}^t \mid [s_1, s_2])$. Then $\hat{B}^t(t_1*\aleph) \succeq [s_1, s_2]$ and $\hat{B}^t(t_2*\Re) \succeq [s_1, s_2]$. It follows that $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) = \{rmin(\hat{B}((t_1*\aleph)*(t_2*\Re)), t')\} \succeq rmin\{rmin(\hat{B}(t_1*\aleph), \hat{B}(t_2*\Re), t')\} = rmin\{rmin(\hat{B}(t_1*\aleph), t'), rmin(\hat{B}(t_2*\Re), t')\} = rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_2*\Re)\} \succeq [s_1, s_2] \Rightarrow (t_1*\aleph)*(t_2*\Re) \in U(\hat{B}^t \mid [s_1, s_2])$. Hence, $U(\hat{B}^t \mid [s_1, s_2]$ is a subalgebra of Y. Let $t_1, t_2 \in L(J^t \mid t_1)$. Then $J^t(t_1*\aleph) \preceq \acute{t}$ and $J^t(t_2*\Re) \preceq \acute{t}$. It follows that $J^t((t_1*\aleph)*(t_2*\Re)) = \{max(J((t_1*\aleph)*(t_2*\Re)), \Im)\} \preceq max\{max(J(t_1*\aleph), J(t_2*\Re), \Im)\} = max\{max(J(t_1*\aleph), t), max(J(t_2*\Re), t)\} = max\{J^t(t_1*\aleph), J^t(t_2*\Re)\} \preceq \acute{t} \Rightarrow (t_1*\aleph)*(t_2*\Re) \in L(J^t \mid \acute{t})$. Hence $L(J^t \mid \acute{t})$ is a subalgebra of Y. □

Theorem 3.18. *Any subalgebra of Y can be considered as upper $\acute{t}$-level, upper $[s_1, s_2]$-level and lower $\acute{t}$-level of some T-MBJ NMSU of Y.*

Proof. Let $\mathcal{D}^t$ be a T-MBJ NMSU of Y, and $\mathcal{C}^t$ be a T-MBJ neutrosophic set on Y defined by

$$M^t = \begin{cases} [\upsilon] & \text{if} t_1 \in \mathcal{D}^t \\ 1, & \text{otherwise.} \end{cases} \hat{B}^t = \begin{cases} [\mu_1, \mu_2] & \text{if} t_1 \in \mathcal{D}^t \\ [0,0] & \text{otherwise.} \end{cases}, J^t = \begin{cases} [\nu] & \text{if} t_1 \in \mathcal{D}^t \\ 0, & \text{otherwise.} \end{cases}$$

$\forall\ [\mu_1, \mu_2] \in D[0,1]$ and $\nu \in [0,1]$. Now we discuss the following cases.

Case 1. If $\forall\ t_1, t_2 \in \mathcal{D}^t$ then $M^t(t_1*\aleph) = \upsilon$, $\hat{B}^t(t_1*\aleph) = [\mu_1, \mu_2]$, $J^t(t_1*\aleph) = \nu$ and $M^t(t_2*\Re) = \upsilon$,$\hat{B}^t(t_2*\Re) = [\mu_1, \mu_2]$, $J^t(t_2*\Re) = \nu$. Thus $M^t((t_1*\aleph)*(t_2*\Re)) = \upsilon = min\{\upsilon, \upsilon\} = min\{M^t(t_1*\aleph), M^t(t_2*\Re)\}$ and $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) = [\mu_1, \mu_2] = rmin\{[\mu_1, \mu_2], [\mu_1, \mu_2]\} = rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_2*\Re)\}$ and $J^t((t_1*\aleph)*(t_2*\Re)) = \nu = max\{\nu, \nu\} = max\{J^t(t_1*\aleph), J^t(t_2*\Re)\}$.

Case 2. If $t_1 \in \Re^t$ and $t_2 \notin \Re^t$, then $M^t(t_1*\aleph) = \upsilon$, $\hat{B}^t(t_1*\aleph) = [\mu_1, \mu_2]$, $J^t(t_1*\aleph) = \nu$ and $M^t(t_2*\Re) = 0$, $\hat{B}^t(t_2*\Re) = [0,0]$, $J^t(t_2*\Re) = 1$. Thus $M^t((t_1*\aleph)*(t_2*\Re)) \succeq 0 = min\{\upsilon, 0\} = min\{M^t(t_1*\aleph), M^t(t_2*\Re)\}$, $\hat{B}^t((t_1*\aleph)*(t_2*\Re)) \succeq [0,0] = rmin\{[\mu_1, \mu_2], [0,0]\} = rmin\{\hat{B}^t(t_1*\aleph), \hat{B}^t(t_2*\Re)\}$ and $J^t((t_1*\aleph)*(t_2*\Re)) \preceq 1 = max\{\nu, 1\} = max\{J^t(t_1*\aleph), J^t(t_2*\Re)\}$.

Case 3. If $t_1 \notin \Re^t$ and $t_2 \in \Re^t$, then $M^t(t_1*\aleph) = 0$,$\hat{B}^t(t_1*\aleph) = [0,0]$, $J^t(t_1*\aleph) = 1$ and $M^t(t_2*\Re) = \upsilon$, $\hat{B}^t(t_2*\Re) = [\mu_1, \mu_2]$, $J^t(t_2*\Re) = \nu$. Thus $M^t((t_1*\aleph)*(t_2*\Re)) \succeq 0 =$

$min\{0, \upsilon\} = min\{M^t(t_1 * \aleph), M^t(t_2 * \Re)\}$, $\hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) \succeq [0,0] = rmin\{[0,0], [\mu_1, \mu_2]\}$ $= rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_2 * \Re)\}$ and $J^t((t_1 * \aleph) * (t_2 * \Re)) \preceq 1 = max\{1, \nu\} = max\{J^t(t_1 * \aleph), J^t(t_2 * \Re)\}$.

Case 4. If $t_1 \notin \Re^t$ and $t_2 \notin \Re^t$, then $M^t(t_1 * \aleph) = 0$, $\hat{B}^t(t_1 * \aleph) = [0,0]$, $J^t(t_1 * \aleph) = 1$ and $M^t(t_2 * \Re) = 0$, $\hat{B}^t(t_2 * \Re) = [0,0]$, $J^t(t_2 * \Re) = 1$. Thus $M^t((t_1 * \aleph) * (t_2 * \Re)) \succeq 1 = min\{0,0\} = min\{M^t(t_1 * \aleph), M^t(t_2 * \Re)\}$, $\hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) \succeq [0,0] = rmin\{[0,0],[0,0]\} = rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_2 * \Re)\}$ and $J^t((t_1 * \aleph) * (t_2 * \Re)) \preceq 1 = max\{1,1\} = max\{J^t(t_1 * \aleph), J^t(t_2 * \Re)\}$. Therefore, $\mathcal{C}^t$ is a T-MBJ NMSU of Y. □

Theorem 3.19. *Let $\mathcal{C}^t$ be a subset of Y and $\mathcal{C}^t$ be a T-MBJ neutrosophic set on Y which is given in the proof of above Theorem. If $\mathcal{C}^t$ is considered as lower level subalgebra and upper level subalgebra of some T-MBJ NMSU of Y, then $\mathcal{C}^t$ is a T-MBJ neutrosophic cubic one of Y.*

Proof. Let $\mathcal{C}^t$ be a T-MBJ NMSU of Y, and $t_1, t_2 \in \mathcal{C}^t$. Then $M^t(t_1 * \aleph) = M^t(t_2 * \Re) = \gamma$, $\hat{B}^t(t_1 * \aleph) = \hat{B}^t(t_2 * \Re) = [\alpha_1, \alpha_2]$ and $J^t(t_1 * \aleph) = J^t(t_2 * \Re) = \beta$. Thus $M^t((t_1 * \aleph) * (t_2 * \Re)) = \{min(M((t_1 * \aleph) * (t_2 * \Re)), t)\} \succeq min\{min(M(t_1 * \aleph), t), min(M(t_2 * \Re), t)\} = min\{M^t(t_1 * \aleph), M^t(t_2 * \Re),\} = min\{\gamma, \gamma\} = \gamma, \Rightarrow (t_1 * \aleph) * (t_2 * \Re) \in \mathcal{C}^t$, $\hat{B}^t((t_1 * \aleph) * (t_2 * \Re)) = \{rmin(\hat{B}((t_1 * \aleph) * (t_2 * \Re)), t')\} \succeq rmin\{rmin(\hat{B}(t_1 * \aleph), \hat{B}(t_2 * \Re), t')\} = rmin\{rmin(\hat{B}(t_1 * \aleph), t'), rmin(\hat{B}(t_2 * \Re), t')\} = rmin\{\hat{B}^t(t_1 * \aleph), \hat{B}^t(t_2 * \Re)\} = rmin\{[\alpha_1, \alpha_2], [\alpha_1, \alpha_2]\} = [\alpha_1, \alpha_2]$ and $J^t((t_1 * \aleph) * (t_2 * \Re)) = \{max(M((t_1 * \aleph) * (t_2 * \Re)), \Im)\} \preceq max\{max(M(t_1 * \aleph), \Im), max(M(t_2 * \Re), \Im)\} = max\{M^t(t_1 * \aleph), M^t(t_2 * \Re),\} = max\{\beta, \beta\} = \beta, \Rightarrow (t_1 * \aleph) * (t_2 * \Re) \in \mathcal{C}^t$. Hence, proof is completed. □

4. **Conclusions**

In this paper, T-MBJ neutrosophic set is defined and notion of T-MBJ neutrosophic M-subalgebra is also introduced by set of conditions on G-algebra. T-MBJ neutrosophic M-subalgebra of G-algebra has investigated by p-union, P-intersection, R-union, R-intersection and some results. For future work this study will be use to discuss the normal ideals, multiplication, translation and magnification of T-MBJ neutrosophic set.

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