Chapter One

New Type Hyper Groups, New Type SuperHyper Groups and Neutro-New Type SuperHyper Groups

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ABSTRACT

In this chapter, a new type Hyper groups are defined, corresponding basic properties and examples for new type Hyper groups are given and proved. Moreover, new type Hyper groups groups and are compared to hyper groups and groups. New type Hyper groups are shown to have a more general structure according to Hyper groups and groups. Also, new type SuperHyper groups are defined, corresponding basic properties and examples for new type SuperHyper are given and proved. Furthermore, we defined neutro-new type SuperHyper groups.

Keywords: SuperHyper Structure, New type Hyper groups, New type SuperHyper groups, Neutro-new type SuperHyper groups

INTRODUCTION

Hyperstructures [1] are defined by Marty in 1934. Hyperstructures are a extended and a new form of classical structures. Corsini obtained hypergroups [2] in 1993. So, many researchers have made studies on this subject [3-7]. Recently, Hashemi studied Hyper JK-algebras [8]; Muhiuddin et al. obtained Hyperstructure Theory Applied to BF-Algebras [9].

Neutrosophic theory, consisting of neutrosophic logic and neutrosophic sets, was defined by Florentin Smarandache in 1998. In neutrosophic set theory, there are T, I and F graphs (membership function, performance function and membership function, respectively) for each element. These functions can be set independently. For this reason, neutrosophic logic and neutrosophic sets are used in decision-making problems in almost all branches of science. So, many researchers have made studies on this subject [11 -20, 38-45].

Florentin Smarandache introduced new research areas in neutrosophy, which he called neutro-structures and anti-structures, respectively, in 2019 [21, 22]. When evaluating <A> as an element (concept, attribute, idea, proposition, theory, etc.), during the neutrosification process, he worked on three regions; two opposites corresponding to <A> and <antiA> and also a neutral (indeterminate) <neutA> (also called <neutralA>). A neutro-algebra consists of at least one neutro-operation (indeterminate for other items and false for other items) or it is an algebra well-defined for some items (also called internally defined), indeterminate for others, and externally defined for others. Therefore, the subject attracted the attention of many researchers [23–32]. Recently, Al-Tahan et al. studied some neutroHyperstructures [33]; Ibrahim and Agboola obtained NeutroHyperGroups [34].

Florentin Smarandache introduced new research areas, which he called SuperHyperstructures [35] in 2022. Recently, Hamidi studied Superhyper BCK-Algebras [36]; Jahanpanah and Daneshpayeh obtained Superhyper BE-Algebras [37].

In the second section, basic definitions on Hypergrup [2], SuperHyperoperation [35] are given. In the third chapter, new type Hyper groups are defined, corresponding basic properties and examples for new type Hyper groups are given and proved. Moreover, new type Hyper groups are compared to hyper group and group. New type Hyper groups are shown to have a more general structure according to Hyper groups and group. In the fourth section, new type SuperHyper groups are defined, corresponding basic properties and examples for new type SuperHyper groups are given and proved. In the fifth section, we defined neutro-new type SuperHyper groups. In the last section, results and suggestions are given.

BACKGROUND

Definition 1. [21]

i) [Law of neutro-well defined]

There exists a double (b, n) ∈ (G, G) such that b # n ∈ G [degree of truth T] and there exist a double (u, v) ∈ (G, G) such that u # v = indeterminate [degree of indeterminacy I], or there exist a double (p, q) ∈ (G, G) such that p # q ∉ G [degree of outer-defined F], where (T, I, F) is different from (1,0,0) and (0,0,1). Because (1,0,0) represents the classical well-defined law (100% well-defined law; T =1, I = 0, F = 0), while (0,0,1) represents the outer-defined law (i.e. 100% outer-defined law, or T=0, I=0, F =1).

ii) [Axiom of neutro-associativity]

There exists a triplet (b, n, m) ∈ (G, G, G) such that b # (n # m) = (b # n) # m [degree of truth T], and there exist two triplets (p, q, r) ∈ (G, G, G) such that p # (q # r) or (p # q) # r = indeterminate [degree of indeterminacy I], or there exist (u, v, w) ∈ (G, G, G) or u # (v # w) ≠ (u # v) # w [degree of falsehood F], where (T, I, F) is different from (1,0,0) and (0,0,1). Because (1,0,0) represents the classical law (100% true law; T =1, I = 0, F = 0), while (0,0,1) represents the anti- law (i.e. 100% false law, or T=0, I=0, F =1).

iii) [Axiom of existence of the neutro-identity element]

For an element a ∈ G, there exists e ∈ G such that a # e = e # a = a [degree of truth T], and for two elements b, c ∈ G, there exists an e ∈ G such that [b # e or e # b = indeterminate (degree of indeterminacy I) or c # e ≠ c ≠ e # c (degree of falsehood F)], where (T, I, F) is different from (1,0,0) and (0,0,1).

iv) [Axiom of existence of the neutro-inverse element]

For an element a ∈ G, there exists u ∈ G such that a # u = u # a = a (degree of truth T), and for two elements b, c ∈ G, there exists u ∈ G such that [b # u or u # b = indeterminate (degree of indeterminacy I) or c # u ≠ c ≠ u # c (degree of falsehood F)], where (T, I, F) is different from (1,0,0) and (0,0,1).

v) [Axiom of neutro-commutativity]

There exists a double (b, n) ∈ (G, G) such that b # n = n # b (degree of truth T) and there exist two doubles (u, v), (p, q) ∈ (G, G) such that [u # v or v # u = indeterminate (degree of indeterminacy I) or p # q ≠ q # p (degree of falsehood F)], where (T, I, F) is different from (1,0,0) and (0,0,1).

Definition 2. [21] A neutro-group is a neutro-algebraic structure which possesses at least one of the axioms {i – iv} of Definition 1 and it is an alternative to classical group.

Definition 3. [21] A neutro-commutative group is a neutro – algebraic structure which possesses at least one of the axioms {i – v} of Definition 1 and it is an alternative to classical commutative group.

Definition 4. [21] Let H be a non-empty set and ∘: H ×H → P^*(H) be a hyperoperation. The couple (H, ∘) is called a hypergroupoid. For any two non-empty subsets A and B of H and x ∈ H, we define

$$A \circ B = \bigcup_{a\in A, b\in B} a \circ b,\ A \circ x = A \circ \{x\} \text{ and } x \circ B = \{x\} \circ B.$$

Where, P^*(H) is power set of H and ∅ ∉ P^*(H).

Definition 5. [2] A hypergroupoid (H, ∘) is called a semihypergroup if for all a, b, c ∈ H,

$$(a \circ b) \circ c = a \circ (b \circ c)$$

A hypergroupoid (H, ∘) is called a quasihypergroup if for all a ∈ H,

$$a \circ H = H \circ a = H.$$

This condition is also called the reproduction axiom.

Definition 6. [2] A hypergroupoid (H, ∘) which is both a semihypergroup and a quasi-hypergroup is called a hypergroup.

Definition 7. [35] Let X be a nonempty set. Then (X, $o^*_{(m,n)}$) is called an (m, n)-super hyperalgebra, where

$$o^*_{(m,n)}: X^m \rightarrow P^n_*(X)$$

is called an (m, n)-super hyperoperation, $P^n_*(X)$ is the n^{th}-powerset of the set X, $\emptyset \notin P^n_*(X)$, for any subset A of $P^n_*(X)$, we identify {A} with A, m, n ≥ 1 and

$$X^m = X \times X \times \ldots \times X \text{ (m times)},$$

$$P^n_*(X) = P(P(\ldots P(X)).$$

Let $o^*_{(m,n)}: X^m \rightarrow P^n_*(X)$ is an (m, n)-super hyperoperation on X and $A_1, \ldots, A_m$ subsets of X. We define $o^*_{(m,n)}(A_1, \ldots, A_m) = \cup_{x_i \in A_i} o^*_{(m,n)}(x_1, \ldots, x_m)$.

If $\emptyset \in P^n_*(X)$, $o^*_{(m,n)}: X^m \rightarrow P^n_*(X)$ is called a neutrosophic (m, n)-super hyperoperation.

Also, it is shown that $o^*_{(m,n)}: X^m \rightarrow P^n(X)$

Definition 8. [35] Let $o^*_{(m,n)}: H^m \rightarrow P^n_*(H)$ be an (m, n)-super hyperalgebra. Strong SuperHyperAssociativity, for all $x_1, \ldots, x_m, y_1, \ldots, y_{m-1} \in H$,

$$o^*_{(m,n)}(o^*_{(m,n)}(x_1, \ldots, x_m), y_1, \ldots, y_{m-1}) = o^*_{(m,n)}(x_1, o^*_{(m,n)}(x_2, \ldots, x_m), y_1, \ldots, y_{m-1})$$

$$= o^*_{(m,n)}(x_1, x_2\, o^*_{(m,n)}(x_3, \ldots, x_m), y_1, \ldots, y_{m-1})$$

$$= o^*_{(m,n)}(x_1, \ldots, x_{m-1}\, o^*_{(m,n)}(x_m, y_1, \ldots, y_{m-1})$$

NEW TYPE HYPER GROUPS

Definition 9. Let H be a non-empty set and #: H×H → P^*(H) be a hyperoperation. If the following conditions are satisfied, then (H, #) is called a new type hyper group.

i) For all h, k ∈ H, h#k∈ P^*(H).

ii) For all h, k, m ∈ H, h #(k#m) = (h#k)#m

iii) For all h ∈ H, there is an e element such that

h#e = e#h = h

iv) For all h ∈ H, there is an h^{-1} element such that

h#h^{-1} = h^{-1}#h = e

Corollary 10. In Definition 9, we take H instead of P^*(H), then (H, #) is a group.

Corallary 11. It is clear that H ∈ P^*(H). Thus, every groups are a new type hyper group. But, the opposite is not always true.

Corollary 12. Let (H, #) be a new type hyper group. If (H, #) satisfies the condition

i) For all h ∈ H, h#H = H#h = H

then, (H, #) is a hyper group.

Example 13. Let H = {a, b, c, {a, b, c}} be a set.

#	a	b	c	{a, b, c}
a	{a, b, c}	b	c	a
b	a	{a, b, c}	c	b
c	a	b	{a, b, c}	c
{a, b, c}	a	b	c	{a, b, c}

i) It is clear that for all h, k ∈ H, h#k ∈ P^*(H).

ii) It is clear that for all h, k, m ∈ H, h #(k#m) = (h#k)#m

iii) For all h ∈ H, there is an e = {a, b, c} element such that

h#e = e#h = h

iv) For all h ∈ H, there is an h^{-1} = h element such that

h#h^{-1} = h^{-1}#h = e

Thus, (H, #) is a new type hyper group.

NEW TYPE SUPERHYPER GROUPS

Definition 14. Let H be a non-empty set and $o^*_{(m,n)}$: $H^m \to P^n_*(H)$ be a superhyperoperation. (H, $o^*_{(m,n)}$) is called a new type superhyper group if the following conditions are satisfied.

i) For all $x_1,\dots,x_m$∈ H$o^*_{(m,n)}(x_1,\dots,x_m) \in P^n_*(H)$

ii) Strong SuperHyperAssociativity, for all $x_1,\dots,x_m$, $y_1,\dots,y_{m-1}$∈ H,

$$o^*_{(m,n)}(o^*_{(m,n)}(x_1,\dots,x_m), y_1,\dots,y_{m-1}) = o^*_{(m,n)}(x_1, o^*_{(m,n)}(x_2,\dots,x_m), y_1,\dots,y_{m-1})$$

$$= o^*_{(m,n)}(x_1,x_2\, o^*_{(m,n)}(x_3,\dots,x_m), y_1,\dots,y_{m-1})$$

$$= o^*_{(m,n)}(x_1,\dots,x_{m-1}\, o^*_{(m,n)}(x_m, y_1,\dots,y_{m-1})$$

iii) For all x ∈ H, there is an e element of H such that

$$o^*_{(m,n)}(x,e,e,\dots,e) = o^*_{(m,n)}(e,x,e,\dots,e) = \dots = o^*_{(m,n)}(e,e,e,\dots,x,e) = o^*_{(m,n)}(e,e,e,\dots e,x) = x$$

iv) For all x ∈ H, there is a x^{-1} element of H such that

$$o^*_{(m,n)}(x, x^{-1}, x^{-1}, \ldots, x^{-1}) = o^*_{(m,n)}(x^{-1}, x, x^{-1}, \ldots, x^{-1})$$

$$= \ldots = o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots, x, x^{-1})$$

$$= o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots x^{-1}, x) = e$$

Corollary 15. In Definition 14, we take m = 2, n = 1, then (H, $o^*_{(m,n)}$) is a new type hyper group.

Corallary 16. Let (H, $o^*_{(m,n)}$) be a new type superhyper group. If the following condition is satisfied, then (H, $o^*_{(m,n)}$) is a superhyper group.

i) For all a ∈ H

$$H = o^*_{(m,n)}(a, H, H, \ldots, H) = o^*_{(m,n)}(H, a, H, H, \ldots, H)$$

$$= \ldots = o^*_{(m,n)}(H, H, \ldots, H, a, H)$$

$$= o^*_{(m,n)}(H, H, H, \ldots, H, a)$$

NEUTRO-NEW TYPE SUPERHYPER GROUPS

In this section, the symbol "$=_{NC}$" will be used for situations where equality is uncertain. For example, if it is not certain whether "a" and "b" are equal, then it is denoted by $a =_{NC} b$.

Definition 17. Let H be a non-empty set and $o^*_{(m,n)}$: $H^m \to P^n_*(H)$ be a neutro-function. If at least one of the following {i, ii, iii} conditions is satisfied, then (H, $o^*_{(m,n)}$) is called a neutro-new type superhyper group.

i) For some $x_i \in A_i$,

$$o^*_{(m,n)}(A_1, \ldots, A_m) = \cup_{x_i \in A_i} o^*_{(m,n)}(x_1, \ldots, x_m) \neq \emptyset \in P^n_*(H) \text{ (degree of truth T)}$$

and For some $z_i \in A_i$, $y_i \in A_i$,

$$(o^*_{(m,n)}(A_1, \ldots, A_m) = \bigcup_{x_i \in A_i} o^*_{(m,n)}(z_1, \ldots, z_m) = \emptyset \notin P^n_*(\mathrm{H}) \text{ (degree of falsity F)}$$

or

$$o^*_{(m,n)}(A_1, \ldots, A_m) = \bigcup_{y_i \in A_i} o^*_{(m,n)}(y_1, \ldots, y_m) =_{\mathrm{NC}} \emptyset \notin P^n_*(\mathrm{H}) \text{ (degree of indeterminacy I)).}$$

Where (T, I, F) is different from (1,0,0) and (0,0,1).

ii) For some $x_1, \ldots, x_m$, $y_1, \ldots, y_{m-1} \in$ H,

$$o^*_{(m,n)}(o^*_{(m,n)}(x_1, \ldots, x_m), y_1, \ldots, y_{m-1}) = o^*_{(m,n)}(x_1, o^*_{(m,n)}(x_2, \ldots, x_m), y_1, \ldots, y_{m-1})$$

$$= o^*_{(m,n)}(x_1, x_2\, o^*_{(m,n)}(x_3, \ldots, x_m), y_1, \ldots, y_{m-1})$$

$$= o^*_{(m,n)}(x_1, \ldots, x_{m-1}\, o^*_{(m,n)}(x_m, y_1, \ldots, y_{m-1})$$

(degree of truth T)

and for some $k_1, \ldots, k_m$, $l_1, \ldots, l_{m-1} \in$ H, $z_1, \ldots, z_m$, $t_1, \ldots, t_{m-1} \in$ H,

$$(o^*_{(m,n)}(o^*_{(m,n)}(k_1, \ldots, k_m), l_1, \ldots, l_{m-1}) \neq o^*_{(m,n)}(k_1, o^*_{(m,n)}(k_2, \ldots, k_m), l_1, \ldots, l_{m-1})$$

$$\neq o^*_{(m,n)}(k_1, k_2\, o^*_{(m,n)}(k_3, \ldots, k_m), l_1, \ldots, l_{m-1})$$

$$\neq o^*_{(m,n)}(k_1, \ldots, k_{m-1}\, o^*_{(m,n)}(k_m, l_1, \ldots, l_{m-1})$$

(degree of falsity F)

or

$$(o^*_{(m,n)}(o^*_{(m,n)}(z_1, \ldots, z_m), y_1, \ldots, y_{m-1}) =_{\mathrm{NC}} o^*_{(m,n)}(z_1, o^*_{(m,n)}(z_2, \ldots, z_m), t_1, \ldots, t_{m-1})$$

$$=_{\mathrm{NC}} o^*_{(m,n)}(z_1, z_2\, o^*_{(m,n)}(z_3, \ldots, z_m), t_1, \ldots, t_{m-1})$$

$$=_{NC}\ o^*_{(m,n)}(z_1, \dots, z_{m-1}\ o^*_{(m,n)}(z_m, t_1, \dots, t_{m-1})$$

(degree of Indeterminacy F)).

Where (T, I, F) is different from (1,0,0) and (0,0,1).

iii) For some x ∈ H, there is an e element of H such that

$$o^*_{(m,n)}(x, e, e, \dots, e) = o^*_{(m,n)}(e, x, e, \dots, e) = \dots = o^*_{(m,n)}(e, e, e, \dots, x, e) = o^*_{(m,n)}(e, e, e, \dots e, x) = x$$

(degree of truth T)

and for some y ∈ H, z ∈ H,

$$(o^*_{(m,n)}(y, e, e, \dots, e) \neq o^*_{(m,n)}(e, y, e, \dots, e) \neq \dots \neq o^*_{(m,n)}(e, e, e, \dots, y, e) \neq o^*_{(m,n)}(e, e, e, \dots e, y) \neq y$$

(degree of falsity F)

or

$$(\ o^*_{(m,n)}(\ z, e, e, \dots, e)\ =_{NC}\ o^*_{(m,n)}(\ e, z, e, \dots, e)\ =_{NC}\ \dots\ =_{NC}\ o^*_{(m,n)}(\ e, e, e, \dots, z, e) =_{NC}\ o^*_{(m,n)}(\ e, e, e, \dots e, z) =_{NC}\ z$$

(degree of indeterminacy F)).

Where (T, I, F) is different from (1,0,0) and (0,0,1).

iv) For some x ∈ H, there is a x^{-1} element of H such that

$$o^*_{(m,n)}(x, x^{-1}, x^{-1}, \dots, x^{-1}) = o^*_{(m,n)}(x^{-1}, x, x^{-1}, \dots, x^{-1})$$

$$= \dots = o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \dots, x, x^{-1})$$

$$= o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \dots x^{-1}, x) = e$$

(degree of truth T)

and for some y ∈ H, z ∈ H,

$$(o^*_{(m,n)}(y, x^{-1}, x^{-1}, \ldots, x^{-1}) \neq o^*_{(m,n)}(x^{-1}, y, x^{-1}, \ldots, x^{-1})$$

$$\neq \ldots \neq o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots, y, x^{-1})$$

$$\neq o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots x^{-1}, y) \neq e$$

or

$$(o^*_{(m,n)}(z, x^{-1}, x^{-1}, \ldots, x^{-1}) =_{NC} o^*_{(m,n)}(x^{-1}, z, x^{-1}, \ldots, x^{-1})$$

$$=_{NC} \ldots =_{NC} o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots, z, x^{-1})$$

$$=_{NC} o^*_{(m,n)}(x^{-1}, x^{-1}, x^{-1}, \ldots x^{-1}, z) =_{NC} e$$

(degree of indeterminacy F)).

Note 18. From Definition 17, the neutro-new type superhypergroup differrent from the new type superhypergroup. Neutro-new type superhypergroup are given as an alternative to new type superhypergroup. But, for a neutro-new type superhypergroup, instead of the ones that are not met in Definition 17, new type superhypergroup conditions are valid.

Example 19. Let H ={h, k}be a set. $o^*_{(2,2)}$: $H^2 \rightarrow P^2_{\cup}$ (H) is a superhyperoperation such that

$$o^*_{(2,2)}(X_1, X_2) = (X_1 \cap X_2) \cup (X_1 \cup X_2)^C$$

Where, $o^{\cup}_{(2,2)}$ is satisfied the condition i in Definition 17. Because, if $X_1 \cap X_2 = \emptyset$ and $X_1 \cup X_2 =$ H, then

$$o^*_{(2,2)}(X_1, X_2) = \emptyset \notin (H, o^*_{(2,2)}).$$

Thus, $(H, o^*_{(2,2)})$ is a neutro-new type superhypergroup. But, $(H, o^*_{(2,2)})$ is not a new type superhypergroup.

Example 20. Let H ={h, k}be a set. $o^{\#}_{(2,2)}$: $\mathrm{H}^2 \to P^2_{\cup}$(H) is a superhyperoperation such that

$$o^{\#}_{(2,2)}(X_1, X_2) = (X_1 \setminus X_2) \cup (X_2 \setminus X_1)$$

Where, $o^{\#}_{(2,2)}$ is satisfied the condition i in Definition 17. Because, if $X_1 \cap X_2 = \emptyset$, then

$o^{\#}_{(2,2)}(X_1, X_2) = \emptyset \notin (\mathrm{H}, o^{\#}_{(2,2)})$.

Thus, $(\mathrm{H}, o^{\#}_{(3,2)})$ is a neutro-new type superhypergroup. But, $(\mathrm{H}, o^{\#}_{(2,2)})$ is not a new type superhypergroup.

Theorem 21. Neutro-new type superhyper groups can be obtained from every new type superhyper group.

Proof. Let (H, $o^{*}_{(m,n)}$) be a new type superhyper group such that

$o^{*}_{(m,n)}$: $\mathrm{H}^{\mathrm{m}} \to P^n_*$(H),

It is clear that $\emptyset \notin P^*$(H). We assume that for any h ∉H such that

h≠ ∅ and $o^{*}_{(m,n)}(a, \dots, x_m) = \emptyset \notin P^*$(H).

Thus, (H∪{h}, $o^{*}_{(m,n)}$) satisfies condition i from Definition 17. Thus, (H∪{h}, $o^{*}_{(m,n)}$) is a neutro-new type superhyper group.

CONCLUSIONS

In this chapter, the new type superhyper group is defined and relevant basic properties are given. Similarities and differences between the hyper group and superhyper group are discussed. Also, the neutro-new type superhyper group is defined and relevant basic properties are given. Similarities and differences between the neutro-new type superhyper group and new type superhyper group are discussed. Researchers can make use of this chapter to define new type superhyper ring, new type superhyper field, new type superhyper modules, neutro- new type superhyper ring, neutro- new type superhyper field, neutro- new type superhyper modules.

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