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TRI-HYPER_IDEALS OF TERNARY SEMIHYPERRINGS

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Abstract

In this paper, we will newly establish the notion of a tri_hyper_ideal as a characterization ofbi_quasi_interior hyper_ideal,quasi-interior hyper_ideal, bi-interior hyper_ideal, bi-quasi hyper_ideal, quasi hyper_ideal, interior hyper_ideal,left(right) hyper_ideal and hyper_ideal of a ternary semihyperring. Then, we study the properties of tri-hyper_ideals of a ternary semihyperring and characterize the tri-simple ternary semihyperring using tri-hyper_ideals of a ternary semihyperring.

Keywords: tri-hyperideal, bi-quasi-interior hyperideal, quasi-interior hyperideal, bi-interior hyperideal, bi-quasi hyperideal, bi-hyperideal, quasi hyperideal, interior hyperideal.

1. INTRODUCTION

In [3] the authors are established the concept of bi-ideals of semi groups in the 1952. In [11], [12] inaugurate the notion of bi-ideals in semirings. In [33] Steinfelddeveloped theconcepts of quasi ideals in semigroups and rings. In [5], [6], [7], [8] Iseki developed the concept of quasi ideals in semirings. In [16], [17], [18], [20] M. Murali Krishna Rao studied the about gamma semirings as generalization of semirings. In [19], [26], [27], [30] M. Murali Krishna Rao et. al studied regular gamma semirings. In [20], [21], [22], [23], [24], [25], [29] he introduced and studied about bi-quasi ideas.

In this paper, we established the concept of tri-hyperideals as a characterization of quasi hyperideal, bi-hyperideal, interior hyperideal, left(right) hyperideal and hyperideal of ternary semihyperring and invented the properties of tri-hyperideals of a ternary semihyperring.

2. Preliminaries:

Definition 2.1: Let H be a non empty set with two "binary operations" like "addition and ternary multiplication" is said to be as "ternary semi ring" if H is an "additive commutative semi group" with the following axioms

1. $\left[\left[h_1h_2h_3\right]h_4h_5\right]=\left[h_1\left[h_2h_3h_4\right]h_5\right]=\left[h_1h_2\left[h_3h_4h_5\right]\right]$
2. $\left[\left(h_1+h_2\right)h_3h_4\right]=\left[h_1h_3h_4\right]+\left[h_2h_3h_4\right]$
3. $\left[h_1(h_2+h_3)h_4\right]=\left[h_1h_2h_4\right]+\left[h_1h_3h_4\right]$
4. $\left[h_1h_2(h_3+h_4)\right]=\left[h_1h_2h_3\right]+\left[h_1h_2h_4\right]\forall h_1,h_2,h_3,h_4,h_5\in H$

Definition 2.2: The mapping [ ]:$H\times H\times H\to P^*(H)$is called"ternary hyper operation" on the non empty set H.Where H is a non empty subset of $P^*(H)=P(H)\backslash\{0\}$

Definition 2.3:A"ternary hyper grouped" is called the doublet (H,[ ]) if H_1,H_2,H_3 are the non-empty subsets of H then we define $[H_1H_2H_3]=\bigcup_{h_1\in H_1,h_2\in H_2,h_3\in H_3}[h_1h_2h_3]$.

Definition 2.4: A non empty set H is called “ternary semi hyper ring” if for all $h_1, h_2, h_3, h_4, h_5 \in H$ and (H, ⊕) is a “commutative semi hyper group and the ternary multiplication [ ]” obeysbelow conditions

1. $\left[\left[h_1h_2h_3\right]h_4h_5\right] = \left[h_1\left[h_2h_3h_4\right]h_5\right] = \left[h_1h_2\left[h_3h_4h_5\right]\right]$
2. $\left[\left(h_1 \oplus h_2\right)h_3h_4\right] = \left[h_1h_3h_4\right] \oplus \left[h_2h_3h_4\right]$
3. $\left[h_1(h_2 \oplus h_3)h_4\right] = \left[h_1h_2h_4\right] \oplus \left[h_1h_3h_4\right]$
4. $\left[h_1h_2(h_3 \oplus h_4)\right] = \left[h_1h_2h_3\right] \oplus \left[h_1h_2h_4\right]$

Example 2.5:The set of all integers on Z, then define a “binary hyper operation and a ternary multiplication” on Z such that a$\oplus$ *b*={a,*b*} *and* [abc]=*a,b,c*. Then (Z,$\oplus$,[ ]) is a “ternary semi hyper ring”.

Definition 2.6:A“ternary semi hyper ring is called commutative” if

$$[h_1h_2h_3] = [h_2h_3h_1] = [h_3h_1h_2] = [h_2h_1h_3] = [h_3h_2h_1] = [h_1h_3h_2] \forall h_1, h_2, h_3 \in H$$

Definition 2.7: Let H be a “ternary semi hyper ring” and let Tbe a non-empty subset of H then T is said to be a ternary sub_semi_hyper_ring T of H iff$[TTT] \subseteq$T.

Definition 2.8: A “ternary semihyperring”H,and0$\in$H is said to be a zero element if then there an elements such that for all $h_1, h_2 \in H$,$[0h_1h_2] = [h_10h_2] = [h_1h_20] = 0$

Definition 2.9: Let an element *e* of “ternary semihyperring” H is said to be an“identity” if $[h_1h_1e] = [h_1eh_1] = [eh_1h_1] = h_1$ for all $h_1 \in H$ and obviously $[eeh_1] = [eh_1e] = [h_1ee] = h_1$

Definition 2.10: Let H be a ternary semi hyper ring and I be a non empty additive sub_semi_ hyper_group I of a ternary semi hyper ring H is called

1. A left hyper ideal of H if [HHI]$\subseteq$I
2. A lateral hyper ideal of H if [HIH]$\subseteq$I
3. A right hyper ideal of H if [IHH]$\subseteq$I

Let I be both the left as well as the right hyper ideal of H, then the set I is known as to be a two sided hyper ideal of H. If I is the left, thelateral , and the right hyper ideal of H then I is said to be a hyper ideal of H.

Remark 2.11: The triplet (H, ⊕, [ ]) is a ternary semi_hyper_ring for each element h ∈ H then the left, the lateral , the right , the two sided and hyper ideal generated by h are respectively represented by

L(*h*) = <*h*>$_l$ = { *h* } ∪ [HH*h*]
M(*h*) = <*h*>$_m$ = { *h* } ∪ [H*h*H] ∪ [H[H*h*H]H]
R(*h*) = <*h*>$_r$ = { *h* } ∪ [*h*HH]
T(*h*)= <*h*>$_t$ ={ *h* } ∪ [HH*h*] ∪ [*h*HH] ∪ [H[H*h*H]H]
J(*h*) = <*h*> = { *h* } ∪ [HH*h*] ∪ [H*h*H] ∪ [H[H*h*H]H] ∪ [*h*HH]

Definition 2.12: Let H be a non empty ternary semi hyper ring and M be a hyper ideal of ternary semi hyper ring H then M is said to be aMaximal hyper ideal of H if M ≠ H and also which does not exist any proper ideal of I of H then M⊆I.

Lemma 2.13: Let us assume that P, Q, R be any three “hyperideals” of a “ternary semihyperring” H, then [PQR] is a hyperideal of H.

3. “Tri-hyperideals in ternary semihyperring”:

Here in this part , we will establish the concept of “tri-hyperideal” as a characterization of “bi-hyperideal”, “quasi-hyperideal” also“interior hyperideal” of a “ternary semihyperring” and introduce some properties of “tri-hyperideal” of a “ternary semihyperring”.Entire of this paperH is a “ternary semihyperring” with the unity element.

Definition 3.1:Let H be ternary semi hyper ring and T be a non-empty subset of a “ternary semihyperring” H is known as “left tri-hyperideal” of H if T is a “ternary subsemihyperring” of H and TTHHTTT⊆T.

Definition 3.2:Let H be a ternary semi hyper ring and T be a non-empty subset of a “ternary semihyperring” H is known as “lateral tri-hyperideal” of H if T is a “ternary subsemihyperring” of H and TTHTHTT⊆T.

Definition 3.3:Let H be a ternary semi hyper ring and T be a non-empty subset of a “ternary semihyperring" H is known as"right tri-hyperideal" of H if T is a "ternary subsemihyperring" of H and TTTHHTT⊆T.

Definition 3.4:Let H be a ternary semi hyper ring and T be a non-empty subset of a "ternary semihyperring" H is known as"tri-hyperideal" of H if T is a "ternary subsemihyperring" of H and T is "left tri-hyperideal", "lateral tri-hyperideal" and "right tri-hyperideal" of H.

Theorem 3.5: Every "left (lateral, right) hyperideal" of a "ternary semihyperring" H is a "left (lateral, right) tri-hyperideal" of H.

The above theorem converse need not be true.

Example 3.6: The followingare "ternary semihyperrings" with hyper operation addition ⊕ and "ternary multiplication" [ ] as follows:

$$H_1 = \left\{ \begin{pmatrix} 0 & h_1 & h_2 & h_3 \\ 0 & 0 & h_4 & h_5 \\ 0 & 0 & 0 & h_6 \\ 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i = 1, 2, 3, 4, 5, 6} \right\}$$

and

$$H_2 = \left\{ \begin{pmatrix} 0 & h_1 & h_2 & h_3 & h_4 & h_5 \\ 0 & 0 & h_6 & h_7 & h_8 & h_9 \\ 0 & 0 & 0 & h_{10} & h_{11} & h_{12} \\ 0 & 0 & 0 & 0 & h_{13} & h_{14} \\ 0 & 0 & 0 & 0 & 0 & h_{15} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i = 1, 2,....., 15} \right\}$$

Let

$$B_1 = \left\{ \begin{pmatrix} 0 & h_1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & h_6 \\ 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i = 1, 6} \right\}$$

and

$$B_2 = \left\{ \begin{pmatrix} 0 & h_1 & 0 & h_3 & 0 & h_5 \\ 0 & 0 & h_6 & 0 & 0 & h_9 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & h_{14} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i = 1, 3, 5, 6, 9, 14} \right\}$$

Here B_1 is the left and the right tri-hyperideals of H but notthe left and "the right hyperideal" of H_1 and B_2 is the "lateral tri-hyperideal" of H_2 but not "lateral hyperideal" of H_2.

Definition 3.7: A "ternary subsemihyperring" B of a "ternary semihyperring" H is said to be a "Bi-hyperideal" of H if [BHBHB] ⊆ B.

Definition 3.8: A "ternary subsemihyperring" Q of a "ternary semihyperring" H is known as "Quasi-hyperideal" of H if [HHQ] ∩ ([HHQHH] ∪ [HQH]) ∩ [QHH] ⊆ Q.

Theorem 3.9: Every "quasi hyperideal of ternary semihyperring"H is a "tri-hyperideal" of H.

Theorem 3.10: If H is a "ternary semihyperring" H, then the following are hold.

1. If J_1be the "left hyperideal", J_2 be the "lateral hyperideal" and J_3 be the "right hyperideal" of J, then J_1∩ J_2∩ J_3 is a "tri-hyperideal" of H, where H is a "ternary semihyperring".
2. If J_1 be the "left hyperideal", J_2 be the "lateral hyperideal" and J_3 be the "right hyperideal" of J, then $[J_1.J_2.J_3]$ is a "tri-hyperideal" of H, where H is a "ternary semihyperring".

Definition 3.11: Let Bbe a non empty subset of a "ternary semihyperring" H is known as a "left bi-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and HHB ∩ BHBHB ⊆ B.

Definition 3.12: Let B be a non empty subset of a of a "ternary semihyperring" H is known as a "lateral bi-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and HBH ∩ BHBHB ⊆ B.

Definition 3.13: Let B be a non empty subset of a"ternary semihyperring" H is known as a "right bi-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and BHH ∩ BHBHB ⊆ B.

Definition 3.14: A nonempty subset B of a "ternary semihyperring" H is known as a "bi-quasi hyperideal" of H if B is a "left bi-quasi hyperideal", "lateral bi-quasi hyperideal" and "right bi-quasi hyperideal" of H.

Example 3.15: Let us take the"simple ternary semihyperring" H_2 in example 4.6, along with "hyper operation addition" ⊕ and "ternary multiplication" [ ]. And let

$$B=\left\{\begin{pmatrix}0 & h_1 & 0 & 0 & 0 & h_2\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & h_3 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & h_4\\ 0 & 0 & 0 & 0 & 0 & 0\end{pmatrix} : h_i^s \text{ are non positive real numbrs}\right\}$$

Here B is a bi – quasi hyperideal of H_2.

Definition 3.16: Let B be a non empty subset of a of a "ternary semihyperring" H is known as a "left tri-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and HHB ⋂ BBHHBBB ⊆ B.

Definition 3.17: Let B be a non empty subset of a of a "ternary semihyperring" H is known as a "lateral tri-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and HBH ⋂ BBHBHBB ⊆ B.

Definition 3.18: Let B be a non empty subset of a of a "ternary semihyperring" H is known as a "right tri-quasi hyperideal" of H if B is a "ternary subsemihyperring" of H and BHH ⋂BBBHHBB⊆ B.

Definition 3.19: Let B be a non empty subset of a of a "ternary semihyperring" H is known as a "tri-quasi hyperideal" of H if B is the "left tri-quasi hyperideal", " the lateral tri-quasi hyperideal" and "the right tri-quasi hyperideal" of H.

Example 3.20: Let us take the"simple ternary semihyperring" H_2 in example 4.6, with "hyper operation addition" ⊕ and "ternary multiplication" [ ]. Let

$$B=\left\{\begin{pmatrix}0 & h_1 & 0 & h_2 & h_3 & h_4\\ 0 & 0 & 0 & h_5 & h_6 & h_7\\ 0 & 0 & 0 & h_8 & 0 & h_9\\ 0 & 0 & 0 & 0 & h_{10} & 0\\ 0 & 0 & 0 & 0 & 0 & h_{11}\\ 0 & 0 & 0 & 0 & 0 & 0\end{pmatrix} : h_i^s \text{ are non positive real numbrs}\right\}$$

Here B is a tri – *quasi hyperideal of* H_2.

Theorem 3.21: Let B be a "left(lateral, right) bi-quasi hyperideal" of "ternary semihyperring" H, the B is a "tri-hyperideal" of H.

Proof: Assume that B is a "left bi-quasi hyperideal" of H. such that HHB ⋂ BHBHB ⊆ B. So that , BBHHBBB ⊆ HHB ⋂ BHBHB ⊆ B, BBBHHBB ⊆ HHB ⋂ BHBHB ⊆ B and BBHBHBB ⊆ HHB ⋂ BHBHB ⊆ Band so B is a "tri-hyperideal" of H.

Corollary 3.22: Let us assume that B is a "bi-quasi hyperideal" of ternary semihyperring H, then"B is a tri-hyperideal of H".

Theorem 3.21: Let us assume that B be a left(lateral, right) "bi-quasi hyperideal" of ternary semihyperring H, then B is a tri-quasi hyperideal of H.

Proof: Let us assume that Bbe the left bi-quasi hyperideal of H. So that HHB⋂ BHBHB ⊆ B. Then HHB⋂ BBHHBBB ⊆ HHB ⋂ BHBHB ⊆ B. so B is a left tri-quasi hyperideal of H.
I that similar way , we will prove the remaining parts.
The Converse of the above theorem 4.21, which is need not be true.

Example 3.22: Let us Consider a simple ternary semihyperring H_2 in example 4.6, with hyper operation addition ⊕ and ternary multiplication [ ]. Let

$$B=\left\{\begin{pmatrix}0 & h_1 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & h_2 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & h_3\\ 0 & 0 & 0 & 0 & 0 & 0\end{pmatrix} : h_i^s \text{ are non positive real numbrs}\right\}$$

Now, H_2H_2B ⋂ BBH_2H_2BBB⊆ B.

$$But\ H_2H_2B \cap BH_2BH_2B == \left\{\begin{pmatrix}0 & 0 & 0 & 0 & 0 & h\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0\end{pmatrix} : h \text{ is non positive real numbrs}\right\}$$

⊈ B

Hence B is a left(lateral, right) tri-quasi hyperideal of H_2. But not left (not lateral, not right) bi-quasi hyperideal of H_2.
Theorem 3.23: Every bi-hyperideal of H is the Left(the lateral, the right) tri-hyperideal of H.
The converse of theabove theorem 4.23, is not to be true.

Example 3.24: Let H_2be the simple ternary semihyperring in the above example 4.6, with hyper operation addition ⊕ and ternary multiplication [ ]. And let

$$H_3 = \left\{ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ h_1 & 0 & 0 & 0 & 0 & 0 \\ h_2 & h_3 & 0 & 0 & 0 & 0 \\ h_4 & h_5 & h_6 & 0 & 0 & 0 \\ h_7 & h_8 & h_9 & h_{10} & 0 & 0 \\ h_{11} & h_{12} & h_{13} & h_{14} & h_{15} & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i = 1, 2,....., 15} \right\}$$

Let

$$B_1 = \left\{ \begin{pmatrix} 0 & h_1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & h_{10} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & h_{15} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i= 1, 10, 15} \right\}$$

And

$$B_2 = \left\{ \begin{pmatrix} 0 & h_1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & h_{10} & 0 & h_{12} \\ 0 & 0 & 0 & 0 & h_{13} & 0 \\ 0 & 0 & 0 & 0 & 0 & h_{15} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i= 1, 10, 12, 13, 15} \right\}$$

,

$$B_3 = \left\{ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ h_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & h_6 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & h_{15} & 0 \end{pmatrix} : h_i^s \text{ are non positive real numbrs, i= 1, 6, 15} \right\}$$

Here B_1 and B_2 are "the left tri-hyperideals" and "the lateral tri-hyperideal" of H_2 but which is not bi-hyperideal of H_2 and B_3 is the right tri-hyperideal H_3 but not bi-hyperideal of H_3.

Definition 3.25: Let H be a ternary semi hyper ring and Abe non empty sub set of a ternary semihyperring H is known as *interior hyperideal* of H if A is a ternary subsemihyperring of H and HAHAH ⊆ A.

Theorem 3.26: Every interior hyper ideal of H is the left(the lateral, the right) tri-hyperideal of H.

Proof: Suppose that A is a interior hyperideal of H. HAHAH⊆ A.
Now AAHHAAA ⊆ HAHAH ⊆ A. therefore, A is a left tri-hyperideal of H.
Similarly, we can prove the other parts.

Theorem 3.27:Let B be a ternary subsemi hyper ring H. Let R be a right hyperideal, and M be a lateral hyperideal and L be a left hyperideal of H such that RML ⊆ B ⊆ R ⋂ M ⋂ L. Then B is a "tri-hyperideal" of H.

Proof: Suppose that R be the right hyper ideal, M be the lateral hyperideal and L be the left hyperideal of H such that RML ⊆ B ⊆ R ⋂ M ⋂ L.
Then BBHHBBB ⊆(R ⋂ M ⋂ L) (R ⋂ M ⋂ L)HH(R ⋂ M ⋂ L) (R ⋂ M ⋂ L) (R ⋂ M ⋂ L)⊆ RMHHLLL ⊆ RMHHL ⊆ RML ⊆ B. So that B is a left "tri-hyperideal" of H. in that similar way that , B is a lateral(right) tri-hyperideal of H and also B is a tri-hyperideal of H.

Theorem 3.28: Any intersection of the left(the lateral, the right) tri-hyperideal B of H and a hyperideal A of H is the left(the lateral, the right) tri-hyperideal of H.

Proof: Let us assume that C = B ⋂ A. Then CCHHCCC ⊆ BBHHBBB ⊆ B. Since A is hyperideal of H. So CCHHCCC ⊆ AAHHAAA ⊆ AHH ⊆ A and CCHHCCC ⊆ AAHHAAA ⊆ HAH ⊆ A, CCHHCCC ⊆ AAHHAAA ⊆ HHA ⊆ A. Thus CCHHCCC ⊆ B ⋂ A = C. Therefore C is a left tri-hyperideal of H. Similarly, we can prove the other sections.

Corollary 3.29: The intersection of tri-hyperideal B of H and a hyperideal A of H is a tri-hyperideal of H.

Corollary 3.30: The intersection of tri-hyperideals of H is a tri-hyperideal of H.

Theorem 3.31: The intersection of tri-hyperideal of H and bi-quasi tri-hyperideal (tri-quasi, interior hyperideal) of H is a tri-hyperideal of H.

Proof: Supposethat B is a tri-hyperideal of H and Q is a "bi-quasi hyperideal" of H. Now we will show that B ∩ Q is a tri-hyperideal of H.
Now, (B ∩ Q) (B ∩ Q)HH(B ∩ Q) (B ∩ Q) (B ∩ Q) ⊆ QHQHQ and (B ∩ Q) (B ∩ Q)HH(B ∩ Q) (B ∩ Q) (B ∩ Q) ⊆ HHQ. Thus (B ∩ Q) (B ∩ Q)HH(B ∩ Q) (B ∩ Q) (B ∩ Q) ⊆ HHQ∩QHQHQ⊆ Q.
Now, (B ∩ Q) (B ∩ Q)HH(B ∩ Q) (B ∩ Q) (B ∩ Q) ⊆ BBHHBBB ⊆ B and hence
(B ∩ Q) (B ∩ Q)HH(B ∩ Q) (B ∩ Q) (B ∩ Q) ⊆ B ∩ Q. so that B ∩ Q is the left tri-hyperideal of H. Similarly, B ∩ Q is the lateral as well as the right tri-hyperidial of H. Thus B ∩ Q is a tri-hyperideal of H. Similarly we can prove the other cases.

Conclusion:

In continuity of this article we may introduced and developed some characteristics of hyper ideals such as prime tri-hyperideals cet.

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