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RESEARCH ARTICLE - MATHEMATICS

Supra Topological Space via Semi Extremally Disconnected Space

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ABSTRACT

In this research we provided new concept namely supra–semi extremally disconnected space (briedly SU-SED spaces) by using semi open set via supra topological spaces and we study the properties of this space, we defend another types of sets such as supra semi closure and supra semi interior on supra semi extremally disconnected space. Like that we knew another supra topological spaces is called supra- semi hyper connected space shortly by SU- SH space we proof supra Semi hyper connected spaces is strong from of supra- semi extremally disconnected space that mean every SU-SH space is SU-SED but the converse not true and we explained an example indicates the validity of the result. We study relationship between supra–semi extremally disconnected space and supra-semi hyper connected space, some facts on this space and results have been given, we expanded to study the product of two spur semi extremally disconnected.. Finally we give example to support our work.

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KEYWORD: supra-extremally disconnected space shortly SU- ED space, supra-semi extremally disconnected space(briedly SU-SED spaces) , supra- semi hyper connected space

1-INTRODUCTION

By using supra topological $space$ $(X, \mathcal{M})$ which defined by A.S Mashhour [1]. In (2011) Alexander Arhangel studies of extremally disconnected topological spaces[2].

Also in (2019), (2021) Ahmad AL – Omari (Ahmed A. Salih, Haider J. Ali)[3] study the above concept via minimal structures spaces. We touched to many concepts such as the definition of supra topological space by S. Modak and S. Mistry [4], N.K.Humadi and H.J.Ali [5]. We also benefited of concept Supra- closure set and Supra- interior set that explain it by M. Devi and R. Vijaya lakshmi [6] to give a new concept supra semi- closure set and supra semi- interior set. After that we developed a concept supra- extremally disconnected which it referred by J. E.Jakson [7], Krishnavei, K, Vigneshwaran [8], to define supra- semi extremally disconnected space. In our paper we introduce a new concept namely supra semi extremally disconnected spaces (briedly SU-SED spaces), whenever supra semi cl (A) is supra open for any supra open set A in supra $space$ $(X, \mathcal{M})$. Also we define su. Semi hyper connected spaces which is strong from of SU-SED spaces. Some characterization, facts, results and examples have been given concerning these concepts.

2-PRELIMINARIES

In this section we give the basic of definition and facts we have needed

Definition 2-1 [9]

Let X a nonempty set, then the collection $\mathcal{M}$ of a subset of X is Saied to be supra topological

Space of X if

1- $\emptyset, X\ belong\ to\ \mathcal{M}$
2- $If\ A_I \in \mathcal{M}\ for\ all\ I\ \in ß, then\ \cup A_I \in \mathcal{M}.$

The elements of $\mathcal{M}$ are to get to know supra – open sets (briefly su-o sets and the complement of Su- o sets are called supra – closed sets.

Definition 2-2[10]
Let $(X, \mathcal{M})$ is a su- top Space. For a subset Z of X, the su- Closure of Z (denoted by su- cl(Z), Su - interior of Z (denoted by su- int(Z)) can be recognized
1- Su- cl(Z) = $\cap$ { K: Z $\subset$ K, $K^c \in \mathcal{M}$ }
2- Su- int(Z) =$\cup$ { M: M $\subset$ Z, M $\in \mathcal{M}$ }

Lemma 2-3 [11]

Let $(X, \mathcal{M})$ be a su- space. For a subset Z of X the below features are holds

1- Z is su- closed set if and only if su- cl(Z) = Z
2- $Z \epsilon \mathcal{M}\ if\ and\ only\ if\ su - int(Z) = Z$
3- $Su - int(Z)\ \epsilon\ \mathcal{M}\ and\ su - cl(Z)\ is\ su - closed.$

Lemma 2-4 [12]

Let $(X, \mathcal{M})$ be a su- top space. Whatever partial set P, B the coming features realized

1- $su - cl(\ X\ /P)\ =\ X/\ su -\ int(P)\ and\ su -\ int(X\ /P) = X/su - cl(P)$
2- $if\ (X)\ /P)\ \epsilon\ \mathcal{M}\ then\ su - cl\ (P) = P\ and\ if\ P\ \epsilon\ \mathcal{M}\ then\ su - int(P) = P$
3- $Su - cl(\emptyset) = \emptyset\ and\ su - cl(X) = X\ , su -\ int(\emptyset)\ =\ \emptyset\ and\ su - int(X) = X$
4- $If\ P \subset B\ , then\ su - cl(P) \subset su - cl(B)\ and\ su - int(P) \subset\ su - int(B)$
5- $P \subset\ su - cl(P)\ and\ su - int(P) \subset P.$
6- $Su - cl(su - cl(P)) = su - cl(P)\ and\ su - int(su - int(P)) = su - int(P).$

Definition 2-5[13]

A subset A of a su – space $(X, \mathcal{M})$ is name

1- A $su - \alpha - closer$
If $su - cl\ (su - int(su - cl(A))) \subset A$
2- $A\ su - semi - closed$
$If\ su - int(su - cl\ (A)) \subset A$ [14]
3- $A\ su - \beta - closed\ (or\ semi - pre\ closed\ )$
$If\ su - int(su - cl(su - int\ (A)))\ \subset A$ [15]
4- $A\ su - regular - closed$
If $A = su - cl(su - (int(A)))$ [16]
5- A su- pre- closed
if $su - cl\big(su - int(A)\big) \subset\ A$ [17]
6- A su- semi- open if $A\ \subset cl\ (su - (int(A)))$ [15]

Definition 2-6 [18]

A su- top space $(Y, \mathcal{M})$ is said to be supra- extremally disconnected space shortly SU- ED space if

$$Su - cl(A) \in \mathcal{M}, for\ each\ A \in \mathcal{M}.$$

Example 2-7[19]

Let X ={c,d,e}, $\mathcal{M}$ ={ Ø,{c},{d},{e},{c,d},{d,e},{c,e},X}is su- ED space.

Definition 2-8 [20]

A topological space $(X,\mathcal{M})$ is said to be extremally disconnected space if $cl(A) \in \mathcal{M}\ for\ each\ A \in \mathcal{M}$.

3-ON SUPRA- SEMI EXTREMALLY DISCONNECTED SPACE

In this section by using semi- open sets we introduce new kind of extremally disconnected space via supra topology as.

Definition 3-1

A su- topological space $(X,\mathcal{M})$ is said to be supra- semi extremally disconnected space denoted by SU- SED space $if\ SU - s\ cl(A) \in \mathcal{M}\ for\ each\ A \in \mathcal{M}.$

Example 3-2

The su- indiscrete space (R, $\mathcal{M}_{ind}$) is SU- SED space

Definition 3-3

A su- top $space$ $(X,\mathcal{M})$ is said to be supra- semi hyper connected space shortly by SU- SH space $if\ SU -\ s\ cl(A) = X, for\ each\ A\ \in \mathcal{M}.$

Example 3-4

The SU- co- finite space (R, $\mathcal{M}_{cof}$) is SU-SH.

Lemma 3-5

Every SU- SH space is SU- SED.

Proof

Suppose $(X,\mathcal{M})$ be a SU- SH space and $P \in \mathcal{M}$, then

$Su - s\ cl(P) = X\ but\ X\ \in \mathcal{M}, then\ su - cl(P) \in \mathcal{M}\ so\ that\ X\ is\ SU - SED.$

Remark 3-6

The Comverse of lemma (3-5) not true by next example

Example 3-7

In SU- discrete space $(R,\mathcal{M})$ is SU- SED space but not SU-SH space.

Definition 3-8

Let $(X,\mathcal{M})$ be a SU- SED space, for a subset P of X the supra semi closure of P (shortly by

SU- s cl(P) and supra semi interior of P (briefly SU- s int(P)) are defined as follows

1- SU- s cl(P) = ⋂ { E: P ⊂ E; $E^c \in \mathcal{M}$ }
2- $SU -\ s\ int(P)\ = \cup\ \{V: V\ \subset\ P;\ V \in \mathcal{M}\}$

Lemma 3-9

Let $(X,\mathcal{M})$ be a SU- SED space, whatever$P \subset X$, the below features are holds

1. $P \in \mathcal{M}\ iff\ SU - s\ int(P) = P$
2. $P\ is\ SU - s\ closed\ iff\ SU - s\ cl(P) = P$
3. $SU - s\ cl(P)\ is\ SU -\ s\ closed\ and\ SU -\ s\ int(P) \in \mathcal{M}.$

Lemma 3- 10

Let $(X, \mathcal{M})$ be a SU- SED space and Q, B by any subset of X, then the below features are holds

1- $SU - s\ cl(X \setminus SU - Q) = X \setminus SU - s\ int(Q)\ and\ SUs\ int(X \setminus SU - Q) =\ X \setminus SU - s\ cl(Q)$
2- $SU - s\ cl(\emptyset) = \emptyset, SU - s\ cl(X\ ) = Y\ , SU - s\ int(\emptyset\ ) = \emptyset\ , su - s\ int(X) = X$
3- $If\ SU - Q \subset SU - B, then\ SU - s\ cl(Q) \subset SU - s\ cl(B), SU - s\ int(Q) \subset SU -\ s\ int(B)$
4- $SU - Q \subset SU - s\ cl(Q)\ and\ SU - s\ in\ (Q) \subset SU - Q$

Theorem 3-11

Let $(X, \mathcal{M})$ be a SU- topological space, so the below features are equivalent

1- $(X, \mathcal{M}\ )$ is $\mathcal{M}$ SU-SED
2- $SU - s\ int(F) is\ SU - closed\ for\ every\ SU - closed\ subset\ F\ of\ X$
3- $SU - s\ cl(SU - int\ (F)) \subset SU - int(SU - s\ cl(F)), for\ every\ subset\ F\ of\ X$

Proof

1»2 Let F be a SU- closed set in X, then X- F is SU- open. By

$SU - s\ cl(X - F) = X - SU - s\ int\ (F)$ is SU- open. Thus SU- s int(F) is SU- closed.

2»3 Let F be any subset of X, then SU- int(F) is SU-open, thus

X/ SU- int (F) is SU- closed in X and by (2) SU- s int(X/ SU- int(F)) is SU- closed in X, but

$SU - s\ int(X\ /\ SU - int(F))\ = X/\ SU - s\ cl(\ SU - int(F))$ is SU- closed, therefore

SU- s cl(SU- int(F)) is SU- open in X and hence SU- s cl(SU- int(F)) ⊂ SU- int(SU- s cl(F)).

3»1 Let F ∈ $\mathcal{M}$, then SU- int(F) = SU-(F) by (3)

$SU - s\ cl(SU - (F)) =\ SU - s\ cl(SU - int\ (F)\ \subset SU - int(SU - s\ cl(F))$,but

$SU - int(SU - s\ cl(F)) \in \mathcal{M}$, then $SU - s\ cl(SU - (F)) \in\ \mathcal{M}$, so that X is SU-SED

Theorem 3-12

Let $(X, \mathcal{M})$ be a supra topological space, then following properties are equivalent

1- X is SU- SED space
2- $for\ any\ E\ \in\ \mathcal{M}\ and\ B\ is\ SU -\ s\ open\ set\ such\ that\ E \cap B = \emptyset,$
$there\ exicst\ a\ disjoint\ SU -\ s\ closed\ set\ W\ and\ SU -\ closed\ V$

$such\ that\ E \subset\ W\ and\ B \subset V$

3- $SU - s\ cl(W) \cap\ SU - cl(V) = \emptyset,\ for\ every\ W \epsilon \mathcal{M}\ and\ V\ is\ SU - s\ open\ and$

$W \cap\ V =\ \emptyset$

4- $SU - s\ cl\left(su - int\left(su - cl(W)\right)\right) \cap su - cl(V) = \emptyset\ for\ every\ W \epsilon \mathcal{M}\ and\ V\ is\ SU -$
$s\ open\ set\ and\ W \cap V = \emptyset$

Proof

1»2 Let X be a SU- SED space and E,B are two disjoint su- open and su- s open sets respectively, then $su - s\ cl(E)\ and\ X - (su -\ s\ cl(E))$ are disjoint su- s closed and su- closed sets containing E and B respectively.

2»3 Let $W \in\ \mathcal{M}\ and\ V\ is\ SU - s\ open\ with\ W\ \cap\ V\ =\ \emptyset$. By (2), there exist disjoint a SU- s closed set F and SU- closed set D such that W ⊂ F and V ⊂ D, therefore

$SU -\ s\ cl(W) \cap\ SU -\ cl(V) \subset F\ \cap\ D\ =\ \emptyset. Thus\ SU - s\ cl(W) \cap\ SU -\ cl(V) =\ \emptyset.$

3»4 Assume that $W \subset X\ and\ V\ is\ SU -\ s\ open\ with\ W\ \cap\ V\ =\ \emptyset. Since\ SU - int(SU - s\ cl(W)\ \in\ \mathcal{M}\ and\ SU - int(SU -\ s\ cl(W) \cap SU(V)\ =\ \emptyset$, by (3)

$SU -\ s\ cl(SU - int\ (SU -\ s\ cl(W)))\ \cap\ SU -\ cl(V) = \emptyset.$

4»1 Assume that W be any SU- open set. Then $[X\ /\ SU - s\ cl(W)]\ \cap\ SU\ (W) = \emptyset$. Thus

$X\ /\ SU - s\ cl(W)$ is SU- s open set and by (4)

$SU -\ s\ cl(SU -\ int(SU - s\ cl\ (W)))\ \cap SU -\ cl(X\ /\ SU - s\ cl(W)) = \emptyset, sice\ W \in\ \mathcal{M}, weget$

$SU -\ s\ cl(W)\ \cap [X\ /\ SU -\ int(SU -\ s\ cl(W))]\ =\ \emptyset,$ so that

$SU -\ s\ cl(W) \subset SU -\ int(SU - s\ cl(W))\ and\ SU -\ s\ cl(W)\ is\ SU - open.$ Therefore X is SU- SED space.

Definition 3-13

A subset S of $(X, \mathcal{M})$ is said to by SU- SR- open (supra- semi regular set) if

S = SU- int(SU- s cl(S)). The complement of SU- SR- open set is called SU- SR closed set.

Theorem 3-14

Let (X, $\mathcal{M}$) be a supra s topological space, then the following properties are equivalent

1- X is SU- SED space
2- Every SU- SR- open set of Y is SU- s closed in X.
3- Every SU-SR- closed set of Y is SU- s open set in X.

Proof

1»2 Let X be SU- SED space, let S be SU-SR - open set in X, then S = SU- int(SU- s cl(S)). Since S is SU- open set, then $SU - s\ cl(S)\ is\ SU - open, thus\ S = SU - int(\ SU -\ s\ cl(S))\ = SU - s\ cl(S)$ so that S is SU- s closed.

2»1 Suppose that every SU- SR- open set of X is SU- s closed in X. Let S be a SU- open subset of X,$since\ SU -\ int(SU -\ s\ cl(S))\ is\ SU - SR - open$, then it is SU-s closed. So that

$SU - s\ cl(S)\ \subset SU - s\ cl\ (SU -\ int(SU - s\ cl(S))) = SU -\ int\ (SU - s\ cl(S),$

Since $S \subset SU - int\ (SU - scl(S)). Thus\ SU - s\ cl(S)\ is\ SU - open\ set$ so that X is SU- SED space.

2»3 Let S be a SU- SR- closed set, then S^c is SU- SR- open. Then by (2) S^c is SU-s closed and in this manner S is a SU-s open set in X.

Theorem 3-15

Let $(X, \mathcal{M})$ be a supra topological space, then the following properties are equivalent

1- X is SU- S ED space
2- $SU - s\,cl(W) \in \mathcal{M}\ for\ each\ SU - SR - open\ set\ W\ in\ X.$

Proof

1»2 Let W be a SU-SR-open set of X, then W is SU- s open so that by (1) $SU - s\,cl(W) \in \mathcal{M}.$

2»1 Let $SU - cl(W) \in \mathcal{M}$ for every SU- SR- open set W of X. Let B be any SU- open set of X, then

$SU - int(SU - s\,cl(B))\ is\ SU - SR - \ open\ set\ and\ SU - s\,cl(B) = SU - s\,cl(SU - int(SU - s\,cl(B))) \in \mathcal{M}. Therefore\ SU - s\,cl(B) \in \mathcal{M}$ so that X is supra extremally disconnected.

Theorem 3-16

Let$(X, \mathcal{M})$ be a supra topological space, X is SU- SED space if and only if for each

SU- open set U like that each SU- s closed set V with $U \subset V$, there exist a SU- open set $U_1$and SU- s closed V_1 such that $U \subset V_1 \subset U_1 \subset V$.

Proof

Let X is a SU-SED space, and U is a SU- open set, V is a SU- s closed set in which $U \subset V$, on him

$U \cap (X - V) = \emptyset$, then by theorem (3-11) $SU - s\,cl(U) \cap SU - cl(X - V) = \emptyset$, that mean

$SU - s\,cl(U) \subset X - SU - cl(X - V)$.We now that $X - SU - cl(X - V) \subset V$ and writing

$SU - s\,cl(U) = V_1, X - SU - cl(X - V) = U_1, we\ have\ U \subset V_1 \subset U_1 \subset V$. Conversely, let the condition hold. Let A be a SU- open set and B be a SU- s open set in X such that $A \cap B = \emptyset$, then $A \subset X - B$ and $X - B$ is SU- s closed then there exist a SU- open set G and SU- s closed set F such that $A \subset F \subset G \subset X - B$. So that

$SU - s\,cl(A) \cap X - (SU - int(X - B)) = \emptyset$, but

$X - (SU - int(X - B)) = SU - cl(B). Hens\ SU - s\,cl(A) \cap SU - cl(B) = \emptyset$ by theorem

(3-11) X is SU-SED space.

4 Finite products

Let $(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$ be SUP- topological space and$X_1 \times X_2$ be the product of

$(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$In this topic we investigate together two problems in specific cases represent.

By $SU - s\,cl(F_1) \times SU - s\,cl(F_2) = SU - s\,cl(F_1 \times F_2)$where $F_1 \subset X_1, F_2 \subset X_2$ holds, and what are relationships between SU-SED space$(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$ and

$X_1 \times X_2$ where $\mathcal{M}$ is the product topology in $X_1 \times X_2$.

Proposition 4-1

Let$(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$ be SU- SED space and $A_1$is SU-s open in $(X_1, \mathcal{M}_1)$ and A_2 is SU-s open in $(X_2, \mathcal{M}_2)$, then $SU - s\,cl(A_1 \times A2) = SU - s\,cl(A_1) \times SU - s\,cl(A_2)$

Proof

By fact $SU - s\,cl(A_1)\, \epsilon \mathcal{M}, therefore\ SU - s\,cl(A_1) = A_1 \cup SU - int\ (SU - cl(A_1)$, and

$SU - s\,cl(A_1) = A_2 \cup SU - int\,(SU - cl(A_2)$, therefore

$$\begin{aligned} SU - s\,cl(A_1) \times SU - s\,cl(A_2) \\ &= A_1 \cup SU - int\,(SU - cl(A_1) \times A_2 \cup SU - int\,(SU - cl(A_2) \\ &\subset (A_1 \times A_2) \cup [SU - int\,(SU - cl(A_1)) \times (SU - int\,(SU - cl(A_2))] \end{aligned}$$

Since X_1 and X_2 are SU- SED spaces, then $SU - scl(A_1) \in \mathcal{M}_1$and $SU - s\,cl(A_2) \in \mathcal{M}_2$,

then $SU - int\,(SU - scl(A_1))$ = $SU - scl(A_1) and\ SU - int\left(SU - scl(A_2)\right) = SU - scl(A_2)) so$

$$\begin{aligned} (A_1 \times A_2) \cup [SU - int\,(SU - scl(A_1)) \times (SU - int\,(SU - scl(A_2))] \\ &= (A_1 \times A_2) \cup [\,SU - scl(A_1)) \times SU - scl(A_2))] \\ &= A_1 \times SU - scl(A_1) \cup A_2 \times SU - scl(A_2)) \\ &= SU - scl(A_1 \times A_2) \end{aligned}$$

Theorem 4-2

Let $(X_1, \mathcal{M}_1)\ and\ (X_2, \mathcal{M}_2)$ be SUP- topological space and $X_1 \times X_2$ be SU- SED, then

$(X_1, \mathcal{M}_1)\ and\ (X_2, \mathcal{M}_2)$ Are both SU- SED space

Proof

Supposed $X_1 \times X_2$ is SU- SED space and let $U \in \mathcal{M}_1$,$V \in \mathcal{M}_2$ by assumption $X_1 \times X_2$ is SU- SED, so

$SU - s\,cl(U \times V) = SU - s\,cl(U) \times SU - s\,cl(V)\ is\ SU - open\ in\ X_1 \times X_2.$

But projections on

$(X_1, \mathcal{M}_1)\ and\ (X_2, \mathcal{M}_2)$ are supra- open mapping, so $SU - s\,cl(U) \in \mathcal{M}_1)$ and

$SU - s\,cl(V) \in \mathcal{M}_2$ on him

$(X_1, \mathcal{M}_1)\ and\ (X_2, \mathcal{M}_2)$ are both SU- SED space

Proposition 4-3

Let $(X_1, \mathcal{M}_1)\ and\ (X_2, \mathcal{M}_2)$ be finite SU- SED spaces, then the space $X_1 \times X_2$ is SU-SED.

Proof

Let $\omega = \cup_{s\epsilon s}\ (U_S \times V_S)$ be any SU- open subset of $s\epsilon s$ in the product topology $U_S \in \mathcal{M}_1$,

$V_S \in \mathcal{M}_2$

(The set S is finite). Then SU- s $cl_{X_1 \times X_2}$(ω) = $\cup_{s\in S}$(SU- s $cl_{\mathcal{M}_1}(U_S)$ × SU-s $cl_{\mathcal{M}_2}(V_S)$, so

$X_1 \times X_2$ is SU-SED.

Remark4-4

The product of infinite SU-SED spaces need not be SU-SED

Remark4-5

We utilize the following fact [the diagonal set of product is open (SU- open) in it

If and only if the product is discrete.

Example 4-4

Let the product $KN \times KN$ is SU- SED space. The set ɳ $= \{ (n,n) \epsilon KN \times KN: n\epsilon N\}$is SU- open in $KN \times KN$ since each singleton { n } is SU- open in KN. The SU-s cl (ɳ) is the whole diagonal in $KN \times KN$ ɑnd is SU- open in it by given. But it is impossible, since the product $KN \times KN$ is not discrete.

Theorem 4-5

Let $(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$ be finite SU- topological spaces, then the space $X_1 \times X_2$ is SU-SED iff $(X_1, \mathcal{M}_1)$ and $(X_2, \mathcal{M}_2)$ are SU- SED space.

Proof

By theorem (4-2) and Proposition (4-3).

CONCLUSION

We proof the su- top space is SU- SED space if and only if SU- s int(F) is SU- closed for every SU-

Closed subset F of Y. A also it is SU- SED space iff SU- s cl(SU- int (F)) ⊂ SU- int(SU- s cl(F)), for

every subset F of Y. We defined supra- semi regular set (SR- open) and we made it Y is SU- SED space

iff every SU- SR- open set of Y is SU- s closed in Y. Finally we knew supra- semi hyper connected

Space and study the relationships between them.

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