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bT-Locally Closed Sets and bT-Locally Continuous Functions In Supra Topological Spaces.

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Abstract: *The aim of this paper is to introduce a decompositions namely supra bT- locally closed sets and define supra bT-locally continuous functions. This paper also discussed some of their properties.*
Keyword *S-BTLC set, S-BTL- continuous,S-BTL- irresolute.*

I. Introduction

In 1983 Mashhour et al [8] introduced Supra topological spaces and studied S- continuous maps and S^*- continuous maps. In 2011,Bharathi.S[3] introduced and investigated several properties of generalization of locally b- closed sets. In 1997, Arokiarani .I[2] introduced and investigated some properties of regular generalized locally closed sets and RGL-continuous functions. In this paper, we define a new set called supra bT- locally closed and also define supra bT- locally continuous functions and investigated some of the basic properties for this class of functions.

II. Preliminaries

Definition 2.1[8,10] A subfamily of μ of X is said to be a supra topology on X, if
(i) $X, \phi \in \mu$
(ii) if $A_i \in \mu$ for all $i \in J$ then $\cup A_i \in \mu$.
The pair (X,μ) is called supra topological space. The elements of μ are called supra open sets in (X,μ) and complement of a supra open set is called a supra closed set.

Definition 2.2[10] (i) The supra closure of a set A is denoted by $cl^{\mu}(A)$ and is defined as $cl^{\mu}(A) = \cap\{B : B \text{ is a supra closed set and } A \subseteq B\}$.
(ii) The supra interior of a set A is denoted by $int^{\mu}(A)$ and defined as
$int^{\mu}(A) = \cup\{B : B \text{ is a supra open set and } A \supseteq B\}$.

Definition 2.3[8] Let (X,τ) be a topological spaces and μ be a supra topology on X. We call μ a supra topology associated with τ if $\tau \subset \mu$.

Definition 2.4[10] Let (X,μ) be a supra topological space. A set A is called a supra b-open set if $A \subseteq cl^{\mu}(int^{\mu}(A)) \cup int^{\mu}(cl^{\mu}(A))$. The complement of a supra b-open set is called a supra b-closed set.

Definition 2.5[7] A subset A of a supra topological space (X,μ) is called bT^{μ}-closed set if $bcl^{\mu}(A) \subseteq U$ whenever $A \subseteq U$ and U is T^{μ}- open in (X,μ).

Definition 2.6[9] Let A and B be subsets of X. Then A and B are said to be supra separated, if $A \cap cl^{\mu}(B) = B \cap cl^{\mu}(A) = \phi$.

Definition 2.7[5] Let $(X,\tau)\to(Y,\sigma)$ be two topological spaces and $\tau \subseteq \mu$. A function f: $(X,\tau)\to(Y,\sigma)$ is called supra continuous, if the inverse image of each open set of Y is a supra open set in X.

Definition 2.8[6] Let $(X,\tau)\to(Y,\sigma)$ be two topological spaces and μ and λ be supra topologies associated with τ and σ respectively. A function f: $(X,\tau)\to(Y,\sigma)$ is called supra irresolute, if $f^{-1}(A)$ is supra open set of X for every supra open set A in Y.

Notations

S-BTLC* denotes supra bT^*- locally closed set and S-BTLC** denotes supra bT^{**} – locally closed set.

III. SUPRA bT-LOCALLY CLOSED SETS

Definition 3.1

Let (X,μ) be a supra topological space. A subset A of (X,μ) is called supra bT – locally closed set, if A = U∩V , where U is supra bT – open in (X,μ) and V is supra bT – closed in (X,μ). The collection of all supra bT- locally closed set S of X will be denoted by S-BTLC(X).

Remark 3.2

Every supra bT-closed set (resp. supra bT- open set) is S-BTLC.

Definition 3.3

For a subset A of supra topological space (X,μ), A ∈ $S\text{-}BTLC^*$ (X,μ), if there exist a supra bT- open set U and a supra closed set V of (X,μ), respectively such that A = U∩V.

Remark 3.4

Every supra bT-closed set (resp. supra bT-open set) is $S\text{-}BTLC^*$.

Definition 3.5

For a subset A of supra topological space (X,μ), A ∈ $S\text{-}BTLC^{**}$ (X,μ), if there exist a supra open set U and a supra bT - closed set V of (X,μ), respectively such that A = U∩V.

Remark 3.6

Every supra bT-closed set (resp. supra bT-open set) is $S\text{-}BTLC^{**}$.

Theorem 3.7 Let A be a subset of (X,μ) . If A ∈ $S\text{-}BTLC^*$ (X,μ) (or) $S\text{-}BTLC^{**}$ (X,μ) then A is S-BTLC (X,μ).

Proof Given A∈ $S\text{-}BTLC^*$ (X,μ) (or) $S\text{-}BTLC^{**}$ (X,μ),by definition A= U∩V, where U is supra bT- open set and V is supra closed set (or) U is supra open set and V is supra bT – closed set. By theorem 3.2 [7] every supra closed set is supra bT – closed set , therefore V is supra bT – closed set (or) every supra open set is supra bT – closed set, therefore U is supra bT- open set. Then A is S-BTLC (X,μ).

Example 3.8

Let X= {a,b,c} and μ = {X,φ,{a},{b},{a,b}}.In this (X,μ), $S\text{-}BTLC^*$ (X,μ) and $S\text{-}BTLC^{**}$ (X,μ) are the proper subset of S-BTLC (X,μ), because S-BTLC (X,μ) = P(X).

Theorem 3.9 Let A be a subset of (X,μ) . If A ∈ S-LC (X,μ) then A is S-BTLC (X,μ).

Proof Given A∈ S-LC,by definition A = U∩V, where U is supra open set and V is supra closed set. Since every supra open set is supra bT – open set and every supra closed set is supra bT – closed set. Then A ∈ S-BTLC (X,μ)

The converse of the above theorem is not true from the following example.

Example 3.10

Let X= {a,b,c} and μ = {X,φ,{a}}. S-LC(X,μ) = {X,φ,{a},{b,c}} and S-BTLC(X,μ) = P(X).

Theorem 3.11 For a subset A of (X,μ), the following are equivalent:

(i) A∈ $S\text{-}BTLC^{**}$(X,μ)

(ii) A = U∩bcl^{μ}(A), for some supra open set U

(iii) bcl^{μ}(A) –A is supra bT- closed

(iv) A∪[X-bcl^{μ}(A)] is supra bT– open

Proof (i)⇒(ii): Given A∈ $S\text{-}BTLC^{**}$(X,μ), then there exist a supra open subset U and a supra bT- closed subset V such that A = U ∩V. Since A⊂U and A⊂bcl^{μ}(A), then A⊂U∩bcl^{μ}(A).

Conversely, we have bcl^{μ}(A)⊂ V and hence A = U∩V⊃U∩bcl^{μ}(A). Therefore A = U∩bcl^{μ}(A).

(ii)⇒(i): Let A = U∩bcl^{μ}(A), for some supra open set U. Clearly, bcl^{μ}(A) is supra bT- closed and hence A = U∩bcl^{μ}(A)∈$S\text{-}BTLC^{**}$(X,μ).

(ii) ⇒(iii): Let A = U∩bcl^{μ}(A), for some supra open set U. Then A∈ $S\text{-}BTLC^{**}$(X,μ). This implies U is supra open and bcl^{μ}(A) is supra bT – closed. Therefore bcl^{μ}(A) –A is supra bT- closed.

(iii) ⇒(ii): Let U= X-[bcl^{μ}(A) –A].By (iii) U is supra bT- open in X. We know that every supra open is supra bT- open , therefore U is supra open in X. Then A = U∩bcl^{μ}(A) holds.

(iii) ⇒(iv): Let Q = bcl^{μ}(A) –A be supra bT – closed. Then X-Q = X-[bcl^{μ}(A) –A] = A∪[X-bcl^{μ}(A)]. Since X-Q is supra bT – open, A∪[X-bcl^{μ}(A)] is supra bT – open.

(iv) ⇒(iii): Let U = A∪[X-bcl^{μ}(A)]. Since X-U is supra bT – closed and X-U = bcl^{μ}(A) –A is supra bT – closed.

Definition 3.12

Let A be subset of (X,μ). Then

(i) The supra bT-closure of a set A is denoted by bT-cl^{μ}(A), define as bT-cl^{μ}(A)=∩{B:B is supra bT-closed and A⊆B}.

(ii) The supra bT-interior of a set A is denoted by bT-int$^{\mu}$(A), define as bT-int$^{\mu}$(A)=$\cap${B:B is supra bT-open and B$\subseteq$A}.

Theorem 3.13 For a subset A of (X,μ), the following are equivalent:

(i) A$\in$ S-BTLC (X,μ)
(ii) A = U$\cap$bT-cl$^{\mu}$(A), for some supra bT - open set U
(iii) bT-cl$^{\mu}$(A) –A is supra bT- closed
(iv) A$\cup$[X–bT-cl$^{\mu}$(A)] is supra bT- open

Proof (i)$\Rightarrow$(ii): Given A$\in$ S-BTLC (X,μ), then there exist a supra bT - open subset U and a supra bT-closed subset V such that A = U $\cap$V. Since A$\subset$U and A$\subset$bT-cl$^{\mu}$(A), then A$\subset$U$\cap$bT-cl$^{\mu}$(A).
Conversely, we have bT-cl$^{\mu}$(A)$\subset$ V and hence A = U$\cap$V$\supset$U$\cap$bT-cl$^{\mu}$(A). Therefore A = U$\cap$bT-cl$^{\mu}$(A).
(ii)$\Rightarrow$(i): Let A = U$\cap$bT-cl$^{\mu}$(A), for some supra bT - open set U. Clearly, bT-cl$^{\mu}$(A) is supra bT- closed and hence A = U$\cap$bT-cl$^{\mu}$(A)$\in$S-BTLC (X,μ).
(ii) $\Rightarrow$(iii): Let A = U$\cap$bT-cl$^{\mu}$(A), for some supra bT - open set U. Then A$\in$ S-BTLC (X,μ). This implies U is supra bT - open and bT-cl$^{\mu}$(A) is supra bT – closed. Therefore bT-cl$^{\mu}$(A) –A is supra bT- closed.
(iii) $\Rightarrow$(ii): Let U= X– [bT-cl$^{\mu}$(A) –A].By (iii) U is supra bT- open in X. Then A = U$\cap$bT-cl$^{\mu}$(A) holds.
(iii) $\Rightarrow$(iv): Let Q = bT-cl$^{\mu}$(A) –A be supra bT – closed. Then X–Q = X– [bT-cl$^{\mu}$(A) –A] = A$\cup$[X–bT-cl$^{\mu}$(A)]. Since X-Q is supra bT – open, A$\cup$[X–bT-cl$^{\mu}$(A)] is supra bT -open.
(iv) $\Rightarrow$(iii): Let U = A$\cup$[X– bT-cl$^{\mu}$(A)]. Since X–U is supra bT – closed and X–U = bT-cl$^{\mu}$(A) –A is supra bT – closed.

Theorem 3.14 For a subset A of (X,μ), the following are equivalent:

(i) A$\in$ S-BTLC* (X,μ)
(ii) A = U$\cap$cl$^{\mu}$(A), for some supra bT - open set U
(iii) bcl$^{\mu}$(A) –A is supra bT- closed
(iv) A$\cup$[X–bcl$^{\mu}$(A)] is supra bT- open

Proof (i)$\Rightarrow$(ii): Given A$\in$ S-BTLC* (X,μ), then there exist a supra bT - open subset U and a supra closed subset V such that A = U $\cap$V. Since A$\subset$U and A$\subset$cl$^{\mu}$(A), then A$\subset$U$\cap$cl$^{\mu}$(A).
Conversely, we have cl$^{\mu}$(A)$\subset$ V and hence A = U$\cap$V$\supset$U$\cap$cl$^{\mu}$(A). Therefore A = U$\cap$cl$^{\mu}$(A).
(ii)$\Rightarrow$(i): Let A = U$\cap$cl$^{\mu}$(A), for some supra bT - open set U. Clearly,cl$^{\mu}$(A) is supra closed and hence A = U$\cap$cl$^{\mu}$(A)$\in$S-BTLC* (X,μ).
(ii) $\Rightarrow$(iii): Let A = U$\cap$cl$^{\mu}$(A), for some supra bT - open set U. Then A$\in$ S-BTLC* (X,μ). This implies U is supra bT - open and cl$^{\mu}$(A) is supra closed. Therefore cl$^{\mu}$(A) –A is supra closed. We know that every supra closed is supra bT- closed, therefore bcl$^{\mu}$(A) –A is supra bT - closed.
(iii) $\Rightarrow$(ii): Let U= X– [bcl$^{\mu}$(A) –A].By (iii) U is supra bT- open in X. Then A = U$\cap$cl$^{\mu}$(A) holds.
(iii) $\Rightarrow$(iv): Let Q =bcl$^{\mu}$(A) –A be supra bT -closed. Then X–Q = X– [bcl$^{\mu}$(A) –A] = A$\cup$[X– bcl$^{\mu}$(A)]. Since X– Q is supra bT - open, A$\cup$[X–bcl$^{\mu}$(A)] is supra bT - open.
(iv) $\Rightarrow$(iii): Let U = A$\cup$[X–bcl$^{\mu}$(A)]. Since X–U is supra bT -closed and X–U = bcl$^{\mu}$(A) –A is supra bT -closed.

Theorem 3.15 For a subset A of (X,μ), if A$\in$S-BTLC**(X,μ), then there exist an supra open set G such that A = G$\cap$bT-cl$^{\mu}$(A).

Proof Let A$\in$S-BTLC**(X,μ). Then A = G$\cap$V$\Rightarrow$A$\subset$G. Then A$\subset$bT-cl$^{\mu}$(A). Therefore, A$\subset$G$\cap$bT-cl$^{\mu}$(A). Also, we have bT-cl$^{\mu}$(A)$\subset$V. This implies A=G$\cap$V$\supset$G$\cap$bT-cl$^{\mu}$(A)$\Rightarrow$A$\supset$G$\cap$bT-cl$^{\mu}$(A).Thus A = G$\cap$bT-cl$^{\mu}$(A).

Theorem 3.16 For a subset A of (X,μ), if A$\in$S-BTLC**(X,μ), then there exist an supra open set G such that A = G$\cap$bcl$^{\mu}$(A).

Proof Let A$\in$S-BTLC**(X,μ). Then A = G$\cap$V, where G is supra open set and V is supra bT-closed set. Then A = G$\cap$V $\Rightarrow$A$\subset$G. Obviously, A$\subset$bcl$^{\mu}$(A).
Therefore, A$\subset$G$\cap$bcl$^{\mu}$(A). ----------------------(1)
Also, we have bcl$^{\mu}$(A)$\subset$V. This implies A=G$\cap$V$\supset$G$\cap$bcl$^{\mu}$(A)$\Rightarrow$A$\supset$G$\cap$bcl$^{\mu}$(A).------------(2)
From (1) and (2), we get A = G$\cap$bcl$^{\mu}$(A).

Theorem 3.17 Let A be a subset of (X,μ). If A$\in$ S-BTLC**(X,μ), then bT-cl$^{\mu}$(A) –A is supra bT- closed and A$\cup$[X–bT-cl$^{\mu}$(A)] is supra bT - open.

Proof Given A$\in$ S-BTLC**(X,μ). Then there exist a supra open subset U and a supra bT- closed subset V such that A = U$\cap$V. This implies bT-cl$^{\mu}$(A) is supra bT- closed. Therefore, bT-cl$^{\mu}$(A) –A is supra bT- closed. Also, [X– [bT-cl$^{\mu}$(A) –A]] = A$\cup$[X–bT-cl$^{\mu}$(A)] . Therefore A$\cup$[X–bT-cl$^{\mu}$(A)] is supra bT - open.

Remark 3.18 The converse of the above theorem need not be true as seen from the following example.

Example 3.19 Let X={a,b,c,d} and μ = (X,ϕ,{a},{b},{a,b}}.Then {X,ϕ,{a},{b},{c},{d},{a,c},{a,d},{b,c},{b,d},{c,d},{a,c,d},{b,c,d}} is the set of all supra bT-closed set in X and S-BTLC**(X,μ) =P(X) – {{a,b,c},{a,b,d}}.If A = {a,b,c}, then bT-cl$^{\mu}$(A) –A = {d} is supra bT- closed and A∪[X-bT-cl$^{\mu}$(A)] = A is supra bT – open but A∉ S-BTLC**(X,μ).

Theorem 3.20 If A ∈ S-BTLC*(X,μ) and B is supra open, then A∩B ∈ S-BTLC*(X,μ).

Proof Suppose A ∈ S-BTLC*(X,μ), then there exist a supra bT- open set U and supra closed set V such that A = U∩V. So A∩B = U∩V∩B = (U∩B)∩V, where U∩B is supra bT- open. Therefore, A∩B ∈ S-BTLC*(X,μ).

Theorem 3.21 If A ∈ S-BTLC(X,μ) and B is supra open, then A∩B ∈ S-BTLC(X,μ).

Proof Suppose A ∈ S-BTLC(X,μ), then there exist a supra bT- open set U and supra bT - closed set V such that A = U∩V. So A∩B = U∩V∩B = (U∩B)∩V, where U∩B is supra bT- open. Therefore, A∩B ∈ S-BTLC(X,μ).

Theorem 3.22 If A ∈ S-BTLC**(X,μ) and B is supra closed, then A∩B ∈ S-BTLC**(X,μ).

Proof Suppose A ∈ S-BTLC**(X,μ), then there exist a supra open set U and supra bT- closed set V such that A = U∩V. So A∩B = U∩V∩B = U∩(B∩V), where B∩V is supra bT- closed. Hence, A∩B ∈ S-BTLC**(X,μ).

IV. SUPRA bT- LOCALLY CONTINUOUS FUNCTIONS

In this section, we define a new type of functions called supra bT- locally continuous functions (S-BTL -continuous functions),supra bT – locally irresolute functions(S-BTL-irresolute) and study some of their properties.

Definition 4.1

Let (X,τ) and (Y,σ) be two topological spaces and τ⊆μ. A function f: (X,τ)→(Y,σ) is called S-BTL-continuous (resp., S-BTL*- continuous, and S-BTL**- continuous), if f^{-1} (A) ∈ S-BTLC(X,μ),(resp., f^{-1} (A) ∈ S-BTLC*(X,μ), and f^{-1} (A) ∈ S-BTLC**(X,μ)) for each A∈σ.

Definition 4.2

Let (X,τ) and (Y,σ) be two topological spaces and μ and λ be a supra topologies associated with τ and σ respectively.A function f: (X,τ)→(Y,σ) is said to be S-BTL-irresolute(resp., S-BTL*- irresolute, resp., S-BTL**-irresolute) if f^{-1} (A) ∈ S-BTLC(X,μ),(resp., f^{-1} (A) ∈ S-BTLC*(X,μ), resp., f^{-1} (A) ∈ S-BTLC**(X,μ)) for each A∈S-BTLC(Y,λ)(resp., A∈S-BTLC*(Y,λ), resp., A∈S-BTLC**(Y,λ)).

Theorem 4.3 Let (X,τ) and (Y,σ) be two topological spaces and μ be a supra topology associated with τ. Let f: (X,τ)→(Y,σ) be a function. If f is S-BTL*- continuous (or) S-BTL**- continuous, then it is S-BTL-continuous.

Proof Let f: (X,τ)→(Y,σ) be a function. If f is S-BTL*- continuous (or) S-BTL**- continuous, by definition f^{-1} (A) ∈ S-BTLC*(X,μ), and f^{-1} (A) ∈ S-BTLC**(X,μ) for each A∈σ. By theorem 3.7 , f^{-1} (A) ∈ S-BTLC(X,μ). Then it is S-BTL- continuous.

Theorem 4.4 Let (X,τ) and (Y,σ) be two topological spaces and μ and λ be a supra topologies associated with τ and σ respectively. Let f: (X,τ)→(Y,σ) be a function . If f is S-BTL-irresolute(resp., S-BTL*- irresolute, and S-BTL**-irresolute) , then it is S-BTL- continuous(resp., S-BTL*- continuous, and S-BTL**- continuous).

Proof Let f: (X,τ)→(Y,σ) be a function . Let A is supra closed of Y. By theorem 3.2[7] every supra closed set is supra bT-closed set, therefore A is supra bT – closed set. Since f is S-BTL-irresolute(resp., S-BTL*-irresolute, and S-BTL**-irresolute), f^{-1} (A) is S-BTL-closed. Therefore f is S-BTL-continuous (resp., S-BTL*-continuous, and S-BTL**- continuous).

Theorem 4.5 If g:X→Y is S-BTL- continuous and h: Y→Z is supra continuous, then hog: X→Z is S-BTL-continuous.

Proof Let g:X→Y is S-BTL- continuous and h: Y→Z is supra continuous. By definition, g^{-1}(V)∈S-BTLC(X),V∈Y and h^{-1}(W)∈Y, W∈Z. Let W∈Z, then $(hog)^{-1}$(W) = ($g^{-1}h^{-1}$)(W) = g^{-1} (h^{-1}(W)) =g^{-1}(V), for V∈Y. This implies, $(hog)^{-1}$(W) = g^{-1}(V)∈S-BTLC(X),W∈Z. Hence hog is S-BTL- continuous.

Theorem 4.6 If g:X→Y is S-BTL-irresolute and h: Y→Z is S-BTL-continuous, then hog : X→Z is S-BTL- continuous.

Proof Let g:X→Y is S-BTL-irresolute and h: Y→Z is S-BTL-continuous. By definition, g^{-1}(V)∈S-BTLC(X), for V∈S-BTLC(Y) and h^{-1}(W)∈S-BTLC(Y), for W∈Z. Let W∈Z, then $(hog)^{-1}$(W) = ($g^{-1}h^{-1}$)(W) = g^{-1} (h^{-1}(W)) =g^{-1}(V), for V∈S-BTLC(Y). This implies, $(hog)^{-1}$(W) = g^{-1}(V)∈S-BTLC(X),W∈Z. Hence hog is S-BTL- continuous.

Theorem 4.7 If g:X→Y and h: Y→Z are S-BTL- irresolute, then hog : X→Z is S-BTL- irresolute.

Proof By the hypothesis and the definition, we have $g^{-1}(V) \in$ S-BTLC(X) , for $V \in$ S-BTLC(Y) and and $h^{-1}(W) \in$ S-BTLC(Y), for $W \in$ S-BTLC(Z).Let $W \in$ S-BTLC(Z), then $(hog)^{-1}(W) = (g^{-1}h^{-1})(W) = g^{-1}(h^{-1}(W)) = g^{-1}(V)$, for $V \in$ S-BTLC(Y). Therefore, $(hog)^{-1}(W) = g^{-1}(V) \in$ S-BTLC(X), $W \in$ S-BTLC(Z). Thus, hog is S-BTL- irresolute.

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