Supra*g-Closed Sets in Supra Topological Spaces

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Abstract
In 1983, Mashhour et al. introduced the supra topological spaces and studied S-continuous functions and S-continuous functions. In 2011, Ravi et al. introduced and investigated several properties of supra generalized closed sets, supra sg-closed sets and gs-closed sets in supra topological spaces. In this paper we introduced Supra*g- closed set in supra topological space and properties and characterization are discussed in details*

Keywords
*Supra closed set, Supra*g- closed set , Supra*g- open set and Supra topological space*

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I. Introduction

In 1983, Mashhour et al. [1] introduced the supra topological spaces and studied S-continuous functions and S*-continuous functions. In 2011, Ravi et al. [3] introduced and investigated several properties of supra generalized closed sets, supra sg-closed sets and gs-closed sets in supra topological spaces. In topological space the arbitrary union condition is enough to have a supra topological space. Here every topological space is a supra topological space but the converse is not always true. Many researchers are Introducing many new notions and investigating the properties and characterizations of such new notions In this paper we introduced Supra*g-closed set in supra topological space and properties and characterization are discussed in details

2 PRELIMINARIES

Throughout this paper, X, Y and Z denote the supra topological spaces (X, μ) , (Y, λ) and (Z, η) respectively, which no separation axioms are assumed. For a subset A of a space X, $cl^{\mu}(A)$ and $int^{\mu}(A)$ denote the supra closure of A and the supra interior of A respectively.

Definition 2.1. *[1]*

A subfamily μ of X is said to be a supra topology on X,

if (i) X, φ ∈ μ ,

(ii) If $A_i \in \mu$ for all i ∈ J, then $\cup A_i \in \mu$. The pair (X, μ) is called the supra topological space.

The elements of μ are called supra open sets in (X, μ) and the complement of a supra open set is called a supra closed set.

Definition 2.2[1]

The supra closure of a set A is denoted by $cl^{\mu}(A)$ and is defined as

$c^{l\mu}(A) = \cap\{B : B \text{ is supra closed and } A \subseteq B\}$.

The supra interior of a set A is denoted by $int^{\mu}(A)$ and is defined as

$int^{\mu}(A) = \cup\{B : B \text{ is supra open and } A \supseteq B\}$.

Definition 2.3. [1]

Let (X, τ) be a topological space and μ be a supra topology associated with τ , if τ ⊂ μ .

Definition 2.4. [2,3,4]

A subset A of a supra topological space X is called

(i) a supra pre-open set if $A\subseteq int^{\mu}(cl^{\mu}(A))$ and a supra pre-closed set if $cl^{\mu}(int^{\mu}(A))\subseteq A$

(ii) a supra semi-open set if $A \subseteq cl^{\mu}(int^{\mu}(A))$ and a supra semi closed set if $int^{\mu}(cl^{\mu}(A))\subseteq A$

(iii) a supra semi-preopen set if $A \subseteq cl^{\mu}(int^{\mu}(cl^{\mu}(A)))$ and a supra semi-preclosed if $int^{\mu}(cl^{\mu}int^{\mu}(A))\subseteq A$.

(iv) a supra α open set if $A\subseteq int^{\mu}(cl^{\mu}(int^{\mu}(A)))$ and an supra α closed set if $c^{\mu}l(int^{\mu}(cl^{\mu}(A)))\subseteq A$

(v) a supra regular-open set if $A = int^{\mu}(cl^{\mu}(A))$ and a supra regular-closed set if $A=cl^{\mu}(int^{\mu}(A))$.

Definition 2.5.[2,3,4]

A subset A of a supra topological space (X, μ) is called

(i) a supra generalized closed set (briefly g^{μ}-closed) if $cl^{\mu}(A)\subseteq U$ whenever A ⊆U and U is supra open in (X, μ).

(ii) a supra generalized semi-closed set (briefly gs^{μ} closed) if $scl^{\mu}\subseteq U$ whenever A ⊆U and U is supra open in (X, μ).

(iii) a supra semi generalized closed set (briefly sg^{μ}-closed) if $scl^{\mu}\subseteq U$ whenever A ⊆U and U is supra semi open in (X, μ).

(iv) a supra generalized α-closed set (briefly $g\alpha^{\mu}$ -closed) if $\alpha^{\mu}cl \subseteq U$ whenever A ⊆U and U is α^{μ}-open in (X, μ).

(v) a supra α- generalized closed set (briefly αg^{μ} closed) if $scl^{\mu}\subseteq U$ whenever A ⊆U and U is supra open in (X, μ).

(vi) a supra generalized semi pre-closed set (briefly gsp-closed) if $spcl^{\mu}\subseteq U$ whenever A ⊆U and U is supra open in (X, μ).

(vii) a supra generalized pre-closed set (briefly gp^{μ}-closed) if $pcl^{\mu}\subseteq U$ whenever A ⊆U and U is supra open in (X, μ).

(viii) a supra regular generalized closed set (briefly rg^{μ}-closed) if $cl^{\mu}\subseteq U$ whenever A ⊆U and U is supra regular open in (X, μ).

(ix) supra ω-closed set if cl^{μ} (A) ⊆U whenever A⊆U and U is supra semi-open in (X, μ).

3. SUPRA*g-CLOSED SETS

In this section , we introduce the supra closed set is called supra*g-closed and investigate some of the basic properties .

Definition 3.1.

A subset A of a supra topological space (X, μ) is called a supra star g -closed set (briefly supra*g-closed) if $cl^{\mu}(A)\subseteq U$ whenever A ⊆U and U is supra ω-open in (X, μ).

Theorem 3.2.

φ and X are supra*g-closed subset of X.

Theorem 3.3.

Every supra closed set in (X, μ) is supra*g-closed in (X, μ).

Proof follows from the definition.

The following example supports that a supra*g-closed set need not be supra closed in general.

Remark 3.4.

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

Example 3.5.

Let X= {1, 2, 3} μ = {φ ,X, {1}, {1, 2}}, A= {1,3} is supra*g-closed but not supra closed.

Theorem 3.6.

Every supra*g-closed set is supra gp closed.

Proof.

Let A be supra*g-closed in X such that A ⊆U, U is supra ω-open. Since $cl^{\mu}(A) \subseteq pcl^{\mu}(A) \subseteq U$.

Hence A is gp^{μ} closed .

Theorem 3.7

Every supra*g-closed set is supra wg closed

Proof.

Let A be supra*g-closed in X such that A ⊆U, U is supra ω-open . $cl^{\mu}(int^{\mu}(A)\subseteq cl^{\mu}(A)\subseteq U$. Hence A is supra wg closed.

Theorem 3.8

Every supra*g-closed set is supra rg closed

Proof.

Let A be supra*g-closed in X such that A ⊆U, an U be supra regular open .Then cl(A) ⊆U. Hence A is supra rg closed.

Example 3.9

Let X= {i, j, k}, μ = {φ,X, {i}, {j, k}}, A={j} is supra rg-closed and supra gpr-closed but not supra*g closed .

Example 3.10

Let X= {1, 2, 3}, μ = {φ, X, {1}, {1, 2}}, A= {2} is supra gp-closed and supra wg-closed but not supra*g closed

Theorem 3.11

Every supra*g-closed set is

(i) supra g - closed (ii) supra gs-closed (iii) supra α g - closed and (iv) supra gsp - closed

Proof:

Let A be a supra*g-closed set

Let A ⊆U and U be supra open. Then U is supra ω- open. Since A is supra*g -closed , cl^{μ} (A) ⊆U.

(i) Hence A is supra g-closed .

(ii) Then scl^{μ} (A) ⊆ cl^{μ} (A) ⊆ U. Hence A is supra gs-closed .

(iii) αcl^{μ} (A) ⊆ cl^{μ} (A) ⊆ U and hence A is supra α g-closed

(iv) $spcl^{\mu}$ (A) ⊆ cl^{μ} (A) ⊆U. Hence A is supra gsp-closed .

The converse of the above proposition need not be true in general as seen in the following examples.

Example 3.12

Let X= {p, q, r}, μ = {φ, X, {q}, {p,r}} , A ={p} is supra g-closed but not supra*g -closed .

Example 3.13

Let X= {1, 2, 3}, μ = {φ, X, {1}, {1, 2}} and let A = {2}.Then A is supra gs - closed ,supra α g -closed and supra gsp - closed but not supra*g-closed .

Proposition 3.14

Every supra *g**-closed set is supra*g -closed.

Proof follows from the definition.

Remark 3.15

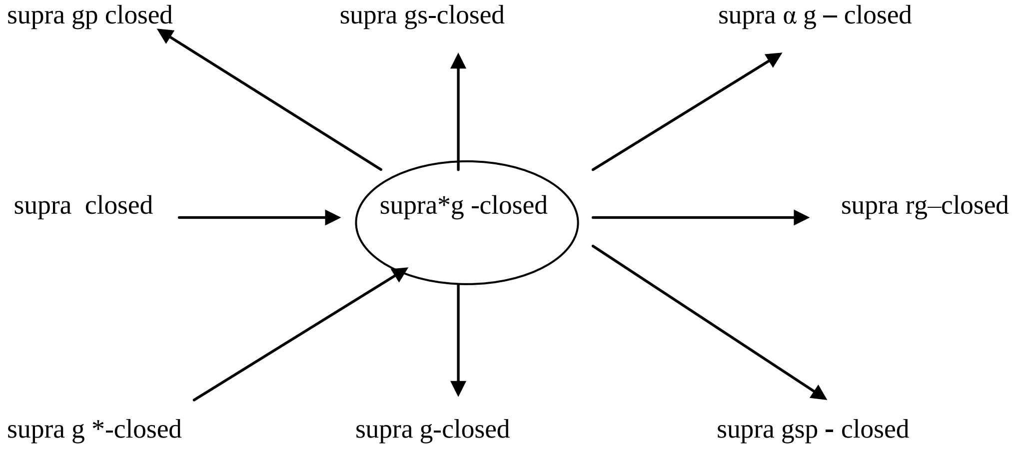
The converse of the above theorem need not be true as seen from the following example

Example 3.16

Let X= {a, b, c}, μ = {φ, X, {a}}.Then A= {b} is a supra*g -closed but not supra g*-closed

Remark 3.17

The above discussions are summarized in the following diagrammatic representation.



4. PROPERTIES OF SUPRA*g–CLOSED SETS

In this section , we study the concepts and properties of supra*g-closed and investigate some of results

Theorem 4.1.

The finite union of the supra*g-closed sets is supra*g-closed.

Proof.

Let A and B be supra*g-closed sets in X.Let U be a supra ω- open in X such that A ∪ B ⊆U. Then A ⊆U and B ⊆U . Since A and B are supra*g-closed, cl^{μ}(A) ⊆U and cl^{μ}(B)⊆U . Hence cl^{μ}(A ∪ B) = cl^{μ}(A) ∪ cl^{μ}(B) ⊆U. Therefore A∪B is supra*g-closed.

Theorem 4.2.

The finite intersection of the supra*g-closed sets is supra*g-closed.

Proof.

Let A and B be supra*g-closed sets in X. Let U be a supra ω-open in X such that A ∩ B⊆U. Then A ⊆U and B ⊆U. Since A and B are supra ω- open closed set, $cl^{\mu}(A)$ ⊆U and $cl^{\mu}(B)$ ⊆U . Hence $cl^{\mu}(A \cap B) = cl^{\mu}(A) \cap cl^{\mu}(B) \subseteq U$. Therefore A ∩ B is supra*g-closed.

Theorem 4.3.

The intersection of a supra*g-closed set and a supra closed set is a supra ω -closed set.

Proof.

Let A be a supra*g-closed subset of X and F be a supra closed set. If U is an supra ω- open subsets of X with A ∩ F ⊆U, then A ⊆U ∪ (X|F). So $cl^{\mu}(A) \subseteq U \cup (X|F)$.Then $cl^{\mu}(A\cap F)=cl^{\mu}(A)\cap cl^{\mu}(F) \subseteq cl^{\mu}(A)\cap cl^{\mu}(F)=cl^{\mu}(A)\cap F \subseteq U$ .So, A ∩ F is a supra ω -closed set.

Theorem 4.4.

Let A ⊆B ⊆$cl^{\mu}(A)$ and A is supra*g-closed subsets of X, then B is also a supra*g-closed subsets of X.

Proof

Since A is supra*g-closed subsets of X. So, $cl^{\mu}(A)$ ⊆U whenever A ⊆U, U is supra ω-open. Let A ⊆B ⊆$cl^{\mu}(A)$. That is, $cl^{\mu}(A)=cl^{\mu}(B)$. There exists an supra open subsets V of X such that B ⊆V . So, A ⊆V and B is supra*g closed subset of X, $cl^{\mu}(A)$ ⊆U . That is, $cl^{\mu}(B)$⊆V . Hence B is also supra*g-closed.

Theorem 4.5.

Let A ⊆B ⊆X , where B is supra ω-open in X. If A is supra*g-closed in X, then A is supra*g-closed in B.

Proof.

Let A ⊆U, where U is supra ω-open set of X, Since U = V∩B for some supra ω -open set V of X and B is supra ω-open in X .By assumption $cl^{\mu}(A) \subseteq U, cl^{\mu}(A)=cl^{\mu}(A)\cap B \subseteq U\cap B \subseteq U$. Hence A is supra*g-closed in B.

Theorem 4.6.

Let A ⊆B ⊆X , where B is supra ω-open and supra*g–closed in X . If A is supra*g-closed in B, then A is supra*g-closed in X.

Proof.

Let U be a supra ω-open set of X such that A ⊆U. Since A ⊆U∩B, where U∩B is supra ω -open in B and A is supra*g-closed in B, $cl^{\mu}(A)$ ⊆U∩B holds. We have $cl^{\mu}(A)\cap B \subseteq U \cap B$. Since A⊆B , we have $cl^{\mu}(A) \subseteq cl^{\mu}(B)$. Since B is supra ω-open and supra*g-closed in X. Hence B is supra-closed. Therefore $cl^{\mu}(B)$ = B . Thus $cl^{\mu}(A)$ ⊆B implies $cl^{\mu}(A) = cl^{\mu}(A)\cap B \subseteq U\cap B \subseteq U$ .Hence A is supra closed in X.

Theorem 4.7.

A subset A of X is supra*g-closed set if and only if $cl^{\mu}(A)\cap A^{C}$ contains the nonzero supra closed set in X .

Proof.

Let A be supra*g-closed subsets of X. Also if possible let M be a supra closed subset of X such that M ⊆$cl^{\mu}(A) \cap A^{C}$. That is, M ⊆$cl^{\mu}(A)$ and M ⊆A^{C} . Since M is a supra closed subset of X, M^{C} is a supra open subset of X ⊆A .A being supra*g-open subset of X, $cl^{\mu}(A)\subseteq M^{C}$. But M ⊆$cl^{\mu}(A)$. We get a contradiction. Then M = φ .

Conversely, Let A ⊆N. N being an open subset of X. Then $N^{C}\subseteq A^{C}$, N^{C} is a supra closed subset of X . Let if possible $cl^{\mu}(A)$ ⊆N , Then $cl^{\mu}(A)\cap N^{C}$ is a non-zero supra closed subset of $cl^{\mu}(A) \subseteq N^{C}$, which is a contradiction. Hence A is supra*g-closed subset of X.

Theorem 4.8.

A subset A of X is supra*g-closed set in X if and only if $cl^{\mu}(A)$-A contains no nonempty supra ω-closed set in X.

Proof.

Suppose that F be a non-empty supra ω-closed subset if $cl^{\mu}(A)$-A . Now F ⊆$cl^{\mu}(A)$ ⊆A .Then F ⊆$cl^{\mu}(A) \cap A^{C}$. Therefore F ⊆$cl^{\mu}(A)$ and F ⊆A^{C}. Since F^{C} is supra ω-open set and A is supra*g-closed, $cl^{\mu}(A) \subseteq F^{C}$. That is, F ⊆ $(cl^{\mu}(A))^{C}$. Hence F ⊆$cl^{\mu}(A)\cap[cl^{\mu}(A)]^{C}$=φ .That is, F=φ. Thus $cl^{\mu}(A)\backslash A$ contains no nonempty supra ω-closed set.

Conversely, assume that $cl^{\mu}(A)\backslash A$ contains no non-empty supra ω-closed set. Let A ⊆U, U is supra ω-open. Suppose that $cl^{\mu}(A)$ is not contained in U.Then $cl^{\mu}(A) \cap U^{C}$ is a non-empty supra ω-closed set and contained in $cl^{\mu}(A)\backslash A$,which is a contradiction. Then $cl^{\mu}(A)$⊆U and hence A is supra*g–closed set.

5. Supra*g-OPEN SETS

Definition 5.1.

A subset A of a supra topological space X is called supra*g-open set if A^{C} is supra*g-closed.

Theorem 5.2.

A subset A of a supra topological space X is called supra*g-open set if A^{C} is supra*g-closed.

Proof.

Necessity:

Suppose B ⊆$int^{\mu}(A)$ where B is supra ω -closed in X and B ⊆A. Let A^{C} ⊆M, where M is supra ω-open. Hence M^{C} ⊆A, where M^{C} is supra ω-closed. By assumption M^{C} ⊆$int^{\mu}(A)$, which implies $[int^{\mu}(A)]^{C}$ ⊆M . Therefore $cl^{\mu}(A^{C})$ ⊆M . Thus A^{C} is supra*g-closed implies A is supra*g-open.

Sufficiency:

Let A be supra*g-open in X with N ⊆A , where N is supra ω -closed . We have $cl^{\mu}(A^{C})$⊆N^{C} implies N⊆X\$cl^{\mu}$(A) = int^{μ}(X \$A^{C}$) =$int^{\mu}$(A) .Hence proved.

Theorem 5.3.

If int^{μ}(A) ⊆B ⊆A and A is a supra*g-open subset of X. Then B is also a supra*g-open subset of X.

Proof.

int^{μ}(A) ⊆B ⊆A implies A^{C} ⊆B^{C} ⊆ int^{μ}(A). Given A^{C} is supra*g-closed. By theorem 4.4, B^{C} is supra*g-closed. Therefore B is supra*g-open.

Theorem 5.4.

If a subset A of a supra topological space X is supra*g-open in X, then F = X whenever F is supra ω-open and int^{μ}(A) ⊆A^{C} ⊆F.

Proof.

Let A be a supra*g-open and F be supra ω-open, int^{μ}(A)∪A^{C} = F .This gives F^{C} ⊆(X\$int^{\mu}$(A))∩A=$cl^{\mu}(A^{C})$∩A = $cl^{\mu}(A^{C})$\$A^{C}$.Since F^{C} is supra ω -closed and A is supra*g-open. We have F^{C}= φ. Thus, F =X.

Theorem 5.5

If a subset A of a supra topological space X is supra*g-closed, then cl^{μ}(A)\A is supra open.

Proof.

Let A = X be a supra*g-closed and let F be supra ω -closed such that F ⊆cl^{μ}(A)\A. Then F =φ . So φ=F ⊆int^{μ}(cl^{μ}(A)\A). This shows that A is supra*g-open set.

Theorem 5.6.

If A × B is a supra*g-open subsetof (X × Y, μ × λ) if and only if A is a supra*g-open subset in X and B is supra*g–open subset in Y.

Proof.

Let if possible A × B is supra*g–open subset of (X × Y, μ × λ). Let H be a supra closed subset of X and G be a supra closed subset of Ysuch that H ⊆A, G ⊆B. Then H×G is supraclosed in (X × Y, μ × λ) such that H ×G ⊆A×B By A×B is a supra*g-open subset of (X ×Y, μ × λ) and H × G ⊆int^{μ}(A × B) ⊆int^{μ}(A)× int^{μ}(B) . That is, H ⊆ int^{μ}(A),G ⊆int^{μ}(A) and hence A is a supra*g-open subset in X and B is a supra*g-open in Y. Conversely Let F be supra closed subset of (X ×Y, μ × λ) such that K ⊆A×B. For each (x, y) ⊆K, cl^{μ}(X) × cl^{μ}(Y) ⊆cl^{μ}(K) = K ⊆A × B. Then the two closed sets cl^{μ}(X) and cl^{μ}(Y) are contained in A and B respectively. By assumption cl^{μ}(X) ⊆int^{μ}(A) and cl^{μ}(Y) ⊆int^{μ} (B) . This implies (x,y) ⊆K, (x, y) int^{μ}(A×B). A×B is a supra*g-open subset of (X × Y, μ × λ).Hence the theorem

CONCLUSIONS

Many different forms of generalized closed sets have been introduced over the years. Various interesting problems arise when one considers openness. Its importance is significant in various areas of mathematics and related sciences, this paper we introduce the closed set is called supra*g-closed in supra topological spaces and investigate some of the basic properties . This shall be extended in the future Research with some applications

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