INTUITIONISTIC FUZZY γ SUPRA OPEN SETS

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Abstract: *Necla Turanl introduced the concept of Intuitionistic fuzzy supra topological space which is a special case of Intuitionistic fuzzy topological space. Aim of this paper is we introduced in Intuitionistic fuzzy γ supra open sets in Intuitionistic fuzzy supra topological space and also discussed about IF γ supra open sets, IF γ supra closed sets,and Intuitionistic fuzzy γ supra Continuity in Intuitionistic fuzzy supra topological spaces*

Key Words: *IF supra open sets, IF supra closed sets, IF γ supra open sets, IF γ supra closed sets, Intuitionistic fuzzy γ supra Continuity*

1.INTRODUCTION

Topology is a classical subjects,as a generalization topological spaces many type of topological spaces introduced over the year. C.L. Chang [4] was introduced and developed fuzzy topological space by using L.A. Zadeh's[23] fuzzy sets. Coker[5] introduced the notion of Intuitionistic fuzzy topological spaces by using Atanassov's[2] Intuitionistic fuzzy set

A.S. Mashhour et al.[13] Introduced the supra topological spaces and studied in the year 1983. M. E. AbdEl-Monsef et al. [1] introduced the fuzzy supra topological spaces and studied fuzzy supra-continuous functions and obtained some properties and characterizations.In 2003 Necla Turanl [21] introduced the concept of Intuitionistic fuzzy supra topological space.

In 1996 D. Andrijevic [2] introduced b open sets in topological space, Aim of this paper is we introduced in Intuitionistic fuzzy γ supra open sets in Intuitionistic fuzzy supra topological space and also discussed about IF γ supra open sets, IF γ supra closed sets,and Intuitionistic fuzzy γ supra Continuity in Intuitionistic fuzzy supra topological spaces

2.PRELIMINARIES

DEFINITION 2.1: [3]
An Intuitionistic fuzzy set (IF for short) A is an object having the form

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle : x \in X\}$$

where the functions μ_A:X⟶[0,1] and ν_A:X⟶ [0,1] denote the degree of membership (namely $\mu_A(x)$) and the degree of non-membership (namely $\nu_A(x)$) of each element x ∈ X to the set A respectively, and $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ for each x ∈ X.
Obviously, every fuzzy set A on a nonempty set X is an IFS of the following form

$$A =\{\langle x, \mu_A(x), 1- \mu_A(x)\rangle: x \in X\}.$$

Definition 2.2: [3]
Let A and B be two IFSs of the form
$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle: x \in X\}$ and $B = \{\langle x, \mu_B(x), \nu_B(x)\rangle : x\in X\}$. Then,
(i) A ⊆ B if and only if $\mu_A(x)\leq\mu_B(x)$ and $\nu_A(x)\geq \nu_B(x)$ for all x ∈ X,
(ii) A = B if and only if A ⊆ B and A ⊇ B,
(iii) $A^C = \{\langle x, \nu_A(x), \mu_A(x)\rangle: x \in X\}$,
(iv) $A\cup B = \{\langle x, \mu_A(x) \vee \mu_B(x), \nu_A(x) \wedge \nu_B(x)\rangle: x \in X\}$,
(v) $A\cap B = \{\langle x, \mu_A(x) \wedge \mu_B(x), \nu_A(x) \vee \nu_B(x)\rangle: x \in X\}$.
(vi) $[\ ]A = \{\langle x, \mu_A(x), 1 - \mu_A(x)\rangle , x \in X\}$;
(vii) $\langle\rangle A = \{\langle x, 1 - \nu_A(x), \nu_A(x)\rangle , x \in X\}$;
The Intuitionistic fuzzy sets 0~ = ⟨x, 0, 1⟩ and 1~ = ⟨x, 1, 0⟩ are respectively the empty set and the whole set of X
Definition 2.3. [3]
Let {Ai : i ∈ J } be an arbitrary family of Intuitionistic fuzzy sets in X. Then
(a) $\cap A_i = \{\langle x,\wedge\mu_{Ai}(x),\vee \nu_{Ai}(x) \rangle : x \in X\}$;
(b) $\cup A_i = \{\langle x,\vee\mu_{Ai}(x),\wedge \nu_{Ai}(x) \rangle : x \in X\}$.
Definition 2.4. [3]
Since our main purpose is to construct the tools for developing Intuitionistic fuzzy topological spaces, we must introduce the Intuitionistic fuzzy sets 0~ and 1~ in X as follows:
0~ = {⟨x, 0, 1⟩: x ∈ X} and 1~ = {⟨x, 1, 0⟩ : x ∈ X}.
Definition 2.5:[3]
Let A,B,C be Intuitionistic fuzzy sets in X. Then
(i) A ⊆ B and C ⊆ D ⟹A ∪ C ⊆ B ∪ D and A ∩ C ⊆ B ∩ D,
(ii) A ⊆ B and A ⊆ C ⟹A ⊆ B ∩ C,
(iii) A ⊆ C and B ⊆ C ⟹A ∪ B ⊆ C,
(iv) A ⊆ B and B ⊆ C ⟹A ⊆ C,
(v) $\overline{A \cup B} = \bar{A} \cap \bar{B}$
(vi) $\overline{A \cap B} = \bar{A} \cup \bar{B}$,
(vii) $A \subseteq B \Rightarrow \bar{B} \subseteq \bar{A}$,
(viii) $\overline{(\bar{A})} = A$,
(ix) $\bar{1}\sim = 0\sim$,
(x) $\bar{0}\sim = 1\sim$.

Definition 2.6.[4]
Let f be a mapping from an ordinary set X into an ordinary set Y ,
If B ={⟨y, $\mu_B(y)$, $\nu_B(y)$ ⟩ : y ∈ Y } is an Intuitionistic fuzzy set in Y , then the inverse image of B under f is an Intuitionistic fuzzy set defined by $f^{-1}(B)$ = {⟨x, $f^{-1}(\mu_B)(x)$, $f^{-1}(\nu_B)(x)$ ⟩ : x ∈ X}
The image of Intuitionistic fuzzy set A = {⟨y, $\mu_A(y)$, $\nu_A(y)$ ⟩ : y ∈ Y } under f is an Intuitionistic fuzzy set defined by
f(A) = {⟨y, $f(\mu_A)(y)$, $f(\nu_A)(y)$ ⟩ : y ∈ Y }.

Definition 2.7[4]
Let A, Ai (i ∈ J) be Intuitionistic fuzzy sets in X, B, Bi (i ∈ K) be Intuitionistic fuzzy sets in Y and f : X → Y is a function. Then
(i) $A_1 \subseteq A_2 \Longrightarrow f(A_1) \subseteq f(A_2)$,
(ii) $B_1 \subseteq B_2 \Longrightarrow f^{-1}(B_1) \subseteq f^{-1}(B_2)$,
(iii) $A \subseteq f^{-1}(f(A))$ { If f is injective, then $A = f^{-1}(f(A))$},
(iv) $f(f^{-1}(B)) \subseteq B$ {If f is surjective, then $f(f^{-1}(B))=B$},
(v) $f^{-1}(\cup B_j) = \cup f^{-1}(B_j)$
(vi) $f^{-1}(\cap B_j) = \cap f^{-1}(B_j)$
(vii) $f(\cup B_j) = \cup f(B_j)$
(viii) $f(\cap B_j) \subseteq \cap f(B_j)$ { If *f* is injective, then $f(\cap B_j) = \cap f(B_j)$}
(ix) $f^{-1}(1\sim) = 1\sim$,
(x) $f^{-1}(0\sim) = 0\sim$,
(xi) $f(1\sim) = 1\sim$, if f is surjective
(xii) $f(0\sim) = 0\sim$,
(xiii) $\overline{f(A)} \subseteq f(\bar{A})$, if f is surjective,
(xiv) $f^{-1}(\bar{B}) = \overline{f^{-1}(B)}$.

Definition 2.8[21]
A family τ_μ Intuitionistic fuzzy sets on X is called an Intuitionistic fuzzy supra topology(in short,IFST) on X if $0\sim \in \tau_\mu, 1\sim \in \tau_\mu$ and τ_μ is closed under arbitrary suprema.
Then we call the pair (X,τ_μ) an Intuitionistic fuzzy supra topological space (in short,IFSTS).
Each member of τ_μ is called an Intuitionistic fuzzy supra open set and the complement of an Intuitionistic fuzzy supra open set is called an Intuitionistic fuzzy supra closed set.

Definition 2.9[21]
The Intuitionistic fuzzy supra closure of a set A is denoted by S-cl(A) and is defined as
S-cl (A) = ∩ {B : B is Intuitionistic fuzzy supra closed and A ⊆ B} .
The Intuitionistic fuzzy supra interior of a set A is denoted by S-int(A) and isdefined as
S-int(A) = ∪{B : B is Intuitionistic fuzzy supra open and A ⊇ B}

Definition 2.10 [21]
(i). ¬ (AqB) $\Leftrightarrow A \subseteq B^C$.
(ii). A is an Intuitionistic fuzzy supra closed set in X ⇔ S-cl (A) = A.
(iii). A is an Intuitionistic fuzzy supra open set in X ⇔S-int (A) = A.
(iv). $S\text{-}cl(A^C) = (S\text{-}int(A))^C$.
(v). $S\text{-}int(A^C) = (S\text{-}cl(A))^C$.
(vi). A ⊆ B ⟹ S-int(A) ⊆ S-int(B).
(vii). A ⊆ B ⟹ S-cl(A) ⊆ S-cl(B).
(viii). S-cl(A∪B) =S-cl(A)∪S-cl(B).
(ix). S-int(A∩ B) = S-int(A)∩ S-int(B).

Definition 2.11
Let (X, τ_μ) be an Intuitionistic fuzzy supra topological space.An IFS A ∈ IF(X) is called
(i) Intuitionistic fuzzy semi-supra open[12] iff A ⊆ S-cl(S-int(A)),
(ii) Intuitionistic fuzzy α-supra open[11] iff A ⊆ S-int(S-cl(S-int(A))),
(iii) Intuitionistic fuzzy pre-supra open [13]iff A ⊆ S-int(S-cl(A)).

Definition 2.12: [21]
Let (X, τμ) and (Y, σμ) be two Intuitionistic fuzzy supra topological spaces and let f: X→Y be a function. Then f is said to be
(i) Intuitionistic fuzzy supra continuous if the pre image of each Intuitionistic fuzzy supra open set of Y is an Intuitionistic fuzzy supra open set in X.
(ii) Intuitionistic fuzzy supra closed if the image of each intuitionisic fuzzy supra closed set in X is an Intuitionistic fuzzy supra closed set in Y.
(iii) Intuitionistic fuzzy supra open if the image of each intuitionisic fuzzy supra open set in X is an Intuitionistic fuzzy supra open set in Y.

.3. INTUITIONISTIC FUZZY γ SUPRA OPEN SETS

Definition 3.1.
Let (X, τμ) is a Intuitionistic fuzzy supra topological spaceand A ⊆ X . Then A is said to be Intuitionistic fuzzy γ supra open(briefly IFγs -open) set if A⊆ s-cl(s-int(A))∪ s-int(s-cl(A)).
The complement of Intuitionistic fuzzy γ supra open set is called Intuitionistic fuzzy γ supra closed set (briefly IFγs closed).

Theorem 3.2.
Every Intuitionistic fuzzy supra open set is Intuitionistic fuzzy γ supra open.

Proof.

Let A be a Intuitionistic fuzzy supra open set in (X, τμ) since A ⊆ s-cl(A) and A = s-int(A)s-int(A) ⊆s-int(s-cl(A)) and then s-int(A)⊆s-cl(s-int((A)) which implies s-int(A)⊆ s-cl(s-int(A))∪s-int(s-cl(A)). Hence A ⊆ s-int(A) ⊆ s-cl(s-int(A)) ∪s-int(s-cl(A)) and A is Intuitionistic fuzzy γ supra open in (X, τμ) The converse of the above theorem need not be true as shown by the following example.

Let X={ a,b}and U ={x, ⟨0.3,0.5⟩, ⟨0.6,0.7⟩} V ={x, ⟨0.5,0.3⟩, ⟨0.4,0.5 ⟩} and W={x, ⟨0.5,0.5⟩, ⟨0.5,0.5 ⟩} , τ_μ ={0~, U, V, U∪ V, 1~} Then W is called an Intuitionistic fuzzy γ-supra open but not an Intuitionistic fuzzy supra open set.

Theorem 3.3.

Every Intuitionistic fuzzy semi supra open set is Intuitionistic fuzzy γ supra open.

Proof.

Let A be a a Intuitionistic fuzzy semi supra open set in (X, τμ) Then A ⊆ s-cl(s-int(A)). Hence A⊆ s-cl(s-int(A))∪s-int(s-cl(A))and A is Intuitionistic fuzzy γ supra open in (X, τμ) The converse of the above theorem need not be true as shown by the following examples.

Example 3.4.

Let X={ a,b}and U ={x, ⟨ 0.5,0.6⟩, ⟨ 0.8,0.6⟩} V ={x, ⟨ 0.4,0.5⟩, ⟨ 0.9,0.8⟩} and W={x, ⟨ 0.5,0.6⟩, ⟨ 0.5,0.6⟩} ,
τ_μ={0~,U,V,U∪ V,1~} Then W is called an Intuitionistic fuzzy γ-supra open but not an Intuitionistic fuzzy semi supra open set.

Theorem 3.5.

Every a Intuitionistic fuzzy pre supra open set is a Intuitionistic fuzzy γ supra open.

Proof.

Let A be a a Intuitionistic fuzzy pre supra open set in (X, τμ) Then A ⊆ s-int(s-cl(A)). Hence s-cl(A) ⊆ s-cl(s-int(A))∪ s-int(s-cl(A))and A is Intuitionistic fuzzy γ supra open in (X, τμ)

Example 3.6.

Let X={ a,b}and U ={x, ⟨0.3,0.4⟩, ⟨ 0.6,0.4⟩} V ={x, ⟨ 0.2,0.3⟩, ⟨ 0.7,0.6⟩} and W={x, ⟨ 0.3,0.4⟩, ⟨ 0.3,0.4⟩} ,
τ_μ={0~, U, V,U∪V, } Then W is called an Intuitionistic fuzzy γ-supra open but not an Intuitionistic fuzzy pre supra open set.

Theorem 3.7.

Every Intuitionistic fuzzy α supra open set is Intuitionistic fuzzy γ supra open.

Proof.

Let A be a Intuitionistic fuzzy α supra open set in (X, τμ) Then A ⊆ s-int(s-cl(s-int(A))). Hence A ⊆ s-int(s-cl(s-int(A))) ⊆ s-cl(s-int(A))⊆ s-cl(s-int(A))∪ s-int(s-cl(A)) and A is Intuitionistic fuzzy γ supra open in (X, τμ) The converse of the above theorem need not be true as shown by the following examples

Example 3.8.

Let X={ a,b}and U ={x, ⟨ 0.2, 0.4⟩, ⟨ 0.3, 0.4⟩} V ={x, ⟨ 0.3, 0.2⟩, ⟨ 0.4, 0.3⟩} and W={x, ⟨ 0.3, 0.3⟩, ⟨ 0.3, 0.3⟩} ,
τμ = {0~, U, V, U∪V, 1~} Then W is called an Intuitionistic fuzzy γ-supra open but not an Intuitionistic fuzzy α supra open set.

Theorem 3.9.

(i) Arbitrary union of two Intuitionistic fuzzy γ supra open sets in (X, τμ) is not a Intuitionistic fuzzy γ supra open sets in (X,τμ)
(ii) Finite intersection of two Intuitionistic fuzzy γ supra open sets may fail to be Intuitionistic fuzzy γ supra open.

Proof.

(i) Let A and B be two Intuitionistic fuzzy γ supra open sets. Then, A ⊆s-cl(s-int(A))∪ s-int(s-cl(A)) and B ⊆ s-cl(Int(B))∪ s-int(cl(B)). Then A ∪ B ⊆ [s-cl(s-int(A))∪ s-int(s-cl(A))] ∪ [s-cl(s-int(B))∪s-int(s-cl(B))]⊆s-cl(s-int(s-cl(A)))∪s-int(s-cl(B)) ⊆ s-cl(s-int(s-cl(A)∪s-cl(B))))⊆s-cl(s-int(s-cl(A∪B))) . Therefore A ∪ B is Intuitionistic fuzzy γ supra open.
(ii) It is obvious

Remark.3.10

It is clear that IFγs-int(A) is a Intuitionistic fuzzy γ supra open and Intuitionistic fuzzy γ supra cl(A) is a Intuitionistic fuzzy γ supra closed set.

Proposition 3.11.

The intersection of a Intuitionistic fuzzy α supra open set and a Intuitionistic fuzzy γ supra open set is a Intuitionistic fuzzy γ supra open set.

Theorem 3.12.

Let X be an Intuitionistic fuzzy supra open spaces. If A and B are two supra sets of X, then
(i) X − IFγs-int(A)=IFγs-cl(X − A)
(ii) X − IFγs-cl(A)=IFγs-int(X − A)
(iii) If A ⊆ B, then IFγs-cl(A) ⊆ IFγs-cl(B) and IFγs-int(A) ⊆ IFγs-int(B)

Proof.

It is obvious.

Theorem 3.13.

Let X be an Intuitionistic fuzzy supra open spaces. If A and B are two sub sets of X, then
(i) IFγs-int(A) ∪ IFγs-int(B) ⊆ IFγs-int(A ∪ B)
(ii) IFγs-int(A ∩ B) ⊆ IFγs-int(A)∩ IFγs-int(B)
(iii) If A ⊆ B, then IFγs-cl(A) ⊆ IFγs-cl(B) and IFγs-int(A) ⊆ IFγs-int(B)
Proof. It is obvious.

4. Intuitionistic fuzzy γ supra Continuity

Definition 4.1.

Let (X, τ_μ) and (Y, σ_μ) be Intuitionistic fuzzy supra topological spaces. Then a mapping $f : (X, \tau_\mu) \rightarrow (Y, \sigma_\mu)$ is Intuitionistic fuzzy γ supra continuous on X if the inverse image of every Intuitionistic fuzzy γ supra open set in Y is a Intuitionistic fuzzy supra open in X .

Example 4.2

Let X = {a, b}, Y = {u, v} and
U={<0.5, 0.2> , <0.3, 0.4>},
V={<0.3, 0.4> , <0.6, 0.5>},
W={<0.5, 0.4> , <0.3, 0.4>},
Z={<0.3, 0.4>, <0.6, 0.5>}.

Then τ_μ = {0~, 1~, U, V, U ∪ V} be an Intuitionistic fuzzy supra topology on X. Then the Intuitionistic fuzzy supra topology σ_μ on Y is defined as follows:
σ_μ = {0~, 1~, W, Z, W ∪Z}.
Define a mapping f (X, τ_μ) → (Y, σ_μ) by f(a) = u and f(b) = v. The inverse image of the IFsOS in Y is not an IFsOS in X but it is an IFsγOS. Then f is an Intuitionistic fuzzy supra γ-continuous map but not be an Intuitionistic fuzzy supra continuous map

Theorem 4.3.
A function f : (X, τμ) → (Y, σ_μ)is Intuitionistic fuzzy γ supra continuous if and only if the inverse image of every Intuitionistic fuzzy γ supra closed set in Y is Intuitionistic fuzzy supra closed in X

Proof.
Let f be Intuitionistic fuzzy γ supra continuous and F be Intuitionistic fuzzy γ supra closed in Y. That is, Y-F is Intuitionistic fuzzy γ supra open in Y. Since f is Intuitionistic fuzzy supra continuous , f^{-1}(F) is Intuitionistic fuzzy supra closed in X . thus the inverse image of every Intuitionistic fuzzy γ supra closed set in Y is Intuitionistic fuzzy supra closed in X , if f is Intuitionistic fuzzy supra continuous in X .
Conversely, let the inverse image of every Intuitionistic fuzzy γ supra closed set be IF closed. Let g be Intuitionistic fuzzy γ supra open in Y.Then Y − G is Intuitionistic fuzzy γ supra closed in Y. then f^{-1}(Y-G) is Intuitionistic fuzzy supra closed in X . That is, X− f^{-1}(G) is Intuitionistic fuzzy supra closed in X . Therefore f^{-1}(G) is Intuitionistic fuzzy supra open in X . Thus, the inverse image of every Intuitionistic fuzzy γ supra open set in Y is Intuitionistic fuzzy supra open in X . That is, f is Intuitionistic fuzzy γ supra continuous on X .

Theorem 4.4.
A function f : (X, τ_μ) → (Y, σ_μ) is Intuitionistic fuzzy γ supra continuous if and only iff (IFγs-cl(A))⊆ IFγs-cl(f(A)) for every sub setA of X .

Proof.
Let f be Intuitionistic fuzzy γ supra continuous and A ⊆ X . Then f(A) ⊆ Y. IFγs-cl(f(A)) is Intuitionistic fuzzy γ supra closed in Y. Since f is IF γ supra continuous, f^{-1}(IFγs-cl(f(A))) is Intuitionistic fuzzy supra closed in X .Since f(A) ⊆ IFγs-cl(f(A)), A ⊆ f^{-1}(IFγs-cl(f(A))). Thus f^{-1}(IFγs-cl(f(A)) is Intuitionistic fuzzy γ supra closed set containing A. Therefore IFγs-cl(A) ⊆f^{-1}(IFγs-cl(A). That is, f(IFγs-cl(A))⊆ IFγs-cl(f(A)).
Conversely, let f(IFγs-cl(A)) ⊆ IFγs-cl(f(A)) for every sub set A of X . If F is Intuitionistic fuzzy γ supra closed in Y, since f^{-1}(F) ⊆ X , f(IFγs-cl(f^{-1}(F)))⊆ IFγs-cl(f(f^{-1}(F)))⊆ IFγs-cl(F). That is, IFγs-cl(f^{-1}(F) ⊆ f^{-1}IFγs-cl((F)). Therefore, IFγs-cl(f^{-1}(F))=f^{-1}(F). Therefore, f^{-1}(F) is Intuitionistic fuzzy supra closed in X for every Intuitionistic fuzzy γ supra closed set F in Y. That is f is fuzzy γ supra continuous.

Theorem 4.5.
A function f : (X, τ_μ) → (Y, σ_μ) is Intuitionistic fuzzy γ supra continuous if and only if IFγs -cl (f^{-1} (B)) ⊆ f^{-1} (IFγs-cl(B)) for every sub set B of Y.

Proof.
Let f be a Intuitionistic fuzzy γ supra continous and B∈Y, IFγs-cl(B) is Intuitionistic fuzzy γ supra closed in Y and hence f^{-1} (IFγs-cl(B)) is Intuitionistic fuzzy supra closed in X . Therefore, [IFγsCl(f^{-1}IFγs-cl(B))] = f^{-1}(IFγs-cl(B)). Since B ⊆ IFγs-cl(B),
f^{-1}(B) ⊆ f^{-1}(IFγs-cl(B)). Therefore, IFγs-cl(f^{-1}(B)) ⊆IFγs (f^{-1}(IFγs-cl(B)))=f^{-1}(IFγs-cl(B)). That is, IFγs-cl(f^{-1} (B)) ⊆ f^{-1}IFγs-cl(B)) for every B∈Y. Let B be Intuitionistic fuzzy γ supra closed in Y. Then IFγs-cl(B) = B. By assumption, IFγs-clf^{-1} (B) ⊆ f^{-1} (IFγs-cl(B)) = f^{-1}(B). Thus, IFγs-clf^{-1}(B)⊆f^{-1}(B). But f^{-1}(B) ⊆ IFγs-cl(f^{-1}(B)).Therefore, IFγs-cl(f^{-1}(B)) =f^{-1}(B). That is,
f^{-1}(B) is Intuitionistic fuzzy supra closed in X for every Intuitionistic fuzzy γ supra closed set B in Y. Therefore, f is Intuitionistic fuzzy γ supra continuous on X

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