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RESEARCH ARTICLE

MULTI INTUITIONISTIC FUZZY RW-CONTINUOUS MAPS AND MULTI INTUITIONISTIC FUZZY RW-IRRESOLUTE MAPS IN MULTI INTUITIONISTIC FUZZY TOPOLOGICAL SPACES

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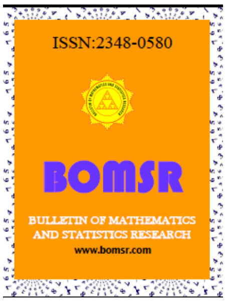

ABSTRACT

In this paper, we have studied some of the properties of multi intuitionistic fuzzy rw-continuous mappings and multi intuitionistic fuzzy rw-irresolute mappings in multi intuitionistic fuzzy topological spaces and have proved some results on these.

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KEY WORDS: Fuzzy subset, multi fuzzy subset, multi fuzzy topological spaces, multi fuzzy rw-closed, multi fuzzy rw-open, multi fuzzy rw-continuous mapping, multi fuzzy rw-irresolute mapping, intuitionistic fuzzy subset, multi intuitionistic fuzzy subset, multi intuitionistic fuzzy topological spaces, multi intuitionistic fuzzy rw-closed, multi intuitionistic fuzzy rw-open, multi intuitionistic fuzzy rw-continuous mapping, multi intuitionistic fuzzy rw-irresolute mapping.

INTRODUCTION

The concept of a fuzzy subset was introduced and studied by L.A.Zadeh [22] in the year 1965. The subsequent research activities in this area and related areas have found applications in many branches of science and engineering. Intuitionistic fuzzy set was introduced and studied by Atanassov.K.T.[2, 3]. The following papers have motivated us to work on this paper. C.L.Chang [8] introduced and studied fuzzy topological spaces in 1968 as a generalization of topological spaces. Many researchers like R.H.Warren [21], K.K.Azad [4], G.Balasubramanian and P.Sundaram [5, 6], S.R.Malghan and S.S.Benchalli [14, 15] and many others have contributed to the development of fuzzy topological spaces. We have introduced the concept of multi intuitionistic fuzzy rw-continuous mappings and multi intuitionistic fuzzy rw-irresolute mappings in multi intuitionistic fuzzy topological spaces and have established some results.

1.PRELIMINARIES

1.1 Definition[22]: Let X be a non-empty set. A **fuzzy subset A** of X is a function A: X → [0, 1].

1.2 Definition: A **multi fuzzy subset** A of a set X is defined as an object of the form A = { ⟨ x, A_1(x), A_2(x), A_3(x), …, A_n(x) ⟩ / x∈X}, where A_i : X→[0, 1] for all i. It is denoted as A = ⟨ A_1, A_2, A_3, …, A_n⟩.

1.3 Definition: Let X be a set and $\Im$ be a family of multi fuzzy subsets of X. Then the family $\Im$ is called a multi fuzzy topology on X if and only if $\Im$ satisfies the following axioms

(i) $\overline{0}$, $\overline{1}$ $\in\Im$, (ii) If { A_i ; i∈I } $\subseteq\Im$, then $\bigcup_{i\in I} A_i \in\Im$, (iii) If A_1, A_2, A_3,….. $A_n\in\Im$, then $\bigcap_{i=1}^{i=n} A_i \in\Im$. The pair (X, $\Im$) is called a multi fuzzy topological space. The members of $\Im$ are called multi fuzzy open sets in X. A multi fuzzy set A in X is said to be multi fuzzy closed set in X if and only if A^c is a multi fuzzy open set in X.

1.4 Definition: Let (X, $\Im$) be a multi fuzzy topological space. A multi fuzzy set A of X is called multi fuzzy regular w-clsoed(briefly, multi fuzzy rw-closed) if mfcl(A) ⊆ U whenever A ⊆ U and U is a multi fuzzy regular semiopen in a multi fuzzy topological space X.

1.5 Definition: A multi fuzzy set A of a multi fuzzy topological space X is called a multi fuzzy regular w-open (briefly, multi fuzzy rw-open) set if its complement A^C is a multi fuzzyrw-closed set in a multi fuzzy topological space X.

1.6 Definition: Let X and Y be multi fuzzy topological spaces. A map f : X⟶ Y is said to be multi fuzzy rw-continuous if the inverse image of every multi fuzzy open set in Y is multi fuzzy rw-open in X.

1.7 Definition: Let X and Y be multi fuzzy topological spaces. A map f : X⟶Y is said to be a multi fuzzy rw-irresolute map if the inverse image of every multi fuzzy rw-open set in Y is a multi fuzzy rw-open set in X.

1.8 Definition[2]: An **intuitionistic fuzzy subset**(**IFS**) A of a set X is defined as an object of the form A = {⟨ x, μ_A(x), ν_A(x) ⟩ / x∈X}, where μ_A: X→[0, 1] and ν_A: X→[0, 1] define the degree of membership and the degree of non-membership of the element x in X respectively and for every x in X satisfying $0 \le \mu_A(x) + \nu_A(x) \le 1$.

1.9 Definition: A **multi intuitionistic fuzzy subset**(M**IFS**) A of a set X is defined as an object of the form A = { ⟨ x, μ_A(x), ν_A(x) ⟩ / x∈X }, where μ_A(x) = (μ_{A1}(x), μ_{A2}(x), … μ_{An}(x)), μ_{Ai} : X →[0, 1] for all i and ν_A(x) = (ν_{A1}(x), ν_{A2}(x), …, ν_{An}(x)), ν_{Ai} : X →[0, 1] for all i, define the degrees of membership and the degrees of non-membership of the element x in X respectively and for every x in X satisfying $0 \le \mu_{Ai}(x) + \nu_{Ai}(x) \le 1$ for all i.

1.10 Definition: Let A and B be any two multi intuitionistic fuzzy subsets of a set X. We define the following relations and operations:

(i) A ⊆ B if and only if $\mu_A(x) \le \mu_B(x)$ and $\nu_A(x) \ge \nu_B(x)$, for all x in X.

(ii) A = B if and only if $\mu_A(x) = \mu_B(x)$ and $\nu_A(x) = \nu_B(x)$, for all x in X.

(iii) A^c = { ⟨ x, ν_A(x), μ_A(x) ⟩ / x∈X }.

(iv) A∩B = { ⟨ x, min{ μ_A(x), μ_B(x) }, max{ ν_A(x), ν_B(x) } ⟩ / x∈X }.

(v) A∪B = { ⟨ x, max { μ_A(x), μ_B(x) }, min{ ν_A(x), ν_B(x) } ⟩ / x∈X }.

1.11 Definition: Let X be a set and $\Im$ be a family of multi intuitionistic fuzzy subsets of X. The family $\Im$ is called a multi intuitionistic fuzzy topology on X if and only if $\Im$ satisfies the following axioms (i) 0_X, $1_X\in\Im$, (ii) If { A_i ; i∈I } $\subseteq\Im$, then $\bigcup_{i\in I} A_i \in\Im$, (iii) If A_1, A_2, A_3,…… $A_n\in\Im$, then $\bigcap_{i=1}^{i=n} A_i \in\Im$. The pair (X,

$\Im$) is called a multi intuitionistic fuzzy topological space. The members of $\Im$ are called multi intuitionistic fuzzy open sets in X. A multi intuitionistic fuzzy set A in X is said to be a multi intuitionistic fuzzy closed set in X if and only if A^c is a multi intuitionistic fuzzy open set in X.

1.12 Definition: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and A be a multi intuitionistic fuzzy set in X. Then $\cap\{ B: B^c \in \Im$ and $B \supseteq A \}$ is called multi intuitionistic fuzzy closure of A and is denoted by mifcl(A).

1.13 Theorem: Let A and B be two multi intuitionistic fuzzy sets in a multi intuitionistic fuzzy topological space (X, $\Im$). Then the following results are true, (i) mifcl(A) is a multi intuitionistic fuzzy closed set in X, (ii) mifcl(A) is the least multi intuitionistic fuzzy closed set containing A, (iii) A is a multi intuitionistic fuzzy closed set if and only if A = mifcl(A), (iv) mifcl(0_X) = 0_X, 0_X is the empty multi intuitionistic fuzzy set, (v) mifcl(mifcl(A)) = mifcl(A), (vi) mifcl(A) $\cup$mifcl(B) = mifcl(A$\cup$B),
(vii) mifcl(A) $\cap$mifcl(B) $\supseteq$mifcl(A$\cap$B),

1.14 Definition: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and A be a multi intuitionistic fuzzy set in X. Then $\cup\{ B : B\in\Im$ and $B \subseteq A \}$ is a called multi intuitionistic fuzzy interior of A and is denoted by mifint(A).

1.15 Theorem: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space, A and B be two multi intuitionistic fuzzy sets in X. Then the following results hold,
(i) mifint(A) is a multi intuitionistic fuzzy open set in X, (ii) mifint(A) is the largest multi intuitionistic fuzzy open set in X which is less than or equal to A, (iii) A is a multi intuitionistic fuzzy open set if and only if A = mifint(A),(iv) A $\subseteq$ B implies mifint(A)$\subseteq$mifint(B), (v) mifint(mifint(A))= A, (vi) mifint(A) $\cap$mifint(B)= mifint(A$\cap$B),
(vii) mifint(A)$\cup$mifint(B)$\subseteq$mifint(A$\cup$B), (viii) mifint(A^c)= (mifcl(A))^c,
(ix) mifcl(A^c) = (mifint(A))^c.

1.16 Definition: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and A be a multi intuitionistic fuzzy set in X. Then A is said to be
(i) multi intuitionistic fuzzy semiopen if and only if there exists a multi intuitionistic fuzzy open set V in X such that V $\subseteq$ A $\subseteq$mifcl(V),
(ii) multi intuitionistic fuzzy semiclosed if and only if there exists a multi intuitionistic fuzzy closed set V in X such that mifint(V) $\subseteq$ A $\subseteq$ V,
(iii) multi intuitionistic fuzzy regular open set of X if mifint(mifcl(A)) = A,
(iv) multi intuitionistic fuzzy regular closed set of X if mifcl(mifint(A)) = A,
(v)multi intuitionistic fuzzy regular semiopen set of X if there exists a multi intuitionistic fuzzy regular open set V in X such that V $\subseteq$ A $\subseteq$mifcl(V).
We denote the class of multi intuitionistic fuzzy regular semiopen sets in a multi intuitionistic fuzzy topological space X by MIFRSO(X).
(vi) multi intuitionistic fuzzy generalized closed (mifg-closed) if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy open set and A is a multi intuitionistic fuzzy generalized open set if A^c is multi intuitionistic fuzzy generalized closed,
(vii) multi intuitionistic fuzzy rg-closed if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy regular open set in X,
(viii) multi intuitionistic fuzzy rg-open if its complement A^c is a multi intuitionistic fuzzy rg-closed set in X,
(ix) multi intuitionistic fuzzy w-closed if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is multi intuitionistic fuzzy semi open set in X,

(x) multi intuitionistic fuzzy w-open if its complement A^c is a multi intuitionistic fuzzy w-closed set in X,

(xi) multi intuitionistic fuzzy gpr-closed if mifpcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy regular open set in X,

(xii) multi intuitionistic fuzzy gpr-open if its complement A^c is a multi intuitionistic fuzzy gpr-closed set in X.

1.17 Theorem: The following are equivalent: (i) A is a multi intuitionistic fuzzy semiclosed set, (ii) A^C is a multi intuitionistic fuzzy semiopen set, (iii) mifint(mifcl(A)) $\subseteq$ A, (iv) mifcl(mifint(A^C)) $\supseteq$ A.

1.18 Theorem: Any union of multi intuitionistic fuzzy semiopen sets is a multi intuitionistic fuzzy semiopen set and any intersection of multi intuitionistic fuzzy semiclosed sets is a multi intuitionistic fuzzy semiclosed set.

1.19 Remark: (i) Every multi intuitionistic fuzzy open set is a multi intuitionistic fuzzy semiopen set but not conversely.

(ii) Every multi intuitionistic fuzzy closed set is a multi intuitionistic fuzzy semi-closed set but not conversely.

(iii) The closure of a multi intuitionistic fuzzy open set is a multi intuitionistic fuzzy semiopen set.

(iv) The interior of a multi intuitionistic fuzzy closed set is multi intuitionistic fuzzy semi-closed set.

1.20 Theorem: A multi intuitionistic fuzzy set A of a multi intuitionistic fuzzy topological space X is a multi intuitionistic fuzzy regular open set if and only if A^c is a multi intuitionistic fuzzy regular closed set.

1.21 Remark: (i) Every multi intuitionistic fuzzy regular open set is a multi intuitionistic fuzzy open set but not conversely. (ii) Every multi intuitionistic fuzzy regular closed set is a multi intuitionistic fuzzy closed set but not conversely.

1.22 Theorem: (i) The closure of a multi intuitionistic fuzzy open set is a multi intuitionistic fuzzy regular closed set. (ii) The interior of a multi intuitionistic fuzzy closed set is a multi intuitionistic fuzzy regular open set.

1.23 Theorem: (i) Every multi intuitionistic fuzzy regular semiopen set is a multi intuitionistic fuzzy semiopen set but not conversely.

(ii) Every multi intuitionistic fuzzy regular closed set is a multi intuitionistic fuzzy regular semiopen set but not conversely.

(iii) Every multi intuitionistic fuzzy regular open set is a multi intuitionistic fuzzy regular semiopen set but not conversely.

1.24 Theorem: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and A be a multi intuitionistic fuzzy set in X. Then the following conditions are equivalent:

(i) A is multi intuitionistic fuzzy regular semiopen, (ii) A is both multi intuitionistic fuzzy semiopen and multi intuitionistic fuzzy semi-closed, (iii) A^c is multi intuitionistic fuzzy regular semiopen in X.

1.25 Definition: A multi intuitionistic fuzzy set A of a multi intuitionistic fuzzy topological space (X, $\Im$) is called:

(i) multi intuitionistic fuzzy g-closed if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy open set in X,

(ii) multi intuitionistic fuzzy g-open if its complement A^c is a multi intuitionistic fuzzy g-closed set in X,

(iii) multi intuitionistic fuzzy rg-closed if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy regular open set in X,

(iv) multi intuitionistic fuzzy rg-open if its complement A^c is a multi intuitionistic fuzzy rg-closed set in X,

(v) multi intuitionistic fuzzy w-closed if mifcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy semi open set in X,

(vi) multi intuitionistic fuzzy w-open if its complement A^c is a multi intuitionistic fuzzy w-closed set in X,

(vii) multi intuitionistic fuzzy gpr-closed if mifpcl(A) $\subseteq$ V whenever A $\subseteq$ V and V is a multi intuitionistic fuzzy regular open set in X,

(viii) multi intuitionistic fuzzy gpr-open if its complement A^c is a multi intuitionistic fuzzy gpr-closed set in X.

1.26 Definition: A mapping f : X⟶Y from a multi intuitionistic fuzzy topological space X to a multi intuitionistic fuzzy topological space Y is called

(i) multi intuitionistic fuzzy continuous if $f^{-1}(A)$ is multi intuitionistic fuzzy open in X for each multi intuitionistic fuzzy open set A in Y,

(ii) multi intuitionistic fuzzy generalized continuousif $f^{-1}(A)$ is multi intuitionistic fuzzy generalized closed in X for each multi intuitionistic fuzzy closed set A in Y,

(iii) multi intuitionistic fuzzy semi continuous if $f^{-1}(A)$ is multi intuitionistic fuzzy semiopen in X for each multi intuitionistic fuzzy open set A in Y,

(iv) multi intuitionistic fuzzy almost continuous if $f^{-1}(A)$ is multi intuitionistic fuzzy open in X for each multi intuitionistic fuzzy regular open set A in Y,

(v) multi intuitionistic fuzzy irresolute if $f^{-1}(A)$ is multi intuitionistic fuzzy semiopen in X for each multi intuitionistic fuzzy semiopen set A in Y,

(vi) multi intuitionistic fuzzy gc-irresolute if $f^{-1}(A)$ is multi intuitionistic fuzzy generalized closed in X for each multi intuitionistic fuzzy generalized closed set A in Y,

(vii)multi intuitionistic fuzzy completely semi continuous if and only if $f^{-1}(A)$ is a multi intuitionistic fuzzy regular semiopen set of X for every multi intuitionistic fuzzy open set A in Y,

(viii) multi intuitionistic fuzzy w-continuous if and only if $f^{-1}(A)$ is a multi intuitionistic fuzzy w-closed set of X for every multi intuitionistic fuzzy closed set A in Y,

(ix) multi intuitionistic fuzzy rg-continuous if $f^{-1}(A)$ is multi intuitionistic fuzzy rg-closed in X for each multi intuitionistic fuzzy closed set A in Y,

(x) multi intuitionistic fuzzy gpr-continuous if $f^{-1}(A)$ is multi intuitionistic fuzzy gpr-closed in X for each multi intuitionistic fuzzy closed set A in Y,

(xi) multi intuitionistic fuzzy almost-irresolute if $f^{-1}(A)$ is multi intuitionistic fuzzy semi open in X for each multi intuitionistic fuzzy regular semi open set A in Y.

1.27 Definition: Let (X, $\mathfrak{I}$) be a multi intuitionistic fuzzy topological space. A multi intuitionistic fuzzy set A of X is called multi intuitionistic fuzzy regular w-closed (briefly, mifrw-closed) if mifcl(A) $\subseteq$ U whenever A $\subseteq$ U and U is a multi intuitionistic fuzzy regular semiopen set in a multi intuitionistic fuzzy topological space X.

1.28 NOTE: We denote the family of all multi intuitionistic fuzzy regular w-closed sets in multi intuitionistic fuzzy topological space X by MIFRWC(X).

1.29 Definition: A multi intuitionistic fuzzy set A of a multi intuitionistic fuzzy topological space X is called a multi intuitionistic fuzzy regular w-open (briefly, mifrw-open) set if its complement A^C is a multi intuitionistic fuzzy rw-closed set in multi intuitionistic fuzzy topological space X.

1.30 NOTE: We denote the family of all multi intuitionistic fuzzy rw-open sets in a multi intuitionistic fuzzy topological space X by MIFRWO(X).

1.31 Definition: Let X and Y be multi intuitionistic fuzzy topological spaces. A map f : X⟶ Y is said to be multi intuitionistic fuzzy rw-continuous if the inverse image of every multi intuitionistic fuzzy open set in Y is multi intuitionistic fuzzy rw-open in X.

1.32 Definition: Let X and Y be multi intuitionistic fuzzy topological spaces. A map f : X⟶Y is said to be a multi intuitionistic fuzzy rw-irresolute map if the inverse image of every multi intuitionistic fuzzy rw-open set in Y is a multi intuitionistic fuzzy rw-open set in X.

1.33 Definition: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and A be a multi intuitionistic fuzzy set of X. Then multi intuitionistic fuzzy rw-interior and multi intuitionistic fuzzy rw-closure of A are defined as follows.

mifrwcl(A) = $\cap$ { K: K is a multi intuitionistic fuzzy rw-closed set in X and A $\subseteq$ K }.

mifrwint(A) = $\cup$ { G: G is a multi intuitionistic fuzzy rw-open set in X and G $\subseteq$ A }.

1.34 Remark: It is clear that A $\subseteq$mifrwcl(A) $\subseteq$mifcl(A) for any multi intuitionistic fuzzy set A.

2. SOME PROPERTIES:

2.1 Theorem: If A is a multi intuitionistic fuzzy regular open and multi intuitionistic fuzzy rg-closed set in a multi intuitionistic fuzzy topological space (X, $\Im$), then A is multi intuitionistic fuzzy rw-closed in X.

Proof: Let A be a multi intuitionistic fuzzy regular open and multi intuitionistic fuzzy rg-closed set in X. We prove that A is a multi intuitionistic fuzzy rw-closed set in X. Let U be any multi intuitionistic fuzzy regular semi open set in X such that A $\subseteq$ U. Since A is multi intuitionistic fuzzy regular open and multi intuitionistic fuzzy rg-closed, we have mifcl(A)$\subseteq$A. Then mifcl(A)$\subseteq$A$\subseteq$U. Hence A is multi intuitionistic fuzzy rw-closed in X.

2.2 Theorem: If a map f : (X, $\Im$)⟶(Y, σ) is a multi intuitionistic fuzzy continuous, then f is a multi intuitionistic fuzzy rw-continuous map.

Proof: Let A be a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Y. Since f is multi intuitionistic fuzzy continuous, f^{-1}(A) is a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space X. As every multi intuitionistic fuzzy open set is multi intuitionistic fuzzy rw-open, we have f^{-1}(A) is a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X. Therefore f is multi intuitionistic fuzzy rw-continuous.

2.3 Remark: The converse of the above Theorem 2.2 need not be true in general.

Proof: Consider the example, let X = Y = { 1, 2, 3 } and the multi intuitionistic fuzzy sets A, B, C are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }, C = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. Consider $\Im$ = { 0_X, 1_X, A }, σ = { 0_X, 1_X, B, C }. Now (X, $\Im$) and (Y, σ) are the multi intuitionistic fuzzy topological spaces. Define a map f : (X, $\Im$)⟶ (Y, σ) by f(1) = 2, f(2) = 3 and f(3) = 1. Then f is multi intuitionistic fuzzy rw-continuous but not multi intuitionistic fuzzy continuous as the inverse image of the multi intuitionistic fuzzy set C in (Y, σ) is D defined as D = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }. This is not a multi intuitionistic fuzzy open set in (X, $\Im$).

2.4 Theorem: A map f : (X, $\Im$)⟶ (Y, σ) is multi intuitionistic fuzzy rw-continuous if and only if the inverse image of every multi intuitionistic fuzzy closed set in a multi intuitionistic fuzzy topological space Y is a multi intuitionistic fuzzy rw-closed set in a multi intuitionistic fuzzy topological space X.

Proof: Let D be a multi intuitionistic fuzzy closed set in a multi intuitionistic fuzzy topological space Y. Then D^c is a multi intuitionistic fuzzy open in a multi intuitionistic fuzzy topological space Y. Since f is multi intuitionistic fuzzy rw-continuous, $f^{-1}(D^c)$ is multi intuitionistic fuzzy rw-open in a multi intuitionistic fuzzy topological space X. But $f^{-1}(D^c) = [f^{-1}(D)]^c$ and so $f^{-1}(D)$ is a multi intuitionistic fuzzy rw-closed set in a multi intuitionistic fuzzy topological space X.

Conversely, assume that the inverse image of every multi intuitionistic fuzzy closed set in Y is multi intuitionistic fuzzy rw-closed in a multi intuitionistic fuzzy topological space X. Let A be a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Y. Then A^c is multi intuitionistic fuzzy closed in Y. By hypothesis $f^{-1}(A^c) = [f^{-1}(A)]^c$ is multi intuitionistic fuzzy rw-closed in X and so $f^{-1}(A)$ is a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X. Thus f is multi intuitionistic fuzzy rw-continuous.

2.5 Theorem: If a function $f : (X, \Im) \longrightarrow (Y, \sigma)$ is multi intuitionistic fuzzy almost continuous, then it is multi intuitionistic fuzzy rw-continuous.

Proof: Let a function $f : (X, \Im) \longrightarrow (Y, \sigma)$ be a multi intuitionistic fuzzy almost continuous map and A be a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Y. Then $f^{-1}(A)$ is a multi intuitionistic fuzzy regular open set in a multi intuitionistic fuzzy topological space X. Now $f^{-1}(A)$ is multi intuitionistic fuzzy rw-open in X, as every multi intuitionistic fuzzy regular open set is multi intuitionistic fuzzy rw-open. Therefore f is multi intuitionistic fuzzy rw-continuous.

2.6 Remark: The converse of the above theorem 2.5 need not be true in general.

Proof: Consider the example, let X = Y = { 1, 2, 3 } and the multi intuitionistic fuzzy sets A, B, C are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }, C = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. Consider $\Im = \{ 0_X, 1_X, A \}$, $\sigma = \{ 0_X, 1_X, B, C \}$. Now $(X, \Im)$ and (Y, σ) are the multi intuitionistic fuzzy topological spaces. Define a map $f : (X, \Im) \longrightarrow (Y, \sigma)$ by f(1) = 2, f(2) = 3 and f(3) = 1. Then f is multi intuitionistic fuzzy rw-continuous but it is not almost continuous.

2.7 Theorem: Multi intuitionistic fuzzy semi continuous maps and multi intuitionistic fuzzy rw-continuous maps are independent.

Proof: Consider the following example. Let X = Y = { 1, 2, 3 } and the multi intuitionistic fuzzy sets A, B are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. Consider $\Im = \{ 0_X, 1_X, A \}$, $\sigma = \{ 0_X, 1_X, B \}$. Now $(X, \Im)$ and (Y, σ) are the multi intuitionistic fuzzy topological spaces. Define a map $f : (X, \Im)\longrightarrow (Y, \sigma)$ by f(1) = 1, f(2) = 2 and f(3) = 3. Then f is multi intuitionistic fuzzy rw-continuous but it is not multi intuitionistic fuzzy semi continuous, as the inverse image of multi intuitionistic fuzzy set B in (Y, σ) is D defined as D = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. This is not a multi intuitionistic fuzzy semiopen set in a multi intuitionistic fuzzy topological space X. And, let X = Y = { 1, 2, 3 } and the multi intuitionistic fuzzy sets A, B, C, D are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }, C = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }, D = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (1, 1, 1), (0, 0, 0) > }. Consider $\Im = \{ 0_X, 1_X, A, B, C \}$ and $\sigma = \{ 0_X, 1_X, D \}$. Now $(X, \Im)$ and (Y, σ) are the multi intuitionistic fuzzy topological spaces. Define a map $f : (X, \Im)\longrightarrow (Y, \sigma)$ by f(1) = 3, f(3) = 3 and f(2) = 2. Then f is multi intuitionistic fuzzy semi continuous but it is not multi intuitionistic fuzzy rw-continuous, as the inverse image of multi intuitionistic fuzzy set D in (Y, σ) is E defined as E = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (1, 1, 1), (0, 0, 0) > }. This is not a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X.

2.8 Theorem: Multi intuitionistic fuzzy generalized continuous maps and multi intuitionistic fuzzy rw-continuous maps are independent.

Proof: Consider the multi intuitionistic fuzzy topological spaces (X, $\Im$) and (Y, σ) as defined in Theorem 2.7. Define a map f : (X, $\Im$)⟶ (Y, σ) by f(1) = 1, f(2) = 2 and f(3) = 3. Then f is multi intuitionistic fuzzy rw-continuous but it is not multi intuitionistic fuzzy g-continuous as the inverse image of multi intuitionistic fuzzy set D in (Y, σ) is E defined as E = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (1, 1, 1), (0, 0, 0) > }. This is not a multi intuitionistic fuzzy g-open set in a multi intuitionistic fuzzy topological space X. And, let X = { 1, 2, 3, 4 } and the multi intuitionistic fuzzy sets A, B, C are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) >, < 4, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) >, < 4, (0, 0, 0), (1, 1, 1) > },C = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) >,< 4, (0, 0, 0), (1, 1, 1) > }. Let Y = { 1, 2, 3 } and the multi intuitionistic fuzzy set D is defined as D = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. Consider $\Im$ = {0_X, 1_X, A, B, C} and σ = {0_X, 1_X, D }. Now (X, $\Im$) and (Y, σ) are the multi intuitionistic fuzzy topological spaces. Define a map f : (X, $\Im$)⟶ (Y, σ) by f(1) = 3, f(4) = 3, f(2) = 2 and f(3)= 3. Then f is multi intuitionistic fuzzy g-continuous but it is not multi intuitionistic fuzzy rw-continuous, as the inverse image of multi intuitionistic fuzzy set D in (Y, σ) is E defined as E ={ < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > }. This is not a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X.

2.9 Theorem: If a function f : (X, $\Im$) ⟶ (Y, σ) is multi intuitionistic fuzzy rw-continuous and multi intuitionistic fuzzy completely semi continuous ,then it is multi intuitionistic fuzzy continuous.

Proof: Let a function f : (X, $\Im$) ⟶ (Y, σ) be a multi intuitionistic fuzzy rw-continuous and multi intuitionistic fuzzy completely semi continuous map. Let E be a multi intuitionistic fuzzy closed set in a multi intuitionistic fuzzy topological space Y. Then f^{-1}(E) is both multi intuitionistic fuzzy regular semiopen and multi intuitionistic fuzzy rw-closed set in a multi intuitionistic fuzzy topological space X. Therefore, f^{-1}(E) is a multi intuitionistic fuzzy closed set in a multi intuitionistic fuzzy topological space X. Therefore f is a multi intuitionistic fuzzy continuous map.

2.10 Theorem: If f : (X, $\Im$)⟶ (Y, σ) is multi intuitionistic fuzzy rw-continuous and g : (Y, σ)⟶ (Z, η) is multi intuitionistic fuzzy continuous, then their composition g•f : (X, $\Im$)⟶ (Z, η) is multi intuitionistic fuzzyrw-continuous.

Proof: Let A be a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Z. Since g is multi intuitionistic fuzzy continuous, g^{-1}(A) is a multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Y. Since f is multi intuitionistic fuzzy rw-continuous, $f^{-1}(g^{-1}(A))$ is a multi intuitionistic fuzzy rw-open set in multi intuitionistic fuzzy topological space X. But $(g\bullet f)^{-1}(A) = f^{-1}(g^{-1}(A))$. Thus g•f is multi intuitionistic fuzzy rw-continuous.

2.11 Theorem: If a map f : X⟶ Y is multi intuitionistic fuzzy rw-irresolute, then it is multi intuitionistic fuzzy rw-continuous.

Proof: Let A be a multi intuitionistic fuzzy open set in Y. Since every multi intuitionistic fuzzy open set is multi intuitionistic fuzzy rw-open, A is a multi intuitionistic fuzzy rw-open set in Y. Since f is multi intuitionistic fuzzy rw-irresolute, f^{-1}(A) is multi intuitionistic fuzzy rw-open in X. Thus f is multi intuitionistic fuzzy rw-continuous.

2.12 Remark: The converse of the above theorem 2.11 need not be true in general.

Proof: Consider the example, let X = Y = { 1, 2, 3 } and the multi intuitionistic fuzzy sets A, B, C are defined as A = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (0, 0, 0), (1, 1, 1) >, < 3, (0, 0, 0), (1, 1, 1) > }, B = { < 1, (0, 0, 0), (1, 1, 1) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }, C = { < 1, (1, 1, 1), (0, 0, 0) >, < 2, (1, 1, 1), (0, 0, 0) >, < 3, (0, 0, 0), (1, 1, 1) > }. Consider $\Im_1$ = { 0_X, 1_X, A, B, C } and $\Im_2$ = { 0_Y, 1_Y, A }. Now (X, $\Im_1$) and (Y, $\Im_2$) are multi intuitionistic fuzzy topological spaces. Define a map f : (X, $\Im_1$)⟶(Y, $\Im_2$) be the identity map. Then f is multi intuitionistic fuzzy rw-continuous but it is not multi intuitionistic fuzzy rw-irresolute. Since for the multi intuitionistic fuzzy rw-open set E is defined as E = { < 1, (0, 0, 0), (1, 1, 1) >,< 2, (1, 1, 1), (0, 0, 0) >, < 3, (1, 1, 1), (0, 0, 0) > } in Y, f^{-1}(E) = E is not multi intuitionistic fuzzy rw-open in (X, $\Im_1$).

2.13 Theorem: Let X, Y and Z be multi intuitionistic fuzzy topological spaces. If f : X ⟶Y is multi intuitionistic fuzzy rw-irresolute and g : Y ⟶ Z is multi intuitionistic fuzzy rw-continuous, then their composition g•f: X⟶ Z is multi intuitionistic fuzzy rw-continuous.

Proof: Let A be any multi intuitionistic fuzzy open set in a multi intuitionistic fuzzy topological space Z. Since g is multi intuitionistic fuzzy rw-continuous, g^{-1}(A) is a multi intuitionistic fuzzy rw-open set in multi intuitionistic fuzzy topological space Y. Since f is multi intuitionistic fuzzy rw-irresolute $f^{-1}(g^{-1}(A))$ is a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X. But $(g\bullet f)^{-1}(A) = f^{-1}(g^{-1}(A))$. Thus g•f is multi intuitionistic fuzzy rw-continuous.

2.14 Theorem: Let X, Y and Z be multi intuitionistic fuzzy topological spaces and f : X ⟶ Y and g : Y⟶ Z be multi intuitionistic fuzzy rw-irresolute maps. Then their composition g•f : X ⟶ Z is a multi intuitionistic fuzzy rw-irresolute map.

Proof: Let A be any multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space Z. Since g is multi intuitionistic fuzzy rw-irresolute, g^{-1}(A) is a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space Y. Since f is multi intuitionistic fuzzy rw-irresolute $f^{-1}(g^{-1}(A))$ is a multi intuitionistic fuzzy rw-open set in a multi intuitionistic fuzzy topological space X. But $(g\bullet f)^{-1}(A) = f^{-1}(g^{-1}(A))$. Thus g•f is multi intuitionistic fuzzy rw-continuous.

2.15 Theorem: Let A be a multi intuitionistic fuzzy w-closed set in a multi intuitionistic fuzzy topological space (X, $\Im$) and f : (X, $\Im$) → (Y, σ) is a multi intuitionistic fuzzy almost irresolute and multi intuitionistic fuzzy closed mapping .Then f(A) is a multi intuitionistic fuzzy rw-closed set in Y.

Proof: Let A be a multi intuitionistic fuzzy w-closed set in X and f :(X, $\Im$) → (Y, σ) is a multi intuitionistic fuzzy almost irresolute and multi intuitionistic fuzzy closed mapping. Let f(A) ⊆ O where O is multi intuitionistic fuzzy regular semi open in Y. Then A ⊆ f^{-1}(O) and f^{-1}(O) is multi intutionistic fuzzy semi open in X because f is multi intuitionistic fuzzy almost irresolute. Now A be a multi intuitionistic fuzzy w-closed set in X, mifcl(A) ⊆ f^{-1}(O). Thus, f(mifcl(A))⊆ O and f(mifcl(A)) is a multi intuitionistic fuzzy closed set in Y (since mifcl(A) is multi intuitionistic fuzzy closed in X and f is multi intuitionistic fuzzy closed mapping). It follows that mifcl(f(A)) ⊆mifcl(f(mifcl(A))) = f(mifcl(A)) ⊆ O. Hence mifcl(f(A)) ⊆ O whenever f(A) ⊆ O and O is multi intuitionistic fuzzy regular semi open in Y. Hence f(A) is a multi intuitionistic fuzzy rw-closed set in Y.

2.16 Theorem: Let (X, $\Im$) be a multi intuitionistic fuzzy topological space and MIFRSO(X) (resp. MIFC(X)) be the family of all multi intuitionistic fuzzy regular semi open (resp. multi intuitionistic fuzzy closed) sets of X. Then MIFRSO(X) ⊆ MIFC(X) if

and only if every multi intuitionistic fuzzy set of X is multi intuitionistic fuzzy rw-closed.

Proof: Suppose that MIFRSO(X)⊆ MIFC(X) and let A be any multi intuitionistic fuzzy set of X such that A ⊆ U∈MIFRSO(X). i.e. U is a multi intuitionistic fuzzy regular semi open set. Then, mifcl(A) ⊆mifcl(U) = U because U∈MIFRSO(X) ⊆ MIFC(X). Hence mifcl(A) ⊆ U whenever A ⊆ U and U is a multi intuitionistic fuzzy regular semi open set. Hence A is a multi intuitionistic fuzzy rw-closed set. Suppose that every multi intuitionistic fuzzy set of X is multi intuitionistic fuzzy rw-closed. Let U∈MIFRSO(X). Then since U ⊆U and U is multi intuitionistic fuzzy rw-closed, mifcl(U) ⊆ U, then U∈MIFC(X). Thus MIFRSO(X) ⊆ MIFC(X).

2.17 Remark: Every multi intuitionistic fuzzy w-continuous mapping is multi intuitionistic fuzzy rw-continuous, but converse may not be true.

Proof: Consider the example, let X = { a, b }, Y = { x, y } and multi intuitionistic fuzzy sets U and V are defined as follows: U = { < a, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >, < b, (0.6, 0.6, 0.6), (0.3, 0.3, 0.3) >}, V = { < x, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >, < y, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) > }. Let $\Im$ = { 1_X, 0_X, U } and σ = { 1_Y, 0_Y, V } be multi intuitionistic fuzzy topologies on X and Y respectively. Then the mapping f : (X, $\Im$)→ (Y, σ) defined by *f* (a) = x and *f* (b) = y is multi intuitionistic fuzzy rw-continuous but not multi intuitionistic fuzzy continuous.

2.18 Remark: Every multi intuitionistic fuzzy rw-continuous mapping is multi intuitionistic fuzzy rg-continuous, but converse may not be true.

Proof: Consider the example, letX = {a, b, c, d}, Y = {p, q r, s} and multi intuitionistic fuzzy sets O, U, V, W, T are defined as follows: O={< a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1) >, < b, (0, 0, 0), (1, 1, 1) >, < c, (0, 0, 0), (1, 1, 1) >, < d, (0, 0, 0), (1, 1, 1) > }, U = { < a, (0, 0, 0), (1, 1, 1) >, < b, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1)>, <c, (0, 0, 0), (1, 1, 1)>, <d, (0, 0, 0), (1, 1, 1) >}, V = {< a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1) >, < b, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < c, (0, 0, 0), (1, 1, 1) >,< d, (0, 0, 0), (1, 1, 1) > }, W = { < a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1) >, < b, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < c, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >, < d, (0, 0, 0), (1, 1, 1) > }, T = {< p, (0, 0, 0), (1, 1, 1) >, < q, (0, 0, 0), (1, 1, 1)>, < r, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >, < s, (0, 0, 0), (1, 1, 1) > }. Let $\Im$ = { 1_X, 0_X, O, U, V, W } and σ = { 1_Y, 0_Y, T } be multi intuitionistic fuzzy topologies on X and Y respectively. Then the mapping f : (X, $\Im$) → (Y, σ) defined by f(a) = p, f (b) = q, f(c) = r, f(d) = s is multi intuitionistic fuzzy rg-continuous but not multi intuitionistic fuzzy rw-continuous.

2.19 Remark: Every multi intuitionistic fuzzy rw-continuous mapping is multi intuitionistic fuzzy gpr-continuous, but converse may not be true.

Proof: Consider the example, let X = { a, b, c, d, e }, Y = { p, q, r, s, t } and multi intuitionistic fuzzy sets O, U, V, W are defined as follows: O = {< a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1)>, < b, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1)>, < c, (0, 0, 0), (1, 1, 1) >, < d, (0, 0, 0), (1, 1, 1) >, < e, (0, 0, 0), (1, 1, 1) > }, U = { < a, (0, 0, 0), (1, 1, 1) >, < b, (0, 0, 0), (1, 1, 1) >, < c, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < d, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >,< e, (0, 0, 0), (1, 1, 1)>}, V ={< a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1)>, < b, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < c, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < d, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >, < e, (0, 0, 0), (1, 1, 1) > }, W = { < a, (0.9, 0.9, 0.9), (0.1, 0.1, 0.1) >, < b, (0, 0, 0) (1, 1, 1) >, < c, (0.8, 0.8, 0.8), (0.1, 0.1, 0.1) >, < d, (0.7, 0.7, 0.7), (0.2, 0.2, 0.2) >,< e, (0, 0, 0), (1, 1, 1) > }. Let $\Im$ = { 1_X, 0_X, O, U, V } and σ = { 1_Y, 0_Y, W} be multi intuitionistic fuzzy topologies on X and Y respectively. Then the mapping f *:* (X, $\Im$) → (Y, σ) defined by f(a) = p, f(b) = q, f(c) = r, f(d) = s, f(e) = t is multi intuitionistic fuzzy gpr-continuous but not multi intuitionistic fuzzy rw-continuous.

2.20 Theorem: If f: (X, $\Im$)→(Y, σ) is multi intuitionistic fuzzy rw-continuous, then f(mifrwcl(A)) $\subseteq$mifcl(f(A)) for every multi intuitionistic fuzzy set A of X.

Proof: Let A be a multi intuitionistic fuzzy set of X. Then mifcl(f(A)) is a multi intuitionistic fuzzy closed set of Y. Since f is multi intuitionistic fuzzy rw-continuous, f^{-1}(mifcl(f(A))) is multi intuitionistic fuzzy rw-closed in X. Clearly A $\subseteq$ f^{-1}(mifcl(A)). Therefore mifwcl(A) $\subseteq$mifwcl(f^{-1}(mifcl(f(A)))) = f^{-1}(mifcl(f(A))). Hence f(mifrwcl(A)) $\subseteq$mifcl(f(A)) for every multi intuitionistic fuzzy set A of X.

2.21 Theorem: If f: (X, $\Im$) → (Y, σ) is multi intuitionistic fuzzy rg-irresolute and *g* : (Y, σ) → (Z, λ) is multi intuitionistic fuzzy rw-continuous. Then *gof* : (X, $\Im$) → (Z, λ) is multi intuitionistic fuzzy rg-continuous.

Proof: Let A be a multi intuitionistic fuzzy closed set in Z. Then g^{-1}(A) is multi intuitionistic fuzzy rw-closed in Y, because *g* is multi intuitionistic fuzzyrw-continuous. Since every multi intuitionistic fuzzy rw-closed set is a multi intuitionistic fuzzy rg-closed set, therefore $g^{-1}(A)$ is multi intuitionistic fuzzy rg-closed in Y .Then $(gof)^{-1}(A) = f^{-1}(g^{-1}(A))$ is multi intuitionistic fuzzy rg-closed in X, because f is multi intuitionistic fuzzy rg-irresolute. Hence *gof* : $(X, \Im) \rightarrow (Z, \lambda)$ is multi intuitionistic fuzzy rg-continuous.

CONCLUSION

In this paper, we have introduced the concepts of multi intuitionistic fuzzyrw-continuous maps and multi intuitionistic fuzzy rw-irresolute maps in the multi intuitionistic fuzzy topological spaces. We have proved that the composition of two multi intuitionistic fuzzy rw-continuous maps need not be multi intuitionistic fuzzyrw-continuous and have studied some of their properties.We can extend this concept into the bipolar valued fuzzy and bipolar valued intuitionistic fuzzy topological spaces.

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