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SEPARATED AND DISCONNECTED SETS IN BIMINIMAL STRUCTURE SPACES

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Abstract

The purpose of this paper is to introduce the concept of separated sets, connected and disconnected sets in biminimal structure spaces. We obtain some fundamental properties of their sets. Moreover, we define connected and disconnected spaces and some properties of their spaces are obtained.

1. Introduction

The minimal structure spaces were introduced by Popa and Noiri [6] in

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2000 and they also introduced the concepts of m_X-open set and m_X-closed set. In [5], Noiri and Popa defined m_X-compactness and m_X-connectedness and investigated their properties. Bitopological Spaces were introduced by Kelly [2], and in 2010, Boonpok [1] introduced the notion of biminimal structure spaces, biminimal structure subspaces and study some fundamental properties of $m_X^1 m_X^2$-closed sets and $m_X^1 m_X^2$-open sets. In this paper, we introduce the concept of separated sets, connected and disconnected sets and study some fundamental properties of their sets. Moreover, we define connected and disconnected spaces and some properties of their spaces are obtained.

2. Preliminaries

In this section, we recall some notions, notations and previous results.

Definition 2.1 [5]. A subfamily m_X of the power set $P(X)$ of a nonempty set X is called a *minimal structure* (briefly *m-structure*) on X if $\varnothing \in m_X$ and $X \in m_X$. Each member of m_X is said to be m_X*-open* and the complement of an m_X-open set is said to be m_X*-closed.*

Definition 2.2 [3]. Let X be a nonempty set and m_X be an m-structure on X. For a subset A of X, the m_X-closure of A and m_X-interior of A are defined as follows:

1. $m_X Cl(A) = \bigcap\{F : A \subseteq F,\ X\backslash F \in m_X\}$,

2. $m_X Int(A) = \bigcup\{U : U \subseteq A,\ U \in m_X\}$.

Lemma 2.3 [3]. *Let X be a nonempty set and m_X be an m-structure on X. For subsets A and B of X, the following hold:*

1. $m_X Cl(X\backslash A) = X\backslash m_X Int(A)$ *and* $m_X Int(X\backslash A) = X\backslash m_X Cl(A)$,

2. *If* $(X\backslash A) \in m_X$, *then* $m_X Cl(A) = A$ *and if* $A \in m_X$, *then* $m_X Int(A) = A$;

3. $m_X Cl(\varnothing) = \varnothing$, $m_X Cl(X) = X$, $m_X Int(\varnothing) = \varnothing$ *and* $m_X Int(X) = X$,

4. *If* $A \subseteq B$, *then* $m_X Cl(A) \subseteq m_X Cl(B)$ *and* $m_X Int(A) \subseteq m_X Int(B)$,

5. $A \subseteq m_X Cl(A)$ *and* $m_X Int(A) \subseteq A$,

6. $m_X Cl(m_X Cl(A)) = m_X Cl(A)$ *and* $m_X Int(m_X Int(A)) = m_X Int(A)$.

Lemma 2.4 [3]. *Let X be a nonempty set with a minimal structure and A be a subset of X. Then* $x \in m_X Cl(A)$ *if and only if* $U \cap A \neq \varnothing$ *for every* $U \in m_X$ *containing x.*

Definition 2.5 [3]. A minimal structure m_X on a nonempty set X is said to *have property* $\mathbb{B}$, if the union of any family of subsets belonging to m_X belongs to m_X.

Lemma 2.6 [5]. *For a minimal structure* m_X *on a nonempty set X, the following are equivalent:*

1. m_X *has property* $\mathbb{B}$,

2. *If* $m_X Int(V) = V$, *then* $V \in m_X$,

3. *If* $m_X Cl(F) = F$, *then* $X \setminus F \in m_X$.

Lemma 2.7 [5]. *Let X be a nonempty set and* m_X *be a minimal structure on X satisfying property* $\mathbb{B}$. *For a subset A of X, the following properties hold:*

1. $A \in m_X$ *if and only if* $m_X Int(A) = A$,

2. *A is* m_X*-closed if and only if* $m_X Cl(A) = A$,

3. $m_X Int(A) \in m_X$ *and* $m_X Cl(A)$ *is* m_X*-closed.*

Definition 2.8 [1]. Let X be a nonempty set and m_X^1, m_X^2 be minimal structures on X. A triple (X, m_X^1, m_X^2) is called a *biminimal structure space* (briefly *bim-space*).

Definition 2.9 [1]. A subset of a biminimal structure space (X, m_X^1, m_X^2) is called $m_X^1m_X^2$*-closed* if $A = m_X^1Cl(m_X^2Cl(A))$. The complement of $m_X^1m_X^2$-closed set is called $m_X^1m_X^2$*-open*.

Proposition 2.10 [1]. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space. If* A *and* B *are* $m_X^1m_X^2$*-closed subsets of* (X, m_X^1, m_X^2)*, then* $A \cap B$ *is* $m_X^1m_X^2$*-closed.*

Proposition 2.11 [1]. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space. Then* A *is* $m_X^1m_X^2$*-open subset of* (X, m_X^1, m_X^2) *if and only if* $A = m_X^1Int(m_X^2Int(A))$.

Proposition 2.12 [1]. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space. If* A *and* B *are* $m_X^1m_X^2$*-open subsets of* (X, m_X^1, m_X^2)*, then* $A \cup B$ *is* $m_X^1m_X^2$*-open.*

Definition 2.13 [1]. Let (X, m_X^1, m_X^2) be a biminimal structure space and Y be a subset of X. Define minimal structures m_Y^1 and m_Y^2 as follows: $m_Y^1 = \{A \cap Y : A \in m_X^1\}$ and $m_Y^2 = \{B \cap Y : B \in m_X^2\}$. A triple (Y, m_Y^1, m_Y^2) is called a *biminimal structure subspace* (briefly *bim-subspace*) of (X, m_X^1, m_X^2).

Let (Y, m_Y^1, m_Y^2) be a biminimal structure subspace of (X, m_X^1, m_X^2), and let A be a subset of Y. The m_Y-closure and m_Y-interior of A with respect to m_Y^i are denoted by $m_Y^iCl(A)$ and $m_Y^iInt(A)$, respectively (for $i = 1, 2$). Then $m_Y^1Cl(A) = Y \cap m_X^1Cl(A)$ and $m_Y^2Cl(A) = Y \cap m_X^2Cl(A)$.

Proposition 2.14 [1]. *Let* (Y, m_Y^1, m_Y^2) *be a biminimal structure subspace of* (X, m_X^1, m_X^2) *and F be a subset of Y. If F is* $m_X^1 m_X^2$*-closed, then F is* $m_Y^1 m_Y^2$*-closed.*

3. Main Results

In this section, we define the new definitions and construct their properties of separated and disconnected sets in biminimal structure spaces.

Lemma 3.1. *Let* (X, m_X) *be a minimal structure space and* $G \subseteq X$. *If G is* m_X*-open, then* $G \cap A = \emptyset$ *if and only if* $G \cap m_X Cl(A) = \emptyset$.

Proof. Let (X, m_X) be a minimal structure space and $G \subseteq X$. Suppose that G is m_X-open.

($\Rightarrow$) Assume that $G \cap A = \emptyset$. Suppose that $G \cap m_X Cl(A) \neq \emptyset$. Thus, there exist $x \in G$ and $x \in m_X Cl(A)$. By Lemma 2.4, we have $U \cap A \neq \emptyset$ for every $U \in m_X$ containing x. Since G is m_X-open and $x \in G$, $G \cap A \neq \emptyset$. Contradiction with $G \cap A = \emptyset$. Thus, $G \cap m_X Cl(A) = \emptyset$.

($\Leftarrow$) Assume that $G \cap m_X Cl(A) = \emptyset$. Since $A \subseteq m_X Cl(A)$, therefore $G \cap A = \emptyset$.

Definition 3.2. Let (X, m_X^1, m_X^2) be a biminimal structure space and let A and B be two nonempty subsets of X. Then A and B are called m_X-*separated sets* if and only if $m_X^i Cl(A) \cap B = \emptyset$ and $A \cap m_X^i Cl(B) = \emptyset$, where $i = 1, 2$.

Example 3.3. Let $X = \{1, 2, 3\}$. Define m-structures m_X^1 and m_X^2 on X as follows: $m_X^1 = \{\emptyset, \{1, 3\}, \{2, 3\}, X\}$ and $m_X^2 = \{\emptyset, \{1\}, \{2\}, \{1, 3\}, \{2, 3\}, X\}$. Then $\{1\}$ and $\{2\}$ are m_X-separated sets. But $\{1\}$ and $\{2, 3\}$ are not m_X-separated sets.

Theorem 3.4. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space, A and B be two nonempty* m_X^i*-open subsets of X, where* $i = 1, 2$. *Then A and B are* m_X*-separated sets if and only if* $A \cap B = \varnothing$.

Proof. Let (X, m_X^1, m_X^2) be a biminimal structure space, A and B be a nonempty m_X^i-open subset of X, where $i = 1, 2$.

($\Rightarrow$) Assume that A and B are m_X-separated sets. Thus, $m_X^i Cl(A) \cap B = \varnothing$ and $A \cap m_X^i Cl(B) = \varnothing$, where $i = 1, 2$. Hence, we have $A \cap B = \varnothing$.

($\Leftarrow$) Assume that $A \cap B = \varnothing$. Since A and B are m_X^i-open subsets of X and Lemma 3.1, we have $m_X^i Cl(A) \cap B = \varnothing$ and $A \cap m_X^i Cl(B) = \varnothing$, where $i = 1, 2$. Thus, A and B are m_X-separated sets.

Theorem 3.5. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space, A and B be two nonempty subsets of X,* $A \cap B = \varnothing$ *and* $m_{A \cup B}^i$ *satisfying property* $\mathbb{B}$. *Then A and B are* m_X*-separated sets if and only if A and B are* $m_{A \cup B}^i$*-open and* $m_{A \cup B}^i$*-closed, where* $i = 1, 2$.

Proof. Let (X, m_X^1, m_X^2) be a biminimal structure space, A and B be two nonempty subsets of X, $A \cap B = \varnothing$ and $m_{A \cup B}^i$ satisfying property $\mathbb{B}$.

($\Rightarrow$) Assume that A and B are m_X-separated sets. Since A and B are m_X*-separated sets*, $m_X^i Cl(A) \cap B = \varnothing$ and $A \cap m_X^i Cl(B) = \varnothing$, where $i = 1, 2$. Let $Y = A \cup B$. Then

$$\begin{aligned} m_Y^i Cl(A) &= m_X^i Cl(A) \cap Y = m_X^i Cl(A) \cap (A \cup B) \\ &= A \cup (m_X^i Cl(A) \cap B) \\ &= A \cup \varnothing = A. \end{aligned}$$

Thus by Lemma 2.7(2), A is $m^i_{A\cup B}$-closed. Similarly, we have B is $m^i_{A\cup B}$-closed, where $i = 1, 2$. Since $A \cap B = \varnothing$, $A = (A \cup B)\backslash B$ and $B = (A \cup B)\backslash A$. Hence, A and B are $m^i_{A\cup B}$-open, where $i = 1, 2$.

($\Leftarrow$) Let $Y = A \cup B$. Since A and B are $m^i_{A\cup B}$-open, where $i = 1, 2$, and $A \cap B = \varnothing$. By Lemma 3.1, we have $m^i_Y Cl(A) \cap B = \varnothing$ and $A \cap m^i_Y Cl(B) = \varnothing$, where $i = 1, 2$. It follows that

$$m^i_X Cl(A) \cap B = m^i_X Cl(A) \cap (Y \cap B) = (m^i_X Cl(A) \cap Y) \cap B$$
$$= m^i_Y Cl(A) \cap B = \varnothing,$$

and similarly we have, $A \cap m^i_X Cl(B) = \varnothing$. Therefore, A and B are m_X-separated sets.

Theorem 3.6. *Let (Y, m^1_Y, m^2_Y) be a biminimal structure subspace of (X, m^1_X, m^2_X) and $A, B \subseteq Y$. Then A and B are m_X-separated sets if and only if A and B are m_Y-separated sets.*

Proof. Let (Y, m^1_Y, m^2_Y) be a biminimal structure subspace of (X, m^1_X, m^2_X) and $A, B \subseteq Y$.

($\Rightarrow$) Assume that A and B are m_X-separated sets.

Since A and B are m_X-separated sets, $m^i_X Cl(A) \cap B = \varnothing$ and $A \cap m^i_X Cl(B) = \varnothing$, where $i = 1, 2$. Therefore

$$m^i_Y Cl(A) \cap B = m^i_X Cl(A) \cap B \cap Y = \varnothing$$

and

$$A \cap m^i_Y Cl(B) = A \cap m^i_X Cl(B) \cap Y = \varnothing,$$

where $i = 1, 2$. Hence, A and B are m_Y-separated sets.

($\Leftarrow$) Suppose that A and B are m_Y-separated sets. By assumption and $A, B \subseteq Y$, thus

$$m_X^i Cl(A) \cap B = m_X^i Cl(A) \cap Y \cap B = m_Y^i Cl(A) \cap B = \varnothing$$

and

$$A \cap m_X^i Cl(B) = A \cap Y \cap m_X^i Cl(B) = A \cap m_Y^i Cl(B) = \varnothing,$$

where $i = 1, 2$. Hence, A and B are m_X-separated sets.

Definition 3.7. Let (X, m_X^1, m_X^2) be a biminimal structure space and $A \subseteq X$. We call A is *m_X-disconnected set* if and only if $A = C \cup D$, where C and D are m_X-separated sets and we call A is m_X-connected set if and only if A is not m_X-disconnected set.

A biminimal structure space (X, m_X^1, m_X^2) is called *m_X-disconnected space* if X is m_X-disconnected set and (X, m_X^1, m_X^2) is called *m_X-connected space* if X is m_X-connected set.

Example 3.8. Let $X = \{1, 2, 3\}$. Define m-structures m_X^1 and m_X^2 on X as follows: $m_X^1 = \{\varnothing, \{1, 3\}, \{2, 3\}, X\}$ and $m_X^2 = \{\varnothing, \{1\}, \{2\}, \{1, 3\}, \{2, 3\}, X\}$. Since $\{1\}$ and $\{2\}$ are m_X-separated sets, $\{1, 2\}$ is m_X-disconnected set. And we have X is m_X-connected set. Therefore, (X, m_X^1, m_X^2) is m_X-connected space.

Theorem 3.9. *Let (Y, m_Y^1, m_Y^2) be a biminimal structure subspace of (X, m_X^1, m_X^2) and $A \subseteq Y$. Then A is m_X-disconnected set if and only if A is m_Y-disconnected set.*

Proof. By Theorem 3.6, we have if $C, D \subseteq Y$, then C and D are m_X-separated sets if and only if C and D are m_Y-separated sets. Thus,

$A = C \cup D$ is m_X-disconnected set if and only if $A = C \cup D$ is m_Y-disconnected set.

By Theorem 3.9, we have the following corollary.

Corollary 3.10. *Let* (Y, m_Y^1, m_Y^2) *be a biminimal structure subspace of* (X, m_X^1, m_X^2) *and* $A \subseteq Y$. *Then A is* m_X*-connected set if and only if A is* m_Y*-connected set.*

Theorem 3.11. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space and* m_X^1, m_X^2 *have property* $\mathbb{B}$. *Thus, X is* m_X*-disconnected set if and only if there exists a nonempty proper subset A of X such that A is* m_X^i*-open set and* m_X^i*-closed set, where* $i = 1, 2$.

Proof. Let (X, m_X^1, m_X^2) be a biminimal structure space and m_X^1, m_X^2 have property $\mathbb{B}$.

($\Rightarrow$) Assume that X is m_X-disconnected set. Thus, there exist nonempty sets C and D such that $X = C \cup D$, C and D are m_X-separated sets. Since $C \subseteq m_X^i Cl(C)$ and $m_X^i Cl(C) \cap D = \varnothing$, $C \cap D = \varnothing$. It follows that $C = X \backslash D$ and $D = X \backslash C$. From $X = C \cup D \subseteq C \cup m_X^i Cl(D) \subseteq X$. We have $X = C \cup m_X^i Cl(D)$. Since

$$C \cap m_X^i Cl(D) = \varnothing,\ C = X \backslash m_X^i Cl(D) = m_X^i Int(X \backslash D) = m_X^i Int(C).$$

By Lemma 2.7, we have C is m_X^i-open set. Then we also have D is m_X^i-closed set. Since $D \cap m_X^i Cl(C) = \varnothing$, $D = m_X^i Int(D)$ and Lemma 2.7, we have D is m_X^i-open set. Then we also have C is m_X^i-closed set, where $i = 1, 2$.

($\Leftarrow$) Suppose that there exists a nonempty proper subset A of X such that A is m_X^i-open set and m_X^i-closed set, where $i = 1, 2$. Let $B = X \backslash A$. Thus,

B is a nonempty proper subset of X and by Lemma 2.7, we have B is m_X^i-closed set and m_X^i-open set, where $i = 1, 2$. Therefore, $X = A \bigcup B$ and $A \bigcap B = \varnothing$. Since A and B are m_X^i-open set and Lemma 3.1, $A \bigcap m_X^i Cl(B) = \varnothing$ and $m_X^i Cl(A) \bigcap B = \varnothing$, where $i = 1, 2$. Hence, X is m_X-disconnected set.

Theorem 3.12. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space and* m_X^1, m_X^2 *satisfy property* $\mathbb{B}$. *Thus, X is* m_X*-disconnected set if and only if* $X = U \bigcup V$, *where U and V are nonempty* m_X^i*-open sets,* $i = 1, 2$ *and* $U \bigcap V = \varnothing$.

Proof. Let (X, m_X^1, m_X^2) be a biminimal structure space and m_X^1, m_X^2 satisfy property $\mathbb{B}$.

($\Rightarrow$) Assume that X is m_X-disconnected set. By Theorem 3.11, there exists a nonempty proper subset A of X such that A is m_X^i-open set and m_X^i-closed set, where $i = 1, 2$. Then by Lemma 2.7, $X \backslash A$ is m_X^i-closed set and m_X^i-open set such that $X \backslash A$ is a nonempty proper subset of X. Put $U = A$ and $V = X \backslash A$. Then $X = U \bigcup V$, $U \bigcap V = \varnothing$ and U and V are nonempty m_X^i-open sets, $i = 1, 2$.

($\Leftarrow$) Assume that $X = U \bigcup V$, where U and V are nonempty m_X^i-open sets, $i = 1, 2$ and $U \bigcap V = \varnothing$. Since U and V are m_X^i-open sets and $U \bigcap V = \varnothing$, by Lemma 3.1, $U \bigcap m_X^i Cl(V) = \varnothing$ and $m_X^i Cl(U) \bigcap V = \varnothing$, where $i = 1, 2$. Therefore, X is m_X-disconnected set.

Theorem 3.13. *Let* (X, m_X^1, m_X^2) *be a biminimal structure space and* $E \subseteq X$ *be* m_X*-connected set. If* $E \subseteq A \bigcup B$, *A and B are* m_X*-separated set, then* $E \subseteq A$ *or* $E \subseteq B$.

Proof. Assume that $E \subseteq A \cup B$, A and B are m_X-separated sets. Then $E = E \cap (A \cup B) = (E \cap A) \cup (E \cap B)$. Since A and B are m_X-separated set, $A \cap m_X^i Cl(B) = \varnothing$ and $m_X^i Cl(A) \cap B = \varnothing$, $i = 1, 2$. Next we will show that $E \cap A = \varnothing$ or $E \cap B = \varnothing$. Suppose that $E \cap A \neq \varnothing$ and $E \cap B \neq \varnothing$. Then

$$\begin{aligned}(E \cap A) \cap m_X^i Cl(E \cap B) &\subseteq (E \cap A) \cap (m_X^i Cl(E) \cap m_X^i Cl(B)) \\ &= E \cap (A \cap m_X^i Cl(B)) \\ &= \varnothing.\end{aligned}$$

Similarly, we have $m_X^i Cl(E \cap A) \cap (E \cap B) = \varnothing$. Then $E \cap A$ and $E \cap B$ are m_X-separated sets. Therefore, E is m_X-disconnected set. This is contradiction with E is m_X-connected set. Thus $E \cap A = \varnothing$ or $E \cap B = \varnothing$. So, we have:

Case 1. If $E \cap A = \varnothing$, then we have

$E = (E \cap A) \cup (E \cap B) = E \cap B$. Hence $E \subseteq B$.

Case 2. If $E \cap B = \varnothing$, then we have

$E = (E \cap A) \cup (E \cap B) = E \cap A$. Hence $E \subseteq A$.

Theorem 3.14. *Let (X, m_X^1, m_X^2) be a biminimal structure space and $E \subseteq X$ be m_X-connected set. If $E \subseteq A \subseteq m_X^i Cl(E)$, where $i = 1, 2$, then A is m_X-connected set.*

Proof. Assume that $E \subseteq A \subseteq m_X Cl(E)$. We will show that A is m_X-connected set. Suppose that A is m_X-disconnected set. Thus, there exist nonempty sets C and D, such that $A = C \cup D$, $C \cap m_X^i Cl(D) = \varnothing$ and $m_X^i Cl(C) \cap D = \varnothing$, for $i = 1, 2$.. Since E is m_X-connected set and $E \subseteq C \cup D$ and Theorem 3.13, we have $E \subseteq C$ or $E \subseteq D$.

Case 1. If $E \subseteq C$, then we have $m^i_X Cl(E) \subseteq m^i_X Cl(C)$ and $m^i_X Cl(E) \cap D = \varnothing$. Since

$$D \subseteq C \cup D = A \subseteq m^i_X Cl(E),\ D = m^i_X Cl(E) \cap D = \varnothing.$$

Contradiction with $D \neq \varnothing$.

Case 2. If $E \subseteq D$, then we have $m^i_X Cl(E) \subseteq m^i_X Cl(D)$ and $m^i_X Cl(E) \cap C = \varnothing$. Since

$$C \subseteq C \cup D = A \subseteq m^i_X Cl(E),\ C = m^i_X Cl(E) \cap C = \varnothing.$$

Contradiction with $C \neq \varnothing$.

Therefore, A is m_X-connected set.

Corollary 3.15. *Let (X, m^1_X, m^2_X) be a biminimal structure space and $E \subseteq X$ be m_X-connected set. If E is m_X-connected set, then $m^i_X Cl(E)$ is m_X-connected set, where $i = 1, 2$.*

Proof. Since $E \subseteq m^i_X Cl(E) \subseteq m^i_X Cl(E)$ and Theorem 3.14, we have $m^i_X Cl(E)$ is m_X-connected set, $i = 1, 2$.

Theorem 3.16. *Let (X, m^1_X, m^2_X) be a biminimal structure space and $E \subseteq X$. If for any $x, y \in E$ and $x \neq y$, there exists m_X-connected set $F \subseteq E$ such that $x, y \in F$. Then E is m_X-connected set.*

Proof. Assume that for any $x, y \in E$ and $x \neq y$, there exists m_X-connected set $F \subseteq E$ such that $x, y \in F$. Next we will show that E is m_X-connected set. Suppose that E is m_X-disconnected set. Then there exist nonempty sets A and B such that $E = A \cup B$, A and B are m_X-separated sets. Since A and B are m_X-separated sets, $A \neq \varnothing$, $B \neq \varnothing$ and $A \cap B = \varnothing$. Then we also have $x \in A$, $y \in B$ and $x \neq y$. Thus, $x, y \in E$ and by assumption there exists m_X-connected set $F \subseteq E$ such that $x, y \in F$.

Since $F \subseteq E = A \cup B$, by Theorem 3.13 we have $F \subseteq A$ or $F \subseteq B$. Then $x, y \in A$ or $x, y \in B$. This is contradiction with $A \cap B = \emptyset$. Therefore, E is m_X-connected set.

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Mathematics (miscellaneous)											Q4	Q4	Q4	Q4	Q4

Quartile (Q1 means highest values and Q4 lowest values)

Publisher: University of Allahabad. **Publication type:** Journals. **ISSN:** 09720871

Coverage: 2008-2013

H Index: 8

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Far East Journal of Mathematical Sciences

Indicator	2006-2013	Value
SJR		0.16
Cites per doc		0.18
Total cites		115

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Display journal title

Just copy the code below and paste within your html page:
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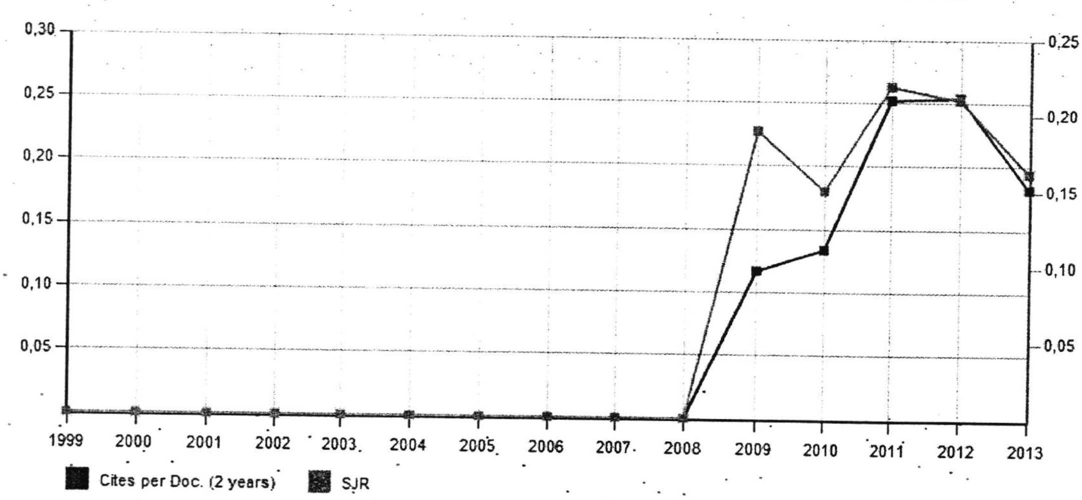
Charts Data

SJR indicator vs. Cites per Doc (2y)



The SJR indicator measures the scientific influence of the average article in a journal, it expresses how central to the global scientific discussion an average article of the journal is. Cites per Doc. (2y) measures the scientific impact of an average article published in the journal, it is computed using the same formula that journal impact factor ™ (Thomson Reuters).

Citation vs. Self-Citation

Related product

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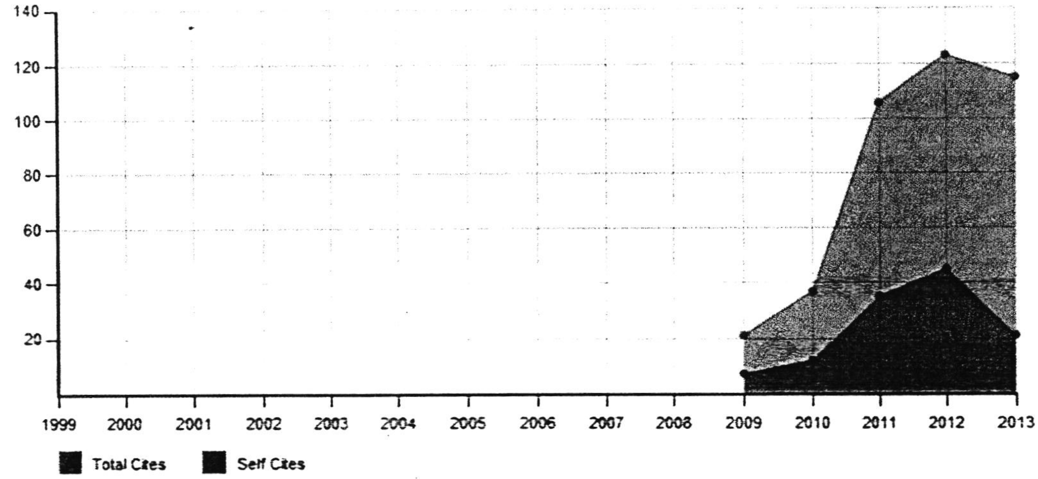
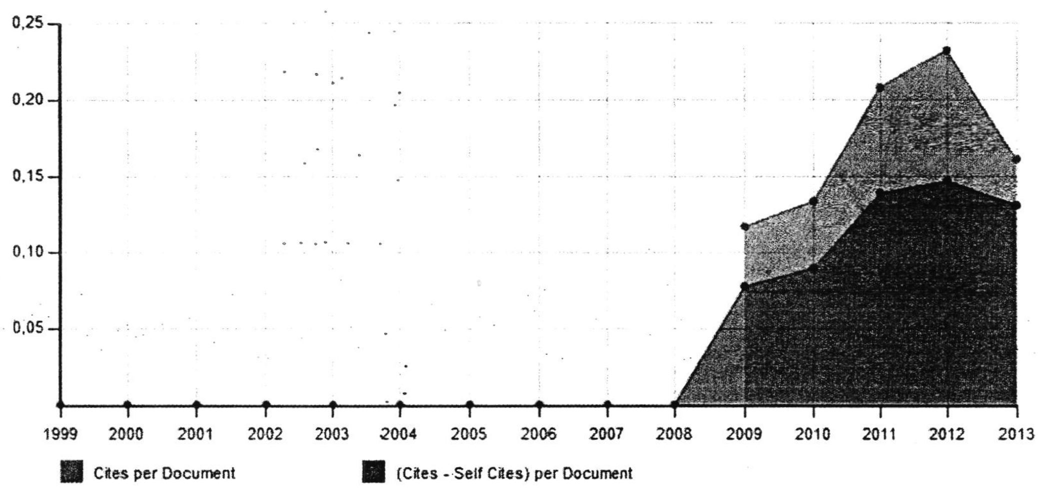


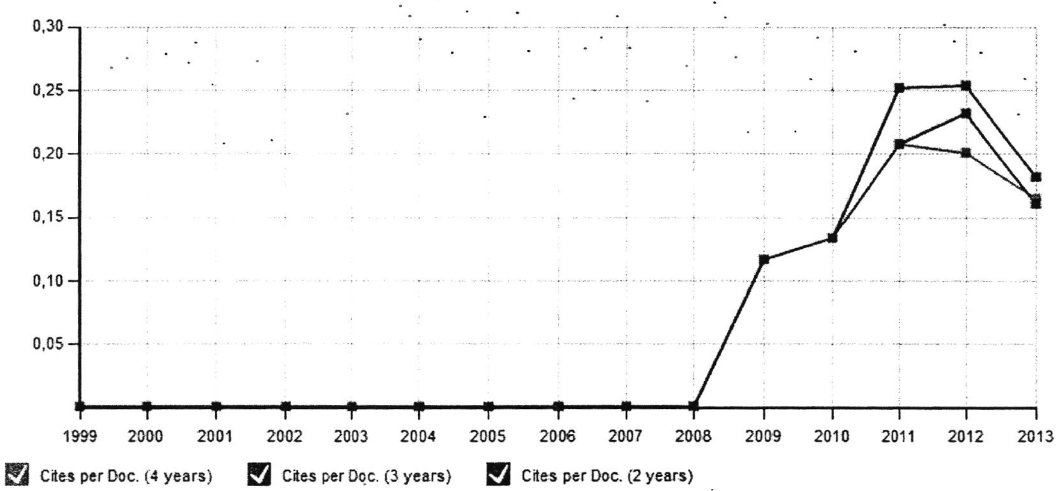
Evolution of the total number of citations and journal's self-citations received by a journal's published documents during the three previous years.

Cites per Document vs. External Cites per Document



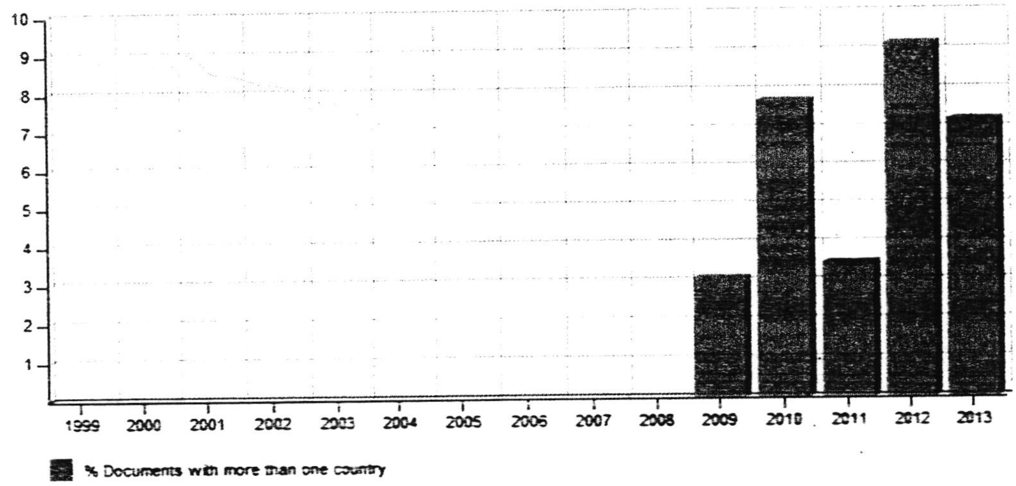
Evolution of the number of total cites per document and external cites per document (i.e. journal self-citations removed) received by a journal's published documents during the three previous years.

Cites per Document in 2, 3 and 4 years windows



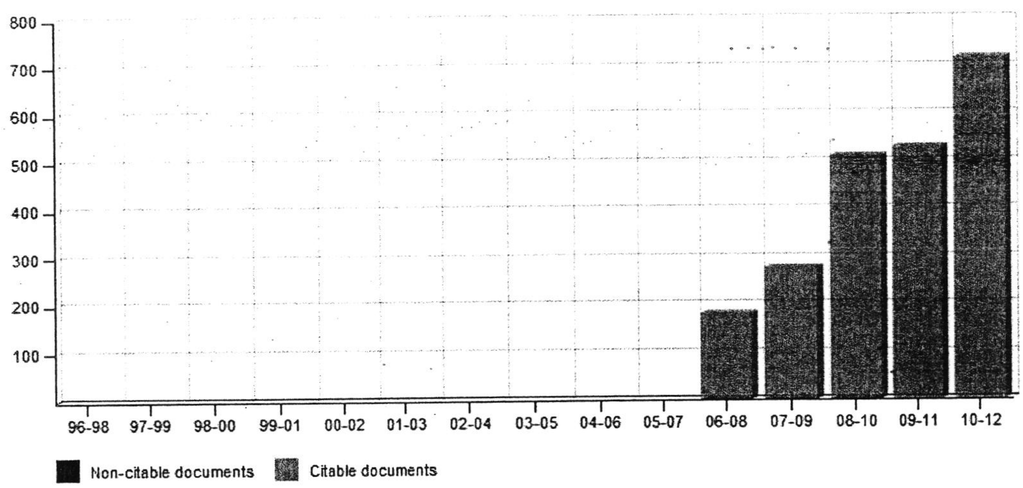
Evolution of Citations per Document to a journal's published documents during the two, three and four previous years. The two years line is equivalent to journal impact factor ™ (Thomson Reuters) metric.

International Collaboration



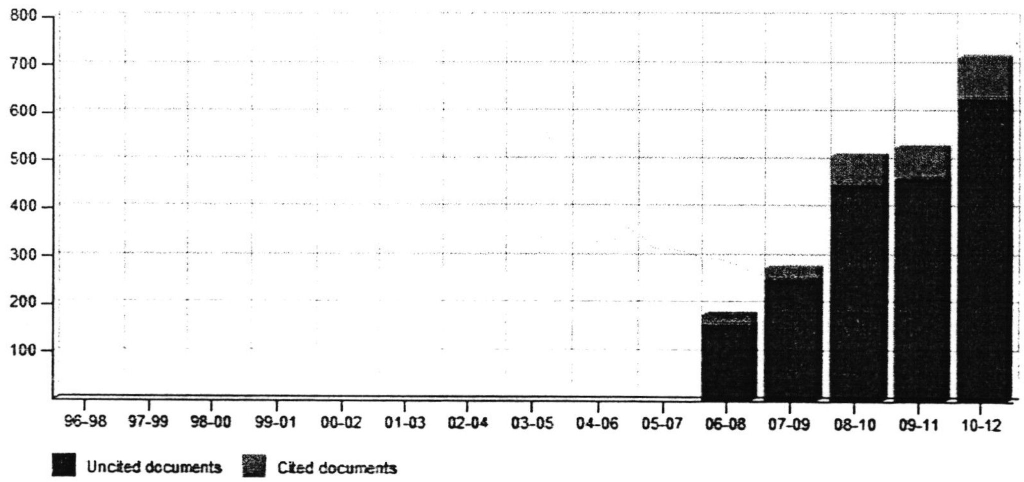
International Collaboration accounts for the articles that have been produced by researchers from several countries. The chart shows the ratio of a journal's documents signed by researchers from more than one country.

Journal's Citable vs. Non Citable Documents



Not every article in a journal is considered primary research and therefore "citable", this chart shows the ratio of a journal's articles including substantial research (research articles, conference papers and reviews) in three year windows.

Journal's Cited vs. Uncited Documents



Ratio of a journal's items, grouped in three years windows, that have been cited at least once vs. those not cited during the following year.