MICRO IDEAL GENERALIZED CLOSED SETS IN MICRO IDEAL TOPOLOGICAL SPACES

SELVARAJ GANESAN

Assistant Professor, PG & Research Department of Mathematics,
Raja Doraisingam Government Arts College, Sivagangai-630561, Tamil Nadu, India.
(Affiliated to Alagappa University, Karaikudi, Tamil Nadu, India)
e-mail : sgsgsgsgsg77@gmail.com

Abstract. The main purpose of this paper is to introduce a new type of generalized closed and open sets called \( mI_g \)-closed set and \( mI_g \)-open set in micro ideal topological spaces and investigate the relation between this set with other sets in micro topological spaces and micro ideal topological spaces. Characterizations and properties of \( mI_g \)-closed sets, \( mI_g \)-open sets are given. Characterizations and properties of \( \star mI-LC \)-sets, \( L-mI-LC \)-sets, \( m\star \)-continuous, \( \star mI-LC \)-continuous, \( L-mI-LC \)-continuous, \( mI_g \)-continuous and to obtain decomposition of \( m\star \)-continuity in micro ideal topological spaces.

1. INTRODUCTION

An ideal \( \mathcal{I} \) on a topological space \( (X, \tau) \) is a nonempty collection of subsets of \( X \) which satisfies (i) \( A \in \mathcal{I} \) and \( B \subset A \Rightarrow B \in \mathcal{I} \) and (ii) \( A \in \mathcal{I} \) and \( B \in \mathcal{I} \Rightarrow A \cup B \in \mathcal{I} \). Given a topological space \( (X, \tau) \) with an ideal \( \mathcal{I} \) on \( X \) and if \( \wp(X) \) is the set of all subsets of \( X \), a set operator \( (.)^\star : \wp(X) \rightarrow \wp(X) \), called a local function \([6]\) of \( A \) with respect to \( \tau \) and \( \mathcal{I} \) is defined as follows: for \( A \subseteq X \), \( A^\star(\mathcal{I}, \tau) = \{ x \in X \mid \)

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U ∩ A ⊈ ℋ for every U ∈ τ(x) where τ(x) = \{ U ∈ τ | x ∈ U \}. We will make use of the basic facts about the local functions [[5], Theorem 2.3] without mentioning it explicitly. A Kuratowski closure operator cl*(.) for a topology τ *(ℋ, τ), called the ∗-topology, finer than τ is defined by cl*(A) = A ∪ A*(ℋ, τ) [8]. When there is no chance for confusion, we will simply write A* for A*(ℋ, τ) and τ* for τ *(ℋ, τ).

If ℋ is an ideal on X, then (X, τ, ℋ) is called an ideal space. ℋ is the ideal of all nowhere dense subsets in (X, τ). A subset A of an ideal space (X, τ, ℋ) is ∗-closed [5] (resp. ∗-dense in itself [4]) if A* ⊆ A (resp. A ⊆ A*).

By a space, we always mean a topological space (X, τ) with no separation properties assumed. If A ⊆ X, cl(A) and int(A) will, respectively, denote the closure and interior of A in (X, τ) and int(A* will denote the interior of A in (X, τ*).

The notion of a micro topology was introduced and studied by Chandrasekar [1] which was defined Micro closed, Micro open, Micro interior and Micro closure. S. Ganesan [2] introduced and studied the concepts of micro generalised closed sets and micro generalized continuous in micro topological spaces. S. Ganesan [3] introduced the concepts of micro ideal topological spaces and investagated some of its basic properties. I introduced the notion of Micro regular open, mℋ-open, α-mℋ-open, pre-mℋ-open, semi-mℋ-open, b-mℋ-open, β-mℋ-open, regular mℋ-closed which are simple forms of micro open sets in an micro ideal topological spaces. Also we characterize the relations between them and the related properties. In this paper i introduce a new type of generalized closed and open sets called mℋg-closed set and mℋg-open set in micro ideal topological spaces and investigate the relation between this set with other sets in micro topological spaces and micro ideal topological spaces. Characterizations and properties of mℋg-closed sets, mℋg-open sets...
are studied. Characterizations and properties of $\star-mI$-LC-sets, $L-mI$-LC-sets, $m\star$-continuous, $\star-mI$-LC-continuous, $L-mI$-LC-continuous, $mI_g$-continuous are studied, and to obtain decomposition of $m\star$-continuity in micro ideal topological spaces.

2. PRELIMINARIES

Definition 2.1. [7] Let $U$ be a non-empty finite set of objects called the universe and $R$ be an equivalence relation on $U$ named as the indiscernibility relation. Then $U$ is divided into disjoint equivalence classes. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair $(U, R)$ is said to be the approximation space. Let $X \subseteq U$.

(1) The lower approximation of $X$ with respect to $R$ is the set of all objects, which can be for certain classified as $X$ with respect to $R$ and it is denoted by $L_R(X)$. Thatis, $L_R(X) = \bigcup x \in U \{ R(x) : R(X) \subseteq X \}$ where $R(x)$ denotes the equivalence class determined by $X$.

(2) The upper approximation of $X$ with respect to $R$ is the set of all objects, which can be possibly classified as $X$ with respect to $R$ and it is denoted by $U_R(X)$. Thatis, $U_R(X) = \bigcup x \in U \{ R(x) : R(X) \cap X \neq \phi \}$

(3) The boundary region of $X$ with respect to $R$ is the set of all objects, which can be neither in nor as not-$X$ with respect to $R$ and it is denoted by $B_R(X)$. Thatis, $B_R(X) = U_R(X) - L_R(X)$

Definition 2.2. [7]
If $(U, \tau_R(X))$ is the nano topological space with respect to $X$ where $X \subseteq U$ and if $A \subseteq U$, then
(1) The nano interior of the set $A$ is defined as the union of all nano open subsets contained in $A$ and it is denoted by $\text{nint}(A)$. That is, $\text{nint}(A)$ is the largest nano open subset of $A$.

(2) The nano closure of the set $A$ is defined as the intersection of all nano closed sets containing $A$ and it is denoted by $\text{ncl}(A)$. That is, $\text{ncl}(A)$ is the smallest nano closed set containing $A$.

**Definition 2.3.** [1] Let $(U, \tau_R(X))$ be a nano topological space. Then, $\mu_R(X) = \{ N \cup (\hat{N} \cap \mu) : N, \hat{N} \in \tau_R(X) \text{ and } \mu \notin \tau_R(X) \}$ is called the Micro topology on $U$ with respect to $X$. The triplet $(U, \tau_R(X), \mu_R(X))$ is called Micro topological space and the elements of $\mu_R(X)$ are called Micro open sets and the complement of a Micro open set is called a Micro closed set.

**Definition 2.4.** [1] The Micro topology $\mu_R(X)$ satisfies the following axioms

(1) $U, \phi \in \mu_R(X)$.

(2) The union of the elements of any sub-collection of $\mu_R(X)$ is in $\mu_R(X)$.

(3) The intersection of the elements of any finite sub collection of $\mu_R(X)$ is in $\mu_R(X)$.

Then $\mu_R(X)$ is called the Micro topology on $U$ with respect to $X$. The triplet $(U, \tau_R(X), \mu_R(X))$ is called Micro topological spaces and The elements of $\mu_R(X)$ are called Micro open (briefly, m-open) sets and the complement of a Micro open set is called a Micro closed (briefly, m-closed) sets.

**Definition 2.5.** [1] For any two Micro sets $A$ and $B$ in a Micro topological space $(U, \tau_R(X), \mu_R(X))$,

(1) $A$ is a Micro closed set if and only if $\text{Mic-cl}(A) = A$.

(2) $A$ is a Micro open set if and only if $\text{Mic-int}(A) = (A)$.
(3) \( A \subseteq B \) implies \( \text{Mic-int}(A) \subseteq \text{Mic-int}(B) \) and \( \text{Mic-cl}(A) \subseteq \text{Mic-cl}(B) \).

(4) \( \text{Mic-cl}(\text{Mic-cl}(A)) = \text{Mic-cl}(A) \) and \( \text{Mic-int}(\text{Mic-int}(A)) = \text{Mic-int}(A) \).

(5) \( \text{Mic-cl}(A \cup B) \supseteq \text{Mic-cl}(A) \cup \text{Mic-cl}(B) \).

(6) \( \text{Mic-cl}(A \cap B) \subseteq \text{Mic-cl}(A) \cap \text{Mic-cl}(B) \).

(7) \( \text{Mic-int}(A \cup B) \supseteq \text{Mic-int}(A) \cup \text{Mic-int}(B) \).

(8) \( \text{Mic-int}(A \cap B) \subseteq \text{Mic-int}(A) \cap \text{Mic-int}(B) \).

(9) \( \text{Mic-cl}(A^C) = [\text{Mic-int}(A)]^C \).

(10) \( \text{Mic-int}(A^C) = [\text{Mic-cl}(A)]^C \).

**Definition 2.6.** Let \((U, \tau_R(X), \mu_R(X))\) be a micro topological space and \( A \subseteq U \). Then,

(1) \( A \) is called Micro semi-open if \( A \subseteq \text{Mic-cl}(\text{Mic-int}(A)) \). \([1]\).

(2) \( A \) is called Micro regular open \( A = \text{Mic-int}(\text{Mic-cl}(A)) \). \([3]\)

The complement of above mentioned micro open sets are called their respective micro closed sets.

**Definition 2.7.** \([2]\) A subset \( A \) of a space \((U, \tau_R(X), \mu_R(X))\) is called Micro generalized closed (briefly mg-closed) set if \( mcl(A) \subseteq T \) whenever \( A \subseteq T \) and \( T \) is \( m \)-open in \((U, \tau_R(X), \mu_R(X))\). The complement of mg-closed set is called mg-open set.

**Definition 2.8.** \([3]\) Let \((K, \mathcal{N}, \mathcal{M})\) be an micro topological space with an ideal \( \mathcal{I} \) on \( K \), where \( \mathcal{N} = \tau_R(X) \), \( \mathcal{M} = \mu_R(X) \) and if \( \varphi(K) \) is the set of all subsets of \( K \), a set operator \((\cdot)^*_m : \varphi(K) \to \varphi(K)\). For a subset \( A \subseteq K \), \( A^*_m(\mathcal{I}, \mathcal{M}) = \{k \in K : S_m \cap A \notin \mathcal{I} \), for every \( S_m \in S_m(k)\} \), where \( S_m(k) = \{S_m \mid k \in S_m, S_m \in \mathcal{M}\} \) is called the micro local function (briefly, \( m \)-local function) of \( A \) with respect to \( \mathcal{I} \) and \( \mathcal{M} \). We will simply write \( A^*_m \) for \( A^*_m(\mathcal{I}, \mathcal{M}) \).
Theorem 2.9. [3] Let \((K, \mathcal{N}, \mathcal{M})\) be a micro topological space with ideal \(\mathcal{I}, \mathcal{I}'\) on \(K\) and \(A, B\) be subsets of \(K\). Then

1. \(A \subseteq B \Rightarrow A^*_m \subseteq B^*_m\),
2. \(\mathcal{I} \subseteq \mathcal{I}' \Rightarrow A^*_m (\mathcal{I}') \subseteq A^*_m (\mathcal{I})\),
3. \(A^*_m = m-cl(A^*_m) \subseteq m-cl(A)\) (\(A^*_m\) is a micro closed subset of \(m-cl(A)\)),
4. \((A^*_m)_m \subseteq A^*_m\),
5. \(A^*_m \cup B^*_m = (A \cup B)^*_m\),
6. \(A^*_m - B^*_m = (A - B)^*_m - B^*_m \subseteq (A - B)^*_m\),
7. \(U \in \mathcal{M} \Rightarrow U \cap A^*_m = U \cap (U \cap A)^*_m \subseteq (U \cap A)^*_m\) and
8. \(F \in \mathcal{I} \Rightarrow (A \cup F)^*_m = A^*_m = (A - F)^*_m\), and so \(A^*_m = \emptyset\), if \(A \in \mathcal{I}\).

Theorem 2.10. [3] Let \((K, \mathcal{N}, \mathcal{M})\) be an micro topological space with an ideal \(\mathcal{I}\) and \(A \subseteq A^*_m\), then \(A^*_m = m-cl(A^*_m) = m-cl(A)\).

Definition 2.11. [3] Let \((K, \mathcal{N}, \mathcal{M})\) be an micro topological space with an ideal \(\mathcal{I}\) on \(K\). The set operator \(m-cl^*\) is called a micro \(\ast\)-closure and is defined as \(m-cl^* (A) = A \cup A^*_m\) for \(A \subseteq K\).

Theorem 2.12. [3] The set operator \(m-cl^*\) satisfies the following conditions:

1. \(A \subseteq m-cl^* (A)\),
2. \(m-cl^* (\emptyset) = \emptyset\) and \(m-cl^* (K) = K\),
3. If \(A \subseteq B\), then \(m-cl^* (A) \subseteq m-cl^* (B)\),
4. \(m-cl^* (A) \cup m-cl^* (B) = m-cl^* (A \cup B)\),
5. \(m-cl^* (m-cl^* (A)) = m-cl^* (A)\).

Theorem 2.13. [3] \((K, \mathcal{N}, \mathcal{M})\) be an micro topological space with an ideal \(\mathcal{I}\) on \(K\) and for every \(A \subseteq K\). If \(A \subseteq A^*_m\), then
(1) $m\text{-}cl(A) = m\text{-}cl^*(A)$,
(2) $m\text{-}int(K - A) = m\text{-}int^*(K - A)$,
(3) $m\text{-}cl(K - A) = m\text{-}cl^*(K - A)$,
(4) $m\text{-}int(A) = m\text{-}int^*(A)$.

**Theorem 2.14.** [3] $(K, \mathcal{N}, \mathcal{M})$ be an micro topological space with an ideal $\mathcal{I}$ on $K$ and for every $A \subseteq K$. If $A \subseteq A^*_m$, then $A^*_m = m\text{-}cl(A^*_m) = m\text{-}cl(A) = m\text{-}cl^*(A)$.

**Definition 2.15.** [3] A subset $A$ of a micro ideal topological space $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is $m^*$-dense in itself (resp. $m^*$-perfect, $m^*$-closed) if $A \subseteq A^*_m$ (resp. $A = A^*_m$, $A^*_m \subseteq A$).

The complement of $m^*$-closed set is $m^*$-open set.

**Theorem 2.16.** [3] $(K, \mathcal{N}, \mathcal{M})$ be an micro topological space with an ideal $\mathcal{I}$ on $K$ and for every $A \subseteq K$. If $A$ is $m^*$ dense in itself, then $A^*_m = m\text{-}cl(A^*_m) = m\text{-}cl(A) = m\text{-}cl^*(A)$.

**Definition 2.17.** [3] An ideal $\mathcal{I}$ in a space $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is called $\mathcal{M}$-codense ideal if $\mathcal{M} \cap \mathcal{I} = \{\phi\}$.

**Theorem 2.18.** [3] Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space and $\mathcal{I}$ is $\mathcal{M}$-codense with $\mathcal{M}$. Then $K = K^*_m$.

**Lemma 2.19.** [3] If $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is any micro ideal topological space, then the following are equivalent

(1) $K = K^*_m$,
(2) $\mathcal{M} \cap \mathcal{I} = \{\phi\}$,
(3) If $F \in \mathcal{I}$ then $m\text{-}int(F) = \phi$,
(4) for every $G \in \mathcal{M}$, $G \subseteq G^*_m$. 
Theorem 2.20. [3] If \((K, N, M, I)\) is any micro ideal topological space, then the following are equivalent

(1) \(K = K^*_m\),
(2) for every \(A \in M\), \(A \subseteq A^*_m\),
(3) for every \(A \in MSO(K, N, M)\), \(A \subseteq A^*_m\),
(4) For every Micro regular closed set \(F\), \(F = F^*_m\).

3. \(m\mathcal{I}_g\)-closed sets and \(m\mathcal{I}_g\)-open sets

I introduce the following definition.

Definition 3.1. A subset \(A\) of an micro ideal topological space \((K, N, M, I)\) is said to be

(1) micro \(I\)-generalized closed (briefly, \(m\mathcal{I}_g\)-closed) if \(A^*_m \subseteq U\) whenever \(A \subseteq U\) and \(U\) is \(m\)-open,
(2) \(m\mathcal{I}_g\)-open if its complement is \(m\mathcal{I}_g\)-closed.

Theorem 3.2. Let \((K, N, M, I)\) be an micro ideal topological space. Then every \(mg\)-closed set is an \(m\mathcal{I}_g\)-closed set but not conversely.

Proof. Let \(A\) be a \(mg\)-closed set. Then \(m\text{-cl}(A) \subseteq U\) whenever \(A \subseteq U\) and \(U\) is \(m\)-open. So [by Theorem 2.9 (3)], \(A^*_m \subseteq m\text{-cl}(A) \subseteq U\) whenever \(A \subseteq U\) and \(U\) is \(m\)-open. Hence \(A\) is \(m\mathcal{I}_g\)-closed. □

Example 3.3. Let \(K = \{n, o, p, q\}\) with \(K/ R = \{\{n, o\}, \{p\}, \{q\}\}\) and \(X = \{n, o\}\). The nano topology \(N = \{\emptyset, \{n, o\}, K\}\). If \(\mu = \{p\}\) then the micro topology \(M = \{\emptyset, \{p\}, \{n, o\}, \{n, o, p\}, K\}\) and \(I = \{\emptyset, \{n\}\}\). Then \(mg\)-closed sets are \(\emptyset, K, \{q\}, \{n, q\}, \{o, q\}, \{p, q\}, \{n, o, q\}, \{n, p, q\}, \{o, p, q\}\) and \(m\mathcal{I}_g\)-closed sets are \(\emptyset, K, \{q\}, \{n, q\}, \{o, q\}, \{p, q\}, \{n, o, q\}, \{n, p, q\}, \{o, p, q\}\).
It is clear that \( \{ n \} \) is m\( I \)g-closed but it is not mg-closed.

**Theorem 3.4.** If \((K, N, M, I)\) is a micro ideal topological space and \(A \subseteq K\), then

\( A \) is m\( I \)g-closed if and only if \( m-cl^*(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \).

**Proof.** Necessity: Since \( A \) is m\( I \)g-closed, we have \( A^*_m \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \). \( m-cl(A) = A \cup A^*_m \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \).

Sufficiency: Let \( A \subseteq U \) and \( U \) is m-open in \( K \). By hypothesis \( m-cl^*(A) \subseteq U \). Since \( m-cl(A) = A \cup A^*_m \), we have \( A^*_m \subseteq U \).

The following theorem gives characterizations of m\( I \)g-closed sets.

**Theorem 3.5.** If \((K, N, M, I)\) is any micro ideal topological space and \(A \subseteq K\), then the following are equivalent.

1. \( A \) is m\( I \)g-closed,
2. \( m-cl^*(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \),
3. For all \( k \in m-cl^*(A) \), \( m-cl(\{ k \}) \cap A \neq \emptyset \).
4. \( m-cl^*(A) - A \) contains no nonempty m-closed set,
5. \( A^*_m - A \) contains no nonempty m-closed set.

**Proof.** (1) \( \Rightarrow \) (2) If \( A \) is m\( I \)g-closed, then \( A^*_m \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \) and so \( m-cl^*(A) = A \cup A^*_m \subseteq U \) whenever \( A \subseteq U \) and \( U \) is m-open in \( K \). This proves (2).

(2) \( \Rightarrow \) (3) Suppose \( k \in m-cl^*(A) \). If \( m-cl(\{ k \}) \cap A = \emptyset \), then \( A \subseteq K - m-cl(\{ k \}) \).

By (2), \( m-cl^*(A) \subseteq K - m-cl(\{ k \}) \), a contradiction, since \( k \in m-cl^*(A) \).

(3) \( \Rightarrow \) (4) Suppose \( F \subseteq m-cl^*(A) - A \), \( F \) is m-closed and \( k \in F \). Since \( F \subseteq K - A \) and \( F \) is m-closed, then \( A \subseteq K - F \) and \( F \) is m-closed, \( m-cl(\{ k \}) \cap A = \emptyset \). Since \( k \in \)
m-cl*(A) by (3), m-cl({x}) ∩ A ≠ φ. Therefore m-cl*(A) − A contains no nonempty m-closed set.

(4) ⇒ (5) Since m-cl*(A) − A = (A ∪ A_m*) − A = (A ∪ A_m*) ∩ A^c = (A ∩ A^c) ∪ (A_m* ∩ A^c) = A_m* ∩ A^c = A_m* − A. Therefore A_m* − A contains no nonempty m-closed set.

(5) ⇒ (1) Let A ⊆ U where U is m-open set. Therefore K − U ⊆ K − A and so A_m* ∩ (K − U) ⊆ A_m* ∩ (K − A) = A_m* − A. Therefore A_m* ∩ (K − U) ⊆ A_m* − A. Since A_m* is always m-closed set, so A_m* is m-closed set and so A_m* ∩ (K − U) is a m-closed set contained in A_m* − A. Therefore A_m* ∩ (K − U) = φ and hence A_m* ⊆ U. Therefore A is mIg-closed. □

**Theorem 3.6.** (1) Every m-closed set is m*-closed but not conversely.

(2) Every m*-closed set is mIg-closed but not conversely.

**Proof.** (1) This is obvious.

(2) Let A be a m*-closed, then A_m* ⊆ A. Let A ⊆ U where U is m-open. Hence A_m* ⊆ U whenever A ⊆ U and U is m-open. Therefore A is mIg-closed. □

**Example 3.7.** Let K, N, μ, M and I be defined as an Example 3.3. Then m*-closed sets are φ, K, {n}, {q}, {n, q}, {p, q}, {n, o, q}. (i) It is clear that {n, q} is m*-closed but it is not m-closed. (ii) It is clear that {o, p, q} is mIg-closed but it is not m*-closed.

**Theorem 3.8.** Let (K, N, M, I) be an micro ideal topological space. For every A ∈ I, A is mIg-closed.

**Proof.** Let A ⊆ U where U is m-open set. Since A_m* = φ for every A ∈ I [Theorem 2.9(8)], then m-cl*(A) = A ∪ A_m* = A ∪ φ = A ⊆ U. Therefore [by Theorem 3.5 (1) and (2)], A is mIg-closed. □
Theorem 3.9. If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is an micro ideal topological space, then \(A^*_m\) is always \(m\mathcal{I}_g\)-closed for every subset \(A\) of \(K\).

Proof. Let \(A^*_m \subseteq U\) where \(U\) is m-open. Since \((A^*_m)^* \subseteq A^*_m\) [Theorem 2.9 (4)], we have \((A^*_m)^* \subseteq U\) whenever \(A^*_m \subseteq U\) and \(U\) is m-open. Hence \(A^*_m\) is \(m\mathcal{I}_g\)-closed. □

Theorem 3.10. Let \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) be an micro ideal topological space. Then every \(m\mathcal{I}_g\)-closed, m-open set is \(m^\star\)-closed set.

Proof. Since \(A\) is \(m\mathcal{I}_g\)-closed and m-open. Then \(A^*_m \subseteq A\) whenever \(A \subseteq A\) and \(A\) is m-open. Hence \(A\) is \(m^\star\)-closed. □

Definition 3.11. An micro ideal topological space \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is said to be a \(mT_{I^*}\)-space if every \(m\mathcal{I}_g\)-closed subset of \(K\) is a \(m^\star\)-closed.

Corollary 3.12. Let \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) be an micro ideal topological space and \(A\) be an \(m\mathcal{I}_g\)-closed set. Then the following are equivalent.

1. \(A\) is a \(m^\star\)-closed set,
2. \(m-cl^*(A) - A\) is a m-closed set,
3. \(A^*_m - A\) is a m-closed set.

Proof. (1) ⇒ (2) If \(A\) is \(m^\star\)-closed, then \(A^*_m \subseteq A\) and so \(m-cl^*(A) - A = (A \cup A^*_m) - A = \phi\). Hence \(m-cl^*(A) - A\) is m-closed set.

(2) ⇒ (3) Since \(m-cl^*(A) - A = A^*_m - A\) and so \(A^*_m - A\) is m-closed set.

(3) ⇒ (1) If \(A^*_m - A\) is a m-closed set, since \(A\) is \(m\mathcal{I}_g\)-closed set [by Theorem 3.5 (5)], \(A^*_m - A = \phi\) and so \(A\) is \(m^\star\)-closed. □

Theorem 3.13. If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is an micro ideal topological space and \(A\) is a \(m^\star\)-dense in itself, \(m\mathcal{I}_g\)-closed subset of \(K\), then \(A\) is \(m\mathcal{I}_g\)-closed.
Proof. Suppose \( A \) is a \( m^\star \)-dense in itself, \( mI_g \)-closed subset of \( K \). Let \( A \subseteq U \) where \( U \) is \( m \)-open. Then [by Theorem 3.5 (2)], \( m\text{-cl}^\star(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is \( m \)-open. Since \( A \) is \( m^\star \)-dense in itself, [by Theorem 2.16], \( m\text{-cl}(A) = m\text{-cl}^\star(A) \). Therefore \( m\text{-cl}(A) \subseteq U \) whenever \( A \subseteq U \) and \( U \) is \( m \)-open. Hence \( A \) is mg-closed. \( \square \)

**Corollary 3.14.** If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is any micro ideal topological space where \( \mathcal{I} = \{\phi\} \), then \( A \) is \( mI_g \)-closed if and only if \( A \) is mg-closed.

**Proof.** The proof follows from the fact that for \( \mathcal{I} = \{\phi\} \), \( A^*_m = m\text{-cl}(A) \supset A \). Therefore \( A \) is \( m^\star \)-dense in itself. Since \( A \) is \( mI_g \)-closed [by Theorem 3.13], \( A \) is mg-closed. Conversely [by Theorem 3.2], every mg-closed set is \( mI_g \)-closed set. \( \square \)

**Corollary 3.15.** If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is any micro ideal topological space where \( \mathcal{I} \) is \( \mathcal{M} \)-codense and \( A \) is a Micro open, \( mI_g \)-closed subset of \( K \), then \( A \) is mg-closed.

**Proof.** The proof follows [Theorem 2.20 (2)], \( A \) is \( m^\star \)-dense in itself. [By Theorem 3.13], \( A \) is mg-closed. \( \square \)

**Corollary 3.16.** If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is any micro ideal topological space where \( \mathcal{I} \) is \( \mathcal{M} \)-codense and \( A \) is a Micro semi-open, \( mI_g \)-closed subset of \( K \), then \( A \) is mg-closed.

**Proof.** The proof follows [Theorem 2.20 (3)], \( A \) is \( m^\star \)-dense in itself. [By Theorem 3.13], \( A \) is mg-closed. \( \square \)

**Corollary 3.17.** If \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is any micro ideal topological space where \( \mathcal{I} \) is \( \mathcal{M} \)-codense and \( A \) is a Micro regular open, \( mI_g \)-closed subset of \( K \), then \( A \) is mg-closed.

**Proof.** The proof follows [Theorem 2.20 (4)], every \( m^\star \)-perfect is \( m^\star \)-dense in itself [[3], Remark 3.15], \( A \) is \( m^\star \)-dense in itself. [By Theorem 3.13], \( A \) is mg-closed. \( \square \)
Proposition 3.18. If \( S \) and \( G \) are \( \text{mg}_g \)-closed sets, then \( S \cup G \) is also a \( \text{mg}_g \)-closed set in \((K, N, M, I)\).

Proof. Let \( S \) and \( G \) are \( \text{mg}_g \)-closed. Then \( S^*_m \subseteq T \) where \( S \subseteq T \) and \( T \) is \( m \)-open and \( G^*_m \subseteq T \) where \( G \subseteq T \) and \( T \) is \( m \)-open. Since \( S \) and \( G \) are subsets of \( T \), \((S^*_m \cup G^*_m) = (S \cup G)^*_m [\text{Theorem 2.9 (5)}]\) is a subset of \( T \) and \( T \) is \( m \)-open which implies that \((S \cup G) \) is \( \text{mg}_g \)-closed. \( \square \)

Remark 3.19. If \( C \) and \( D \) are \( \text{mg}_g \)-closed sets, then \( C \cap D \) is not \( \text{mg}_g \)-closed set.

Example 3.20. Let \( K = \{n, o, p\} \) with \( U/ R = \{\{n, o, p\}\} \) and \( X = \{o, p\} \). The nano topology \( N = \{\phi, K\} \). If \( \mu = \{n\} \) then the micro topology \( M = \{\phi, \{n\}, K\} \) and \( I = \{\emptyset\} \). Then \( \text{mg}_g \)-closed sets are \( \phi, K, \{o\}, \{p\}, \{n, o\}, \{n, p\}, \{o, p\} \). Here, \( C = \{n, o\} \) and \( D = \{n, p\} \) are \( \text{mg}_g \)-closed sets but \( C \cap D = \{n\} \) is not \( \text{mg}_g \)-closed.

Proposition 3.21. [2] Every \( m \)-closed set is \( \text{mg} \)-closed but not conversely.

Remark 3.22. From the above discussions and known result in [2] we obtain the following diagram where \( A \rightarrow B \) represents \( A \) implies \( B \), but not conversely.

\[
\begin{array}{ccc}
m - \text{closed} & \longrightarrow & \text{mg} - \text{closed} \\
\downarrow & & \downarrow \\
m \star - \text{closed} & \longrightarrow & \text{mg}_g - \text{closed}
\end{array}
\]

Theorem 3.23. Let \((K, N, M, I)\) be an micro ideal topological space and \( A \subseteq K \). Then \( A \) is \( \text{mg}_g \)-closed if and only if \( A = F - S \) where \( F \) is \( m \star \)-closed and \( S \) contains no nonempty \( m \)-closed set.
Proof. If $A$ is $mI_g$-closed, then [by Theorem 3.5 (5)], $S = A^*_m - A$ contains no nonempty $m$-closed set. If $F = mcl^*(A)$, then $F$ is $m^*$-closed such that $F - S = (A \cup A^*_m) - (A^*_m - A) = (A \cup A^*_m) \cap (A^*_m \cap A^c) = (A \cup A^*_m) \cap ((A^*_m)^c \cup A) = (A \cup A^*_m) \cap (A^*_m \cap (A^*_m)^c) = A$.

Conversely, suppose $A = F - S$ where $F$ is $m^*$-closed and $S$ contains no nonempty $m$-closed set. Let $U$ be an $m$-open set such that $A \subseteq U$. Then $F - S \subseteq U$ which implies that $F \cap (K - U) \subseteq S$. Now $A \subseteq F$ and $F^*_m \subseteq F$ then $A^*_m \subseteq F^*_m$ and so $A^*_m \cap (K - U) \subseteq F^*_m \cap (K - U) \subseteq F \cap (K - U) \subseteq S$. By hypothesis, since $A^*_m \cap (K - U)$ is $m$-closed, $A^*_m \cap (K - U) = \phi$ and so $A^*_m \subseteq U$. Hence $A$ is $mI_g$-closed.

Theorem 3.24. Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space and $A \subseteq K$.
If $A \subseteq B \subseteq A^*_m$, then $A^*_m = B^*_m$ and $B$ is $m^*$-dense in itself.

Proof. Since $A \subseteq B$, then $A^*_m \subseteq B^*_m$ and since $B \subseteq A^*_m$, then $B^*_m \subseteq (A^*_m)^*_m \subseteq A^*_m$ [Theorem 2.9(4)]. Therefore $A^*_m = B^*_m$ and $B \subseteq A^*_m \subseteq B^*_m$. Hence proved. □

Theorem 3.25. Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space. If $A$ and $B$ are subsets of $K$ such that $A \subseteq B \subseteq m-cl^*(A)$ and $A$ is $mI_g$-closed, then $B$ is $mI_g$-closed.

Proof. Since $A$ is $mI_g$-closed, then [by Theorem 3.5(1)], $m-cl^*(A) - A$ contains no nonempty $m$-closed set. Since $m-cl^*(B) - B \subseteq m-cl^*(A) - A$ and so $m-cl^*(B) - B$ contains no nonempty $m$-closed set and so [by Theorem 3.5 (4)], $B$ is $mI_g$-closed. □

Corollary 3.26. Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space. If $A$ and $B$ are subsets of $K$ such that $A \subseteq B \subseteq A^*_m$ and $A$ is $mI_g$-closed, then $A$ and $B$ are $mg$-closed sets.

Proof. Let $A$ and $B$ be subsets of $K$ such that $A \subseteq B \subseteq A^*_m$ which implies that $A \subseteq B \subseteq A^*_m \subseteq m-cl^*(A)$ and $A$ is $mI_g$-closed. [By Theorem 3.25], $B$ is $mI_g$-closed. Since
A ⊆ B ⊆ A^*_m, then A^*_m = B^*_m and so A and B are m*-dense in itself. [By Theorem 3.13], A and B are mg-closed. □

**Definition 3.27.** A subset A of (K, N, M, I) is said to be mIg-open if A^C is mIg-closed.

**Proposition 3.28.** Every m-open set is mIg-open set but not conversely.

*Proof.* Omitted. □

The following theorem gives a characterization of mIg-open sets.

**Theorem 3.29.** Let (K, N, M, I) be an micro ideal topological space and A ⊆ K. Then A is mIg-open if and only if F ⊆ m-int^*(A) whenever F is m-closed and F ⊆ A.

*Proof.* Suppose A is mIg-open. If F is m-closed and F ⊆ A, then K − A ⊆ K − F and so m-cl^*(K − A) ⊆ K − F [by Theorem 3.5 (2)]. Therefore F ⊆ K − m-cl^*(K − A) = m-int^*(A). Hence F ⊆ m-int^*(A).

Conversely, suppose the condition holds. Let U be a m-open set such that K − A ⊆ U. Then K − U ⊆ A and so K − U ⊆ m-int^*(A). Therefore m-cl^*(K − A) ⊆ U. [By Theorem 3.5 (2)], K − A is mIg-closed. Hence A is mIg-open. □

The following theorem gives a property of mIg-closed.

**Theorem 3.30.** Let (K, N, M, I) be an micro ideal topological space and A ⊆ K. If A is mIg-open and m-int^*(A) ⊆ B ⊆ A, then B is mIg-open.

*Proof.* Since A is mIg-open, then K − A is mIg-closed. [By Theorem 3.5 (4)], m-cl^*(K − A) − (K − A) contains no nonempty m-closed set. Since m-int^*(A) ⊆ m-int^*(B)
which implies that \( m\text{-cl}^*(K - B) \subseteq m\text{-cl}^*(K - A) \) and so \( m\text{-cl}^*(K - B) - (K - B) \subseteq m\text{-cl}^*(K - A) - (K - A) \). Hence \( B \) is \( m\mathcal{I}_g \)-open. □

The following theorem gives a characterization of \( m\mathcal{I}_g \)-closed sets in terms of \( m\mathcal{I}_g \)-open sets.

**Theorem 3.31.** Let \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) be an micro ideal topological space and \( A \subseteq K \).

Then the following are equivalent.

1. \( A \) is \( m\mathcal{I}_g \)-closed,
2. \( A \cup (K - A^*_m) \) is \( m\mathcal{I}_g \)-closed,
3. \( A^*_m - A \) is \( m\mathcal{I}_g \)-open.

**Proof.**
1. \( \Rightarrow \) (2) Suppose \( A \) is \( m\mathcal{I}_g \)-closed. If \( U \) is any \( m \)-open set such that \( A \cup (K - A^*_m) \subseteq U \), then \( K - U \subseteq K - (A \cup (K - A^*_m)) = K \cap (A \cup (A^*_m)^c)^c = A^*_m \cap A^c = A^*_m - A \). Since \( A \) is \( m\mathcal{I}_g \)-closed, [by Theorem 3.5 (5)], it follows that \( K - U = \phi \) and so \( K = U \). Therefore \( A \cup (K - A^*_m) \subseteq U \) which implies that \( A \cup (K - A^*_m) \subseteq K \) and so \( (A \cup (K - A^*_m))_{m} \subseteq K_{m} \subseteq K = U \). Hence \( A \cup (K - A^*_m) \) is \( m\mathcal{I}_g \)-closed.

2. \( \Rightarrow \) (1) Suppose \( A \cup (K - A^*_m) \) is \( m\mathcal{I}_g \)-closed. If \( F \) is any \( m \)-closed set such that \( F \subseteq A^*_m - A \), then \( F \subseteq A^*_m \) and \( F \not\subseteq A \) which implies that \( K - A^*_m \subseteq K - F \) and \( A \subseteq K - F \). Therefore \( A \cup (K - A^*_m) \subseteq A \cup (K - F) = K - F \) and \( K - F \) is \( m \)-open. Since \( (A \cup (K - A^*_m))_{m} \subseteq K - F \) which implies that \( A^*_m \cup (K - A^*_m)_{m} \subseteq K - F \) and so \( A^*_m \subseteq K - F \) which implies that \( F \subseteq K - A^*_m \). Since \( F \subseteq A^*_m \), it follows that \( F = \phi \). Hence \( A \) is \( m\mathcal{I}_g \)-closed.

2. \( \Leftrightarrow \) (3) Since \( K - (A^*_m - A) = K \cap (A^*_m \cap A)^c = K \cap ((A^*_m)^c \cup A) = (K \cap (A^*_m)^c) \cup (K \cap A) = A \cup (K - A^*_m) \) is \( m\mathcal{I}_g \)-closed. Hence \( A^*_m - A \) is \( m\mathcal{I}_g \)-open. □
**Definition 3.32.** Let $A$ be a subset of a micro topological space $(K, \tau_R(X), \mu_R(X))$. Then the micro kernel of the set $A$, denoted by $m$-ker$(A)$, is the intersection of all $m$-open supersets of $A$.

**Lemma 3.33.** If $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is a micro ideal topological spaces and $A \subseteq K$ then $A$ is $m\mathcal{I}_g$-closed if and only if $m$-cl$^\ast$(A) $\subseteq$ m-ker(A).

**Proof.** Suppose that $A \subseteq K$ is an $m\mathcal{I}_g$-closed set. Then $A^*_m \subseteq U$ whenever $A \subseteq U$ and $U$ is $m$-open. Let $k \in m$-cl$^\ast$(A). If $k \notin m$-ker(A), then there is a $m$-open set $U$ containing $A$ such that $k \notin U$. Since $U$ is $m$-open set containing $A$, we have, $k \notin m$-cl$^\ast$(A) and this is a contradiction. Therefore $m$-cl$^\ast$(A) $\subseteq$ m-ker(A).

Conversely, let $m$-cl$^\ast$(A) $\subseteq$ m-ker(A). If $U$ is any $m$-open containing $A$, then $m$-cl$^\ast$(A) $\subseteq$ m-ker(A) $\subseteq U$ [ by Theorem 3.4]. Therefore, $A$ is $m\mathcal{I}_g$-closed. $\Box$

4. micro $\ast\mathcal{I}$-locally closed sets and lightly micro $\mathcal{I}$-locally closed sets

I introduce the following definitions.

**Definition 4.1.** A subset $A$ of of an micro ideal topological space $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is called an micro $\ast\mathcal{I}$-locally closed set (briefly, $\ast$-$m\mathcal{I}$-LC) if $A = S \cap G$ where $S$ is $m\ast$-open and $G$ is $m\ast$-closed.

**Definition 4.2.** A subset $A$ of of an micro ideal topological space $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ is called an lightly micro $\mathcal{I}$-locally closed (briefly, $L$-$m\mathcal{I}$-LC) if $A = E \cap F$ where $E$ is $m$-open and $F$ is $m\ast$-closed.

**Proposition 4.3.** Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space and $A \subseteq K$. Then the following hold.

1. If $A$ is $m\ast$-open, then $A$ is $\ast$-$m\mathcal{I}$-LC set.
(2) $A$ is $m^\ast$-closed, then $A$ is $\ast-m\mathcal{I}$-LC set.

(3) If $A$ is $m$-open, then $A$ is $L-m\mathcal{I}$-LC set.

(4) $A$ is $m^\ast$-closed, then $A$ is $L-m\mathcal{I}$-LC set.

Proof. It is obvious from Definitions 4.1 and 4.2. \(\square\)

The converse of the above Proposition 4.3 need not be true as shown in the following examples.

Example 4.4. Let $K, \mathcal{N}, \mu, \mathcal{M}$ and $\mathcal{I}$ be defined as an Example 3.7. Then $\ast-m\mathcal{I}$-LC sets are $\phi, K, \{n\}, \{o\}, \{p\}, \{q\}, \{n, o\}, \{n, q\}, \{o, p\}, \{p, q\}, \{n, o, p\}, \{n, o, q\}, \{n, p, q\}, \{o, p, q\}, \{o, q\}$. (1) It is clear that $\{n, q\}$ is an $\ast-m\mathcal{I}$-LC set but it is not $m^\ast$-open. Also it is clear that $\{o, p\}$ is $\ast-m\mathcal{I}$-LC set but it is not $m^\ast$-closed.

(2) It is clear that $\{n, o, q\}$ is an $L-m\mathcal{I}$-LC set but it is not $m^\ast$-closed. Also it is clear that $\{n, o, p\}$ is $L-m\mathcal{I}$-LC set but it is not $m^\ast$-closed.

Theorem 4.5. Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space. If $A$ is an $\ast-m\mathcal{I}$-LC-set and $B$ is a $m^\ast$-closed set, then $A \cap B$ is an $\ast-m\mathcal{I}$-LC-set.

Proof. Let $B$ be $m^\ast$-closed and $A$ be $\ast-m\mathcal{I}$-LC set. Then [by Definition 4.1], $A = S \cap G$ where $S$ is $m^\ast$-open and $G$ is $m^\ast$-closed. Then $A \cap B = (S \cap G) \cap B = S \cap (G \cap B)$. Since the intersection of two $m^\ast$-closed sets is $m^\ast$-closed, $G \cap B$ is $m^\ast$-closed. Hence $A \cap B$ is $\ast-m\mathcal{I}$-LC set. \(\square\)

Theorem 4.6. Let $(K, \mathcal{N}, \mathcal{M}, \mathcal{I})$ be an micro ideal topological space. If $A$ is an $L-m\mathcal{I}$-LC-set and $B$ is a $m^\ast$-closed set, then $A \cap B$ is an $L-m\mathcal{I}$-LC-set.

Proof. Let $B$ be $m^\ast$-closed and $A$ be $L-m\mathcal{I}$-LC. Then [by Definition 4.2], $A = E \cap F$ where $E$ is $m$-open and $F$ is $m^\ast$-closed. Then $A \cap B = (E \cap F) \cap B = E \cap (F \cap B)$. 
Since the intersection of two \( m^\ast\)-closed sets is \( m^\ast\)-closed, \( F \cap B \) is \( m^\ast\)-closed. Hence \( A \cap B \) is an \( \mathcal{L}-m\mathcal{I}-LC \) set. □

**Theorem 4.7.** A subset of an micro ideal topological space \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) is \( m^\ast\)-closed if and only if \( \mathcal{L}-m\mathcal{I}-LC \)-set and \( m\mathcal{I}_g\)-closed.

**Proof.** Necessity is trivial. We prove only sufficiency. Let \( A \) be \( \mathcal{L}-m\mathcal{I}-LC \)-set and \( m\mathcal{I}_g \)-closed set. Since \( A \) is \( \mathcal{L}-m\mathcal{I}-LC \) set, \( A = E \cap F \), where \( E \) is \( m \)-open and \( F \) is \( m^\ast \)-closed. So we have \( A = E \cap F \subseteq E \) where \( E \) is \( m \)-open. Since \( A \) is \( m\mathcal{I}_g \)-closed, \( A_m^* \subseteq E \). Again \( A = E \cap F \subseteq F \) where \( F \) is \( m^* \)-closed. So \( A_m^* \subseteq F_m^* \subseteq F \). Thus \( A_m^* \subseteq E \cap F = A \) and hence \( A \) is \( m^\ast \)-closed. □

**Remark 4.8.** (1) The notions of \( \ast-m\mathcal{I}-LC \)-set and \( m\mathcal{I}_g \)-closed set are independent.

(2) The notions of \( \mathcal{L}-m\mathcal{I}-LC \)-set and \( m\mathcal{I}_g \)-closed set are independent.

**Example 4.9.** Let \( K, \mathcal{N}, \mu, \mathcal{M} \) and \( \mathcal{I} \) be defined as an Example 4.4. (1) It is clear that \( \{n, o\} \) is \( \ast-m\mathcal{I}-LC \)-set but it is not \( m\mathcal{I}_g \)-closed. Also it is clear that \( \{n, p, q\} \) is an \( m\mathcal{I}_g \)-closed but it is not \( \ast-m\mathcal{I}-LC \)-set.

(2) It is clear that \( \{n, o, p\} \) is \( \mathcal{L}-m\mathcal{I}-LC \)-set but it is not \( m\mathcal{I}_g \)-closed. Also it is clear that \( \{o, p, q\} \) is an \( m\mathcal{I}_g \)-closed but it is not \( \mathcal{L}-m\mathcal{I}-LC \)-set.

5. Decompositions of \( m^\ast \)-continuity

I introduce the following definitions.

**Definition 5.1.** A map \( f : (K, \mathcal{N}, \mathcal{M}, \mathcal{I}) \to (L, \mathcal{N}', \mathcal{M}') \) is said to be \( m^\ast \)-continuous (resp. \( \ast-m\mathcal{I}-LC \)-continuous, \( \mathcal{L}-m\mathcal{I}-LC \)-continuous, \( m\mathcal{I}_g \)-continuous) if \( f^{-1}(A) \) is \( m^\ast \)-closed (resp. \( \ast-m\mathcal{I}-LC \)-set, \( \mathcal{L}-m\mathcal{I}-LC \)-set, \( m\mathcal{I}_g \)-closed) in \((K, \mathcal{N}, \mathcal{M}, \mathcal{I})\) for every \( m \)-closed set \( A \) of \((L, \mathcal{N}', \mathcal{M}')\).
Theorem 5.2. A map \( f : (K, N, M, I) \to (L, N', M') \) is \( m\star \)-continuous if and only if \( L\cdot m\cdot I\cdot L\cdot C\)-continuous and \( m I_g\)-continuous.

Proof. It is an immediate consequence of Theorem 4.7. □

Conclusion

Every year different type of topological spaces are introduced by many topologist. Now a days available topologies are ideal topology, bitopology, fuzzy topology, fine topology, micro topology and so on. New concepts micro topological spaces via micro ideals introduced and studied by S. Ganesan [3]. In this paper, i introduced a new type of generalized closed and open sets called \( mI_g\)-closed set and \( mI_g\)-open set in micro ideal topological spaces and investigate the relation between this set with other sets in micro topological spaces and micro ideal topological spaces. Characterizations and properties of \( mI_g\)-closed sets, \( mI_g\)-open sets are studied. I introduce the concepts of \( \star mI\cdot L\cdot C\)-sets, \( L\cdot mI\cdot L\cdot C\)-sets, \( m\star \)-continuous, \( \star mI\cdot L\cdot C\)-continuous, \( L\cdot mI\cdot L\cdot C\)-continuous, \( mI_g\)-continuous and to obtain decomposition of \( m\star \)-continuity in micro ideal topological spaces. In future, i have extended this work in various micro ideal topological fields with some applications.

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