Fuzzy $\alpha-\psi*-$Irreducible Spaces

M. Rowthri, B. Amudhambigai

Abstract*: In this paper, the concept of $\psi*$ operator on a family of fuzzy $\alpha-$open sets in a fuzzy topological space is introduced. Also, the concepts of fuzzy $\alpha-\psi*-$irreducible spaces, fuzzy $\alpha-\psi*-$ generic sets and fuzzy $\alpha-\psi*-$quasi-Sober spaces are initiated and some properties are discussed.

***Keywords* : operator on $F\alpha O(X,\tau)$, fuzzy $\alpha-\psi*-$generic sets , fuzzy $\alpha-\psi*-$ irreducible spaces, fuzzy $\alpha-\psi*-$ quasi-Sober spaces**
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I. INTRODUCTION

L.A. Zadeh[8] initiated fuzzy set in 1965. In 1968, Chang [2] characterized fuzzy topological space. Njastad [5] introduced $\alpha-$open sets. In the same sprit Bin Shahna [1] defined fuzzy $\alpha-$open sets and fuzzy $\alpha-$closed sets. The idea of an irreducible or hyperconnected topological space has been studied by T. Thompson. In this paper, the concept of $\psi*$ operator on a family of fuzzy $\alpha-$open sets in a fts is introduced. Also, the concepts of fuzzy $\alpha-\psi*-$irreducible spaces, fuzzy $\alpha-\psi*-$ generic sets and fuzzy $\alpha-\psi*-$ quasi-Sober spaces are initiated and some properties are discussed.

II. PRELIMINARIES

This section contains basic definitions and preliminary results needed for this paper.

Definition 2.1 [4] Let X be a topological space.

(i) X is irreducible, if $X \neq \Phi$, and whenever $X = Z_1 \cup Z_2$ with Z_i closed, $X = Z_1$ or $X = Z_2$.

(ii) $Z \subset X$ is an irreducible component of X if Z is a maximal irreducible subset of X.

Definition 2.2 [3] A subset $F \neq \Phi$ of a topological space is irreducible if, $F \subseteq A \cup B$ where A and B then $F \subseteq A$ or $F \subseteq B$.

Definition 2.3 [4] A topological space X is said to be quasi-sober if for every irreducible closed subset has a generic point.

Definition 2.4 [6] A fuzzy set μ_A is quasi-coincident with the fuzzy set μ_B iff $\exists x \in X$ such that $\mu_A(x) + \mu_B(x) > 1$.

Definition 2.5 [7] A fuzzy set λ in a fuzzy topological space (X,T) is called fuzzy dense if there exists no fuzzy closed set μ in (X,T) such that $\lambda < \mu < 1$. That is., $cl(\lambda) = 1$ in (X,T).

Definition 2.6 [7] A fuzzy set λ in a fuzzy topological space (X,T) is called fuzzy nowhere dense if there exists no non-zero fuzzy open set μ in (X,T) such that $\mu < cl(\lambda)$. That is., $\text{int}(cl(\lambda)) = 0$ in (X,T).

III. FUZZY $\alpha-\psi*-$ IRREDUCIBLE SPACES

Throughout this paper, fuzzy topological space is shortly denoted by fts. Then $F\alpha O(X,\tau)$, $F\alpha C(X,\tau)$ and $\mathcal{FP}(X)$ denote set of all fuzzy $\alpha-$ open sets, fuzzy $\alpha-$ closed sets in (X,τ) and fuzzy points over X respectively.

Definition 3.1 Let (X,τ) be a fts. A fuzzy operator

$$\psi*: F\alpha O(X,\tau) \to I^X$$

is defined as, if for each $\mu \in F\alpha O(X,\tau)$ with $\mu \neq 0_X$, $F\text{int}(\mu) \leq \psi*(\mu)$ and $\psi*(0_X) = 0_X$.

Remark 3.1 It is easy to check that some examples of fuzzy operators on $F\alpha O(X,\tau)$ are the well known fuzzy operators viz. $F\text{int}$, $F\text{int}(Fcl)$, $Fcl(F\text{int})$, Fint(Fcl(Fint)) and $Fcl(F\text{int}(Fcl))$.

Definition 3.2 Let (X,τ) be a fts and $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$. Then any $\mu \in F\alpha O(X,\tau)$ is called fuzzy $\alpha-\psi*-$open if $\mu \leq \psi*(\mu)$. Then $1_X - \mu$ is called fuzzy $\alpha-\psi*-$closed set.

Notation 3.1 The family of all fuzzy $\alpha-\psi*-$open (resp. fuzzy $\alpha-\psi*-$ closed) sets in (X,τ) is notated by $F\alpha-\psi*O(X,\tau)$ (resp. $F\alpha-\psi*C(X,\tau)$).

Definition 3.3 For any $\mu \in I^X$ in a fts (X,τ) and $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$, the fuzzy $\alpha-\psi*-$interior of μ (briefly, $F\alpha-\psi*\text{int}(\mu)$) is defined by

$F\alpha-\psi*\text{int}(\mu) = \vee\{\sigma : \sigma \leq \mu$ and $\sigma \in F\alpha-\psi*O(X,\tau)$ }.

Definition 3.4 For any $\mu \in I^X$ in a fts (X,τ) and $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$, the fuzzy $\alpha-\psi*-$closure of μ (briefly, $F\alpha-\psi*cl(\mu)$) is defined by

$F\alpha-\psi*cl(\mu) = \wedge\{\sigma : \sigma \geq \mu$ and $\sigma \in F\alpha-\psi*C(X,\tau)$ }.

Definition 3.5 Any fts (X,τ) is said to be a fuzzy $\alpha-\psi*-$irreducible space, where $\psi*$ is a fuzzy operator on $F\alpha O(X,\tau)$ if, for any $\mu_1, \mu_2 \in F\alpha-\psi*O(X,\tau)$ where $\mu_1 \neq 0_X$, $\mu_2 \neq 0_X$ and $\mu_1 q \mu_2$.

Definition 3.6 Any $\lambda \in I^X$ in a fts (X,τ) is said to be fuzzy $\alpha-\psi*-$ irreducible,

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where $\psi*$ is a fuzzy operator on $F\alpha O(X,\tau)$ if, $\lambda \neq 0_X$ and $\lambda \leq (\mu_1 \vee \mu_2)$ where $\mu_1, \mu_2 \in F\alpha-\psi*C(X,\tau)$, then either $\lambda \leq \mu_1$ or $\lambda \leq \mu_2$. Then the set of all fuzzy $\alpha-\psi*-$irreducible sets is noted by $F\alpha-\psi*I(X,\tau)$

Definition 3.7 Any $\lambda \in I^X$ is called a fuzzy $\alpha-\psi*-$maximal irreducible set of fts (X,τ), where $\psi*$ is a fuzzy operator on $F\alpha O(X,\tau)$, if there is no $\mu \in F\alpha-\psi*I(X,\tau)$ such that $\mu > \lambda$. Then collection of all fuzzy $\alpha-\psi*-$maximal irreducible sets is denoted by $F\alpha-\psi*MI(X,\tau)$

Definition 3.8 Let $\psi*$ be a fuzzy operator on $F\alpha O(X_1,\tau_1)$ and $F\alpha O(X_2,\tau_2)$ in a ftss (X_1,τ_1) and (X_2,τ_2) respectively. Any function $f:(X_1,\tau_1)\to(X_2,\tau_2)$ is said to be a fuzzy $\alpha-\psi*-$ continuous function if for every $\mu \in F\alpha-\psi*O(X_2,\tau_2)$, $f^{-1}(\mu) \in F\alpha-\psi*O(X_1,\tau_1)$.

Proposition 3.1 Let $\psi*$ be a fuzzy operator on $F\alpha O(X_1,\tau_1)$ and $F\alpha O(X_2,\tau_2)$ in a ftss (X_1,τ_1) and (X_2,τ_2) respectively. Let $f:(X_1,\tau_1)\to(X_2,\tau_2)$ be a bijective and fuzzy $\alpha-\psi*-$ continuous function. If $\lambda \in F\alpha-\psi*I(X_1,\tau_1)$ then $f(\lambda) \in F\alpha-\psi*I(X_2,\tau_2)$

Proof. Let $\mu_1, \mu_2 \in F\alpha-\psi*C(X_2,\tau_2)$ such that $f(\lambda) \leq (\mu_1 \vee \mu_2)$. Then $f^{-1}(f(\lambda)) \leq f^{-1}(\mu_1 \vee \mu_2)$, which implies that $\lambda \leq f^{-1}(\mu_1 \vee \mu_2)$. Then $f^{-1}(f(\lambda)) = \lambda$, since f is one-one Thus $\lambda \leq f^{-1}(\mu_1) \vee f^{-1}(\mu_2)$. Since $\lambda \in F\alpha-\psi*I(X_1,\tau_1)$, $\lambda \leq f^{-1}(\mu_1)$ or $\lambda \leq f^{-1}(\mu_2)$ Thus $f(\lambda) \leq f(f^{-1}(\mu_1))$ and hence $f(\lambda) \leq \mu_1$ as f is onto, $f(f^{-1}(\mu_1)) = \mu_1$.
or $f(\lambda) \leq f(f^{-1}(\mu_2))$ and so $f(\lambda) \leq \mu_2$. Therefore $f(\lambda) \in F\alpha-\psi*I(X_2,\tau_2)$.

Remark 3.2 For any $\lambda \in I^X$ in a fts (X,τ) and $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$, $\lambda \leq F\alpha-\psi*cl(\lambda)$.

Proof. Proof is obvious from the definition of fuzzy $\alpha-\psi*-$closure of a fuzzy set $\lambda \in I^X$.

Proposition 3.2 If $\lambda \in F\alpha-\psi*I(X,\tau)$ in fts (X,τ) and $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$, then $F\alpha-\psi*cl(\lambda) \in F\alpha-\psi*I(X,\tau)$.

Proof. Assume that $\lambda \in I^X$ and $F\alpha-\psi*cl(\lambda) \leq \mu_1 \vee \mu_2$ where $\mu_1, \mu_2 \in F\alpha-\psi*C(X,\tau)$. Since $\lambda \leq F\alpha-\psi*cl(\lambda)$ and $\lambda \in F\alpha-\psi*I(X,\tau)$, $\lambda \leq \mu_1$ or $\lambda \leq \mu_2$. Then $F\alpha-\psi*cl(\lambda) \leq \mu_1$ or $F\alpha-\psi*cl(\lambda) \leq \mu_2$. Hence $F\alpha-\psi*cl(\lambda) \in F\alpha-\psi*I(X,\tau)$

Proposition 3.3. If $\lambda \in F\alpha-\psi*MI(X,\tau)$, then $\lambda \in F\alpha-\psi*C(X,\tau)$.

Proof. Let $\lambda \in F\alpha-\psi*MI(X,\tau)$. Then, there is no $\mu \in F\alpha-\psi*I(X,\tau)$ such that $\mu > \lambda$. By Proposition 3.2, $F\alpha-\psi*cl(\lambda) \in F\alpha-\psi*I(X,\tau)$. Since $\lambda \leq F\alpha-\psi*cl(\lambda)$, the only possibility is $\lambda = F\alpha-\psi*cl(\lambda)$. Hence $\lambda \in F\alpha-\psi*C(X,\tau)$.

Proposition 3.4 Let $\lambda \in F\alpha-\psi*MI(X,\tau)$ in fts (X,τ), where $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$. If $\mu \in F\alpha-\psi*I(X,\tau)$, then $\mu \leq \lambda$.

Proof. Let $\lambda \in F\alpha-\psi*I(X,\tau)$. Let $\mathcal{A}$ be the set of all fuzzy $\alpha-\psi*-$ irreducible sets $\lambda_j \in I^X$ such that $\lambda < \lambda_j, j \in J$ where J is an indexed set. Let $\mathcal{A}' \subset \mathcal{A}$ be the set of fuzzy $\alpha-\psi*-$irreducible sets $\lambda_k, k=1,2,...,l$ such that $\lambda_1 < \lambda_2 < ... < \lambda_l$.

Let $\lambda' = \vee_k \lambda_k$, $k=1,2,...,l$. It is enough to show that $\lambda' \in F\alpha-\psi*I(X,\tau)$. Let $\lambda' \leq \mu_1 \vee \mu_2$, where $\mu_1, \mu_2 \in F\alpha-\psi*C(X,\tau)$. Since each $\lambda_k \in F\alpha-\psi*I(X,\tau)$, $i=1,2,...,l$, we get $\lambda_i \leq \mu_1$ or $\lambda_i \leq \mu_2$. Suppose that for some $i_0 \in J$, $\lambda_{i_0} \in \mathcal{A}'$ and $\lambda_{i_0} \nleq \mu_1$, then $\lambda_i \leq \mu_2$ for all $i \in J$. Thus $\lambda' \leq \mu_2$. Therefore $\lambda' \in F\alpha-\psi*I(X,\tau)$ and $\lambda' \in F\alpha-\psi*MI(X,\tau)$.

Proposition 3.5 If (X,τ) is fuzzy $\alpha-\psi*-$irreducible, then for any $\lambda \in F\alpha-\psi*O(X,\tau)$, $F\alpha-\psi*cl(\lambda) = 1_X$.

Proof. Since (X,τ) is fuzzy $\alpha-\psi*-$irreducible, for any two $\lambda, \mu \in F\alpha-\psi*O(X,\tau)$ where $\lambda \neq 0_X$ and $\mu \neq 0_X$, $\lambda q \mu$. Let $\lambda_1 \in F\alpha-\psi*O(X,\tau)$ such that $\lambda_1 \neq 0_X$. If $\lambda_1 = 1_X$, then $F\alpha-\psi*cl(\lambda_1) = 1_X$. Assume that $\lambda_1 \neq 1_X$ and $x_{t_1} \in \mathcal{FP}(X)$ be such that $x_{t_1} \neq \lambda_1$. Let $\mu_1 \in F\alpha-\psi*O(X,\tau)$ and $\mu_1 \neq 0_X$ such that $x_{t_1} \leq \mu_1$. By hypothesis, $\lambda_1 q \mu_1$. That is, there exist some $x_{t_i} \leq \lambda_1$ where $i \neq 1$ and $i \in J$, J is an indexed set such that $x_{t_i} \leq \mu_1$ with $x_{t_1} \tilde{q} x_{t_i}$. Since μ_1 is an arbitrary fuzzy $\alpha-\psi*-$open set in (X,τ), it follows that every fuzzy $\alpha-\psi*-$ open μ_1 in (X,τ) is such that $x_{t_i} \leq \lambda_1$ $i \neq 1$ and $i \in J$ such that $x_{t_i} \leq \mu_1$ with $\lambda_1 q \mu_1$. Therefore x_{t_i} is a fuzzy limit point of λ_1. So every fuzzy point over X is a fuzzy limit point of λ_1. Thus, every $x_{t_i} \in \mathcal{FP}(X)$ is such that $x_{t_i} \leq F\alpha-\psi*cl(\lambda)$, $\lambda \in F\alpha-\psi*O(X,\tau)$. Hence, fuzzy $\alpha-\psi*-$ closure of every fuzzy $\alpha-\psi*-$open set is 1_X.

$f(\lambda) \leq f(f^{-1}(\mu_2))$

IV. FUZZY $\alpha-\psi*-$ QUASI SOBER SPACE

Definition 4.1 Let $\psi*$ be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Let $\lambda \in I^X$ be a fuzzy $\alpha-\psi*-$irreducible closed set. Any fuzzy set $\mu \in I^X$ with $\mu \leq \lambda$, is said to be a fuzzy $\alpha-\psi*-$generic set of λ if $F\alpha-\psi*cl(\mu) = \lambda$.

Definition 4.2 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Then (X,τ) is said to be a fuzzy $\alpha-\psi^*-$ quasi-Sober space, if for every fuzzy $\alpha-\psi^*-$ irreducible closed set there exists a fuzzy $\alpha-\psi^*-$generic set.

Remark 4.1 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Let $Y\subset X$ and (Y,τ_Y) be a fuzzy subspace of (X,τ). Then ψ^* be a fuzzy operator on $F\alpha O(Y,\tau_Y)$.

Definition 4.3 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). If for $\lambda,\mu\in I^X$ with $\lambda q\mu$ there exists a $\delta\in F\alpha-\psi^*C(X,\tau)$ such that either $\mu\le\delta$, $\lambda q\delta$ or $\lambda\le\delta$, $\mu q\delta$, then (X,τ) is called fuzzy $\alpha-\psi^*-$Kolmogorov.

Proposition 4.1 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Let $Y\subset X$ and (Y,τ_Y) be a fuzzy subspace of (X,τ). If (X,τ) is fuzzy $\alpha-\psi^*-$Kolmogorov, then (Y,τ_Y) is fuzzy $\alpha-\psi^*-$Kolmogorov.

Proof. Let $\lambda,\mu\in I^X$ with $\lambda q\mu$. Then there exists a $\delta\in F\alpha-\psi^*C(X,\tau)$ such that $\mu\le\delta$, $\lambda q\delta$ or $\lambda\le\delta$, $\mu q\delta$. Let $\lambda_{|Y},\mu_{|Y}\in I^Y$ with $\lambda_{|Y}$ q $\mu_{|Y}$. Since $\delta\in F\alpha-\psi^*C(X,\tau)$, $\delta_{|Y}\in F\alpha-\psi^*C(Y,\tau_Y)$. Also, since $\lambda_{|Y}\le\lambda$, $\lambda\le\delta$ and $\mu_{|Y}\le\mu$, $\mu\le\delta$, $\lambda_{|Y}\le\delta_{|Y}$ with $\mu_{|Y}$q $\delta_{|Y}$ or $\mu_{|Y}\le\delta_{|Y}$ with $\lambda_{|Y}$ q $\delta_{|Y}$. Hence (Y,τ_Y) is fuzzy $\alpha-\psi^*-$Kolmogorov.

Notation 4.1 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ and $F\alpha O(Y,\sigma)$ where (X,τ) and (Y,σ) are any two ftss. For any $\lambda\in I^X$, $\mu\in I^Y$, $F\alpha-\psi^*cl(\lambda)$ with respect to (X,τ) and (Y,σ) are denoted by $F\alpha-\psi^*cl(\lambda)$ and $F\alpha-\psi^*cl(\mu)$ respectively. Then the collection of all fuzzy $\alpha-\psi^*-$ irreducible closed in (X,τ) id denoted by $F\alpha-\psi^*IC(X,\tau)$

Proposition 4.2 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Let $Y\subset X$ and (Y,τ_Y) be a fuzzy $\alpha-\psi^*-$ closed subspace of (X,τ). If (X,τ) is fuzzy $\alpha-\psi^*-$ quasi-Sober, then (Y,τ_Y) is fuzzy $\alpha-\psi^*-$quasi-Sober.

Proof. Let $\lambda\in F\alpha-\psi^*IC(Y,\tau_Y)$. Then $\lambda\in F\alpha-\psi^*IC(X,\tau)$. Since (X,τ) is fuzzy $\alpha-\psi^*-$quasi-Sober, there exists a fuzzy $\alpha-\psi^*$-generic set $\mu\in I^X$ such that $F\alpha-\psi^*cl(\mu)=\lambda$. Thus $F\alpha-\psi^*cl(\mu)\wedge 1_Y=\lambda\wedge 1_Y$. This implies that $F\alpha-\psi^*cl(\mu)\wedge 1_Y=\lambda$. Therefor1e $F\alpha-\psi^*cl(\mu)=\lambda$. Hence (Y,τ_Y) is fuzzy $\alpha-\psi^*-$quasi-Sober.

Proposition 4.3 Let ψ^* be a fuzzy operator on $F\alpha O(X_1,\tau_1)$ and $F\alpha O(X_2,\tau_2)$ where (X_1,τ_1) and (X_2,τ_2) are any two ftss. Let $f:(X_1,\tau_1)\to(X_2,\tau_2)$ be a injective and fuzzy $\alpha-\psi^*-$ continuous function. If $\lambda\in F\alpha-\psi^*IC(X_1,\tau_1)$, then $F\alpha-\psi^*cl(f(\lambda))\in F\alpha-\psi^*IC(X_2,\tau_2)$.

Proof. Let $\lambda\in F\alpha-\psi^*IC(X_1,\tau_1)$. Let $\mu_1,\mu_2\in F\alpha-\psi^*C(X_2,\tau_2)$ such that $F\alpha-\psi^*cl(f(\lambda))\le\mu_1\vee\mu_2$. Since $f(\lambda)\le F\alpha-\psi^*cl(f(\lambda))$, $f(\lambda)\le\mu_1\vee\mu_2$. As f is injective, $\lambda\le(f^{-1}(\mu_1))\vee(f^{-1}(\mu_2))$. Then $\lambda\le(\lambda\wedge f^{-1}(\mu_1))\vee(\lambda\wedge f^{-1}(\mu_2))$. Since f is a fuzzy $\alpha-\psi^*-$ continuous function, $f^{-1}(\mu_1), f^{-1}(\mu_2)\in F\alpha-\psi^*C(X_1,\tau_1)$. This implies that $\lambda\wedge f^{-1}(\mu_1)$, $\lambda\wedge f^{-1}(\mu_2)\in F\alpha-\psi^*C(X_1,\tau_1)$. Since $\lambda\in F\alpha-\psi^*IC(X_1,\tau_1)$, $\lambda\le(\lambda\wedge f^{-1}(\mu_1))$ or $\lambda\le(\lambda\wedge f^{-1}(\mu_2))$. Thus $\lambda\le f^{-1}(\mu_1)$ or $\lambda\le f^{-1}(\mu_2)$. Therefore, $f(\lambda)\le\mu_1$ or $f(\lambda)\le\mu_2$. This implies that $F\alpha-\psi^*cl(f(\lambda))\le\mu_1$ or $F\alpha-\psi^*cl(f(\lambda))\le\mu_2$. Hence $F\alpha-\psi^*cl(f(\lambda))\in F\alpha-\psi^*IC(X_2,\tau_2)$.

Proposition 4.4 Let ψ^* be a fuzzy operator on $F\alpha O(X,\tau)$ in a fts (X,τ). Let $Y\subset X$ and (Y,τ_Y) be a fuzzy $\alpha-\psi^*-$ open subspace of (X,τ). If (X,τ) is fuzzy $\alpha-\psi^*-$ quasi-Sober, then (Y,τ_Y) is fuzzy $\alpha-\psi^*-$quasi-Sober.

Proof. Let $\mu\in F\alpha-\psi^*IC(Y,\tau_Y)$. Then $\mu\in F\alpha-\psi^*IC(X,\tau)$. Since (X,τ) is fuzzy $\alpha-\psi^*-$quasi-Sober, there exists a fuzzy $\alpha-\psi^*-$generic set $\lambda\in I^X$ such that $F\alpha-\psi^*cl(\lambda)=\mu$. Then $F\alpha-\psi^*cl_X(\lambda)\wedge\chi_Y=\mu\wedge\chi_Y$. Since $\mu\in F\alpha-\psi^*IC(Y,\tau_Y)$, $F\alpha-\psi^*cl(\lambda)=\mu$ and $\lambda\le\mu$. Hence (Y,τ_Y) is fuzzy s $\alpha-\psi^*-$quasi-Sober.

V. CONCLUSION

In this paper, we explored ψ^* operator on a family of fuzzy $\alpha-$open sets in a fuzzy topological spaces . We can extend ψ^* operator on fuzzy homotopy and fuzzy spectral spaces.

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