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Research article

A systematic study in the applications of fuzzy hyperlattice

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Abstract: In the last few decennium, the acquaintance between algebraic hyperstructures and fuzzy sets have been considered for its theoretical as well as applications in various fields. Fuzzy hyperstructures are fascinating research topic and substantial amount of researches have been undergoing as of now. As a consequence, fuzzy hyperlattice was introduced by Pengfei He, Xiaolong Xin. But the applications on fuzzy hyperlattice are not defined so far. By scrutinizing the fuzzy hyperlattice, our objective is to present some applications of fuzzy hyperlattice in Biological and Physical Sciences. We find the first and second applications in dihybrid cross of Drosophila melanogaster (housefly) and Pisum sativum (Peas), respectively. Third application is in particle Physics (Elementary particles interaction).

Keywords: hyperstructure; hyperlattice; fuzzy hyperlattice; inheritance; elementary particles
Mathematics Subject Classification: 03E72, 06D72, 20N20

1. Introduction

Algebraic structures play an outstanding role in mathematical science with vast ranging applications in various disciplines such as control engineering, theoretical physics, information sciences, computer sciences, coding theory, etc. This gives plenteous encouragement for researchers to develop numerous concepts and results from abstract algebra .
The composition of two elements forms an element in classical algebraic hyperstructure, but the composition of two elements forms a set in algebraic hyperstructure hence algebraic hyperstructures are the generalizations of classical algebraic structures. Comparison of multiple domains are possible through hyperstructure theory, it leads to the development of many applications. Many research works exist on the applications of hyperstructure theory [21, 22]. Moreover, the notion of hyperlattice was introduced by Konstantinidou and Mittas in [8]. Rasouli and Davvaz developed the theory of hyperlattices and proposed various interesting results [17, 18], which enhanced the hyperlattice theory.

Some new interesting topics developed from the combination of fuzzy set theory and hyperalgebraic systems which have drawn attention of many computer scientists and mathematicians. Many papers have been developed as a recent work on fuzzy hyperstructures (see [19, 28]). Fuzzy hyperlattice was introduced by Pengfei He, Xiaolong Xin [13] and they studied some connections between hyperlattices and fuzzy hyperlattices.
Every fields of science attempt to and desire to make use of mathematical models in the process of predicting, whenever and wherever possible and also describing the numerous phenomena under subject. In this article, we define some real life models of fuzzy hyperlattice. For that we took some data from Biology and Physics.
The paper is arranged in the following manner. In Section 2, we recall some basic notions. Section 3 deals with three applications of fuzzy hyperlattice. Section 4 ends with a conclusion.

2. Preliminaries

The generalizations of classical algebraic structures are the algebraic hyperstructures[13, 12, 2]. In algebraic hyperstructure, the composition of two elements is a set. If $\mathbb{H}$ be a nonempty set, $\mathbb{P}^*(\mathbb{H})$ be the set of all nonempty subsets of $\mathbb{H}$, then consider a map
$f_i : \mathbb{H} \times \mathbb{H} \longrightarrow \mathbb{P}^*(\mathbb{H})$
where $i \in \{1, 2, ..., h\}$ and h is a positive integer. The maps f_i are called hyperoperations. An algebraic system $(\mathbb{H}, f_1, .., f_h)$ is called a hyperstructure. Usually a hyperstructure involves two hyperoperations. Let $\mathbb{L}$ be a nonempty set and $\mathbb{P}^*(\mathbb{L})$ be the set of all nonempty subsets of $\mathbb{L}$. A hyperoperation on $\mathbb{L}$ is a map $\oplus : \mathbb{L} \times \mathbb{L} \longrightarrow \mathbb{P}^*(\mathbb{L})$, which associates a nonempty subset $u \oplus v$ with any pair (u,v) of elements of $\mathbb{L} \times \mathbb{L}$.

If $\mathbb{A}$ and $\mathbb{B}$ are nonempty subsets of $\mathbb{L}$, for $u, v, x \in \mathbb{L}$, then we denote
(1) $x \oplus \mathbb{A} = \{x\} \oplus \mathbb{A} = \bigcup_{u\in\mathbb{A}}(x \oplus u)$, $\mathbb{A} \oplus x = \mathbb{A} \oplus \{x\} = \bigcup_{u\in\mathbb{A}}(u \oplus x)$;
(2) $\mathbb{A} \oplus \mathbb{B} = \bigcup_{u\in\mathbb{A}, v\in\mathbb{B}}(u \oplus v)$.

Definition 2.1. [13, 6] Consider a nonempty set $\mathbb{L}$ with two hyperoperations ”$\otimes$” and ”$\oplus$”. The triple $(\mathbb{L}, \otimes, \oplus)$ is called a hyperlattice if it satisfies the following conditions, $\forall\ u, v, w \in \mathbb{L}$,
(1) (Idempotent laws) $u \in u \otimes u$, $u \in u \oplus u$;
(2) (Commutative laws) $u \otimes v = v \otimes u$, $u \oplus v = v \oplus u$;
(3) (Associative laws) $(u \otimes v) \otimes w = u \otimes (v \otimes w)$, $(u \oplus v) \oplus w = u \oplus (v \oplus w)$;
(4) (Absorption laws) $u \in u \otimes (u \oplus v)$, $u \in u \oplus (u \otimes v)$.

Definition 2.2. [29] Let $\mathbb{X}$ be a set. A function $\mathbb{A} : \mathbb{X} \longrightarrow [0, 1]$ is known as a fuzzy relation on $\mathbb{X}$.

Definition 2.3. [29] A fuzzy relation $\mathbb{A}$ is a fuzzy partial order relation if $\mathbb{A}$ is reflexive, antisymmetric and transitive.

Definition 2.4. [29] Let $(\mathbb{X}, \mathbb{A})$ be a fuzzy poset. $(\mathbb{X}, \mathbb{A})$ is a fuzzy lattice if and only if $x \vee y$ and $x \wedge y$ exist $\forall\ x, y \in \mathbb{X}$.

Definition 2.5. If $\mathbb{A}$ is a nonempty subset of $\mathbb{L}$, then the characteristic function of $\mathbb{A}$ is $\chi_{\mathbb{A}}$, where $\forall$, $x \in \mathbb{L}$,

$$\chi_{\mathbb{A}}(x) = \begin{cases} 1, & x \in \mathbb{A} \\ 0, & x \notin \mathbb{A} \end{cases}$$

Definition 2.6. [13] Consider a nonempty set $\mathbb{L}$ with two fuzzy hyperoperations $\otimes$ and $\oplus$ ($F^*(\mathbb{L})$ be the set of all non zero fuzzy subsets of $\mathbb{L}$. The mapping of a fuzzy hyperoperation is of the form $\circ : \mathbb{L} \times \mathbb{L} \longrightarrow F^*(\mathbb{L})$). The triple $(\mathbb{L}, \otimes, \oplus)$ is called a fuzzy hyperlattice if it satisfies the following conditions , $\forall\ u, v, w \in \mathbb{L}$,
(i) (Fuzzy idempotent laws) $(u \otimes u)(u) > 0$, $(u \oplus u)(u) > 0$;
(ii) (Fuzzy commutative laws) $u \otimes v = v \otimes u$, $u \oplus v = v \oplus u$;
(iii) (Fuzzy associative laws) $(u \otimes v) \otimes w = u \otimes (v \otimes w)$, $(u \oplus v) \oplus w = u \oplus (v \oplus w)$;
(iv) (Fuzzy absorption laws) $(u \otimes (u \oplus v))(u) > 0$, $(u \oplus (u \otimes v))(u) > 0$.
Note: [13] If $\mathbb{U}$ and $\mathbb{V}$ are two non zero fuzzy subsets, $\forall u, x \in \mathbb{L}$ then ,
(i) $(u \circ \mathbb{U})(x) = \sup_{t\in\mathbb{L}}\{(u \circ t)(x) \wedge \mathbb{U}(t)\}$.
$(\mathbb{U} \circ u)(x) = \sup_{t\in\mathbb{L}}\{\mathbb{U}(t) \wedge (t \circ u)(x)\}$.
(ii) $(\mathbb{U} \circ \mathbb{V})(x) = \sup_{p\in\mathbb{L},q\in\mathbb{L}}\{\mathbb{U}(p) \wedge (p \circ q)(x) \wedge \mathbb{V}(q)\}$.

Example 2.7. [13] Consider a lattice $(\mathbb{L}, \wedge, \vee)$. If the fuzzy hyperoperations on $\mathbb{L}$ defined by : $\forall\ u, v \in \mathbb{L}$, $u \times v = \chi_{\{u,v\}}$ and $u + v = \chi_{u\wedge v}$, then $(\mathbb{L}, \times, +)$ is a fuzzy hyperlattice.

Example 2.8. [13] Consider a lattice $(\mathbb{L}, \wedge, \vee)$. If the fuzzy hyperoperations on $\mathbb{L}$ defined by : $\forall\ u, v \in \mathbb{L}$, $u \times v = \chi_{\{u,v\}}$ and $\forall\ x \in \mathbb{L}$,

$$(u + v)(x) = \begin{cases} 1/2, & x = u \wedge v \\ 0, & \text{otherwise} \end{cases}$$

Then $(\mathbb{L}, \times, +)$ is a fuzzy hyperlattice.

Example 2.9. [13] Consider a lattice $(\mathbb{L}, \wedge, \vee)$. If the fuzzy hyperoperations on $\mathbb{L}$ defined by: $\forall\ u, v \in \mathbb{L}$, $u \times v = \chi_{u\vee v}$ and $\forall\ x \in \mathbb{L}$,

$$(u + v)(x) = \begin{cases} 1/2, & x = u \wedge v \\ 0, & \text{otherwise} \end{cases}$$

Then $(\mathbb{L}, \times, +)$ is a fuzzy hyperlattice.

3. Applications of fuzzy hyperlattice

This section consists of three subsections. The subsections deal with three applications of fuzzy hyperlattice.

3.1. Application 1: The dihybrid cross in Drosophila melanogaster

Mendel crossed some varieties of Drosophila melanogaster that differed in two characteristics such as colour of bodies and length of wings[3].
For example:
$\mathbb{P}$ Generation: Grey bodies; Long wings (GGLL genotype) $\otimes$ Black bodies; Short wings (ggll genotype)

↓
$\mathbb{F}_1$: Grey bodies; Long wings (GgLl genotype) and
$\mathbb{F}_1 \times \mathbb{F}_1$: Grey bodies; Long wings (GgLl genotype) $\otimes$ Grey bodies; Long wings(GgLl genotype)
↓
$\mathbb{F}_2$: Grey bodies; Long wings (GGLL, GgLl, GgLL and GGLl genotypes) Grey bodies; Short wings (GGll and Ggll genotypes) Black bodies; Long wings (ggLL and ggLl genotypes) Black bodies; Short wings (ggll genotype) Figure 1, refers the possible outcomes of $\mathbb{F}_2$ generations.

Now, let us consider the Long wings and Grey bodies by $\mathcal{A}$, Long wings and Black bodies by $\mathcal{B}$, Short wings and Grey bodies by C, Short wings and Black bodies by $\mathcal{D}$. Hence we have Table 1,

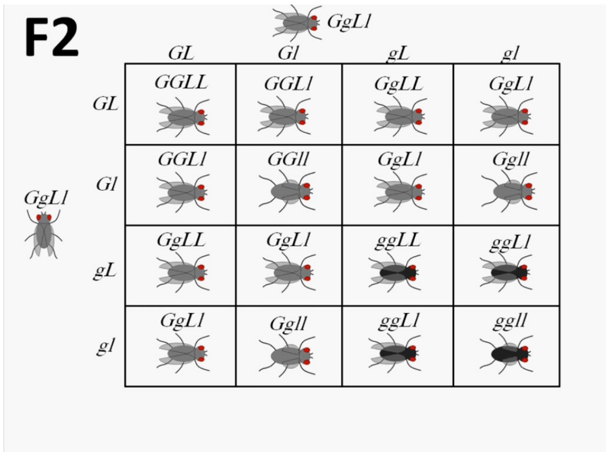

Figure 1. Possible outcomes of $\mathbb{F}_2$ generations.

Table 1. A diagrammatic explanations of the dihybrid cross in the Drosophila melanogaster.

$\times$	$\mathcal{A}$	$\mathcal{B}$	C	$\mathcal{D}$
$\mathcal{A}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$
$\mathcal{B}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{B},\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{B},\mathcal{D}$
C	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$C,\mathcal{D}$	$C,\mathcal{D}$
$\mathcal{D}$	$\mathcal{A},\mathcal{B},C,\mathcal{D}$	$\mathcal{B},\mathcal{D}$	$C,\mathcal{D}$	$\mathcal{D}$

Let $\mathcal{L} = \{\mathcal{A}, \mathcal{B}, C, \mathcal{D}\}$. Here for all $\mathcal{M}, \mathcal{S} \in \mathcal{L}$, we define the fuzzy hyperoperations '$\oplus$' and '$\otimes$' by,
$\mathcal{M} \oplus \mathcal{S} = \chi_{\{\mathcal{M},\mathcal{S}\}}$ and
$\mathcal{M} \otimes \mathcal{S} = \chi_{\mathcal{L}}$
Now let us check whether the above defined fuzzy hyperoperations satisfies the conditions of fuzzy hyperlattice.
Condition 1: Fuzzy idempotent laws of fuzzy hyperlattice:

$$
\begin{aligned}
(\mathcal{A} \oplus \mathcal{A})(\mathcal{A}) &= \chi_{\{\mathcal{A},\mathcal{A}\}}(\mathcal{A}) &= 1 > 0 \\
(\mathcal{B} \oplus \mathcal{B})(\mathcal{B}) &= \chi_{\{\mathcal{B},\mathcal{B}\}}(\mathcal{B}) &= 1 > 0 \\
(C \oplus C)(C) &= \chi_{\{C,C\}}(C) &= 1 > 0
\end{aligned}
$$

$$(\mathcal{D}\oplus\mathcal{D})(\mathcal{D}) = \chi_{\{\mathcal{D},\mathcal{D}\}}(\mathcal{D}) = 1 > 0$$

$$\begin{aligned}(\mathcal{A}\otimes\mathcal{A})(\mathcal{A}) &= \chi_{\{\mathcal{L}\}}(\mathcal{A}) &= 1 > 0\\ (\mathcal{B}\otimes\mathcal{B})(\mathcal{B}) &= \chi_{\{\mathcal{L}\}}(\mathcal{B}) &= 1 > 0\\ (\mathcal{C}\otimes\mathcal{C})(\mathcal{C}) &= \chi_{\{\mathcal{L}\}}(\mathcal{C}) &= 1 > 0\\ (\mathcal{D}\otimes\mathcal{D})(\mathcal{D}) &= \chi_{\{\mathcal{L}\}}(\mathcal{D}) &= 1 > 0\end{aligned}$$

Condition 2: Fuzzy commutative laws of fuzzy hyperlattice:
(i) $(\mathcal{A}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B}\}} = \chi_{\{\mathcal{B},\mathcal{A}\}} = (\mathcal{B}\oplus\mathcal{A})$
$(\mathcal{A}\oplus\mathcal{C}) = \chi_{\{\mathcal{A},\mathcal{C}\}} = \chi_{\{\mathcal{C},\mathcal{A}\}} = (\mathcal{C}\oplus\mathcal{A})$
Similarly, $(\mathcal{A}\oplus\mathcal{D}) = (\mathcal{D}\oplus\mathcal{A})$, $(\mathcal{B}\oplus\mathcal{C}) = (\mathcal{C}\oplus\mathcal{B})$, $(\mathcal{B}\oplus\mathcal{D}) = (\mathcal{D}\oplus\mathcal{B})$, $(\mathcal{C}\oplus\mathcal{D}) = (\mathcal{D}\oplus\mathcal{C})$.
(ii) $(\mathcal{A}\otimes\mathcal{B}) = \chi_{\{\mathcal{L}\}} = (\mathcal{B}\otimes\mathcal{A})$
$(\mathcal{A}\otimes\mathcal{C}) = \chi_{\{\mathcal{L}\}} = (\mathcal{C}\otimes\mathcal{A})$
Similarly, $(\mathcal{A}\otimes\mathcal{D}) = (\mathcal{D}\otimes\mathcal{A})$, $(\mathcal{B}\otimes\mathcal{C}) = (\mathcal{C}\otimes\mathcal{B})$, $(\mathcal{B}\otimes\mathcal{D}) = (\mathcal{D}\otimes\mathcal{B})$, $(\mathcal{C}\otimes\mathcal{D}) = (\mathcal{D}\otimes\mathcal{C})$.
Condition 3: Fuzzy associative laws of fuzzy hyperlattice:

$$\begin{aligned}(\mathcal{A}\oplus\mathcal{B})\oplus\mathcal{A} &= \chi_{\{\mathcal{A},\mathcal{B}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B}\}}; & \mathcal{A}\oplus(\mathcal{B}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B}\}}\\ (\mathcal{A}\oplus\mathcal{C})\oplus\mathcal{A} &= \chi_{\{\mathcal{A},\mathcal{C}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{C}\}}; & \mathcal{A}\oplus(\mathcal{C}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{C}\}}\\ (\mathcal{A}\oplus\mathcal{D})\oplus\mathcal{A} &= \chi_{\{\mathcal{A},\mathcal{D}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{D}\}}; & \mathcal{A}\oplus(\mathcal{D}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{D}\}}\\ (\mathcal{B}\oplus\mathcal{A})\oplus\mathcal{A} &= \chi_{\{\mathcal{B},\mathcal{A}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B}\}}; & \mathcal{B}\oplus(\mathcal{A}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B}\}}\\ (\mathcal{B}\oplus\mathcal{C})\oplus\mathcal{A} &= \chi_{\{\mathcal{B},\mathcal{C}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}; & \mathcal{B}\oplus(\mathcal{C}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}\\ (\mathcal{B}\oplus\mathcal{D})\oplus\mathcal{A} &= \chi_{\{\mathcal{B},\mathcal{D}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}; & \mathcal{B}\oplus(\mathcal{D}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}\\ (\mathcal{C}\oplus\mathcal{A})\oplus\mathcal{A} &= \chi_{\{\mathcal{C},\mathcal{A}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{A}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{C}\}}\\ (\mathcal{C}\oplus\mathcal{B})\oplus\mathcal{A} &= \chi_{\{\mathcal{C},\mathcal{B}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{B}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}\\ (\mathcal{C}\oplus\mathcal{D})\oplus\mathcal{A} &= \chi_{\{\mathcal{C},\mathcal{D}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}; & \mathcal{C}\oplus(\mathcal{D}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}\\ (\mathcal{D}\oplus\mathcal{A})\oplus\mathcal{A} &= \chi_{\{\mathcal{D},\mathcal{A}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{A}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{D}\}}\\ (\mathcal{D}\oplus\mathcal{B})\oplus\mathcal{A} &= \chi_{\{\mathcal{D},\mathcal{B}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{B}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}\\ (\mathcal{D}\oplus\mathcal{C})\oplus\mathcal{A} &= \chi_{\{\mathcal{D},\mathcal{C}\}}\oplus\mathcal{A} = \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{C}\oplus\mathcal{A}) = \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}\end{aligned}$$

$$\begin{aligned}(\mathcal{A}\oplus\mathcal{B})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B}\}}; & \mathcal{A}\oplus(\mathcal{B}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B}\}}\\ (\mathcal{A}\oplus\mathcal{C})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}; & \mathcal{A}\oplus(\mathcal{C}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}\\ (\mathcal{A}\oplus\mathcal{D})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}; & \mathcal{A}\oplus(\mathcal{D}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}\\ (\mathcal{B}\oplus\mathcal{A})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B}\}}; & \mathcal{B}\oplus(\mathcal{A}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B}\}}\\ (\mathcal{B}\oplus\mathcal{C})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{C}\}}; & \mathcal{B}\oplus(\mathcal{C}\oplus\mathcal{B}) = \chi_{\{\mathcal{B},\mathcal{C}\}}\\ \mathcal{B}\oplus\mathcal{D})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{D}\}}; & \mathcal{B}\oplus(\mathcal{D}\oplus\mathcal{B}) = \chi_{\{\mathcal{B},\mathcal{D}\}}\\ (\mathcal{C}\oplus\mathcal{A})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{A}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}\\ (\mathcal{C}\oplus\mathcal{B})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{B}\oplus\mathcal{B}) = \chi_{\{\mathcal{B},\mathcal{C}\}}\\ (\mathcal{C}\oplus\mathcal{D})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}; & \mathcal{C}\oplus(\mathcal{D}\oplus\mathcal{B}) = \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}\\ (\mathcal{D}\oplus\mathcal{A})\oplus\mathcal{B} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{A}\oplus\mathcal{B}) = \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}\end{aligned}$$

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\begin{aligned}
(\mathcal{D}\oplus\mathcal{B})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{B}\oplus\mathcal{B}) &= \chi_{\{\mathcal{B},\mathcal{D}\}}\\
(\mathcal{D}\oplus\mathcal{C})\oplus\mathcal{B} &= \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{C}\oplus\mathcal{B}) &= \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}
\end{aligned}
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\begin{aligned}
(\mathcal{A}\oplus\mathcal{B})\oplus\mathcal{C} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}; & \mathcal{A}\oplus(\mathcal{B}\oplus\mathcal{C}) &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{C}\}}\\
(\mathcal{A}\oplus\mathcal{C})\oplus\mathcal{C} &= \chi_{\{\mathcal{A},\mathcal{C}\}}; & \mathcal{A}\oplus(\mathcal{C}\oplus\mathcal{C}) &= \chi_{\{\mathcal{A},\mathcal{C}\}}\\
(\mathcal{A}\oplus\mathcal{D})\oplus\mathcal{C} &= \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}; & \mathcal{A}\oplus(\mathcal{D}\oplus\mathcal{C}) &= \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}\\
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(\mathcal{C}\oplus\mathcal{A})\oplus\mathcal{C} &= \chi_{\{\mathcal{A},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{A}\oplus\mathcal{C}) &= \chi_{\{\mathcal{A},\mathcal{C}\}}\\
(\mathcal{C}\oplus\mathcal{B})\oplus\mathcal{C} &= \chi_{\{\mathcal{B},\mathcal{C}\}}; & \mathcal{C}\oplus(\mathcal{B}\oplus\mathcal{C}) &= \chi_{\{\mathcal{B},\mathcal{C}\}}\\
(\mathcal{C}\oplus\mathcal{D})\oplus\mathcal{C} &= \chi_{\{\mathcal{C},\mathcal{D}\}}; & \mathcal{C}\oplus(\mathcal{D}\oplus\mathcal{C}) &= \chi_{\{\mathcal{C},\mathcal{D}\}}\\
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(\mathcal{D}\oplus\mathcal{B})\oplus\mathcal{C} &= \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{B}\oplus\mathcal{C}) &= \chi_{\{\mathcal{B},\mathcal{C},\mathcal{D}\}}\\
(\mathcal{D}\oplus\mathcal{C})\oplus\mathcal{C} &= \chi_{\{\mathcal{C},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{C}\oplus\mathcal{C}) &= \chi_{\{\mathcal{C},\mathcal{D}\}}
\end{aligned}
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$$
\begin{aligned}
(\mathcal{A}\oplus\mathcal{B})\oplus\mathcal{D} &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}; & \mathcal{A}\oplus(\mathcal{B}\oplus\mathcal{D}) &= \chi_{\{\mathcal{A},\mathcal{B},\mathcal{D}\}}\\
(\mathcal{A}\oplus\mathcal{C})\oplus\mathcal{D} &= \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}; & \mathcal{A}\oplus(\mathcal{C}\oplus\mathcal{D}) &= \chi_{\{\mathcal{A},\mathcal{C},\mathcal{D}\}}\\
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(\mathcal{D}\oplus\mathcal{B})\oplus\mathcal{D} &= \chi_{\{\mathcal{B},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{B}\oplus\mathcal{D}) &= \chi_{\{\mathcal{B},\mathcal{D}\}}\\
(\mathcal{D}\oplus\mathcal{C})\oplus\mathcal{D} &= \chi_{\{\mathcal{C},\mathcal{D}\}}; & \mathcal{D}\oplus(\mathcal{C}\oplus\mathcal{D}) &= \chi_{\{\mathcal{C},\mathcal{D}\}}
\end{aligned}
$$

Similarly, the fuzzy associative law satisfies for the fuzzy hyperoperation $\otimes$.
Condition 4: Fuzzy absorption laws of fuzzy hyperlattice:

$$
\begin{aligned}
(\mathcal{A}\oplus(\mathcal{A}\otimes\mathcal{B}))(\mathcal{A}) &= (\mathcal{A}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0\\
(\mathcal{A}\oplus(\mathcal{A}\otimes\mathcal{C}))(\mathcal{A}) &= (\mathcal{A}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0\\
(\mathcal{A}\oplus(\mathcal{A}\otimes\mathcal{D}))(\mathcal{A}) &= (\mathcal{A}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0\\
(\mathcal{B}\oplus(\mathcal{B}\otimes\mathcal{A}))(\mathcal{B}) &= (\mathcal{B}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0\\
(\mathcal{B}\oplus(\mathcal{B}\otimes\mathcal{C}))(\mathcal{B}) &= (\mathcal{B}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0\\
(\mathcal{B}\oplus(\mathcal{B}\otimes\mathcal{D}))(\mathcal{B}) &= (\mathcal{B}\oplus\chi_{\{\mathcal{L}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0
\end{aligned}
$$

$$
\begin{aligned}
(\mathcal{C} \oplus (\mathcal{C} \otimes \mathcal{A}))(\mathcal{C}) &= (\mathcal{C} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{C} \oplus (\mathcal{C} \otimes \mathcal{B}))(\mathcal{C}) &= (\mathcal{C} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{C} \oplus (\mathcal{C} \otimes \mathcal{D}))(\mathcal{C}) &= (\mathcal{C} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{D} \oplus (\mathcal{D} \otimes \mathcal{A}))(\mathcal{D}) &= (\mathcal{D} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0 \\
(\mathcal{D} \oplus (\mathcal{D} \otimes \mathcal{B}))(\mathcal{D}) &= (\mathcal{D} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0 \\
(\mathcal{D} \oplus (\mathcal{D} \otimes \mathcal{C}))(\mathcal{D}) &= (\mathcal{D} \oplus \chi_{\{\mathcal{L}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0
\end{aligned}
$$

$$
\begin{aligned}
(\mathcal{A} \otimes (\mathcal{A} \oplus \mathcal{B}))(\mathcal{A}) &= (\mathcal{A} \otimes \chi_{\{\mathcal{A},\mathcal{B}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0 \\
(\mathcal{A} \otimes (\mathcal{A} \oplus \mathcal{C}))(\mathcal{A}) &= (\mathcal{A} \otimes \chi_{\{\mathcal{A},\mathcal{C}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0 \\
(\mathcal{A} \otimes (\mathcal{A} \oplus \mathcal{D}))(\mathcal{A}) &= (\mathcal{A} \otimes \chi_{\{\mathcal{A},\mathcal{D}\}})(\mathcal{A}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{A}) = 1 > 0 \\
(\mathcal{B} \otimes (\mathcal{B} \oplus \mathcal{A}))(\mathcal{B}) &= (\mathcal{B} \otimes \chi_{\{\mathcal{B},\mathcal{A}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0 \\
(\mathcal{B} \otimes (\mathcal{B} \oplus \mathcal{C}))(\mathcal{B}) &= (\mathcal{B} \otimes \chi_{\{\mathcal{B},\mathcal{C}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0 \\
(\mathcal{B} \otimes (\mathcal{B} \oplus \mathcal{D}))(\mathcal{B}) &= (\mathcal{B} \otimes \chi_{\{\mathcal{B},\mathcal{D}\}})(\mathcal{B}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{B}) = 1 > 0 \\
(\mathcal{C} \otimes (\mathcal{C} \oplus \mathcal{A}))(\mathcal{C}) &= (\mathcal{C} \otimes \chi_{\{\mathcal{C},\mathcal{A}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{C} \otimes (\mathcal{C} \oplus \mathcal{B}))(\mathcal{C}) &= (\mathcal{C} \otimes \chi_{\{\mathcal{C},\mathcal{B}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{C} \otimes (\mathcal{C} \oplus \mathcal{D}))(\mathcal{C}) &= (\mathcal{C} \otimes \chi_{\{\mathcal{C},\mathcal{D}\}})(\mathcal{C}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{C}) = 1 > 0 \\
(\mathcal{D} \otimes (\mathcal{D} \oplus \mathcal{A}))(\mathcal{D}) &= (\mathcal{D} \otimes \chi_{\{\mathcal{D},\mathcal{A}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0 \\
(\mathcal{D} \otimes (\mathcal{D} \oplus \mathcal{B}))(\mathcal{D}) &= (\mathcal{D} \otimes \chi_{\{\mathcal{D},\mathcal{B}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0 \\
(\mathcal{D} \otimes (\mathcal{D} \oplus \mathcal{C}))(\mathcal{D}) &= (\mathcal{D} \otimes \chi_{\{\mathcal{D},\mathcal{C}\}})(\mathcal{D}) &&= \chi_{\{\mathcal{L}\}}(\mathcal{D}) = 1 > 0
\end{aligned}
$$

Here the fuzzy hyperoperations satisfies the fuzzy idempotent, fuzzy commutative, fuzzy associative and fuzzy absorption laws of Fuzzy Hyperlattice.
Hence the dihybrid cross in Drosophila melanogaster is an application of Fuzzy Hyperlattice.

3.2. Application 2: The dihybrid cross in Pisum sativum

[3, 25, 7] As an extension to the work on monohybrid crosses Mendel crossed two different characteristics peas [7, 25]. For example:

$\mathbb{P}$: Tall; Round (TTRR genotype) $\otimes$ Short; Wrinkled(ttrr genotype)

↓

$\mathbb{F}_1$: All Tall; Round (TtRr genotype) and

$\mathbb{F}_1 \times \mathbb{F}_1$: Tall; Round (TtRr genotype) $\otimes$ Tall; Round (TtRr genotype)

↓

$\mathbb{F}_2$: Tall; Round (TTRR, TtRr, TtRR, TTRr genotypes) Short; Round (ttRR and ttRr genotypes) Tall; Wrinkled(TTrr and Ttrr genotypes) Short; Wrinkled (ttrr genotype)

Now, let us consider the Round and Tall by $\mathcal{P}$, Wrinkled and Tall by $\mathcal{Q}$, Round and Dwarf by $\mathcal{R}$, Wrinkled and Dwarf by $\mathcal{S}$. We have Table 2,

Table 2. A diagrammatic explanations of the dihybrid cross in Pisum sativum.

$\times$	$\mathcal{P}$	$\mathcal{Q}$	$\mathcal{R}$	$\mathcal{S}$
$\mathcal{P}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$
$\mathcal{Q}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{Q}$,$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{Q}$,$\mathcal{S}$
$\mathcal{R}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{R}$,$\mathcal{S}$	$\mathcal{R}$,$\mathcal{S}$
$\mathcal{S}$	$\mathcal{P}$,$\mathcal{Q}$,$\mathcal{R}$,$\mathcal{S}$	$\mathcal{Q}$,$\mathcal{S}$	$\mathcal{R}$,$\mathcal{S}$	$\mathcal{S}$

Let $\mathcal{L} = \{\mathcal{P}, \mathcal{Q}, \mathcal{R}, \mathcal{S}\}$. Here for all $\mathcal{M}, \mathcal{S} \in \mathcal{L}$, we define the fuzzy hyperoperations '$\oplus$' and '$\otimes$' by,
$\mathcal{M} \oplus \mathcal{S} = \chi_{\{\mathcal{M},\mathcal{S}\}}$ and
$\mathcal{M} \otimes \mathcal{S} = \chi_{\mathcal{L}}$
Here the fuzzy hyperoperations satisfies the fuzzy idempotent , fuzzy commutative , fuzzy associative and fuzzy absorption laws of fuzzy hyperlattice.
The dihybrid cross in Pisum sativum is an application of fuzzy hyperlattice.

3.3. Application 3: Particle physics

[4] In particle physics, a particle with no substructure are called as a fundamental particle or elementary particle, i.e. it is not made up of tiny particles and it is the building bricks of the universe (i.e.,) all the particles of the universe are made up of elementary particles. Some theories had been developed to explain the elementary particles and the interacting forces amidst them. Among which, the significant one is the Standard Model (SM) [11]. The Quarks, Leptons and Gauge bosons are the elementary particles in the SM.

Leptons: The significant part of the SM is leptons, particularly the electrons are the main components of atoms. Leptons are one of the major elementary particles because it can be found anywhere in the universe freely. In this paper we considered this particles only. The six types of leptons are as follows, the electron (e), electron neutrino (ν_e), muon (μ), muon neutrino (ν_μ), tau (τ) and tau neutrino (ν_τ). The corresponding antiparticle of each leptons are called as antileptons. The electronic leptons, the muonic leptons and the tauonic leptons are the first generation, second generation, third generation respectively.
Electronic Leptons: The electron (e), electron neutrino (ν_e) and their antiparticles, positron (e^+) and electron antineutrino $\bar{\nu_e}$ respectively.
Muonic Leptons: Muon (μ), muon neutrino (ν_μ) and their antiparticles, antimuon (μ^+) and muon antineutrino $\bar{\nu_\mu}$.
Tauonic Leptons: Tau (τ), tau neutrino (ν_τ) and their antiparticles, antitau (τ^+) and tau antineutrino $\bar{\nu_\tau}$.
Totally, the lepton group consists of 12 particles { e, ν_e, μ, ν_μ, τ, ν_τ , e^+, $\bar{\nu_e}$, μ^+, $\bar{\nu_\mu}$, τ^+, $\bar{\nu_\tau}$ } . In the leptons group, the electric charge Q of the electron, muon and tau is -1 and the neutrinos are neutral. By the definition of antiparticle, the electric charge Q of positron, antimuon and antitau is -1 but the antineutrinos are neutral . The interactions between the leptons are shown in the Figure 2.

$\otimes$	e	ν_e	e^+	$\bar{\nu}_e$	μ	ν_μ	μ^+	$\bar{\nu}_\mu$	τ	ν_τ	τ^+	$\bar{\nu}_\tau$
e	e	e, ν_e	L	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	e, μ	e, μ, ν_e, ν_μ	$e, \mu^+, \bar{\nu}_\mu, \nu_e$	$e, \bar{\nu}_\mu$	e, τ	e, τ, ν_e, ν_τ	$e, \tau^+, \bar{\nu}_\tau, \nu_e$	$e, \bar{\nu}_\tau$
ν_e	e, ν_e	ν_e	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	L	e, μ, ν_e, ν_μ	ν_e, ν_μ	μ^+, ν_e	$e, \mu^+, \bar{\nu}_\mu, \nu_e$	e, τ, ν_e, ν_τ	ν_e, ν_τ	τ^+, ν_e	$e, \tau^+, \bar{\nu}_\tau, \nu_e$
e^+	L	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	e^+	$e^+, \bar{\nu}_e$	$e^+, \mu, \bar{\nu}_e, \nu_\mu$	e^+, ν_μ	e^+, μ^+	$e^+, \mu^+, \bar{\nu}_e, \bar{\nu}_\mu$	$e^+, \tau, \bar{\nu}_e, \nu_\tau$	e^+, ν_τ	e^+, τ^+	$e^+, \tau^+, \bar{\nu}_e, \bar{\nu}_\tau$
$\bar{\nu}_e$	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	L	$e^+, \bar{\nu}_\mu$	$\bar{\nu}_e$	$\mu, \bar{\nu}_e$	$e^+, \mu, \bar{\nu}_e, \nu_\mu$	$e^+, \mu^+, \bar{\nu}_e, \bar{\nu}_\mu$	$\bar{\nu}_e, \bar{\nu}_\mu$	$\tau, \bar{\nu}_e$	$e^+, \tau, \bar{\nu}_e, \nu_\tau$	$e^+, \tau^+, \bar{\nu}_e, \bar{\nu}_\tau$	$\bar{\nu}_e, \bar{\nu}_\tau$
μ	e, μ	e, μ, ν_e, ν_μ	$e^+, \mu, \bar{\nu}_e, \nu_\mu$	$\mu, \bar{\nu}_e$	μ	μ, ν_μ	L	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	μ, τ	$\mu, \tau, \nu_\mu, \nu_\tau$	$\mu, \tau^+, \bar{\nu}_\tau, \nu_\mu$	$\mu, \bar{\nu}_\tau$
ν_μ	e, μ, ν_e, ν_μ	ν_e, ν_μ	e^+, ν_μ	$e^+, \mu, \bar{\nu}_e, \nu_\mu$	μ, ν_μ	ν_μ	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	L	$\mu, \tau, \nu_\mu, \nu_\tau$	ν_μ, ν_τ	τ^+, ν_μ	$\mu, \tau^+, \bar{\nu}_\tau, \nu_\mu$
μ^+	$e, \mu^+, \bar{\nu}_\mu, \nu_e$	μ^+, ν_e	e^+, μ^+	$e^+, \mu^+, \bar{\nu}_e, \bar{\nu}_\mu$	L	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	μ^+	$\mu^+, \bar{\nu}_\mu$	$\mu^+, \tau, \bar{\nu}_\mu, \nu_\tau$	μ^+, ν_τ	μ^+, τ^+	$\mu^+, \tau^+, \bar{\nu}_\mu, \bar{\nu}_\tau$
$\bar{\nu}_\mu$	$e, \bar{\nu}_\mu$	$e, \mu^+, \bar{\nu}_\mu, \nu_e$	$e^+, \mu^+, \bar{\nu}_e, \bar{\nu}_\mu$	$\bar{\nu}_e, \bar{\nu}_\mu$	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	L	$\bar{\nu}_\mu \mu^+$	$\bar{\nu}_\mu$	$\tau \bar{\nu}_\mu$	$\mu^+, \tau, \bar{\nu}_\mu, \nu_\tau$	$\mu^+, \tau^+, \bar{\nu}_\mu, \bar{\nu}_\tau$	$\bar{\nu}_\mu, \bar{\nu}_\tau$
τ	e, τ	e, τ, ν_e, ν_τ	$e^+, \tau, \bar{\nu}_e, \nu_\tau$	$\tau, \bar{\nu}_e$	μ, τ	$\mu, \tau, \nu_\mu, \nu_\tau$	$\mu^+, \tau, \bar{\nu}_\mu, \nu_\tau$	$\tau, \bar{\nu}_\mu$	τ	τ, ν_τ	L	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$
ν_τ	e, τ, ν_e, ν_τ	ν_e, ν_τ	e^+, ν_τ	$e^+, \tau, \bar{\nu}_e, \nu_\tau$	$\mu, \tau, \nu_\mu, \nu_\tau$	ν_μ, ν_τ	μ^+, ν_τ	$\mu^+, \tau, \bar{\nu}_\mu, \nu_\tau$	τ, ν_τ	ν_τ	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	L
τ^+	$e, \tau^+, \bar{\nu}_\tau, \nu_e$	τ^+, ν_e	e^+, τ^+	$e^+, \tau^+, \bar{\nu}_e, \bar{\nu}_\tau$	$\mu, \tau^+, \bar{\nu}_\tau, \nu_\mu$	τ^+, ν_μ	μ^+, τ^+	$\mu^+, \tau^+, \bar{\nu}_\mu, \bar{\nu}_\tau$	L	$e^+, \mu^+, \tau^+, \nu_e, \nu_\mu, \nu_\tau$	τ^+	$\tau^+, \bar{\nu}_\tau$
$\bar{\nu}_\tau$	$e, \bar{\nu}_\tau$	$e, \tau^+, \bar{\nu}_\tau, \nu_e$	$e^+, \tau^+, \bar{\nu}_e, \bar{\nu}_\tau$	$\bar{\nu}_e, \bar{\nu}_\tau$	$\mu, \bar{\nu}_\tau$	$\mu, \tau^+, \bar{\nu}_\tau, \nu_\mu$	$\mu^+, \tau^+, \bar{\nu}_\mu, \bar{\nu}_\tau$	$\bar{\nu}_\mu, \bar{\nu}_\tau$	$e, \mu, \tau, \bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	L	$\tau^+, \bar{\nu}_\tau$	$\bar{\nu}_\tau$

Figure 2. Diagrammatic representation of interactions between leptons.

Let $\mathcal{L}$= { e, ν_e, μ, ν_μ, τ, ν_τ , e^+, $\bar{\nu_e}$, μ^+, $\bar{\nu_\mu}$, τ^+, $\bar{\nu_\tau}$ }. Here for all $\mathcal{M}, \mathcal{S} \in \mathcal{L}$, we define the fuzzy hyperoperations '$\oplus$' and '$\otimes$' by,
$\mathcal{M} \oplus \mathcal{S} = \chi_{\{\mathcal{M},\mathcal{S}\}}$ and
$\mathcal{M} \otimes \mathcal{S} = \chi_{\mathcal{L}}$

Here the fuzzy hyperoperations satisfies the fuzzy idempotent, fuzzy commutative, fuzzy associative and fuzzy absorption laws of Fuzzy Hyperlattice.
Hence the interaction between leptons is an application of fuzzy hyperlattice.

4. Conclusions

In this manuscript we developed some real life applications of fuzzy hyperlattice. Several representations of fuzzy hyperlattice are proffered from different areas such as Biology and Physics (i.e) it is presented that the definition of fuzzy hyperlattice is exactly apt for the outcomes of dihybrid cross in Biology and the interactions between the leptons in Physics. In future, we will extend the theory of fuzzy hyperlattice in order to develop varieties of applications in various fields of Science.

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Conflict of interest

The authors declare that they have no conflict of interest.

References

1. P. Corsini, V. Leoreanu-Fotea, *Applications of hyperstructure theory*, Kluwer Dordrecht, 2003.
2. B. Davvaz, V. Leoreanu-Fotea, *Hyperring theory and applications*, International Academic Press, USA, 2007.
3. B. Davvaz, A. D. Nezhad, M. M. Heidari, Inheritance examples of algebraic hyperstructures, *Inf. Sci.*, **224** (2013), 180–187.
4. A. D. Nezhada, M. Nadjafikhahb, S. M. Moosavi Nejadc, B. Davvaz, The algebraic hyperstructure of elementary particles in physical theory, *Indian J. Phys.*, **86** (2012), 1027–1032. DOI: 10.1007/s12648-012-0151-x.
5. G. Birkhoff, Lattice Ordered Grou, *Annals Math., Second Series*, **43** (1942), 298–331.
6. X. Z. Guo, X. L. Xin, Hyperlattices, *Pure Appl. Math.*, **20** (2004), 40–43.
7. D. L. Hartl, E. W. Jones, *Genetics: Principles and Analysis*, Jones and Bartlett Publishers, 1998.

8. M. Konstantinidou, J. Mittas, An introduction to the theory of hyperlattices, *Math. Balkanica.*, **7** (1977), 187–193.
9. A. D. Lokhande, A. B. Gangadhara, J. A. Ansari, Characterizations of Prime and Minimal Prime Ideals of Hyperlattices, *Int. J. Recent Innovation Trends Comput. Commun.*, **5**(2017), 532–548.
10. F. Marty, *Sur une generalisation de la notion de groupe*, 8th congres des Mathematiciens Scandinaves, (1934), 45–49.
11. T. Muta, Foundations of quantum chromodynamics, *Second edition, World Sci. Lect. Notes Phys.*, **57** (1998).
12. P. He, X. Xin, J. Zhan, On rough hyperideals in hyperlattices, *J. Appl. Math.*, (2013), Article ID 915217.
13. P. He, X. Xin, Fuzzy hyperlattices, *Comput. Math. Appl.*, **62** (2011), 4682–4690.
14. D. Preethi, J. Vimala, B. Davvaz, S. Rajareega, Biological inheritance on fuzzy hyperlattice ordered group, *J. Intell. Fuzzy Syst.*, **38** (2020), 6457–6464. DOI: 10.3233/JIFS-179726.
15. D. Preethi, J. Vimala, S. Rajareega, Some properties on fuzzy hyperlattice ordered group, *Int. J. Adv. Sci. Technol.*, **28** (2020), 124–132.
16. S. Rajareega, J. Vimala, D. Preethi, Complex intuitionistic fuzzy soft lattice ordered group and its weighted distance measures, *Mathematics*, **8** (2020).
17. S. Rasouli, B. Davvaz, Lattices derived from hyperlattices, *Commun. Algebra.*, **38** (2010), 2720–2737.
18. S. Rasouli, B. Davvaz, Construction and spectral topology on hyperlattices, *Mediterr. J. Math.*, **7** (2010), 249–262.
19. M. K. Sen, R. Ameri, G. Chowdhury, Fuzzy hypersemigroups, *Soft. Comput.*, **12** (2008), 891–900.
20. A. S. Lashkenari, B. Davvaz, Ordered Join Hyperlattices, *U.P.B. Sci. Bull., Series A.*, **78** (2016).
21. M. AI-Tahan, B. Davvaz, Fuzzy subsets of the phenotypes of F2-offspring, *FACTA UNIVERSITATIS (NIS) Ser. Math. Inform.*, **34** (2016).
22. M. AI-Tahan, B. Davvaz, A new relationship between intuitionistic fuzzy sets and genetics, *J. Classif. (Springer).*, **36** (2019), 494–512.
23. M. AI-Tahan, B. Davvaz, Algebraic hyperstructures associated to Biological inheritance, *Math. Biosci., Elsevier.*, **285**(2017), 112–118.
24. M. AI-Tahan, B. Davvaz, n-ary hyperstructures associated to the genotypes of F2-offspring, *Int. J. Biomath.*, **10** (2017).
25. R. H. Tamarin, *Principles of Genetics*, 7Eds., The McGraw-Hill Companies, 2001.
26. I. Tofan, A. C. Volf, On some connections between hyperstructures and fuzzy sets, *Ital. J. Pure Appl. Math.*, **7** (2000), 63–68.
27. J. Vimala, Fuzzy lattice ordered group, *Int. J. Sci. Eng. Res.*, **5** (2014).
28. Y. Q. Yin, J. M. Zhang, D. H. Xu, J. Y. Wang, The L-fuzzy hypermodules, *Comput. Math. Appl.*, **59** (2010), 953–963.
29. L. A. Zadeh, Fuzzy sets, *Inf. Control.*, **8** (1965), 338–353.