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КОНЦЕПЦИЯ ТЕХНОЛОГИЧНОСТИ АРХИТЕКТУРНОЙ СИСТЕМЫ И СПОСОБ 
РАСШИРЕНИЯ ВОЗМОЖНОСТЕЙ АРХИТЕКТУРНОЙ КОМПОЗИЦИИ

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THE CONCEPT OF TECHNOLOGICAL EFFECTIVENESS OF AN ARCHITECTURAL SYSTEM 
AND A WAY TO EXPAND THE CAPABILITIES OF AN ARCHITECTURAL COMPOSITION

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Architecture of buildings and structures. Creative concepts of architectural activity
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Аннотация. Введение: в основу исследований положена научная гипотеза о роли и значимости свойства технологичности для создания эффективных архитектурных систем. Предметом исследований являются особенности взаимодействия технологичности с основными составляющими композиции (функциональной, конструктивной, художственно-эстетической) архитектурных образов, рассмотренные для некоторых этапов исторического, технологического развития. Актуальность исследований связана с оценкой перспектив влияния технологичности на развитие направлений, связанных с использованием инновационных приёмов архитектурной деятельности.

Материалы и методы: методы системного анализа, предназначенные для анализа особенностей взаимодействия составляющих композиции архитектурного образа. Теоретический анализ организации учета влияния технологичности на свойства целостной композиционной системы включает: методы анализа сущности процессов разработки композиционных решений, разработку гипотезы исследования, анализ и обобщение результатов исследований, формулирование выводов.

Результаты: в результате проведенных исследований рассмотрены особенности взаимодействия основных структурных составляющих в составе композиции (композиционного решения) архитектурного образа. Показаны возможности системного анализа для выявления связей между элементами (составляющими) системы и установления их влияния на состояние системы (композиции) в целом. Приведен понятийный аппарат категорий, структура и состав архитектурной композиции. Подтверждено значение композиции, как традиционного творческого инструмента, который применяется для создания объектов материальной культуры и пространственного наполнения архитектурных образов. Рассмотрены особенности основных средств и приемов формирования объемно-пространственной структуры, как основного фактора обеспечения единства функционального содержания и формы архитектурного объекта. Дана характеристика составляющей технологичности и определен характер взаимодействия между основными составляющими композиционных решений объектов пространственной среды. Отмечено, что применение перспективных приемов технологичности способствуют расширению возможностей (приемов и средств) объемно-пространственной композиции.

Выводы: В исследовании рассмотрены роль и значение основных составляющих композиции, которые целесообразно дополнить свойством технологичности для расширения возможностей (средств, приемов) формирования эффективных архитектурных систем.

Abstract. Introduction: this research is based on the scientific hypothesis about role and importance property of the manufacturability for creating effective architectural systems. The subject of this research is the features at interaction of manufacturability with the main components composition (functional, constructive, artistic and aesthetic) architectural images, considered for some stages of historical, technological development. The relevance of this research is associated with assessing the prospects for the impact manufacturability on the development at areas related to the use innovative techniques in architectural activity.

Materials and methods: system analysis methods designed to analyze the characteristics at the interaction of components composition at the architectural image. A theoretical analysis at the organization of the influence manufacturability on the properties a holistic compositional system includes: methods for analyzing the processes developing composite solutions, developing a research hypothesis, analyzing and summarizing research results, formulating conclusions.

Results: As a result of this research are considered the features interaction of the main structural components in the composition (compositional solution) for the architectural image. The capabilities at system analysis are shown to identify the relationships between elements (components) in the system and establish their influence on the state of the system (composition), as a whole. Are given the conceptual apparatus of categories, the structure
Композиция (от латинского: «compositio» — «составлять», «располагать взаимно части», «сочетать разнородные компоненты») одновременно обозначает: и творческий процесс в развитии и некоторый, промежуточный результат процесса в любой момент времени, как по отношению к объекту, так и к отдельным его компонентам.

Этимология слова (термина) «композиция» обозначает мотивированное действие, процесс, трансформацию состояния объекта, вплоть до формирования характерных признаков, указывающих на достижение устойчивого и гармоничного взаимодействия с условиями среды. Каждая из возможных итераций (стадий) композиции характеризуется частным и разнородным составом приоритетов (например, художственно-образных, функциональных, экономических), ориентированных на последовательную реализацию целостной композиционной задачи [1,2,3].

Архитектурная композиция характеризуется присутствием основного закона и использованием специфических категорий (главных и второстепенных, например: объемно-пространственная структура, гармония, пропорция, масштаб), которые характеризуют основные особенности и признаки, связанные с формированием и функционированием архитектурного объекта (Рисунок 1).
Использование общих понятий и основных категорий архитектурной композиции, как традиционного творческого инструмента, который применяется для создания объектов материальной культуры и пространственного наполнения архитектурных образов, характеризуется широким диапазоном географического, исторического и типологического масштабов [4,5,6,7,8].

Творческое и осмысленное следование определенным закономерностям на основе количественных изменений пространственных форм и их сочетаний (выраженных в показательных категориях, например: величина, вес, масса, положение в пространстве, пропорции) позволяет отобразить художественно-эстетическую и выразительность заданной объемно-пространственной композиции архитектурного образа.

Теория архитектурной композиции характеризуется присутствием многочисленных и разнообразных средств и приёмов формирования объемно-пространственной структуры, как основного фактора обеспечения единства функционального содержания и формы архитектурного объекта. Средства и приемы объемно-пространственной композиции необходимо рассматривать в качестве носителей определенной содержательности, которые, взаимодействуя между собой в композиционном процессе, формируют свойства архитектурного объекта [9,10,11,12].

Традиционный формат архитектурной композиции (в различных своих видах) также подразумевает следование основополагающему (традиционному) канону архитектуры, несмотря на то обстоятельство, что в формуле Витрувия («цель ↔ прочность ↔ красота») предполагается взаимодействие достаточно противоречивых составляющих (формально рассматриваемых, из условий их равновесной значимости, несмотря на принятую последовательность их реализации) [13,14,15,16].

Под термином «технологичность» рассматриваются целенаправленные действия (приёмы), направленные на обработку исходных природных материалов, искусственных изделий и конструкций (материальных ресурсов) посредством профильных исполнителей (труда), с применением определенных средств механизации (технических ресурсов). Теоретический и практический опыт формирования архитектурных образов, отображённых в соответствующих строительных объектах различных исторических (цивилизационных) состояний, сопровождается развитием свойства технологичности [5,13,17,18].

Под технологичностью архитектурного образа (или технологичностью условий формирования целостной композиции архитектурного образа) подразумевается отображение параметров функционально-технологических процессов (объемно-планировочных решений), конструктивных и художественных решений посредством рациональных технологических приемов (для всех этапов строительного производства), с учетом особенностей состояния и доступности материальных и нематериальных ресурсов [19,20,21,22,23].

Гармония функциональной назначения и технологической составляющих архитектурной композиции достигается преодолением определенных противоречий между технологическими возможностями определенного вида архитектурной системы и способом организации взаимодействия структурных пространственных элементов (например: групп помещений и/или технологических зон).

**ЗАКЛЮЧЕНИЕ И ОБСУЖДЕНИЕ**

Генезис архитектурного пространства представляет, как форму природно-экологической, территориально-пространственной, композиционно-стилистической, функционально-градостроительной и строительно-технологической целостности архитектурной среды.

Традиционная методика приоритетной мотивации художественно-образного мышления архитектора, сопровождающая канонический подход к разработке проектных (композиционных) решений в значительной мере неоправданно снижает современную значимость такого фактора влияния, как технологичность (технологическая составляющая) архитектурной системы. Применение принципа единства технологичности с основными структурными элементами архитектурной композиции представляет интерес, как для традиционных, так и для нетрадиционных приемов формирования архитектурных образов. Перспективные приемы технологичности способны значительно расширить возможности архитектурного творчества (при сохранении канонического подхода к архитектурной композиции) для формирования высокого уровня качества для известных видов строительной продукции и принципиально новых архитектурных систем.

**ЛИТЕРАТУРА**

REFERENCES


ФИЗИКО-МАТЕМАТИЧЕСКИЕ НАУКИ

УДК 004.9

ИНФОРМАЦИОННЫЕ МАССИВЫ БОЛЬШИХ ДАННЫХ В ДЕЯТЕЛЬНОСТИ УПОЛНОМОЧЕННОГО ПО ПРАВАМ ЧЕЛОВЕКА В РОССИЙСКОЙ ФЕДЕРАЦИИ

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«Россия должна стать не только ключевым логистическим, транспортным узлом планеты, но и одним из мировых центров хранения, обработки, передачи и надежной защиты информационных массивов, так называемых больших данных.

Введение. Большие информационные данные
12 сентября 2019 года во Владивостоке состоялось расширенное заседание Координационного совета Уполномоченных по правам человека, посвященное вопросам защиты прав граждан на безопасную окружающую среду. В интервью телеканалу «Восток24» Уполномоченный по правам человека в Российской Федерации Т.Н. Москалькова на один из вопросов дала очень обстоятельный ответ [2]:

- Татьяна Николаевна, почти чуть более 38 тысяч обращений в прошлом году было направлено в Ваш институт. Каков процент обращений от дальневосточников, есть ли какая-нибудь региональная специфика, поскольку страна у нас большая и проблемы у людей, наверняка, разные?
- Всего ко всем региональным Уполномоченным поступило в прошлом году около 200 тысяч обращений. К нам приходит те люди, которые уже прошли и прокуратуру и судебные органы и другие инстанции и обращаются к нам, как к органу, который может усилить дополнительные аргументы, вступить в диалог с органами власти и помочь человеку восстановить нарушенное право.

В работе [3] автор данной статьи обратил внимание читателей на информационно-математическую особенность ответа Т.Н. Москальковой:

«Примечание 4. В течение 2018 года Уполномоченным по правам человека в Российской Федерации и всем его региональным коллегам в совокупности поступило примерно двести сорок тысяч обращений».

В самом деле, информационный массив больших данных емкостью 240 000 единиц может стать источником создания другого массива, который как минимум в 1,5-2 раза больше – массива запросов в различные инстанции от Уполномоченного по правам человека в Российской Федерации и его региональных коллег. «Большие данные» (англ. big data) - обозначение структурированных и неструктурированных данных огромных объёмов и значительного многообразия, эффективно обрабатываемых горизонтально масштабируемыми программными инструментами, появившимись в конце 2000-х годов и альтернативных традиционным системам управления базами данных и решениям класса Business Intelligence.

В широком смысле о «больших данных» говорят как о социально-экономическом феномене, связанном с появлением технологических возможностей анализировать огромные массивы данных» – из Википедии.

Профессиональное общение
Вслед за авторами книги [4, Введение: с. XIV-XV] выделим обстоятельства, которые делают разработку требований к анализу больших данных и соответствующему программному обеспечению (далее ПО) делом важным и уместным:

«Многие из тех, кто работает в области ПО, слишком увлечены техническими и процессными решениями наших задач. Мы иногда забываем, что выявление требований – и большая часть работы в проектах разработки ПО и систем вообще – основаны в первую очередь на взаимодействии людей. Разработка ПО включает по крайней мере столько же общения, сколько и обычая работа с компьютером, но зачастую мы делаем акцент на работе с компьютером и не уделяем достаточно внимания общению».

Организация общения - источники информации
Диссертационные работы на соискание ученых степеней кандидата и доктора наук В российской юридической науке проблемы государственной системы защиты основных прав и свобод человека и гражданина, в том числе институтов Уполномоченного по правам человека
в Российской Федерации и его региональных коллег, как одних из ее элементов, относятся к числу наиболее широко изученных [5, 6]:

Теоретическую основу исследований составляют труды зарубежных и российских ученых-правоведов по вопросам прав человека, проблемам деятельности государственных органов, правового статуса социальных институтов. Это работы: М.М. Абдулаева, С.А. Авакьян, А.С. Автономова, А. Азоларова, С.С. Алексеева, Х.–Р. Альваро, М.В. Баглая, С.В. Бендюдорная, Н. С. Бондарь, Н.А. Богдановой, А.С. Бурмистрова, А.Б. Венгерова, Н.В. Витрука, Л.Д. Воеводина, С. И. Глушковой, А.В. Деменевой, В.О. Лучина, А.Ю. Сунгурова, В.М. Сырых, Ю.А. Тихомирова, Б.Н. Шабо и многих других.

Изучением механизма защиты прав и свобод человека и гражданина занимаются ученые в различных отраслях права. В отечественной литературе «Российский омбудсмен вызывает постоянный растущий интерес со стороны научного сообщества и общественности, наблюдается увеличение числа граждан, получивших поддержку и действенную помощь в борьбе за свои нарушенные права именно в этом государственном органе. Только за последние четыре года (диссертация защищена в 2013 году - прим. О.В. Адмаев) по 2009 по 2012 гг. уполномоченному по правам человека в Российской Федерации поступило более 110 тысяч жалоб, по большей части которых либо удалось добиться восстановления прав заявителей, либо были предложены пути разрешения проблемы с подробными разъяснениями [5]».

Научно-исследовательские издания. Бюллетень Уполномоченного по правам человека в Российской Федерации

В статье «Институт Уполномоченного по правам человека в Российской Федерации: вчера, сегодня, завтра» Уполномоченный по правам человека в Российской Федерации Т.Н. Москалькова ведет общение с читателями о перспективах руководимого ею учреждения. Она постоянно присутствует в деятельности Уполномоченного по правам человека в Российской Федерации и его региональных коллег.

Данные обстоятельства особо отмечены диссертантами в своих работах (выделено мною – О.В. Адмаев):

Таблица 1

Настоящее время (2009 год – прим. О.В. Адмаев) институт Уполномоченного по правам человека существует как на уровне Российской Федерации, так и в 50 субъектах Федерации. Накоплен определенный опыт функционирования данного института, его взаимодействия с другими федеральными и региональными государственными органами в процессе защиты прав и свобод человека и гражданина, что актуализирует необходимость осуществления не только теоретических исследований института омбудсмена, но и осмысления практических результатов деятельности Уполномоченных по правам человека в субъектах Российской Федерации [6].

Наиболее значительное количество жалоб поступает по вопросам уголовно-исполнительного производства, установления и приобретения гражданства, выдворения иностранных граждан и выездного удостоверения, лиц без гражданства, что указанный период поступило 10 939 жалоб (на 58,7% больше, чем за аналогичный период 2015 г.). На втором месте по количеству жалоб — нарушение жилищных прав и прав в сфере ЖКХ, поступило 6068 жалоб (на 53,5% больше, чем за аналогичный период 2015 г.). На третьем месте — нарушения прав в сфере уголовно-исполнительного производства, поступило 3013 жалоб (на 7,1% меньше, чем за аналогичный период 2015 г.).

Ежегодно значительное количество жалоб поступает по вопросам трудового законодательства, в 2016 г. их число увеличилось на 10%. В наибольшей степени увеличилось число обращений на нарушения миграционного законодательства (на 71,1%), приобретение гражданства (с 471 в 2015 г. до 967 в 2016 г.) и на 33% — количество жалоб, связанных с выдворением иностранных граждан за пределы РФ (с 156 в 2015 г. до 208 в 2016 г.).

Анализ этих статистических данных ставит проблему о выработке понимания, какие
индикаторы, критерии должны применяться при оценке эффективности государственной защиты прав и свобод человека и гражданина.

Зачастую в качестве таких критериев предлагаются масштабы и характер жалоб на нарушения прав; статистика дел, рассматриваемых судами; статистика мер прокурорского реагирования; доступность субъективного права, которая выражается в обеспечении возможности соответствующее право осуществить.

Число обращений, поступивших в компетентные органы, результаты социологических исследований, анализ информации о соблюдении прав человека из официальных источников позволяют получить представление о картине соблюдения прав человека, однако отсутствие единого алгоритма обобщения и анализа полученных данных, а также неоднозначность статистических показателей зачастую не позволяют дать ситуацию с правами человека универсальную оценку».

Доклады Уполномоченного по правам человека в Российской Федерации и его региональных коллег

В соответствии с Докладом Уполномоченного по правам человека в Российской Федерации за 2019 год [8] выделим четыре важных социально-значимых направления деятельности федерального омбудсмена (Табл. 2):

<table>
<thead>
<tr>
<th>№№</th>
<th>Направление деятельности</th>
<th>Количество обращений</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Пенитенциарная система: исполнение наказаний, реабилитация</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Создание рабочих мест для инвалидов и граждан с ограниченными возможностями здоровья</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Соблюдение трудовых прав иностранных граждан</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Соблюдение трудовых прав выпускников профессиональных образовательных организаций и образовательных организаций высшего образования</td>
<td></td>
</tr>
</tbody>
</table>

Необходимо согласиться с мнением Татьяны Николаевны – заполнение каждой открытой ячейки в строке-массиве «Количество обращений» для каждого столбца Таблицы 2 потребует привлечения различных математических дисциплин, в частности, теории множеств, поскольку принятое в Докладах группирование обращений в соответствии с нарушениями соответствующих прав граждан несет в себе пересечение, а в некоторых случаях, возможно, и объединение близких по содержанию обращений для рассматриваемых четырех направлений деятельности.

Сайт «Правозащитная карта России»

«Правозащитная карта России» является приложением к ежегодному Докладу Уполномоченного по правам человека в Российской Федерации с 2016 года и представляет собой программный продукт информационно-просветительского характера [9].

Карта размещена на официальном сайте Уполномоченного в сети Интернет по адресу http://map.rightsrf.ru/ и содержит консолидированную базу данных, объединившую статистические сведения, результаты социологических опросов, сведения о деятельности уполномоченных по правам человека в субъектах Российской Федерации, тексты и перечни нормативных правовых актов Российской Федерации и ее субъектов, которые регламентируют деятельность в области государственной защиты прав человека.

С большим интересом автор данной статьи ознакомился с Библиотекой Уполномоченного по правам человека в Российской Федерации. Например, права инвалидов постоянно находятся в сфере внимания правозащитного сообщества [10].
По словам федерального омбудсмена, «за последнее время в России принят целый ряд мер системного характера, направленных на защиту прав женщин, утверждена Национальная стратегия действий в интересах женщин на 2017–2022 годы».

«Необходимо создать специальные стандарты прав женщин, попавших в места лишения свободы», — это предложение красной нитью прошло через всё выступление Уполномоченного.

«Мне хотелось бы обратить внимание на то, что у нас нет сегодня специальных стандартов прав и свобод женщин, попавших в места лишения свободы. В этом контексте речь идёт не о гендерном равенстве, а о особых преференциях женщинам, поскольку они являются матерями», — подчеркнула Татьяна Москалькова.

Уполномоченный также убеждена, что женщину должны отпускать к ребёнку вне колонии при условии ее положительной характеристики, а в институте помилования для женщин нужно создать реальные гарантии и стандарты ресоциализации.

На одном из ключевых мероприятий Второго евразийского женского форума - заседании «Женской двадцатки», которое впервые проходит в нашей стране, ключевыми темами стали сокращение разрыва между мужчинами и женщинами на глобальном рынке труда; вопросы борьбы против дискриминации женщин; повышение роли женщин в политике, экономике и других аспектах жизни общества. Нам есть чему поучиться у зарубежных коллег, но и есть о чём рассказать: за последнее десятилетия женщины в нашей стране стали весомой политической и экономической силой, а их вклад в защиту прав человека и совершенствование институтов гражданского общества - просто бессилен.

Задачи Уполномоченного по правам человека в Российской Федерации:
Право на благоприятную окружающую среду
Один из номеров Бюллетеня Уполномоченного по правам человека в Российской Федерации - №2–2017 посвящен экологическим проблемам.

Уполномоченный по правам человека в Новосибирской области Н.Н. Шалабаева предлагает привлечь к анализу экологической ситуации в регионе всех участников экологического процесса [11]:
«Следовательно, для решения этого (экологического – прим. О.В. Адмаев) вопроса необходима скоординированная позиция федеральных органов государственной власти в области благополучия человека, охраны окружающей среды и органов государственной власти Новосибирской области».

Из информации, представленной в статье Н.Н. Шалабаевой, сформируем Таблицу 3:
Уполномоченным по правам человека в Новосибирской области было рассмотрено 30 обращений граждан о нарушении их прав в экологической сфере.

В проценном исчислении от общего числа обращений граждан составляет 1,3%.

В департамент природных ресурсов и охраны окружающей среды Новосибирской области поступило 637 обращений граждан, проживающих в области, о нарушении их прав на благоприятную окружающую среду.

Из общего числа поступивших обращений было выявлено 92 нарушения в экологической сфере.

По данным Роспотребнадзора, в 2016 г. поступило 115 обращений от граждан, проживающих в области, о нарушении благоприятной окружающей среды, из которых 67 обращений от жителей города Новосибирска, 48 - от жителей области.

По информации Управления Федеральной службы судебных приставов по Новосибирской области, за 2016 г. в структурных подразделениях управления возбуждено 36 исполнительных производств в экологической сфере об обязании устранения нарушений в сфере природопользования и охраны окружающей среды.

По сведениям региональных управлений Росприроднадзора известны основные виды нарушений: сброс в водные объекты неочищенных и необезвреженных сточных вод; самовольное размещение хозяйственных объектов, влияющих на состояние водных объектов, без согласования; нарушение режима использования земельных участков в пределах водоохранных зон и прибрежных защитных полос; выброс вредных (загрязняющих) веществ в атмосферный воздух без специального разрешения.

Каждое нарушение есть элемент информационного массива больших данных.

**Обработка информационных массивов больших данных**

**Пример 1.** Расчет различных характеристик, например, плотности населения с помощью языков программирования высокого уровня и использованием методов, изложенных в специализированной литературе [12-15].

<table>
<thead>
<tr>
<th>№</th>
<th>Регион</th>
<th>Население (чел)</th>
<th>Площадь (кв. км)</th>
<th>Плотность (чел/кв.км) (расчет Способ 1)</th>
<th>Плотность (чел/кв.км) (расчет Способ 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Республика Алтай</td>
<td>218866</td>
<td>92903</td>
<td>2,36</td>
<td>2,355855032</td>
</tr>
<tr>
<td>2</td>
<td>Республика Тыва</td>
<td>324423</td>
<td>168604</td>
<td>1,92</td>
<td>1,924171431</td>
</tr>
<tr>
<td>3</td>
<td>Республика Хакасия</td>
<td>536167</td>
<td>61569</td>
<td>8,71</td>
<td>8,70839221</td>
</tr>
<tr>
<td>4</td>
<td>Алтайский край</td>
<td>2332813</td>
<td>167996</td>
<td>13,89</td>
<td>13,88612229</td>
</tr>
<tr>
<td>5</td>
<td>Красноярский край</td>
<td>2874026</td>
<td>2366797</td>
<td>1,21</td>
<td>1,214310311</td>
</tr>
<tr>
<td>6</td>
<td>Иркутская область</td>
<td>2397763</td>
<td>774846</td>
<td>3,09</td>
<td>3,09450265</td>
</tr>
<tr>
<td>7</td>
<td>Кемеровская область</td>
<td>2674256</td>
<td>95725</td>
<td>27,94</td>
<td>27,9368608</td>
</tr>
<tr>
<td>8</td>
<td>Новосибирская область</td>
<td>2793384</td>
<td>177756</td>
<td>15,71</td>
<td>15,71471005</td>
</tr>
<tr>
<td>9</td>
<td>Омская область</td>
<td>1944195</td>
<td>141140</td>
<td>13,77</td>
<td>13,77493978</td>
</tr>
<tr>
<td>10</td>
<td>Томская область</td>
<td>1077442</td>
<td>314391</td>
<td>3,43</td>
<td>3,427076475</td>
</tr>
</tbody>
</table>
Пример 2. Численность безработных в России в возрасте 15-72 лет в Сибирском федеральном округе, тысяч человек.

Рис. 3. Сибирский федеральный округ

Пример 3. Красноярская городская агломерация
Уполномоченный по правам человека в Красноярском крае также работает с информационными массивами больших данных. Экономическое содержание проекта «Красноярская городская агломерация» [3] можно дополнить очень важной общественно-значимой гуманитарной составляющей - проведение Конкурса профессионального мастерства среди представленных категорий граждан по актуальным проблемам - например, представляется очень важной тема «Экология Красноярска и Красноярского края». Необходимы задания, выбор участников из различных образовательных организаций Красноярской городской агломерации, базовых предприятий, на которых можно проводить предварительные этапы Конкурса, методическое обоснование проекта [16-19]. Одним из примеров базового предприятия может стать агропромышленный комплекс Красноярского края [20]. Выбраные направления деятельности (Табл. 2) представлены на Рис. 4 в качестве внутренних слотов фрейма «Паллиативная помощь – важнейшая задача».
Выводы

Можно не сомневаться, что поставленные Президентом Российской Федерации В.В. Путиным задачи будут решены в полной мере, и мы все при этом будем постоянно учиться доброте у своих предшественников, как отечественных, так и зарубежных.

Список литературы:
GEOPHYSICS OF ENTANGLED STATES OF THE COVID-19 PANDEMIC AND QUANTUM TELEPORTATION OF SARS COV-2 IN THE PLANET’S BIOGEOSPHERE

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Abstract. In their previous works, leading their history since 1988, the authors of this article have repeatedly conceptually shown and experimentally verified the results of research on the teleportation of information between macro objects. Early author's works were performed during the existence of the Russian Federation – as a country called the Union of Soviet Socialist Republics (USSR). Some of which were marked "Top Secret" - links further down the text. Since they were performed under the supervision of the relevant special services and further "Department of external relations of the Russian Federation". The authors used numerous examples to demonstrate the possibility of teleportation of information in macro-systems, including ecosystem, biogeocenotic levels, and then tissue and organism levels. Successful experimental verifications occurred only in cases when all the principles and rules laid down in the theory of quantum information, applied to biological objects, were correctly combined. Namely, the preparation of cascades of entangled States was performed both on the mental and somatic levels. In full accordance with the principle of complementarity and taking into account the fact that the observer and the observed are actively connected by the sum of similarities. In addition, the role of the classical communication channel in this process was performed by carrier electromagnetic fields modulated by a useful signal. This signal represented a cast of the simulated experimental process. An example of a real COVID-19 pandemic is the verification of author's works in nature on a biogeocenotic scale. And certainly with anthropogenic – so to speak-participation.

Keywords: CoViD-19 pandemic, quantum teleportation, quantum non-locality, macroscopic entanglement, standing waves of Schumann resonances, Louis de Broglie waves, quantum theory of gravity, evolution.
INTRODUCTION
In this article, the authors would like to consider the mechanisms of quantum teleportation at the mesoscopic level in macrosystems, using the example of quantum-wave mechanisms of the evolution of the CoViD-19 pandemic, in the form of the SARS-CoV-2 (2019-nCoV) coronavirus in 2020. In fact, it implies a certain information exchange in the planet's biogeosphere [1 – 16]. In their previous works on the study of quantum information teleportation between macroscopic objects and systems [17 – 61], the authors considered both the mechanisms of such interaction at the level of natural biogeocenoses [17 – 19], and some issues related to the study of processes based on new physical principles of action [50 – 61]. Early author's works [17 – 19] were performed during the existence of the Russian Federation – as a country called the Union of Soviet Socialist Republics (USSR). And were marked "Top Secret" [18, 19]. And in an obvious natural-like form, mechanisms based on new physical principles are shown in [53] exactly as it could occur naturally when biological objects interact with each other and the environment [7, 8, 9, 53, 65 – 68, 78] within the framework of biogeocenotic relationships in ecosystems. The authors would also like to emphasize that this article was written as an urgent and timely commentary on the work [87] and was created on its motives. It should also be noted that this work is not about the CoViD-19 pandemic, in the personification of the SARS-CoV-2 coronavirus. This work is about the mechanisms of possible quantum – wave nonlocal nature of the processes of interaction between material bodies and biological objects.

In fact, this article should be considered as a note on possible quantum-wave mechanisms of evolution, both in the general sense and in particular cases of pandemics and nosological forms. And within this note - on the example of the CoViD-19 pandemic of the severe acute respiratory syndrome coronavirus (SARS-CoV-2/2019-nCoV). The authors are not inclined to talk about the criteria of natural selection. These criteria are unknown to us. We can assume only one thing: the steps of natural selection seem to have some nano-, bio-, info-, cogno - (NBIC) format. Therefore, this article is legitimate only as a sum of assumptions based on the sum of previous publications [17 – 61; biogeocenotic and ecosystem levels [17 – 19], physical and technical aspects [20 – 47, 51 – 61], based on new physical principles of action, as well as some synthesis of all previous meanings [49 – 51].

MAIN CONTENT
So: in some favorable electromagnetic environment, which is the natural geomagnetic background of the planet, there is a phenomenon of formation of standing waves with a frequency \( f = 7.83 \text{ Hz} \), as well as their harmonics at frequencies \( \sim 14, 20, 26, 32 \text{ Hz} \) between the earth's surface and the ionosphere. These are the so-called Schumann resonances [79 – 81], which are, apparently, nothing more than a natural "laboratory" for the preparation and preservation of entangled states where information is present in a non-local and collapsed form that makes up the entire possible completeness of SARS-CoV-2 coronavirus manifestations in groups of events based on the nosological form of CoViD-19 pandemic. The manifestation in a variety of clinical forms of the picture of coronavirus disease is the localization and deployment of the quantum picture on the "screen" of the world of classical objects. Just as the information that was originally recorded in a non-local, collapsed form on a solid-state drive is localized and deployed on a computer monitor. In parallel to the electromagnetic field of standing waves (Schumann resonances*-fermion source), there is soft x-ray radiation, which is a carrier of Louis de Broglie waves [82 – 85], as a source of bosons, which are a component of the natural version of the flow of unlikely events, assuming a certain interaction of biological objects with the environment, a quantum leap of events of some small probability to events that are statistically more reliable [48, 49, 87].

The waves of Louis de Broglie can be with different individual information loads apparently. It is a complete set of CoViD-19 manifestations in this case. The SARS-CoV-2 (2019-nCoV) coronavirus appears to be a virus of the NBIC format generation. However, a non-local information pool will appear as a disease with a certain clinical picture and accept classic features only under certain conditions of interaction of a biological object with the surrounding environment. We don't know what the terms of this interaction are.

Therefore, the recommendations of a quarantine nature seem very logical in order to exclude the possible decoherence of undefined states, which, in fact, determine a certain modality, the timbre of these possible premorbid states - from the determinative adverb "almost". Decoherence will lead to the collapse of the wave function and the transition of the quantum system "biological object-external environment" to one of the eigenvalues of the probability density matrix for the flow of events. Some variants of physical and technical implementation of these natural mechanisms are considered in [50-61, 69]. A certain nature-like model based on new physical principles of action is shown by us in [53].

* Note: the Earth and its ionosphere is a giant spherical resonator, the cavity of which is filled with an electrically conducting medium. If the electromagnetic wave that has appeared in this environment after rounding the globe again coincides with its own phase (enters into resonance), then it can exist for a long time.

The basis, or main, for these resonances is a wave with a frequency of 7.83 Hz (cycles per second), which is a standing wave in the resonator between the ionosphere and the Earth. Since this rhythmic pattern lies within human brain ranges, various authors have suggested that this aspect of the earth's electromagnetic field may act as a kind of global mind... [https://skladchik.com/threads/Resonance-Schumann-Pulse-Earth-full-upgrade-improved-version.177416/].

The authors believe that this article was written as an urgent and timely commentary on the work [88] and was created on its motives. It should also be noted that this work is not about the CoViD-19 pandemic, in the personification of the SARS-CoV-2 coronavirus, but
about the mechanisms of the possible quantum–wave nonlocal nature of natural selection processes on the example of current events.

The authors are planning to publish a paper in the near future that shows the possibility of technical implementation of the described mechanisms on the example of the functioning of a nature-like laboratory model, based on research conducted earlier in [17 – 61].

A VARIANT OF IMPLEMENTING SOME THERAPEUTIC EFFECT - BASED ON THE MATERIALS [51 – 61]

The principle of organizing a certain therapeutic effect in the variant presented in Fig. 1 is implemented as follows. The subject (1) (in this case, the patient) is placed inside a device similar to a magnetic resonance imaging (MRI) machine (2). An installation like a tomograph is needed to create a favorable electromagnetic environment that simulates the natural geomagnetic background of the planet in the combination of Schumann resonances, Louis de Broglie waves (soft x-ray – in the range of 0.1 to 10^{-10} m) and a broadband emitter of UHF or EHF waves modulated by the necessary information – to simulate events and processes specified by the operator. The impact is carried out in a forced mode, in the form of an alternating electromagnetic field with a frequency f =7.83 Hz, as well as their harmonics at frequencies ~14, 20, 26, 32 Hz around the object of impact (1). Inside the electromagnetic field of Schumann resonances, which are a "laboratory" for the preparation of entangled states, it is necessary to create a favorable environment for transmitting to the object of influence (1) the information component that is linked under the influence of Schumann resonance fields. The role of such a medium is played by soft x-ray radiation (4), which is a carrier of Louis de Broglie waves, as a source of bosons, which are a component of the natural version of the flow of unlikely events in the forced mode, which assumes a statistical quantum leap of events of low probability to events that are statistically more reliable [86]. The x-ray emitter (5) is controlled by a modulator (6) operating in both continuous and pulsed modes. The stimulating effect (7) is carried out by means of an electromagnetic field radiated by a broadband emitter (8), whose operation is controlled by a modulator (9). Modulators (6) and (9) are synchronized for all wave parameters and are information entangled states. The modulated broadband emitter puts an information component into the configuration of the electromagnetic fields by its radiation. This information component was obtained using the previously described schemes [52-55] and principles [17-61]. As a result, there is an increment of some mass of information in the original system presented in the figure. This system simulates the phenomenon of information accretion in laboratory conditions [88, 89].

Based on the above, it seems possible that: "gravity is a product of "quantum entanglement", and not "space curvature" [90 – 92]. "Therefore, it is possible to adequately describe macroscopic objects and gravitational effects typical of General relativity using quantum mechanical tools... And ... quantum entanglement is a condition of energy density, and this condition should satisfy the future theory of quantum gravity. Thus, entanglement and gravity are dually related: what appears as a quantum entanglement in a small-dimensional space becomes a gravitational interaction in a larger-dimensional space. If this interpretation is correct, then a significant step towards the creation of a quantum theory of gravity has been made" [92].

Figure 1. Variant of implementing a certain therapeutic effect based on new physical principles of action
The authors plan to consider the diffraction problems, conceptual and technological details, as well as the interdisciplinary convergence of mechanisms for implementing the above-described technotron model in upcoming publications.

**CONCLUSION**

In this article, the authors considered some ontological possibilities of teleportation of quantum information at the biogeospheric level on the example of the CoViD-19 pandemic. The scientific novelty of the work, according to the authors, is that for the first time a hypothetical possibility of forming stable cascades of entangled quantum states at the macro level and, possibly, on the basis of mechanisms equivalent to the phenomenon of quantum gravity is considered. Quantum gravity seems to be an adequate description of macroscopic objects and gravitational effects typical of General relativity using quantum mechanical tools. Quantum entanglement is a condition of energy density, and, therefore, a kind of "preservative" of prepared entangled states, which allows these states not to undergo random decoherence when interacting with the external environment. The phenomenon of decoherence occurs only when necessary and sufficient prerequisites occur, which are contained in certain conditions and under certain circumstances. It is then that Louis de Broglie waves modulated by certain information of natural or artificial geophysical origin can collapse to one of the eigenvalues of the information matrix. And one of these values is the activation of the clinical picture of virology in a certain sample of biological objects. This information matrix is "preserved" - as cascades of entangled states - in the depths of standing waves of Schumann resonances with the highest energy density. This is how wave functions become real virulent particles of the SARS-CoV-2/2019-nCoV reduced to corpuscles of one of the diagonal values of the information matrix in the acts of cascades of certain decoherences. Before the corresponding act of decoherence, the virulence of quantum viral particles is only a probability that is in full accordance with the quantum-wave dualism of the hypothetical process described. Thus, entanglement and gravity are dually related: what appears as a quantum entanglement in a small-dimensional space becomes a gravitational interaction in a larger-dimensional space. Thus, SARS-CoV viruses-2/2019-nCoV are activated as virulent particles only when biological objects interact with the environment in some way. What and the nature of this interaction is, we cannot say for sure. Which determines the biogeospheric and ecosystem aspects of these meanings in the NBIC convergent nature of this scientific work. Some features of the impact, interaction and aftereffect of various types of virus on the immune system are discussed in: [94]: «The outbreak of SARS-CoV-2 in Wuhan, China caused a pandemic of COVID-19. However, it remains enigmatic why the mortality rate is variable among countries. Here we show that at least three types of SARS-CoV-2 virus, type S, K, and G. have spread globally and formed complex infectious trends in terms of transmissibility and virulence. Type K establishes herd immunity and protects against the most virulent type G. Immunity to type S is involved in aggravating type G infections through antibody-dependent enhancement (ADE)». This is confirmed indirectly by the mechanisms and features of the evolutionary dynamics of the coronavirus described above in the arena of current geophysical and biophysical events.

**GENERALIZATION**

The term quantum field was formed in physics as a synthesis of representations of physical fields like probability fields and the Faraday — Maxwell electromagnetic field, described in quantum mechanics by wave functions. It is worth noting that physical fields were introduced when it became necessary to completely abandon the principle of instantaneous action of forces, which existed in Newton's mechanics. It was introduced that the space between interacting particles (for example, two electric charges) is completely filled with a field. It is the carrier of the interaction of particles (from one to another), and the transfer occurs at a certain speed. When transmitting an electromagnetic field, all actions are sent from one charged particle to another moving at the speed of light and serves as a carrier for the electromagnetic interaction between the particles. Taking into account quantum fields, there is a process of transmitting the interaction, it comes in quantum portions, where the latter are already elementary particles. They have fixed characteristics of mass, charge, spin, etc. Similarly, on the one hand, interacting particles have common quantized characteristics of mass, charge, and spin, and on the other hand, the interaction between them is transmitted by a quantum field of a certain type with quantized characteristics. Quantum fields include the known physical interactions discussed below in terms of their possible participation in the teleportation of quantum information at the macro level and participation in the creation of space-time itself [95 – 97].

1. **Strong interactions (microscopic level):**

Quantum theory for the strong interaction also consists in the increment of the mass of information teleported by flows (cascades) of entangled baryons and mesons constructed from quarks. They interact by exchanging gluons that have mass 0 and spin 1.

2. **Electromagnetic interactions (mesoscopic level):**

Electromagnetic interaction refers to fundamental interactions. And stands in line with the gravitational, weak and strong interactions. The world that surrounds us is a manifestation of electromagnetic interaction. A large number of forces in mechanics have an electromagnetic nature (forces of tension, elasticity, etc.). Charged particles are sources of electromagnetic fields. Particles that do not have a charge (neutral) interact with such a field due to a complex internal structure or quantum effects. This distinguishes the electromagnetic field from the gravitational field, which acts on all particles. But due to the electromagnetic interaction, there are atoms and molecules, because they are "connected" by electromagnetic forces. Therefore, the electromagnetic interaction is the basis of all existing phenomena on
Earth. The chemical forces that unite molecules from atoms are also electromagnetic in nature. The strength of the electromagnetic interaction is much greater than the gravitational one. What distinguishes the electromagnetic from the weak and strong interaction is that its radius of action is infinite. The ability of the electromagnetic interaction to manifest at infinity is explained by the lack of mass in the photon, which is the carrier of this interaction. However, the mass of a moving photon is determined using Einstein's formula, which establishes the equivalence of mass m and energy E, i.e. E = mc².

The electromagnetic interaction retains its parity with respect to space and charge. This is another difference between the electromagnetic interaction and the weak interaction. And the electromagnetic interaction does not preserve the isotopic spin – this is the difference from the strong interaction.

• From the point of view of classical electrodynamics: interference-results in an interference pattern (hologram). That is, to a quasi-classical object representing a holographic superposition of probable States in the Schumann resonance field [79 – 81], where the sum of certain conditions creates space-time [95 – 97].

• From the point of view of quantum electrodynamics: depending on the variants of interaction of a biological object with Louis de Broglie waves [83-86], which carry full information about CoVid-19. All this is superimposed on the matrix of cascades of entangled States located in the field of Schumann resonances. Which can lead to the collapse of the wave function (COVID-19 pandemic) to one of the eigenvalues (SARS – CoV-2). That is, from the point of view of a hypothetical observer, the interaction of his gaze with this set of holograms occurs – as if at a different angle of incidence of the reference wave on the carrier of these contents. What causes the manifestation of the disease – in its different variations and forms of manifestation of the clinical picture, or does not cause it.

3. Weak interactions (mesoscopic level):
Quantum theory for the weak interaction is analogous to quantum electrodynamics. In physics, the beta decay of elementary particles (for example, neutrons) and nuclei, where the birth of positron-neutrino or electron-neutrino (anti-neutrino) pairs, the capture of muons or electrons by nuclei, and the scattering of neutrinos located on protons, electrons, or in the nuclei of atoms (there are similar processes of weak electron scattering), are referred to as weak processes. Given the quantum field theory, the elementary act of weak interaction was the process of the birth of a nucleon (neutron or proton), as well as an electron (Tau meson, muon) of a heavy neutral (Z0), charged (W±, W--) and a boson, which instantly decays into a pair of particles. The heavy intermediate boson serves as a similar transmission link as it is in the electromagnetic process of the virtual gamma quantum or Louis de Broglie waves (x-ray radiation of the geophysical background). In contrast to the latter, bosons also have a huge mass, and the interaction radius, which turns out to be quite small, is about 10-17 centimeters. This is the radius of the weak interaction. At the same time, the fact that the physical picture of the weak and electromagnetic interactions is similar, helped physicists create a General theory where the two interactions are combined into a single electroweak, at fairly high particle energies. There is a difference between them during the transition from large to small energies, but in the sphere of high energies it actually disappears.

4. Gravitational interactions (macroscopic level):
From the point of view of the topology of the Poincare-Perelman theorem [99-102]: the object (the wave of the CoViD-19 pandemic) acquires in its nested state the dimensionality that is inherent in the medium (space) of the manifestation of the now SARS – CoV-2 virus.

5. Unified field theory:
• Heuristic meaning: the process of incrementing the mass of information on an object (accretion), by attracting congruent physical sense modes from the surrounding space, by the mechanism of the «strange attractor»
• When accretion of information from the background of a Louis de Broglie plasma to a material medium that has its own magnetic field, the accretion mechanisms are determined by the magnetohydrodynamic interaction of this background with the magnetic field of Schumann resonances.
• The interaction carrier is a heavy intermediate boson of the virtual gamma quantum. Or the waves of Louis de Broglie – a natural soft x-ray of the geophysical background. The laboratory and storage of information in cascades of entangled States are Schumann resonances.
• Louis de Broglie waves are a weak component of the process (information and energy components; a catalyst for decoherence directions).
• Schumann resonances – electromagnetic component (holographic probability matrix).
• The quark composition of the two previous components determines the strong component of the process (the microscopic component of the material environment is the source of accretion of matter at the meso-and macro-levels).
Quantum gravity and in a General sense, gravity-in a heuristic sense-is the interaction of cascades of entangled quantum States of all the listed components of certain information flows at the macro level-in their system combination and interaction (information matrix of probabilities).
Quasiparticles of the electromagnetic field, described as quanta of collective excitations in multiparticle systems (for example, in condensed media), can also carry spin and be classified as bosons and fermions. In particular, bosons are phonons ("sound quanta"), magnons (quanta of spin waves in magnets), and rotons (excitations in superfluid helium-4).

This is the system combination and interaction of cascades of entangled States in the information matrix of probabilities that is the reason for the appearance of the space-time continuum in its classical form [95 – 97].
6. Hierarchy and synarchy of interactions:

The microcosm (Suprimir) strong interactions is of the macrocosm (Infraero) gravitational interactions source material. And the macrocosm of gravitational interactions is a source of information for the micro-suprimir-through weak interactions. In our case, these are Louis de Broglie waves. Mesomir is a link between information and matter — through the energy of the electromagnetic field that entangles all processes in a non–local continuum [70 – 77]. In our case, these are Schumann resonances. Which, under certain conditions, manifests its local (diagonal) variants of event realization, based on its own probability matrix. Variants of realization of certain events depend on certain conditions of interaction of information flows of Louis de Broglie waves with the hierarchy of cascades of entangled States in the field of Schumann resonances. When an object interacts with the environment in the form of the components listed above.

Some mathematical apparatus of the processes described above is currently presented in the necessary and sufficient form in [102].

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PHYSICAL FOUNDATIONS OF UNIFIED KNOWLEDGE

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Abstract. A physical model of the Universe is proposed, which is based on the idea of the world as two interconnected branches of a single evolutionary process. One branch is the creation of a postulated primary particles - forms and their cells of a multilevel oscillating structure - a Unified set of forms (USF), which, in the model, is space; second, the formation of material realities by combining the same forms in a structured space. The interaction of the same particles representing “matter” and “space” gives a strict coordination of their development at all scale levels, from elementary particles, atoms, up to Homo sapiens.

USF is the "constructor" of all material realities, and is responsible for their interactions - the forces that arise between them. So, gravitational forces are the stresses in the USF caused by its deformation ("space curvature") by material objects. This explains its long-range and high-speed performance, which was clearly shown by experiments on elastic models.

USF also gives wave properties to all particles moving along its corridors, which determine the transmission properties of space. At this stage of knowledge, USF provides a clear physical explanation for the de Broglie hypothesis, the Heisenberg uncertainty principle, and some other physical phenomena. The constant interaction and mutual development of the USF and the material world give the direction of the evolution process of the Universe.

Keywords: particles – forms, spin, the Unified Set of Forms (USF), structuring of space; hexagonal oscillation cells; structuring of matter, corridors of USF, wave-particle duality

"We come to a strange conclusion: now it begins to seem to us that space plays a primary role; matter must be obtained from space, so to speak, at the next stage" [1].

1. Introduction.

There is currently no comprehensive model covering the entire universe: particles, interactions and space, dark matter and energy. The Standard Model, Special relativity (SR) and General relativity (GR), strings theory, preons, E8, structural vacuum, and others do not give a unified picture of the material world. It is probably impossible to describe the world in parts. None of the models for the development of the structures of the material world will be successful if it does not take into account the existence of a space with physical properties. Therefore, the construction of quantum mechanics is becoming more complex and has long lost any physical interpretation. On the other hand, for several centuries of the existence of modern science, it is intuitively felt that the Universe is a unified
mechanism that can be described in a clear and understandable deterministic form [2-4]. In this work, such an attempt was made to build a comprehensive model of the Universe, within the framework of Unified knowledge, in which matter and space are two basics of a unified physical process [5].

II. Postulates.
Like any other physical model, Unified knowledge is based on certain postulates that will have to be taken on faith.

The first postulate: Matter has a limit of fragmentation, i.e. all material objects, bodies and their systems are based on some simple particles – protoforms, meaning that over time all objects of matter and space will arise from them.

The second postulate: the initial protoforms have the property of mutual attraction through empty gaps between them. Following the laws of dialectics, along with the introduced discreteness – the first opposite, the second postulate introduces continuity – the second opposite.

The third postulate: two protoforms, that have reached the point of meeting due to mutual attraction, capture each other, unite into a single particle that receives a rotational movement - this is the act of "negation-negation" of both opposites: the first two postulates. In this case, the first real particle is born and its fundamental property - movement appears. The particle is called the form (forming the world). The form has acquired a single moment of rotational motion (spin) (Fig. 1).

Interaction of forms.
Thanks to spin forms become qualitatively distinguishable from each other, both in the orientation of the axes of rotation, and in two possible directions - clockwise and counterclockwise. If the original types were all the same and any pair of them could be combined with each other, then the combination of forms should already become selective. If we choose the form with a certain spin orientation, then only the form with a parallel spin can be combined with it, so that their rotations on the contact are compatible.

Two forms whose spins are mutually perpendicular are not capable to combining. The force of attraction brings them into contact, and the incompatibility on contact throws them away. At the same time, they will make oscillatory movements (Fig. 2).

Two branches of world development.
Hence follow two possible branches of the development of the entire initial substance. Forms that are not capable of mutual association will be located in it according to the principle of mutual perpendicular of the spins of neighboring forms. They will give the entire space structure and will serve as a kind of frame for it. Being attracted and bouncing from each other,
they are in constant oscillatory motion. Let’s call this part of the initial substance a Unified Set of Forms (USF), since it will represent an absolutely stable combination of these forms.

The second branch of our Universe is represented by forms that can be combined and have the compatibility of movements on contact, i.e. parallel spins. This branch will continue the process of development of the initial substance: forms will combine in pairs, triples, and so on, creating first elementary particles, then atoms and molecules, and finally living organisms, including Humans.

III. Structuring the space (USF).

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**Fig. 3**

Let’s consider structuring by the first type. Let’s imagine that at some initial moment of time the Unified Set of Forms construct a stationary medium of particles with perpendicular spins at neighboring points (Fig. 3). The forces of attraction between the particles balance each other in pairs, and the entire system is in a state of unstable equilibrium.

The simplest model of such unstable equilibrium was reproduced experimentally in the one-dimensional case. Cylindrical magnets were located along their axes in a line at a certain distance from each other (Fig. 4).

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**Fig. 4**
At the slightest displacement of any of the magnets the total equilibrium is disturbed – they all come into motion and as a result, cells of these magnets, form an avalanche, each of which is 2-4 (average -3) magnet (4b). Although each of these groups is influenced by the neighboring ones, the force of attraction contains is already less than the force of friction. Therefore, the new state is stable. But theoretically, you can imagine the friction force equal to zero. In this case, the resulting groups of magnets will in turn begin to combine into larger groups, those into even larger ones, and so on, until all the magnets are combined into a single discrete "rod".

Now let's consider the interaction of forms in the plane. It is enough for one of them to shift to one side or the other in the direction of the neighboring form, as the general balance will be disturbed. First, the forms will be combined in pairs, then in triples and so on. A qualitatively obtained, hexagonal version of such a new structure (cells) of eight images, capable of structuring the entire USF, is shown in Figure 5.

At the same time, the new system of forms will be more stable along with interacting forms in individual cells, their groups (cells) will also interact in it. They, like single forms, are attracted to each other and bouncing, will oscillate with a lower frequency.

The next, larger version of structuring the forms system by joining in a group takes a three-level system, in which, along with the free forms of the first level, working mainly inside the first hexahedral cells of the second level, a new hexahedral cell of the third level appeared, which united the first seven hexahedrons (elements of the second level).

The process of structuring the system of forms on the plane can be continued: seven structural elements of the third level are able to combine into a new element of the fourth level (Fig. 6) and so on. Thus, in USF we have an arbitrarily large (but finite) set of structures that are hierarchical in nature and obey a strict ratio in size and number of structural elements of different scales. Each level of association will have its own frequency of oscillations of the forms – cells.
And if we now take any material system, whether it is a galaxy, a Solar system, the Earth, or some fragment of it, then in each of these systems there will be a whole set of structural elements in the USF, starting with the size of this material system and ending with the micro level. Oscillations of these structures will determine the entire process of formation and development of this material system, as a whole, and all its components.

Three-dimensional structuring of USF, while intuitively, can be assumed to follow two types: in planes, and simultaneously in a perpendicular direction, when the structure of some "first" plane will be exactly reproduced in all parallel planes. They will form hexagonal "prisms" that pulsate along these axes, along with radial pulsation.

In the future, the first prisms will begin to combine with each other, like triples of real magnets without friction (Fig.4). This will be followed by the third level of integration, the fourth, and so on to the "border" of the environment.

IV. Structuring of matter.
If we now “throw” forms of the material world (with parallel spins) into such a pulsating medium (USF), then their general behavior will be determined by the processes of the micro level, at which the combining of individual forms into elementary particles, atoms, etc begins, and the process of contraction of all material clumps to a certain central plane, and in the plane to the center of the primary cell. From here, obviously, one of the main features of the structure of our Universe at the macro level follows - all cosmic bodies are combined into star-planet and galactic systems that have a clearly expressed flat shape (Fig.7). USF, both as a whole and within all of its cells, is characterized by a general regularity: the average bulk density of images increases towards the centers of the cells and their axial planes.

The formation of particles of matter. At the micro level, the formation of material particles occurs due to the coalescence of forms with parallel spins. Photon.

If the spins are directed in parallel, then they can connect only in series so that their rotations coincide. So, presumably, a photon is created from two forms, with a total spin of 1 (Fig.8).

Mass of particles.
Forms with antiparallel spins cannot connect in series, due to incompatibility of movement, but can combine in the plane of rotation. In this case, a particle having a mass with zero spin is created (Fig.9). Call it em (mass element).

It seems that of them, the further development of matter in two directions is possible. One is the enlargement of mass, and the other is the creation of particles with a new quality.

By the type of mass enlargement, the figure 10 shows the sequential association of particles into larger structures, analogues of strings with a total zero spin. From them in the future will be collected masses of all particles. The possibility of the decay of "matter" into energy - "photons" circled in blue is shown.
Fig. 10.

Lepton number.

Fig. 11

The figure 11 shows the union of two particles of two forms each in the plane of their rotation. As you can see, the rotation of the particles on the contact are compatible. As follows from the third postulate, two attracting particles by mutual capture form a new rotational pair with an axis of rotation directed orthogonally to the plane of the figure (with a rotation of 90 degrees). The appearance of a new rotational particle is the birth of a new material quality, it receives a new characteristic. An analog in quantum mechanics, apparently, is the lepton number.

Fig. 12
Neutrino. Further development can go by joining a free form to a new particle with a spin direction compatible with its new torque (Fig.12). They can be combined according to the principle of series connection (like forms in a photon). As a result, a particle appears, consisting of five images and characterized by two quantum characteristics: a spin equal to 1/2 (due to the image), and a lepton number (due to a new rotating pair of particles). The real analogue of such triples, apparently, is the first lepton - the electron neutrino.

Neutrinos of the second and third generations can be formed in the future according to this principle due to the addition of the corresponding masses.

Electric charge.

It can be assumed that, according to the same scheme, two formed particles from four forms will combine and a new particle will be created with a new quality - electric charge (e/3). The combination of these three particles, the addition of a particle characterizing a lepton number and a free form to them, will create a new particle that will already be characterized by three quantum numbers (spin is 1/2, lepton number and electric charge). An analogue of such a particle can be an electron.

Most likely, it is necessary that a chargeless particle - “mass” - be attached to this particle. The number of these attached particles (their mass) will determine the generation of particles with an electric charge of -1: the first generation is an electron, the second (muon) and the third (tau).

To preserve the moment of momentum, the formation of charge particles should occur in pairs. In the course of development, one of these paired particles can already acquire independent existence (electrons) at this level, while the opposite particles (quasipositron) continue the process of further enlargement (combining with their own kind) and, as it were, form the basis for particles of the following scale levels, for example, quarks with charges that are multiples of 1/3.

Quarks. Protons. Neutrons. On the way to the complication of matter, the next quality is the baryon number. The process of formation of particles with this charge is likely to repeat the process of formation of lepton and electric charges due to the formation of new paired particles with a new rotation of different signs, due to the combination of particles of the previous level.

The subsequent attachment of quasipositron clumps to them, obviously, led to the formation of quarks and their further unification already on the scale of some "nucleon" cells.

Particle antiparticle.

In the formation of new particles due to the combination and joint rotation of particles of the previous level, to preserve the moment of momentum, they were born in pairs: an antiparticle particle with rotation both clockwise and counterclockwise. All particles with different quantum numbers: lepton, baryon, electric and color, have antiparticles.

There are no antiparticles in the form and a pair of forms connected, both in series - a photon, and antiparallel, forming a mass. Therefore, the Universe has particles and antiparticles, but there is no antimatter, because there is no “anti-mass”.

Atom. USF structures are also of fundamental importance in the assembly of atoms. The force of attraction inherent in nuclei attracts electrons to them, but they cannot “contact” with each other - they are not allowed to the nuclei surrounding their forms of the primary cell of the USF. The gaps between the primary cells (“corridors” of the USF) obviously make up the possible location of electrons. Its existence can be figuratively imagined as a constant passage through an annular system, on the sides of which oscillating forms of neighboring cells are located, giving electrons rotation in orbit. The principle of Pauli becomes clear. Two particles with the same spin in the same orbit, in the same corridor, are incompatible in their motion.
The filling of the orbits with electrons will be determined by the capabilities of the free corridors between the USF cells. After filling the closest corridor - the orbits near the nucleus (level K), new electrons tending to the nucleus will fill the corridors of the second level (L) (Fig.13). First, a circular corridor between cells of the next level around the nucleus (s-orbital). Between the K and L levels there are places between cells that can be filled with electrons to form three dumbbell-shaped p - orbitals, etc.

At the f-orbitals and the Q-energy level, the atomic stage of the complication of matter ends. The size of the nuclei reaches critical values at which the USF structures become impassable for them. The phenomenon of radioactivity is apparently associated with this.

V. Structures USF. Interactions.

This increases the density of USF forms in the body, causes an additional force, the force of gravity, towards it. In this case, the field of deformations of the USF around the body, the so-called “curvature of space”, will be its gravitational field. This is well visualized by experiments simulating elastic stresses in core models, where $\sigma r \sim r^2$ (fig. 14b).

Long range gravity. Signal transmission rate through USF.

Thanks to USF, all particles and objects are interconnected through its structure. The local perturbations of the USF that they cause almost instantly propagate to the farthest distances.

This is embodied in quantum entanglement when the quantum states of two or more objects are interdependent. An experimental verification of the speed of such a signal is at least hundreds of thousands of times faster than the speed of light.

Structures USF in nature. The degree of manifestation of USF structures in natural processes depends on the degree of equilibrium of the transition from one state to another. The photo shows basalt hexagonal columns on the Giant's dam on the coast of Northern Ireland, formed during crystallization during the slow cooling of volcanic lava (Fig. 15).
A similar picture occurs during the compaction of sedimentary rocks or the drying of wet clay soils (Fig.16). The biaxial tension that occurs in the above examples in the upper layer of a crystallized or shrinking volume can be realized by any network of cracks. But the one that the USF imposes with its additional field is implemented.
The hexagonal shape of the "honeycombs" is USF well known to astrophysicists studying large-scale structures of the Universe (Fig.17). The vibrational movements of structures USF of the galactic level determine the process of formation and development of galaxies and their clusters, collecting them in sparseness corridors of USF, thread-like walls of hexagons separated by voids, in which there is practically no luminous matter.

It is the strict dynamic orderliness of NATURE that exists in the "non-material" world that is clearly manifested in the uniformity of natural (material) formations.

VI. Modern physics and USF.

Modern physics does not take into account the existence of the ether and the USF as well. Its equations were initially selected in such a way that they satisfy the requirements of the real existence and behavior of material systems. There is no physical explanation for the adequacy of many such models and reality.

Perhaps this is impossible to explain, because it turned out to be lost the main principle of the world – USF, which actually acts as the Creator of all the realities of the material world. It provides a simple and convincing explanation of many physical models and mathematical equations in modern science.

Wave-particle duality.
In this model a photon is a particle to which space – USF gives "wave characteristics". When moving along the corridors of USF between its cells, the photon (and other particles) constantly interact with their "walls" - forms that make vibrations. When interacting with them, the photons will experience impacts that lead to both a straight forward movement along the corridor and a transverse movement from the "wall" to the "wall" (Fig.18). Interaction with the corridor particles is probably physically limited the maximum speed of movement of the smallest particle of matter – photon by the speed of light (c). In this case, the transverse displacements of the photon give it the appearance of a" transverse wave " with the polarization of oscillations s in a plane perpendicular to the direction of movement. For the same reason, other particles get wave properties also. With increasing the velocity (V) or mass (m) of the particle, the frequency of collisions increases, and the free path or wavelength (λ) decreases accordingly, which explains the de Broglie hypothesis \( mV\lambda = \hbar \).

**Bandwidth of the space.**

The de Broglie hypothesis is the correctly guessed bandwidth of the USF corridors.

---

**Fig. 19. Corridors of USF (2) with particles (1) with different "wavelength" (λ), the distance from impact to impact on the forms (3) that make up the walls of the corridor (2).**

Part of the length of the corridor (λ), which the particle occupies from one impact against the wall of the corridor to the other, which cannot be occupied by another particle at the same time. Multiplied by the speed, it will be the area that will be occupied by the particle per unit of time \( \lambda \cdot V = S/t \).

This is how highway throughput is calculated for cars of different lengths moving at different speeds. Figure 19 shows the motion of two particles with different" wavelengths " λ and velocities V. From the condition of limiting the throughput over the area \( S = S_1 = S_2 \); \( \lambda_1 \cdot V_1 = \lambda_2 \cdot V_2 \). But here, on equal terms, another parameter arises that limiting the throughput – the mass of the particle \( m \cdot V \cdot S/t = \hbar \).

**The Heisenberg uncertainty principle** is also determined by the capacity of the USF corridors. The particle moves along the corridor from impact on the image of one of its walls, to impact on the opposite wall at a half-wave distance \( \Delta x = \lambda/2 \) at which its position is uncertain (fig. 18). From the de Broglie formula \( \lambda = 2 \cdot \lambda_0 = \hbar / p \) we obtain \( \Delta x \cdot p \geq \hbar / 2 \). As can be seen, the basic tenets of quantum mechanics find their clear explanation in the framework of the proposed model. Proceeding from it, the USF structures limit the movement of particles by the conditions \( l = c \cdot m \cdot \dot{S} = \hbar \).

**Inertia. Relativistic mass.**

The inertia phenomenon is also associated with the action of USF: with the displacement of any body, it meets the resistance of USF. At the initial moment, it is necessary not only to move the body, but also to deform this medium, rest inertia arises. At high speeds, the resistance of the University structures increases sharply. This may explain the increase in mass at near-light speeds. Thus, the mass of the body can be represented as the sum of two components: the actual mass \( m \) and the resistance of the medium (USF) \( \Omega \).

Then \( M = m + \Omega \), where \( \Omega = m \left( 1/v^2 - 1/c^2 \right) \). [6]

When the body is already moving, the density of forms in the USF in front of it is higher than on the opposite side. And if you stop the action of an external force on a given body, which generated its movement, then it will continue to move due to the greater density of forms of the USF in front of the body, i.e., by inertia.
Structural vacuum.
The closest to the concept of USF came the scientists involved in the structural vacuum. Modern physics unambiguously shows that vacuum is not a void, and a system of zero-point oscillations of quantum fields measured experimentally. This, in particular, is indicated by the Casimir effect, which consists in the mutual attraction of two parallel uncharged plates in a vacuum placed at a short distance. This is consistent with the proposed model of space, which is an oscillating structure of USF forms, which from free forms collect photons and other paired elementary particles striking the plates. Since there will be more such influences from the outside of the plates than from the inside, the plates will be attracted to each other (Fig.20).

Stages and direction of development of the world.
The creation of the Universe is a Unified process, at each new stage a new material structure or a new physical quality is formed. Starting with the combination of the two postulated primary particles – forms, a qualitative and quantitative complication of matter occurs. Two types of particles are formed, one gets the possibility of independent existence, and the other a new physical quality and is involved in the further structuring of matter. Two forms, combining with parallel spins create an independent particle - a photon, and with antiparallel spins, a particle with a new quality en (mass element) (Fig.21). At the next level, it forms a particle with a real mass, and by another type, combined with a similar one in a rotational pair, it will create a particle with a new quality - a lepton number. This particle at the next level, combined with a particle of the previous level in mass and in a free form, will create an independent neutrino particle, and, by a different type, combined with a similar particle in a rotational pair, will create a particle with a new quality - electric charge (e/3).

At the next level, the union of three such particles, with the addition of particles of previous levels of mass and lepton number, form an independent electron particle. And according to another type, combining with a similar one with a new torque, it will create a particle with a baryon number (1/3). At the next level, this particle, combined with particles carrying an electric charge and mass, and attach a free form, will create a quark particle. An attached form can be one of three orthogonal orientations, which in accepted terminology gives them color charge. Further unification of three quarks with spins of different orientations (colors), according to the Pauli principle,
will create nucleons (protons and neutrons). This completes the pre-atomic stage of structuring matter.

At the atomic stage, the complication of matter occurs due to the formation of new elements when electrons fill the corridors of the USF around the nuclei of atoms. The nuclei become heavier as long as they fit into the sizes of the primary cells of the USF. The next molecular stage is associated with the process of contraction of USF with the corresponding densification of atomic structures.

![Big Bang](image)

**Fig.22. Universe evolution (Arrow of Time):**
1. The development of structures of Unified set of forms (USF);
2. Structures of USF;
3. The development of material structures.

The collection and compaction of hydrogen molecules in clumps led to the formation, sequentially, of stars of the first, then second generation, in which heavy elements gradually formed. As a result of explosions of stars, they scattered in space. Of these, through a series of intermediate structures, the Solar system and the Earth formed, on which, in stages, the lithosphere, hydrosphere and atmosphere were formed. They created the conditions for the formation of organized matter at the next stage. All created material realities and interactions supplemented the rotation of the Earth, leading to the emergence in the USF of integral quasistationary cells that formed and scattered over time. They formed material structures that were also born and died. So a living cell arose, then a phased plant and animal world, mammals and finally man (Fig. 22). And all this complication of material structures was strictly controlled by USF structures, which ensured the coordination of the work of all structures of the Universe. In human society, the USF structure has become known as the spiritual half of the world.

This is already beyond the scope of physics. The authors understand that they will not be taken seriously by most scientists brought up on the traditions of quantum mechanics and theories of relativity. Despite this, we hope on the basis of the proposed model to create an open space for scientists of all specialties who are ready to take part in the creation of Unified Knowledge. Based on it, it is supposed to solve not only the physical problems of matter and space, but also to describe all world structures, including man, with his exclusive ability to cognize the world and determine its role in the Universe. The need for such knowledge is dictated by the current state of both world science and society.

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PROPERTIES OF HIGH-ENTROPIC FECOCRNIATIMOCOATINGS

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Abstract. The FeCoCrNiTaTiMo alloy and coatings based on it have been synthesized by mechanical alloying. The optical microstructure of high-entropy coatings exhibits irregularity, which is clearly visible on the maps of energy-dispersive spectroscopy. XPS spectra indicate the formation of high-entropy coatings. Analysis of the elemental composition shows the complexity of the high-entropy alloy FeCoCrNiTaTiMo. The structure consists of solid solutions with a chaotic arrangement of atoms of elements. The microhardness of our coating (345 HV) is not inferior to stainless steels, and the wear resistance of the coating is $3 \times 10^4$ g/min. High-entropy FeCoCrNiTaTiMo coatings turn out to be antifrictional, which obviously leads to energy savings. The thickness of the surface layer d(l) is determined by one fundamental parameter - the molar (atomic) volume of the element and is equal to 12.3 nm. It is shown that the formation of a cellular nanostructure in a coating can occur according to several models.

Key words: high-entropy alloy, plasma coating, surface layer, microhardness, friction, wear resistance, wear resistance of the coating.

Introduction

According to the authors of [1], a distinctive feature of high-entropy alloys (HEAs) from traditional ones is that these alloys have a high entropy of mixing, which affects the formation of structures based on solid solutions. A little over 15 years have passed since the discovery of high-entropy alloys (2004). The first review was made as a complete material science cycle "production - structure - properties" for a new class of vacuum-plasma coatings - nitrides of multielement metal high-entropy alloys in [2]. An analysis was made of the current state of obtaining such coatings, their morphology, elemental and phase compositions, structure, substructure, stress state, and functional properties depending on the main formation parameters: substrate temperature during deposition, the magnitude of the bias potential applied to the substrate, and the composition of the gas atmosphere. Then there were many works devoted to the synthesis and study of various HEAs [3-9]. The last review on HEAs was made in [10]. The analysis of more than 200 obtained high-entropy alloys (HEAs) made it possible to establish the relationship between the electron concentration, phase composition, lattice parameter and properties of solid solutions based on bcc and fcc lattices. The main conditions for the appearance of high-entropy chemical compounds - the Laves phase, $\sigma$- and $\mu$-phases, are revealed. For the formation of a 100% high-entropy $\sigma$-phase, a necessary condition is that all elements that make up the HES must form a $\alpha$-phase in two-component alloys in various combinations, and the electron concentration of the alloy must be in the range of 6.7-7.3 el./at. For the formation of a 100% high-entropy Laves phase, it is necessary to have: the total negative enthalpy of mixing of the alloy at the level of -7 kJ/mol and below; pairs with a difference in atomic sizes of more than 12%; the presence in the alloy of two elements with an enthalpy of mixing less than -30 kJ/mol, the average electron concentration should be in the range of 6-7 el./at. It is shown that the ratio of the lattice parameters of solid-solution HES, determined in the experiment, to the lattice parameter of the most refractory metal in the HES determines the value of the elastic modulus.

In this work, the physicomechanical properties of the high-entropy FeCoCrNiTaTiMo coating synthesized by us are investigated.

Methods for the synthesis of the FeCoCrNiTaTiMo alloy and coatings.

To prepare the tablets, micropowders of the corresponding metals were taken (Fig. 1a) and mixed in equiatomic proportions. Then the prepared mixture of powders was placed in a grinding bowl of a planetary ball mill (Fig.1b) made of tungsten carbide, and grinding bodies (balls 5-10 mm in diameter) also made of tungsten carbide were added, the mass of which was equal to 10 masses of the powder mixture. After that, the glass was filled with Galosh gasoline, the lid was tightly closed, and the planetary ball mill was turned on (rotation speed was 500 rpm, operating time 5 hours). The homogenized compositions obtained in this way were then dried in a vacuum and, using a mold (pressure of 20 tons), were pressed into flat disks 12 mm in diameter and 3 mm thick (Fig.1c).
Experimental technique. In the study of the microstructure of the coatings of the samples, we used an Epiquant metallographic microscope (Fig. 2 a). This device operates on the principle of a linear analyzer and is intended for structural and analytical studies of solid, heterogeneous substances, in which physical and technological properties depend on the geometric microstructure and the structural components of which have different reflection coefficients (Fig. 2 b).

Electron microscopic examination was carried out on a JEOL JSM-5910 scanning electron microscope (Fig. 3 a). The studies were carried out at an accelerating voltage of 20 kV. For each sample, 4 images were taken from 4 points of the surface at magnifications: 245, 1060, 4500 and 14600 times (Fig. 3 b).

X-ray fluorescence electron spectroscopy (XPS) was carried out using a TESCAN MIRA 3 electron microscope. The elemental composition (Fig. 4 a) and the unevenness of the elemental composition (Fig. 4 b) were determined.
Figure 4 - Elemental composition (a) and uneven elemental composition (b).

On an XRD-6000 X-ray diffractometer (Fig. 5 a), the phase composition and structure parameters of the deposited ion-plasma coating were studied (Fig. 5 b).

Figure 5 - XRD-6000 diffractometer (a) and a section of the diffractogram (b)

Система Quanta 200 3D совмещает в себе сканирующий электронный микроскоп с термоэмиссионным катодом (рис. 6 а), сфокусированный ионный пучок, позволяющий прицельно наносить и удалять материалы, определяя толщину покрытия (рис. 6 б).

Figure 6 - Quanta 200 3D system (a) and coating thickness (b)

Investigation of the morphology (Fig. 7 b) of the surface of the films obtained by thermal evaporation in a vacuum was carried out on a JSPM-5400 atomic force microscope (AFM) manufactured by JEOL (Fig. 7 a).
The experimental setup for determining the friction coefficients was built by us on the principle of modularity. The general scheme of the installation for determining the friction coefficients is shown in Fig. 8 a, and the appearance of the graphical presentation of research results using the system is shown in Fig. 8 b.

We used the method of testing for microabrasive wear by the action of a rotating steel ball on a flat sample with the addition of an emulsion containing abrasive particles (Fig. 9 b). A spherical crater, called a calotte, is formed at the point of contact; therefore, the device for this type of testing was called a caloteter (Fig. 9 a).

The control of coatings for hardness was carried out on an HVC-1000A electronic microhardness meter (Fig. 10 a). The results are shown in Fig. 10 b.
Structure of FeCoCrNiTaTiMo coatings. In Fig. 11 shows the optical microstructure of high-entropy (HES) FeCoCrNiTaTiMo coatings at two points. The unevenness of the coating is observed, which is clearly visible on the maps of energy dispersive spectroscopy (emf) of this coating (Fig. 12).

The distribution maps of elements (Fig. 12) show the nonequilibrium of the chemical elements Fe, Co, Mo in comparison with the elements Ta, Cr, Ni. The concentration of other elements is negligible. The XPS spectra shown in Fig. 13 and in table. 1 indicate the formation of high-entropy coatings.
### Chemical composition in % FeCoCrNiTaTiMo

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<th></th>
<th>Fe</th>
<th>Co</th>
<th>Cr</th>
<th>Ni</th>
<th>Ta</th>
<th>Ti</th>
<th>Mo</th>
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<td>17</td>
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<td>16</td>
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<td>18</td>
<td>16</td>
<td>9</td>
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*Figure 13 - XPS spectra FeCoCrNiTaTiMo*

The content in the spectra in Fig. 12 and 13 elements of tungsten are quite noticeable. It was not added in our metal micropowders, but appeared in the process of grinding the powders with tungsten carbide balls. In fig. 14 shows PEM FeCoCrNiTaTiMo.

*Figure 14 - PEM coating FeCoCrNiTaTiMo*

Studies have shown that the alloy of the FeCoCrNiTaTiMo system consists of large elongated grains with an average width of 100-150 μm and an average length of 200-300 μm. It should be noted that black precipitates about 5-7 microns in size are observed in the alloys. According to the literature data, these precipitates are oxides (Me₂O₃). In the course of the study, more complex structural components were discovered. The inner part of the grains of the alloys is similar to the eutectoid structure. The grains are separated by thick layers of the second phase.

In fig. 15 shows the diffraction pattern of the FeCoCrNiTaTiMo coating. Phases are present: Fe, Ti, TaFe₂, possibly the presence of phases TaCo₂, Mo, Ti, Ni₃Ti, TaCrNi, TiCr, TiNi, Fe₅Ta₃.

Special tantalum alloys are used in industry for high temperature applications, for making cutters with high cutting speeds and for making acid-resistant hardware. The presence of cobalt in high-speed steels does not increase their hardness, but shifts the temperature of the onset of hardness loss to 600 °C, while in ordinary steel it decreases from 200 °C. Cobalt is also widely used to obtain magnetic materials with high magnetic permeability and alloys for permanent magnets (alloys of cobalt with iron, platinum; alloys based on cobalt, alloyed with aluminum, nickel, copper, titanium, samarium, lanthanum, cerium).
Figure 15 - Diffraction pattern of FeCoCrNiTaTiMo coating

The introduction of cobalt additives into the alloys in the amount of 0.5-4.0% helps to reduce the grain size, due to which the coercive force (demagnetization resistance) and residual magnetization increase. Industrial alloys for "alnico" magnets contain aluminum, nickel, cobalt, the rest of iron. Certain alloys also include copper and titanium.

An analysis of the elemental composition (Fig. 13-15) shows the complexity of the high-entropy FeCoCrNiTaTiMo alloy. The structure of seven-atomic high-entropy alloys consists of solid solutions with a chaotic arrangement of element atoms. It is assumed that lattice distortions due to doping with atoms of different sorts is one of the reasons for the stability of the structures of solid solutions at higher temperatures than intermetallic compounds.

**Microhardness of coatings.** The results of measurements of the microhardness of the FeCoCrNiTaTiMo coatings are given in Table 2.

### Table 2

| Microhardness of the FeCoCrNiTaTiMo coating in argon |
|---|---|---|---|---|---|---|---|---|
|                  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | The average |
| HV                | 342| 292| 299| 292| 370| 298| 265| 331| 307         |

Comparative data on the values of microhardness (HV) of high-entropy equiatomic and traditional alloys (for example, typical high-strength stainless steels and alloys of nickel, cobalt or titanium) are given in table. 3. The microhardness of our FeCoCrNiTaTiMo coating (Table 2) is not inferior to stainless steels.

### Table 3

| Microhardness of stainless steels |
|---|---|---|---|---|---|---|
| Alloy           | Microhardness, HV | Alloy          | Microhardness, HV |
| X18H9T          | 186              | 20XH           | 260              |
| 316 Stainless steel | 189              | Hastelloy C    | 236              |
| IIIX15         | 200              | 17-4 PH Stainless steel | 362          |
| X12M           | 225              | Stellite 6     | 413              |

Wear resistance of coatings. The results of studies of the wear resistance of FeCoCrNiTaTiMo coatings are shown in Table 4.

### Table 4

| Wear resistance of FeCoCrNiTaTiMo coatings |
|---|---|---|---|---|---|---|
| Sample wear (weight in grams) for 30 min |
| Before | 15,14852 | 15,14857 | 15,14859 | 15,14856 | The average | 15,148566 |
| After  | 15,14745 | 15,14763 | 15,14759 | 15,14759 | Difference  | 0.000986 |

Table 4 shows the wear resistance of the FeCoCrNiTaTiMo coating ~ 3x10^-4 g/min.

**Tribological features of FeCoCrNiTaTiMo coatings.** The deposition of FeCoCrNiTaTiMo was carried out on a stationary sample for an hour with a reference voltage of 150 and 250 volts in a constant power mode of 1.5 kW.
Table 5

<table>
<thead>
<tr>
<th>Coefficients of friction for copper and aluminum</th>
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<td>FeCoCrNiTaTiMo</td>
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High-entropy coatings FeCoCrNiTaTiMo turn out to be antifriction, which obviously leads to energy savings. The surface layer of high-entropy coatings FeCoCrNiTaTiMo. In fig. 16 shows the thickness of the deposited coating over 40 minutes. From the figure, a columnar structure is observed; it has a size of about 1.5 microns.

![Figure 16 - Thickness of FeCoCrNiTaTiMo coating in argon gas atmosphere](image)

In [11-13], we showed that the thickness of the surface layer \( d(I) \) is determined by one fundamental parameter - the molar (atomic) volume of an element \( v = M/\rho \), \( M \) is the molar mass (g/mol), \( \rho \) is the density (g/cm\(^3\)), which periodically changes in accordance with the table of D.I. Mendeleev:

\[
d(I) = 0.17 \cdot 10^{-9}v
\]

For seven-atom high-entropy FeCoCrNiTaTiMo alloys, the thickness of the surface layer will have the values given in Table 6.

<table>
<thead>
<tr>
<th>Thickness of the surface layer ( d ) FeCoCrNiTaTiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy</td>
</tr>
<tr>
<td>FeCoCrNiTaTiMo</td>
</tr>
</tbody>
</table>

**Atomic force microscopy.** In fig. 17 shows 3D images of the surface of FeCoCrNiTaTiMo coatings on AISI-201 steel samples at three different points, and below their fractal structures. The cellular structure of the high-entropy coating is observed. In [14], we gave the following explanation of this structure. Plasma deposition of coatings is a thermodynamically nonequilibrium process in an open system. The formation of a cellular nanostructure in a coating can occur according to several models:

- a cellular substructure is often formed during solidification as a result of concentration hypothermia;
- Benard cells are an example of self-organization. The control parameter of self-organization is the temperature gradient leading to a cellular substructure;
- a cellular dislocation structure is a process of self-organization of dislocations under conditions of multiple slip.
Conclusion.
In conclusion, the following main conclusions can be drawn:
- the FeCoCrNiTaTiMo alloy and coatings based on it have been synthesized by mechanical alloying;
- the optical microstructure of high-entropy coatings reveals unevenness, which is clearly visible on the maps of energy-dispersive spectroscopy;
- XPS spectra indicate the formation of high-entropy coatings;
- analysis of the elemental composition shows the complexity of the high-entropy alloy FeCoCrNiTaTiMo. The structure consists of solid solutions with a chaotic arrangement of atoms of elements;
- the microhardness of our coating (307 HV) is not inferior to stainless steels, and the wear resistance of the coating is $3 \times 10^{4}$ g/min;
- high-entropy coatings FeCoCrNiTaTiMo turn out to be antifriction, which obviously leads to energy savings;
- the thickness of the surface layer d(I) is determined by one fundamental parameter - the molar (atomic) volume of the element and is equal to 12.3 nm;
- it has been shown that the formation of a cellular nanostructure in a coating can occur according to several models.

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