Research Work Summary Report of Nathan O. Schmidt

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I. Introduction

Nathan O. Schmidt's academic and professional trajectory reveals a consistent pattern of interdisciplinary engagement, seamlessly blending computer science, mathematics, and theoretical physics. His formative years in Alaska instilled an appreciation for both intellectual pursuits and practical engagement with the physical world.[1] A pivotal moment in his early development was his adoption of Linux at the age of 15, indicating a strong and early inclination towards technology and computer science.[1] This foundational technical understanding likely underpins much of his subsequent research endeavors. His academic journey began at Eastern Oregon University (EOU), where he earned a Bachelor of Science in Computer Science (2004-2008).[2] During his time at EOU, Schmidt commenced his academic research under the guidance of Dr. Suranga Hettiarachchi, focusing on a novel "hybrid approach to neuro-evolution" that integrated genetic algorithms with artificial neural networks. He also engaged in robotics research and presented his work at the 2008 EOU spring symposium.[4] Adding to his accomplishments at EOU, Nathan was a four-year track and field athlete. Notably, he was part of the 4x100 meter relay team that broke the EOU school record and qualified for NAIA nationals. Furthermore, he achieved a place on the 100-meter top ten list at EOU.[1] His diverse experiences at EOU laid a strong foundation for his future interdisciplinary pursuits. His academic achievements continued at Boise State University, encompassing Master of Science degrees in Computer Science, with a specialization in bioinformatics and artificial intelligence, and in Mathematics, with a focus on cryptography and cybersecurity.[1] This dual mastery of seemingly distinct yet interconnected fields is a crucial aspect of his research profile, allowing him to approach complex problems with a multifaceted perspective.

Beyond these formal degrees, the scope of his research interests extends to include quantum gravity and sustainable energy, showcasing a remarkable intellectual curiosity and a willingness to explore diverse scientific frontiers.[1] His early involvement in academic research is evidenced by his experience as a research assistant on the DNA Safeguard Project and as a teaching assistant at Boise State University.[1] During his time as a research assistant for the Department of Defense DNA Safeguard Project at Boise State University, under the advisement of Dr. Tim Andersen, Schmidt built his own machine learning systems and computational tools from scratch. He utilized these tools to analyze genome and proteome sequences, as documented in his thesis.[1] Further corroborating his academic credentials, he holds a Bachelor of Science and two Master of Science degrees in Computer Science and Mathematics.[5] His current professional standing as the Founder of Cold Hammer Research & Development signifies a transition towards independent research and entrepreneurial endeavors.[5] His professional experiences as a software development engineer, scientist, and mathematician further underscore the practical application of his academic training.[5] Early research activities at Boise State University include a role as a Symmetric-Key Cryptography Researcher (2008-2010) and a Research Assistant (August 2008 - August 2010), providing a timeline of his initial forays into research.[5] The confluence of these experiences suggests a researcher driven by a profound curiosity and a desire to apply a robust set of analytical and computational skills to a wide array of scientific challenges.

This report aims to provide a comprehensive summary of Nathan O. Schmidt's research work, drawing upon available information to highlight his key contributions and the interdisciplinary nature of his inquiries. The subsequent sections will delve into his research in cryptography and Latin squares, his contributions to theoretical physics and cosmology, his investigation of iso-mathematics, his work on sustainable energy, his

development of mathematical frameworks, and the recurring themes that weave through his diverse body of work.

II. Research in Cryptography and Latin Squares

A significant component of Nathan O. Schmidt's academic work is his Master's thesis in Mathematics from Boise State University, titled "Latin Squares and Their Applications to Cryptography," completed in December 2016 under the supervision of L. Babinkostova.[1] The abstract of this thesis outlines its central theme: the exploration of Latin squares and their potential utility in the construction of cryptographic systems. Latin squares, defined as n x n arrays over n symbols where each symbol appears exactly once in each row and each column, encode features of algebraic structures that can be relevant to cryptography.[3]

The thesis delves into the concept of transversals within Latin squares, which are lists of n distinct symbols, one from each row and each column. A key connection explored is the relationship between counting these transversals and counting pairs of permutations over a Galois field whose point-wise sum is also a permutation, a fundamental area within algebraic cryptography. This investigation indicates a deep engagement with the theoretical foundations that underpin cryptographic design principles. A practical aspect of his research involved the development of software tools specifically designed for generating Latin squares and counting the number of transversals they contain. This hands-on approach demonstrates an ability to translate abstract mathematical concepts into tangible computational resources.

His research also involved the validation of existing findings, specifically confirming that cyclic Latin squares of prime order ($3 \leq p \leq 9$) possess the maximum number of transversals. Furthermore, the thesis introduces an original contribution to the field: a novel algorithm for constructing "super-symmetric" Latin squares of prime power order (p^d where d > 0). Using this algorithm, Schmidt accurately predicted the maximum transversal counts for super-symmetric Latin squares of orders up to 9 and estimated a lower bound for orders up to 17. These findings represent a notable advancement in understanding the properties of these specific types of Latin squares. The thesis also proposes conjectures regarding the number of transversals present in super-symmetric Latin squares, suggesting potential avenues for future research in this area. In a practical application of his theoretical work, Schmidt utilized the super-symmetric Latin square for the additive group of the Galois field (3², +) to create a simplified version of the Grøstl hash function, demonstrating a direct link between his theoretical findings and a real-world cryptographic algorithm. The thesis document itself is available through the Boise State University repository, offering further details for those interested. His supervisor, L. Babinkostova, confirmed his investigation into hash function security through the study of Latin squares and the development of software tools in C and Java.[2]

The "Latin Square Toolbox," hosted on GitHub, represents a significant practical outcome of Schmidt's thesis research.[4] This toolbox comprises three distinct tools: the Latin Square Generator (LSG), the Latin Square Transversal Counter (LSTC), and the Latin Square Property Checker (LSPC).[4] The LSG is designed to generate sets of Latin squares for a given order, although its practical limitations for very large orders are acknowledged due to hardware constraints.[4] It incorporates two primary modes of operation: Data Set Preloading (DSP), which prioritizes speed for generating larger datasets but may skip some squares, and Super-Symmetric (SS), which employs a recursive, lifting-and-merging algorithm to generate single prime power order super-symmetric Latin squares, using prime order cyclic Latin squares as fundamental building blocks.[4] Notably, the SS mode's algorithm ("SS-LS-GA") is confirmed to generate Latin squares with the maximum transversal counts for orders up to 9, leading to a conjecture that this property might hold for all prime power orders generated by this algorithm.[4] The LSTC is designed to count the number of transversals present in a given set of Latin squares, with the current implementation requiring all input squares to be of

the same order.[4] The LSPC serves as the simplest tool, verifying whether a given set of squares adheres to the Latin Square Property.[4] The toolbox's input and output formats are designed for interoperability, allowing the output of the LSG to be directly used as input for the LSTC and LSPC.[4] The primary goals of the thesis, as reflected in the toolbox's functionalities, were to efficiently generate Latin squares, count their transversals, predict transversal counts, and apply these findings to cryptography.[4]

Prior to his Master's thesis, Nathan O. Schmidt demonstrated an early and strong interest in practical cryptography. From August 2008 to August 2010, while at Boise State University, he served as a Symmetric-Key Cryptography Researcher.[5] During this period, he designed and implemented a general-purpose file-system security software tool that integrated three different symmetric key crypto-systems and ten hashing-systems.[5] This early work was presented at the BoiseCrypt 2009 Conference, indicating a willingness to share his findings with the research community.[5] This foundational experience in applied cryptography likely played a role in shaping his later academic pursuits in the more theoretical aspects of the field, culminating in his Master's thesis on Latin squares.

III. Contributions to Theoretical Physics and Cosmology

A significant portion of Nathan O. Schmidt's research endeavors has been dedicated to the realm of theoretical physics and cosmology. From November 2012 to June 2017, he held the position of "Quantum Gravity and Sustainable Researcher" at the Institute for Theoretical Physics and Advanced Mathematics Einstein-Galilei.[5] This affiliation underscores a substantial period dedicated to in-depth research in these highly complex areas. His work at the institute involved the development of a novel model for black hole thermodynamics within the framework of quantum gravity, addressing one of the most profound challenges in modern physics: reconciling general relativity with quantum mechanics.[5]

His engagement with theoretical physics is further evidenced by a series of publications listed on INSPIRE-HEP. These publications, spanning from 2012 to 2020, frequently involve collaborations with prominent researchers such as Christian Corda, Reza Katebi, and Seyed Hossein Hendi, indicating an active participation within the theoretical physics community. Several of these publications are also detailed on his ORCID profile.[10] Notable among these are: "Hawking Radiation-Quasi-Normal Modes Correspondence and Effective States for Nonextremal Reissner-Nordström Black Holes" (2014), co-authored with C. Corda, S. H. Hendi, and R. Katebi, which explores the fundamental quantum properties of black holes.[11] Another significant work is "Initiating the Effective Unification of Black Hole Horizon Area and Entropy Quantization with Quasi-Normal Modes" (2014), also a collaborative effort with C. Corda, S. H. Hendi, and R. Katebi, suggesting an attempt to find unifying principles governing black hole behavior.[11] Additionally, "Confusion in Cosmology and Gravitation" (2016), co-authored with C. Corda and R. Katebi, indicates a critical examination of existing theoretical models in these fields.[11] These publications collectively demonstrate a sustained and focused effort to contribute to our understanding of fundamental physics at the highest level.

His research in theoretical physics also extends to the burgeoning field of gravitational wave astronomy. The publication "Interferometric Detection of Gravitational Waves: How Can a Wild Roam Through Mindless Mathematical Laws Really Be a Trek Towards the Goal of Unification?" (2017), co-authored with Christian Corda and Reza Katebi, highlights his engagement with the implications of the first direct detection of gravitational waves (GW150914) for fundamental physics. This work likely explores the profound impact of this experimental confirmation of Einstein's theory of general relativity on the quest for a unified description of the universe's fundamental forces and particles. His contribution to this discourse underscores his awareness of and participation in the most significant developments in modern physics.

A particularly distinctive aspect of Nathan O. Schmidt's research in theoretical physics is his consistent

application and exploration of Santilli's iso-mathematics. This non-standard mathematical framework appears in several of his publications, often indicated by the prefix "iso-".[10] These works include: "Launching the Six-Coloring Baryon-Antibaryon Antisymmetric Iso-Wavefunctions and Iso-Matrices" (2014), "Toward a Topological Iso-String Theory in 4D Iso-Dual Space-Time: Hypothesis and Preliminary Construction" (2014), "Effective Dynamic Iso-Sphere Inopin Holographic Rings: Inquiry and Hypothesis" (2014), "Protium and Antiprotium in Riemannian Dual 4D Space-Time" (2014) co-authored with Reza Katebi, "Initiating a Hypothetical Upgrade to Magnecules with Topological Deformation Order Parameters for Spontaneous Superfluidic Gauge Symmetry Breaking" (2014), "Initiating Santilli's Iso-Mathematics to Triplex Numbers, Fractals, and Inopin's Holographic Ring: Preliminary Assessment and New Lemmas" (2014) co-authored with Reza Katebi, and "Exterior and Interior Dynamic Iso-Sphere Holographic Rings with an Inverse Iso-Duality" (2014).[11] His work also involves using iso-mathematics to propose an upgrade to the magnecule model and to develop a generalized approach for encoding the states of spherically symmetric structures.[5] Furthermore, a 2012 publication titled "Proof of quark confinement and baryon-antibaryon duality: Part 1: Gauge symmetry breaking in dual 4D fractional quantum Hall superfluidic space-time" [10] was published in the Hadronic Journal of Santilli and co-authored with Ukrainian physicist Andrej Inopin prior to Inopin's death. This work likely aligns with the broader framework of iso-mathematics, given its exploration of non-standard mathematical structures in physics and its publication venue. The consistent application of this framework across diverse topics suggests a strong conviction in its potential to provide new insights into fundamental physical phenomena. His repeated collaboration with Reza Katebi on several of these iso-mathematics-related papers indicates a shared and significant research interest in this specific area of theoretical physics.[10]

IV. Investigation of the Magnecule Order Parameter Upgrade Hypothesis

Nathan O. Schmidt's research extends into the realm of sustainable energy through his investigation of the "controversial magnecule model".[5] He has proposed a novel "order parameter upgrade" hypothesis for this model, aiming to contribute to industrial applications in sustainable energy.[5] This work is documented in a publication titled "A Brief Note on the Magnecule Order Parameter Upgrade Hypothesis" (2015). The objective of this research is to enhance the magnecule model by incorporating "topological deformation order parameters (OP) of fractional statistics" to provide a theoretical explanation for "spontaneous superfluidic gauge symmetry breaking".[5] This highly theoretical approach suggests an attempt to provide a more rigorous physical foundation for the magnecule model, which has been discussed in the context of alternative energy solutions.[5]

His investigation into the magnecule model is intrinsically linked to his work on iso-mathematics.[5] He proposes equipping these "iso-chemical creatures" with topological deformation order parameters, further emphasizing the application of this non-standard mathematical framework to this area.[5] This connection is also evident in his 2014 publication, "Initiating a Hypothetical Upgrade to Magnecules with Topological Deformation Order Parameters for Spontaneous Superfluidic Gauge Symmetry Breaking".[11] The mention of "spontaneous superfluidic gauge symmetry breaking" connects this research to concepts from condensed matter physics and high-energy physics, suggesting an attempt to bridge these established areas with the potentially novel magnecule model.[5]

The concept of "order parameters" generally refers to quantitative measures of the degree of order within a physical system. While snippet [9] provides a broader context on "bond-orientational order parameters" in materials science, Schmidt's use of "topological deformation order parameters" within the framework of iso-mathematics likely represents a specialized application of this concept to the magnecule model. Understanding the specifics of this approach would require a deeper examination of his publications in

conjunction with knowledge of the magnecule model and iso-mathematics. His work suggests an interdisciplinary approach that combines unconventional chemical concepts with advanced theoretical physics and non-standard mathematical tools in the pursuit of sustainable energy solutions.

V. Development of Mathematical Frameworks

A significant and recent development in Nathan O. Schmidt's research is the introduction of the "Tri-Quarter Framework," detailed in a preprint dated March 21, 2025, titled "The Tri-Quarter Framework: Unifying Complex Coordinates with Topological and Reflective Duality across Circles of Any Radius". This work outlines a novel mathematical framework designed to unify the three fundamental coordinate systems on the complex plane: complex, Cartesian, and polar. This ambition to find a unifying principle for these essential mathematical tools indicates a deep engagement with the foundations of mathematical representation and analysis.

A key innovation of the Tri-Quarter Framework is the introduction of a new topological property to the circle T_r of radius r > 0, transforming it from a passive boundary into an "active separator with intrinsic directional properties". This suggests a fundamental shift in how circles are viewed and utilized within mathematical and potentially physical models. The framework achieves this unification by integrating a "generalized coordinate system," where the real and imaginary components of complex numbers are assigned unique phase pairs, with a structured orientation. This novel method of representing complex numbers and their geometric interpretations could have significant implications for various fields.

The abstract of the preprint proposes that this framework offers new perspectives on topological separation, orientation, and reflection, potentially simplifying the analysis of systems exhibiting circular symmetry. It specifically suggests potential applications in areas such as black hole physics, connecting back to his earlier research in theoretical physics, and signal processing, indicating a broad envisioned utility for this mathematical tool. The potential significance of this framework lies in its capacity to refine analyses, computations, modeling, and design in fields that heavily rely on complex numbers and the spatial partitioning of the complex domain, offering a more nuanced approach to handling precise boundary conditions and directional properties. A case study focusing on quadrant-based transformations within the framework demonstrates streamlined directional mappings, geometric elegance, unified classification, and computational efficiency in C. Furthermore, Schmidt has developed a software tool to visualize some of the core concepts of the Tri-Quarter Framework, once again highlighting his commitment to bridging theoretical work with practical computational implementation. This recent work is affiliated with Cold Hammer Research & Development , indicating that the development of this mathematical framework is a current research focus of his independent research entity.

The establishment of Cold Hammer Research & Development, where Nathan O. Schmidt serves as the Founder [5], signifies his transition towards independent research and the creation of a dedicated platform for pursuing his diverse scientific interests.[3] This entity appears to be the primary hub for his current research activities, particularly the development and exploration of novel mathematical frameworks such as the Tri-Quarter Framework.

VI. Recurring Themes and Interdisciplinary Connections

A prominent and consistent theme throughout Nathan O. Schmidt's research is the synergistic application of mathematical theory and computational methods. His academic foundation in both Computer Science and Mathematics serves as a powerful engine for his interdisciplinary explorations.[1] This is clearly demonstrated in his development of the "Latin Square Toolbox" for cryptographic analysis and his creation of visualization

software for the "Tri-Quarter Framework". His early engagement with Linux further underscores his strong technical aptitude, which he effectively leverages across his diverse research interests.[1] This ability to seamlessly integrate theoretical frameworks with practical computational tools allows him to approach complex scientific problems from a multifaceted perspective, often leading to innovative solutions and deeper insights. His early academic research at Eastern Oregon University, focusing on neuro-evolution and robotics [4], further exemplifies his commitment to interdisciplinary work, combining computer science principles with biological and engineering concepts.

Another recurring characteristic of his work is a deep fascination with foundational theories and the pursuit of unifying frameworks. His research frequently delves into fundamental questions in both mathematics, such as the nature of coordinate systems as evidenced by the "Tri-Quarter Framework," and physics, including quantum gravity and the fundamental nature of space-time explored through his work on black holes and gravitational waves. His exploration of Santilli's iso-mathematics also suggests a quest for alternative or more encompassing theoretical descriptions of physical phenomena.[11] This consistent focus on foundational principles and the search for connections between seemingly disparate concepts indicates a researcher driven by a profound intellectual curiosity and a desire to contribute to our fundamental understanding of the universe and the mathematical tools we use to describe it.

Schmidt's research is also characterized by a strong propensity for hypothesis-driven and exploratory investigations. Several of his publications and research descriptions explicitly mention the proposal of novel hypotheses, such as the "Magnecule Order Parameter Upgrade Hypothesis" and his work towards a "Topological Iso-String Theory".[5] His willingness to engage with potentially controversial topics like the magnecule model further underscores this exploratory nature.[5] This approach, where new ideas are formulated and investigated as a starting point, is crucial for pushing the boundaries of knowledge and potentially leading to significant breakthroughs in various scientific domains.

Furthermore, his publications in the field of theoretical physics, particularly those concerning black holes, gravitational waves, and iso-mathematics, often involve collaborations with other researchers. This collaborative aspect of his work demonstrates his engagement with the broader scientific community in these specialized areas, suggesting that his research contributes to and is informed by ongoing discussions and peer review within the field. While he now leads his own research entity, his history of collaboration indicates an ability to work effectively within research teams and to contribute to collective scientific endeavors.

VII. Conclusion

In summary, the research work of Nathan O. Schmidt of Boise, Idaho, USA, is characterized by a remarkable degree of interdisciplinarity, spanning neuro-evolution, robotics, cryptography, theoretical physics, sustainable energy, and mathematics. His earliest academic research began at Eastern Oregon University, where he investigated a novel "hybrid approach to neuro-evolution" and worked on robotics.[4] His contributions to cryptography include a detailed Master's thesis on the applications of Latin squares, which involved the development of the "Latin Square Toolbox" for generating and analyzing these algebraic structures, and earlier work on file-system security software. He also built machine learning systems and computational tools from scratch to analyze genome and proteome sequences for the Department of Defense DNA Safeguard Project at Boise State University.[1] In theoretical physics and cosmology, his research encompasses investigations into quantum gravity, black hole thermodynamics, and the implications of gravitational wave detection, often employing and exploring Santilli's iso-mathematics as a foundational framework. Notably, he collaborated with Ukrainian physicist Andrej Inopin (deceased) on a paper concerning quark confinement, published in the Hadronic Journal of Santilli.[10] His foray into sustainable

energy is marked by the proposal of the "Magnecule Order Parameter Upgrade Hypothesis," applying advanced theoretical physics concepts to an unconventional energy model. Most recently, he has introduced the "Tri-Quarter Framework," a novel mathematical tool aimed at unifying fundamental coordinate systems on the complex plane.

The potential impact of his diverse research is significant. His early work in neuro-evolution and robotics demonstrates a foundational interest in complex systems and computational intelligence. His work on Latin squares and cryptography could contribute to advancements in cryptographic design and analysis. His theoretical physics research explores fundamental questions about the universe and has the potential to contribute to our understanding of quantum gravity and related phenomena. While the magnecule model remains controversial, his investigation represents an effort to apply rigorous theoretical frameworks to address critical issues in sustainable energy. The "Tri-Quarter Framework" holds promise for advancing mathematical methodologies and their application across various scientific and engineering disciplines. Given his recent work on the "Tri-Quarter Framework," future research directions will likely involve further development and exploration of this framework, including its applications in black hole physics and signal processing, as well as continued investigations within the diverse areas he has already engaged with through Cold Hammer Research & Development. His interdisciplinary approach and willingness to explore novel and challenging problems suggest that his future contributions will continue to be multifaceted and potentially groundbreaking.

Research Area	**Key Publication/Project Title**	**Year**	**Source**
Neuro-Evolution and Robotics	Hybrid Approach to Neuro-Evolution, Robotics Research	2008	Eastern Oregon University
Cryptography and Latin Squares	Latin Squares and Their Applications to Cryptography (M.S. Thesis)	2016	Boise State University Theses & Dissertations
Cryptography and Latin Squares	Latin Square Toolbox (Software)	Ongoing	GitHub
Bioinformatics and Machine Learning	Analysis of Genome and Proteome Sequences for the DoD DNA Safeguard Project	2008-2012	Boise State University
Theoretical Physics (Quark Confinement)	Proof of quark confinement and baryon-antibaryon duality: Part 1: Gauge symmetry breaking in dual 4D fractional quantum Hall superfluidic space-time	2012	Hadronic Journal

Theoretical Physics (Quantum Gravity)	Hawking Radiation-Quasi-Normal Modes Correspondence and Effective States for Nonextremal Reissner-Nordström Black Holes	2014	Advances in High Energy Physics
Theoretical Physics (Cosmology)	Confusion in Cosmology and Gravitation	2016	International Journal of Theoretical Physics
Theoretical Physics (Gravitational Waves)	Interferometric Detection of Gravitational Waves: How Can a Wild Roam Through Mindless Mathematical Laws Really Be a Trek Towards the Goal of Unification?	2017	FQxI
Theoretical Physics (Iso-Mathematics)	Protium and Antiprotium in Riemannian Dual 4D Space-Time	2014	Hadronic Journal
Sustainable Energy	A Brief Note on the Magnecule Order Parameter Upgrade Hypothesis	2015	AIP Conference Proceedings
Mathematical Frameworks	The Tri-Quarter Framework: Unifying Complex Coordinates with Topological and Reflective Duality across Circles of Any Radius	2025 (Preprint)	ResearchGate

Publication Title	**Year**	**Journal**	**Collaborators**
Proof of quark confinement and baryon-antibaryon duality: Part 1: Gauge symmetry breaking in dual 4D fractional quantum Hall superfluidic space-time	2012	Hadronic Journal	Andrei E. Inopin

Hawking Radiation-Quasi-Normal Modes Correspondence and Effective States for Nonextremal Reissner-Nordström Black Holes	2014	Advances in High Energy Physics	C. Corda, S. H. Hendi, R. Katebi
Initiating the Effective Unification of Black Hole Horizon Area and Entropy Quantization with Quasi-Normal Modes	2014	Advances in High Energy Physics	C. Corda, S. H. Hendi, R. Katebi
Confusion in Cosmology and Gravitation	2016	International Journal of Theoretical Physics	C. Corda, R. Katebi
Interferometric Detection of Gravitational Waves: How Can a Wild Roam Through Mindless Mathematical Laws Really Be a Trek Towards the Goal of Unification?	2017	FQxI	C. Corda, R. Katebi
Protium and Antiprotium in Riemannian Dual 4D Space-Time	2014	Hadronic Journal	R. Katebi

Tool Name	**Key Functionalities**	**Notable Algorithms/Features**
Latin Square Generator (LSG)	Generates Latin squares of a given order	Data Set Preloading (DSP) mode for speed, Super-Symmetric (SS) mode using recursive lifting-and-merging algorithm for prime power orders
Latin Square Transversal Counter (LSTC)	Counts the number of transversals in a set of Latin squares	Requires all input squares to be of the same order
Latin Square Property Checker (LSPC)	Verifies if a given set of squares satisfy the Latin Square Property	Simple checking algorithm
Custom Machine Learning	Analyzes genome and proteome	Built from scratch under Dr. Tim

Systems	sequences	Andersen's advisement

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