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A Brief Course in Noncommutative Physics

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Introduction

The concept of noncommutativity in physics dates back to classical mechanics. Numerous recent advances in theoretical physics and practical applications rely on various noncommutative algebraic methods. Noncommutative algebras, such as the classical Poisson brackets, the Heisenberg algebra, the Lie and Clifford algebras, the Dirac algebra, and the Snyder and Nambu algebras, as well as some important examples of noncommutative algebras, are discussed in this overview. In addition, we present some important examples of noncommutative algebras. Noncommutative structures' potential applications in high-energy physics and gravitational theory are also discussed.

Description

In particular, we go over the Seiberg–Witten map-based formalism for noncommutative quantum mechanics and offer a parameterization scheme for connecting the noncommutative parameters to the Planck length and cosmological constant. In the Schrödinger and Pauli equations, we demonstrate that an effective gauge field arises from noncommutativity. Even for free particles, this term breaks translational and rotational symmetries in the noncommutative phase space, causing quantum fluctuations in velocity and acceleration. For physicists, this review is meant to serve as an introduction to noncommutative phenomenology and the mathematical formalisms that underlie these effects. Different mathematical structures underpin various physical theories.

A symplectic manifold is used to define classical Hamiltonian mechanics, relativistic gravity theories describe the dynamics of pseudo-Riemann geometries, and complex vector spaces are used to define quantum theories. From classical mechanics' descriptions of angular momentum and work to canonical quantum mechanics' Heisenberg algebra and its associated uncertainty relations to more speculative recent theories regarding the noncommutative nature of spacetime at the Planck scale, noncommutativity naturally arises in various formalisms. The Snyder algebra is one of the latter. A pedagogical introduction to noncommutative physics with a strong emphasis on phenomenology is presented in this paper. For fulfillment, thus that the text can be perused as an independent reference, we likewise incorporate brief outlines of the essential numerical formalisms expected to execute noncommutative designs in a scope of model frameworks [1].

The canonical Poisson brackets of classical mechanics, permutation symmetries in statistical mechanics, and the classical and quantum Hall effects are just a few notable examples of noncommutative phenomena in physics. In light of the SW map, we give the Heisenberg portrayal of the Schrödinger, Heisenberg, and Pauli conditions, and think about a few essential properties of the model, including the presence of irregular speed and speed increase terms in the free-molecule elements prompted by the noncommutativity of the foundation. Particle physics and cosmology will benefit from our proposal of a parameterization scheme that links the Planck length and the cosmological constant to the noncommutative parameters of the space–space and momentum–momentum commutators, respectively. New ideas for resolving nature's unsolved puzzles are stimulated by the interaction of physics and mathematics [2].

In this overview, we have provided a succinct introduction to the interaction between physics and mathematics in the areas of noncommutative geometry and noncommutative phase space, which cover topics from quantum mechanics as well as classical physics. Since then, noncommutative structures have sparked daring new efforts to resolve unsolved issues in high-energy theory and gravity, and it is conceivable that their significance to contemporary theoretical physics has only grown since the excitement of the early 20th century.

Physicists have discovered real-world phenomena that can be described by noncommutative algebras and geometries, ranging from the classical Poisson brackets to the Heisenberg commutation relations and the quantum Hall effect. In addition, as we attempt to extend our current physical theories into previously unstudied regimes at the Planck scale, also known as the dark energy scale, infinities and singularities will unavoidably emerge, pointing to new kinds of noncommutative structures that might be capable of treating them. Quantum fluctuations of the spacetime background governed by noncommutative algebras are thought by a growing number of researchers to be capable of preventing the infinities and singularities that break all known physical laws. In this way, noncommutative peculiarities rouse many endeavors to develop a bound together structure for both gravity and high-energy molecule material science [3].

In this overview, we have discussed important examples from condensed matter and statistical physics as well as the fundamental ideas behind noncommutative phenomena in classical and quantum mechanics. The classical Poisson brackets in symplectic geometry, the Heisenberg algebra of fundamental operators acting on the Hilbert space of canonical quantum mechanics, and the Lie, Clifford, and Dirac algebras associated with rotational symmetry and spin were among the fundamental noncommutative algebras that arise in physical theories. The Snyder and Nambu algebras, which have been proposed as extensions of existing physical theories and are intended to aid in curing the emergence of the aforementioned singularities, were also briefly discussed in a theoretical context [4].

Incorporating both momentum–momentum and space–space noncommutativity, we described the fundamental properties and novel phenomena of the noncommutative extension of the Heisenberg phase space on the basis of the SW map. These incorporate the breaking of interpretation and rotational balances, as well as significant phenomenological expectations like the presence of abnormal, stochastic bothers to the speed and speed increase of free particles, initiated by noncommutativity. We demonstrated that the noncommutative terms generate an effective gauge field in the Schrödinger and Pauli equations, which can be viewed as an additional quantum force driving particle motion due to quantum fluctuations in the background geometry. In light of this, we proposed a parametrization scheme for the noncommutative parameters that linked them to the Planck length and the dark energy density—the latter of which is expressed in terms of the cosmological constant The effective gauge field that results from the noncommutativity of the phase space can also be interpreted in terms of the universe's minimum length and energy density using this parametrization scheme. We demonstrated that this results in phenomenologically intriguing effects on the intrinsic stochastic velocity and acceleration perturbations that affect the dynamics of free particles [5].

Conclusion

The noncommutative phase space causes these perturbations, which are quantum effects that are dependent on the initial momentum and position. A microphysical model for dark energy could actually be provided by the quantum anomalous acceleration of free particles.at the same time.

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None.

Conflict of Interest

No conflict of interest.

References

1. Afzal, Usman, Nauman Raza and Isma Ghulam Murtaza. "On soliton solutions of time fractional form of Sawada–Kotera equation." *Nonlinear Dyn* 95 (2019): 391-405.
2. Raza, Nauman, Aly R. Seadawy, Melike Kaplan and Asma Rashid Butt, et al. "Symbolic computation and sensitivity analysis of nonlinear Kudryashov's dynamical equation with applications." *Phys Scr* 96 (2021): 105216.
3. Javid, Ahmad, Nauman Raza and M.S. Osman. "Multi-solitons of thermophoretic motion equation depicting the wrinkle propagation in substrate-supported graphene sheets." *Commun Theor Phys* 71 (2019): 362.
4. Falaye, B.J., K.J. Oyewumi and M. Abbas. "Exact solution of Schrödinger equation with q-deformed quantum potentials using Nikiforov—Uvarov method." *Chin Phys B* 22 (2013): 110301.
5. Yılmaz, Hale, Doğan Demirhan and Fevzi Büyükkılıç. "Solution of the Schrödinger equation for two q-deformed potentials by the SWKB method." *J Math Chem* 47 (2010): 539-547.

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