FAMP Colloquium - Spring 2020

Date and Time: Friday, May 22, 2020 at 2:00 PM

Location: Zoom https://fresnostate.zoom.us/j/93790863658

Title: *Can One Hear the Shape of a Fractal Drum?*

Speaker: Michel L. Lapidus, (American Mathematical Society Associate Secretary for the Western Section, Distinguished Professor of Mathematics, Burton Jones Endowed Chair in Pure Mathematics, University of California, Riverside)

Abstract: A well-known problem in mathematics and physics consists in understanding how the geometry (or shape) of a musical instrument affects it sound. This gives rise to two related types of mathematical problems: direct spectral problems (how the shape of a drum affects its sound) and inverse spectral problems (how one can recover the shape of a drum from its sound). Here, we consider both types of problems in the context of drums with fractal (that is, very rough) boundary. We show, in particular, that one can "hear" the fractal dimension of the boundary (a certain measure of its roughness) and, in certain cases, a fractal analog of its length. In the special case of vibrating fractal strings (the one-dimensional situation), we show that the corresponding inverse spectral problem is intimately connected with the Riemann Hypothesis, which is arguably the most famous open problem in mathematics and whose solution will likely unlock deep secrets about the prime numbers. In conclusion, we briefly explain how this work eventually gave rise to a mathematical theory of complex fractal dimensions (developed by the author and his collaborators), which captures the vibrations that are intrinsic to both fractal geometries and the prime numbers.

Date and Time: Friday, April 17, 2020 at 10:00 AM

Location: Zoom https://fresnostate.zoom.us/j/139040417

Title: *One Observer Universe: A Geometric Interpretation of Speed of Light and Mass*

Speaker: Ahmed Farag Ali (Benha University, Egypt and Quantum Gravity Research, Los Angeles)

Abstract: We investigate how the Rindler observer measures the universe in the ADM formalism. We compute his measurements in each slice of the space-time in terms of gravitational red-shift which is a property of general covariance. In this way, we found special relativity preferred frames to match with the general relativity Rindler frame in ADM formalism. This may resolve the widely known incompatibility between special relativity and general relativity on how each theory sees the red-shift. We found a geometric interpretation of the speed of light and mass.

Date and Time: Friday, April 3, 2020 at 10:00 AM

Location: Zoom https://fresnostate.zoom.us/j/139040417

Title: *Multisoliton Solutions of Manakov System. Effects of External Potentials*

Speaker: Michail Todorov (Technical University of Sofia, Bulgaria and Fulbright Scholar to San Diego State University Mathematics)

Abstract: We detail an asymptotic description of the interaction between N solitons of perturbed nonlinear Schrödinger equation (NLSE), Manakov system and two-component coupled system of nonlinear Schrödinger equations. These equations are perturbed by gain/loss terms, periodic, polynomial, single and composite well (hump) external potentials. The gain and loss are taken to balance so that the solutions do not blow up or decay away. The distance between the solitons is taken to be large, so that they only interact in their tails, which is the basis for the asymptotic analysis. The inverse of this large separation is the perturbation parameter. The evolution of the soliton parameters is governed by a discrete system related to the complex Toda Chain. We derive the corresponding perturbed complex Toda Chain (PCTC) models for both NLSE and Manakov model. We show that the soliton interactions dynamics for the PCTC models compares favorably to full numerical results of the original perturbed NLSE and Manakov model. The cross-modulation in CNSE sets the limits of practical validity of the celebrated Manakov solution and corresponding CTC. In the majority of cases the interaction is ostensibly inelastic: either one of the solitons virtually disappears, or additional solitons are born after the interaction. Since the Manakov system loses its full integrability when the nontrivial nonlinear coupling is present, the approach for its study is numerical.

Date and Time: Friday, March 27, 2020 at 10:00 AM

Location: Zoom https://fresnostate.zoom.us/j/139040417

Title: *Modified Commutators Are Not sufficient to Determine a Quantum Gravity Minimal Length Scale*

Speaker: Michael Bishop, Ph.D. (Department of Mathematics, CSU, Fresno)

Abstract:

Date and Time: Friday, March 6, 2020 at 10:00 AM

Location: Peters Business Building Room 428

Title: *Modified Commutators Are Not sufficient to Determine a Quantum Gravity Minimal Length Scale*

Speaker: Michael Bishop, Ph.D. (Department of Mathematics, CSU, Fresno)

Abstract:

In quantum gravity it is generally thought that a modified commutator of the form $[\hat{x}, \hat{p}] = i\hbar(1+\beta p^2)$ is sufficient to give rise to a minimum length scale. We test this assumption and find that different pairs of modified operators can lead to the same modified commutator and yet give different or even no minimal length. The conclusion is that the modification of the operators is the main factor in determining whether there is a minimal length. This fact - that it is the specific form of the modified operators which determine the existence or not of a minimal length scale - can be used to keep or reject specific modifications of the position and momentum operators in theory of quantum gravity. This is joint work with Jaeyeong Lee and Douglas Singleton from the physics department.

Date and Time: Fridays, February 21 and 28, 2020 at 10:00 AM

Location: Peters Business Building Room 428

Title: *The Path Integral Approach to Quantum Mechanics and the 2-Slit Experiment*

Speaker: Douglas Singleton, Ph.D. and Gerardo Muñoz, Ph.D. (Department of Physics, CSU, Fresno)

Abstract: In this two-talk series, we present how one can formulate ordinary quantum mechanics in terms of the Feynman "sum of paths" approach, i.e., the path integral. In this picture of quantum mechanics a particle will take *every* possible path connecting the beginning and ending points, but with each path weighed by an exponential involving the classical action of the particle. We also discuss some recent work on the quantum 2-slit experiment and the possibility that complex paths play a role in explaining the observed interference pattern. Time permitting, we also intend to discuss the Ahronov-Bohm effect (2-slit experiment with a solenoid between the slits) via the path integral approach.

Date and Time: Friday, February 7, 2020 at 10:00 AM

Location: Peters Business Building Room 428

Title: *Hirota Method for q-Toda Chain*

Speaker: Bayan Kutum (Eurasian National University, Nur-Sultan, Kazakhstan)

Abstract: In this talk, we consider the Toda chain model, which is a non-linear evolution equation is describing an infinite system of masses on a line interacting through an exponential force. We present solutions of the q-Toda chain using the Hirota method, which behave like particles that do not collapse when interacting with each other. This quality can be used to transfer data over long distances with virtually no interference.

Date and Time: Friday, January 31, 2020 at 10:00 AM

Location: Peters Business Building Room 428

Title: *On Generalized Paley-Wiener Theorems*

Speaker: Marat V. Markin, Ph.D.

Abstract: Known descriptions of the *Carleman classes of vectors* of a normal operator in a complex Hilbert space in terms of its spectral measure are extended to the case of a *scalar type spectral operator* in a complex Banach space.

The results can be considered as operator analogues of the classical *Paley-Wiener Theorems* relating the smoothness of the Fourier transform of a square-integrable on the real axis function to its decay at infinity.