AD-A255 983

‖‖‖‖‖‖‖‖‖‖‖‖‖‖

TATION PAGE

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
		FINAL 1 Jul 89 – 30 Sep 92

4. TITLE AND SUBTITLE
"THE CENTER FOR NONLINEAR PHENOMENA & MAGNETIC MATERIALS" (U)

5. FUNDING NUMBERS
61102F
2304/A4

6. AUTHOR(S)
Dr. Tepper L. Gill

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Howard University
ComSERC
Washington DC 20059

8. PERFORMING ORGANIZATION REPORT NUMBER

AFOSR-TR. ᵕ2 0854

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

AFOSR/NM
Bldg 410
Bolling AFB DC 20332-6448

DTIC
SELECTE
OCT 0 2 1992
B

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

F49620-89-C-0079

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release;
Distribution unlimited

12b. DISTRIBUTION CODE

UL

13. ABSTRACT *(Maximum 200 words)*

We have proved existence and obtained estimates for the (finite) Hausdorff and fractal dimensions of global (maximal compact) attractors for the Landau-Lifschitz equations. These are the fundamental equations of the classical theory ferromagnetism. In order to obtain more detailed information about these attractors, we are currently developing approximation methods based on the theory of inertial manifolds. Inertial manifolds are finite dimensional manifolds which attract all solutions at an exponential rate. They contain the global attractor and have the advantage that they are manifolds whereas the attractors generally are not (they can be complicated fractal sets). The equations reduce to a finite-dimensional system of O.D.E.'s on the inertial manifolds. There is a class of calculational methods that have been developed in recent years, called nonlinear or modified Galerkin methods, which are closely related to the concept of inertial manifold and which are especially useful for the long-time integration of nonlinear differential equations. In the usual Galerkin approach, solutions of the nonlinear equation are sought in linear manifolds PuH which are spanned by the eigenfunctions of a linear operator which occurs in the problem. In the case of the Landau-Lifschitz equations, this is the Laplacian.

14. SUBJECT TERMS

15. NUMBER OF PAGES
30

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

FINAL REPORT

JULY 1989 - JUNE 1992

Air Force Contract

F-49620-89-C-0079

92 10 6 063

Introduction

The Center for Nonlinear Phenomena and Magnetic Materials began with support from the Air Force Office of Scientific Research in July 1989. This support was a major factor in the successful bid to obtain the Army High Performance Computing Research Center contract. This contract broadened the mission of the Center and its name was changed to the Computational Science and Engineering Research Center (ComSERC).

Students

Several students were partially supported on this contract. At the award time of this contract Dr. Vernise Steadman was working toward her terminal degree and has subsequently earned her Ph.D. in Mathematics. During the time of support she not only completed her Ph.D. studies but assisted in preparing two papers for publication. Ms. Crystal Cooper was preparing for her qualifying examinations and she is currently completing her Ph.D. research. Ms. Tracey Hill an undergraduate student in electrical engineering was being partially supported by this contract. She completed her B.S.E.E. degree this past May. Mr. Robert Jongwe, completed his masters in electrical engineering, he is currently working on his Ph.D., Mr. Esam Ghanem is a master's degree student who is also partially supported.

Equipment/Software

This contract enabled us to secure a Sun 4/370 Sparcstation (server) which was instrumental in securing additional support from the University to obtain four Sun 4/P60 Sparcstations to expand the Center

Overview

In previous work ([1], [4], [5] ,[6]) we have proved existence and obtained estimates for the (finite) Hausdorff and fractal dimensions of

global (maximal compact) attractors for the Landau-Lifschitz equations. These are the fundamental equations of the classical theory ferromagnetism.

In order to obtain more detailed information about these attractors, we are currently developing approximation methods based on the theory of inertial manifolds. Inertial manifolds are finite dimensional manifolds which attract all solutions at an exponential rate. They contain the global attractor and have the advantage that they are manifolds whereas the attractors generally are not(they can be complicated fractal sets). The equations reduce to a finite-dimensional system of O.D.E.'s on the inertial manifolds .

There is a class of calculational methods that have been developed in recent years, called nonlinear or modified Galerkin methods, which are closely related to the concept of inertial manifold and which are especially useful for the long-time integration of nonlinear differential equations. In the usual Galerkin approach, solutions of the nonlinear equation are sought in linear manifolds $P_\mu H$ which are spanned by the eigenfunctions of a linear operator which occurs in the problem. In the case of the Landau-Lifschitz equations, this is the Laplacian.

In nonlinear Galerkin methods, one looks for solutions in nonlinear manifolds which include corrections to the linear terms. These have cumulative effects when integrated over long time intervals. The relation between the linear terms and the correction terms depend on the equations under investigation. This has been worked out mainly in connection with the Navier- Stokes equations and, to a less extent, the Kuramoto-Sivashinsky equations. We expect that this aspect of the formulation will be quite different for the Landau-Lifschitz equations.

Current and Future Research

In a recent preprint [2], Yin Yan has discussed discretization of the 2-D Navier-Stokes equations by the finite difference method. We are presently formulating a combination of this technique with a nonlinear Galerkin approach to study the Landau-Lifschitz equations.

As a first step, we are using this approach to study approximations for the Galerkin case on a parallelepiped domain with periodic boundary conditions. By using finite difference methods, we can replace the system of P.D.E.'s by a set of O.D.E.'s in the time variable. this is then amenable to numerical solution by use of standard O.D.E. solvers. After this phase is completed, the next step to investigate the various nonlinear (or modified) Galerkin approximations. We are also pursuing a number of theoretical results concerning the approximate inertial manifolds.

In recently completed work [3], we have extended well known estimates of Hausdorff and fractal dimensions of global attractors for autonomous and periodically forced dissipative nonlinear P.D.E.'s in terms of uniform Lyapunov exponents to certain types of nonautonomous equations. In the course of this work, we discovered that very little is known about the detailed structure of invariant sets in nonautonomous cases. In autonomous cases, the simplest structure for global attractors is obtained for gradient systems where, under certain conditions, the global attractor is the union of the unstable manifolds of the equilibrium points of the P.D.E. We are currently investigating the possibility of an analogous gradient structure for a class of nonautonomous dissipative nonlinear P.D.E.'s.

Significant progress was made on researach in the following areas: 1) investigation of the properties of a new class of Banach spaces; 2) use of these spaces to solve a long-standing problem in the mathematical formulation of the nonstationary Navier-Stokes equations for viscous incompressible fluids, viz., the problem of the uniqueness of the Hopf weak solutions. Papers on these topics are now being written. A number of talks were given on these and other topics as indicated in the appendix.

Several seminar series were organized during the years on subjects of Mathematical Physics, Computation Physics, and Signal Processing. A list of speakers and abstracts is given in the appendix.

A workshop on Harmonic Oscillators was organized at the University of Maryland in March. This was a sequel to the "Workshop on Squeezed States and Uncertainty Relations" organized in March, 1991.

Publications

1. T.L. Gill, W.W. Zachary, "Dimensionality of invariant sets for nonautonomous processes", SIAM J. Math. Anal. to appear in September, 1992.

2. _____, "A class of weighted-mean Banach spaces", submitted Bull. AMS.

3. _____, "Uniqueness of Hopf's solutions to the nonstationary Navier-Stokes equations", submitted to the Proceedings, AMS.

4. T.L. Gill and W.W. Zachary, Nonlinear Semigroups, Partial Differential Equations and Attractors, Lecture Notes in Mathematics, 1394, Springer-Verlag (1989).

5. T.L. Gill and Yen-Chou Chu, "Quantum Probability Theory", - submitted to Hadronic J.

6. V. Steadman, T.L. Gill and W.W. Zachary, "Physical Equivalence I" - submitted to Hadronic J.

7.   T.L. Gill and W.W. Zachary, "Physical Equivalence II', - submitted to Hadronic J.

8.   V. Steadman and T.L. Gill, "Hilbert Space Approach to Operator Theory on Banach Space", - in preparation.

9.   T.L. Gill and W.W. Zachary, "Existence and Finite-Dimensionality of Attractors for a System of Equations Arising in Ferromagnetism Nonlinear Analysis, Theory, Methods and Applications, **15**, 405-425 (1990).

10. A.P. Maclin, T.L. Gill and W.W. Zachary (eds) Magnetic Phenomena, Lecture Notes in Physics, **336**, (1989).

11. T.L. Gill and W.W. Zachary, "The Dirac Equation and the Lamb Shift" in Spacetime Symmetries (Y.S. Kim and W.W. Zachary, eds) Nuclear Physics B (Proc. Supp.) **6**, 251-254 (1989).

12. T.L. Gill and W.W. Zachary, "Attractors for the Landau-Lifshitz Equations, Lecture Notes in Physics, Magnetic Phenomena, A.P. Maclin et al (eds), 1989.

13. T.L. Gill and W.W. Zachary, "Existence and Finite-Dimensionality of Universal Attractors for the Landau-Lifshitz Equations of Ferromagnetism", in The Connection Between Infinite Dimensional and Finite Dimensional Systems (B. Nicolaenka, C. Fioas and R. Teman, eds) Contemporaty Mathematics, **99**, 181-212 (1989).

Presentations

1.   W.W. Zachary, "Gradient Structure of Global Attractors for Dissipative Nonlinear Nonautonomous PDE's", II International Wigner Symposium, Goslar, Germay, July 16-20, 1991. (work with T.L. Gill)

2.   T.L. Gill, "F_p spaces and applications to the Feynman integral", Eighth Auburn Miniconference on Real Analysis , Auburn University, Alabama, March 20-21, 1992. (work with W.W. Zachary)

3.   W.W. Zachary, " F_p spaces and uniqueness for the Navier-Stokes equations", Eighth Auburn Miniconference on Real Analysis, Auburn University, Alabama, March 20-21, 1992. (work with t.L. Gill)

4. T. L. Gill, "A Hilbert space setting for Feynman path integrals", Georgia Tech-UAB International Conference on Differential Equations and Mathematical Physics, Goergia Institute of Technology, Atlanta, GA, March 22-28, 1992. (work with W.W. Zachary)

5. W.W. Zachary, "On weak solutions of the incompressible Navier-Stokes equations", Georgia Tech - UAB International Conference on Differential Equations and Mathematical Physics, Goergia Institute of Technology, Atlanta, GA, March 22-28, 1992. (work with T. L. Gill)

6. W.W. Zachary, "Some recent results in Inerse Scattering Theory", IEEE Signal Processing Chapter, McLean, VA, April 15, 1992.

7. T.L. Gill, "Weighted Mean Banach Spaces and Hopf's Solutions to the Navier-Stokes Equations Mathematics Colloquium, University of Iowa, April 7, 1992.

8. T.L. Gill, "Mathematical and Physical Problems in Quantum Electrodynamics", Mathematical Physics Seminar, University of Iowa, April 8, 1992.

9. T.L. Gill, "Weighted Mean Banach Spaces and Uniqueness of Weak Solutions to the 3-D Navier-Stokes Equations", Partial Differential Equations Seminar, University of California, Berkeley, May 21, 1992.

Conference Organization

1. W.W. Zachary, "Workshop on Squeezed States adn Uncertainty Relations", NASA CP-3135, December 1991 (coeditors: Dr. Han, Y. S. Kim).

2. W.W. Zachary, "Workshop on Harmonic Oscillators", University of Maryland, College Park, MD, March 25-28, 1992 (co-organizers: Dr. Han, Y.S. Kim).

SEMINARS SPONSORED BY ComSERC

Held in the Department of Mathematics

October 25, 1991:   Dr. Gerald Chachere, Math Dept., Howard University. Visualization - Improved Marching Cubes.

January 27, 1992:   Dr. Gerald Chachere, Math Dept., Howard University. "An algorithm for box counting in O(n) time".

February 3, 1992:   Dr. Ying-Cheng Lai, Laboratory for Plasma Research, University of Maryland. "The Measure of Nonhyperbolicity in Chaotic Dynamical Systems".

February 10, 1992:   Dr. Tepper L. Gill, Director of ComSERC. "Introduction to Path-integrals and Their Approximation Methods, Part I".

February 24, 1992:   Dr. Tepper L. Gill, Director of ComSERC. "Introduction to Path-integrals and Their Approximation Methods, Part II".

April 1, 1992:   Dr. William Harris, Jr., Math Department, University of Southern California. "Experiments in Theorem Proving Using Symbolic Manipulators".

April 20, 1992:   Dr. Zaven Karian, Math Department, Denison University, Granville, Ohio. "Symbolics in Computational Mathematics and Science".

Held in the Department of Physics:

January 22, 1992:   Dr. Robert Oerter, Bell Lab. "Recent Developments Concerning Bell's Inequality".

January 29, 1992:   Dr. James Gates, Physics Department, Howard University. "Introduction to Strings Part I".

February 5, 1992:   Dr. James Gates, Physics Department, Howard University. "Introduction to Strings Part II".

February 12, 1992:   Dr. James Gates, Physics Department, Howard University. "Introduction to Strings Part III".

March 30, 1992:   Dr. H. Pierre Noyes, Stanford Linear Accelerated Center (SLAC). "On the Measurement of π".

April 9, 1992:   Dr. Leonid Beryland, Math Department, Pennsylvania State University. "Checkerboard Models in

Homogenization Periodic and Continuum Percolation Problems".

April 22, 1992:   Dr. T. Tsang, Physics Department, Howard University. "High-Temperature Superconductivity (HTSC)".

May 6, 1992:   Dr. Ruggero Maria Santilli, President, The Institute for Basic Research. "Isotopic Liftings of Contemporary Relativities for Nonlinear, NonHamiltonian and Dynamic Systems Part I" (Mathematical Foundations).

May 7, 1992:   Dr. Ruggero Maria Santilli, President, The Institute for Basic Research. "Isotopic Liftings of Contemporary Relativities for Nonlinear, NonHamiltonian and Dynamic Systems Part II" (Theoretical Foundations).

May 8, 1992:   Dr. Ruggero Maria Santilli, President, The Institute for Basic Research. "Isotopic Liftings of Contemporary Relativities for Nonlinear, NonHamiltonian and Dynamic Systems Part III" (Experimental Tests).

Held in the School of Engineering:

March 10, 1992:   Dr. James D. Johnston, AT&T Bell Labs. "Digital Speech Processing".

April 9, 1992:   Dr. Raymond Chen, AT&T Bell Labs. "Low bit-rate CELP Coding of Speech".

April 27, 1992:   Dr. Mohammed N. Islam, AT&T Bell Labs. "Ultrafast Logic Gates in a Soliton Ring Network".

Held at the Blackburn Center:

November 14, 1991: Dr. Lawrence R. Rabiner, AT&T Bell Labs. "Current Methods of Digital Speech Processing".

References

[1] T. L. Gill and W. W. Zachary, "Existence and Finite-Dimensionality of Attractors for a System of Equations Arising in Ferromagnetism",(to appear in Nonlinear Analysis, Theory, Methods and Applications 1990).

[2] Yin Yan, "Dimensions of Attractors for Discretizations of the Navier-Stokes Equations ", AHPCRC preprint 91-01.

[3] T. L. Gill and W. W. Zachary, "Dimensionality of Invariant Sets for Nonautonomous Processes", 1990, submitted for publication

[4] T. L. Gill and W.W. Zachary, Nonlinear Semigroups, Partial Differential Equations and Attractors, Lecture Notes Mathematics, **1394**, Springer-Verlag (1989).

[5] T . L . Gill and W . W . Zachary " Existence and Finite-Dimensionality of Univers Attractors for the Landau-Lifschitz Equations of Ferromagnetism", in The Connection Between Infinite Dimensional and Finite Dimensional Systems (B. Nicolaenka, C. Fioas and R. Teman, eds.,) Contemporary Mathematics, 99, 181-212, (1989)

[6] W.W. Zachary and T.L. Gill, " Attractors for the Landau-Lifschitz Equations, Lecture Notes in Physics, Magnetic Phenomena, A.P. Maclin et al (eds), 1989.

Seminar by

Dr. Gerald Chachere

Department of Mathematics, Howard University

on

VISUALIZATION –

IMPROVED MARCHING CUBES

FRIDAY, OCTOBER 25
2:00 - 3:00

TELECOMMUNICATIONS CONFERENCE ROOM
2216 6TH STREET, N.W.
SECOND FLOOR

sponsored by the

Computational Science and Engineering
Research Center

SEMINAR

COMPUTATIONAL SCIENCE

WHEN: Monday, January 27, 1992
WHERE: Mathematics Department
            Room 213 ASB-B
TIME: 4:00 – 5:00 P.M.
SPEAKER: Dr. Gerald Chachere

TOPIC: An Algorithm for Box Counting in $O(n)$ time

ABSTRACT

We will discuss a new algorithm for box counting that runs in $O(n)$ time, where n is the number of points in the box. Box counting is a method used to calculate the capacity dimension of an attractor in nonlinear dynamics.

The purpose of this seminar is to provide a weekly forum for faculty and graduate students with interests in the rigorous application of computational methods to problems in engineering and science.

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750
                  Howard University, Washington, D.C. 20059

SEMINAR

COMPUTATIONAL SCIENCE

WHEN: Monday, February 3, 1992
WHERE: Mathematics Department
            Room 213 ASB-B
TIME: 3:00 – 4:00 P.M.
SPEAKER: Dr. Ying-Cheng Lai
            Laboratory for Plasma Research
            University of Maryland
TOPIC: The Measure of Nonhyperbolicity in
            Chaotic Dynamical Systems

ABSTRACT

In this work, we numerically investigate the measure of nonhyper-
bolicity of chaotic dynamical systems in the parameter range where
there is no attractor. For dynamical processes given by $X_{n+1} = T(X_n, \mu)$,
where X is in the plane and μ is the parameter to be varied, Newhouse
and Robinson proved that if at $\mu = \mu_0$ there exist tangencies between
stable and unstable manifolds for T, then there exists an interval
(Newhouse interval) of nearby μ values for which there are tangencies.
Hence, the tangency parameter values have positive measure. We
numerically compute the measure of the set of nonhyperbolic
parameter values for the Henon map. Similar two-dimensional
diffeomorphisms may arise in the study of Poincare return map for
physical systems. Our results suggest that the Newhouse interval can
be quite large in the parameter space.

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750

SEMINAR
COMPUTATIONAL SCIENCE

WHEN: Monday, February 10, 1992

WHERE: Mathematics Department
Room 213 ASB-B

TIME: 4:00 – 5:00 P.M.

SPEAKER: Dr. Tepper L. Gill
ComSERC

TOPIC: Introduction to Path-Integrals and
Their Approximation Methods, Part I

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750

SEMINAR

COMPUTATIONAL SCIENCE

WHEN: Monday, February 24, 1992

WHERE: Mathematics Department
Room 213 ASB-B

TIME: 4:00 – 5:00 P.M.

SPEAKER: Dr. Tepper L. Gill
ComSERC

TOPIC: Introduction to Path-Integrals and
Their Approximation Methods, Part II

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750

SEMINAR
COMPUTATIONAL SCIENCE

WHEN: **Wednesday, April 1, 1992**

WHERE: **Department of Mathematics**
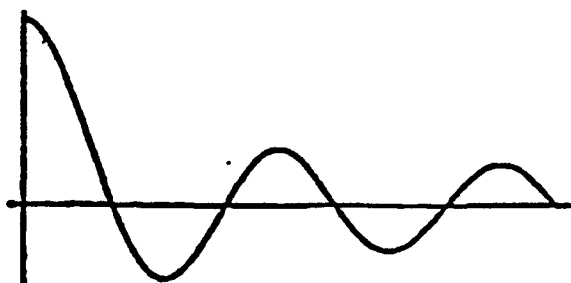   **Room 213 ASB-B**

TIME: **3:00 - 4:00 P.M.**

SPEAKER: **Dr. William A. Harris, Jr.**
                Professor of Mathematics
                University of Southern California
                Sr. Fellow & Director Summer
                Institute - AHPCRC (U. of Minnesota)

TOPIC: **Experiments in Theorem Proving**
                Using Symbolic Manipulators

Abstract

Can powerful symbolic manipulators such as MAPLE and MACSYMA really help in proving theorems about complex situations? We present experiments using these symbolic manipulators to answer the question: "Given that $J_0(x)$ is a solution of the Bessel equation $xf'' + f' + xf = 0$, does $1/J_0(x)$ satisfy a linear ordinary differential equation of any order?" This talk is suitable for undergraduate and graduate students in mathematics, science, and engineering.
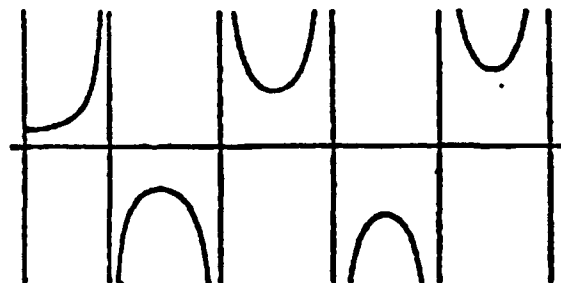
$J_0(x)$ $1/J_0(x)$

SEMINAR
COMPUTATIONAL SCIENCE

WHEN: Monday, April 20, 1992

WHERE: Mathematics Department
Room 213 ASB-B

TIME: 2:00 – 3:00 P.M.

SPEAKER: Dr. Zaven Karian
Denison University
Granville, Ohio

TOPIC: Symbolics in Computational
Mathematics and Science

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Wednesday, January 22, 1992

WHERE: Physics Department
Room 103

TIME: 3:00 – 4:00 P.M.

SPEAKER: Dr. Robert Oerter

TOPIC: Recent Developments Concerning
Bell's Inequality

The purpose of this seminar is to provide a forum for
those faculty and students interested in learning about
some of the most exciting current research level topics
in theoretical and mathematical physics.

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750
Howard University, Washington, D.C. 20059

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: **Wednesday, January 29, 1992**

WHERE: **Physics Department**
Room 103

TIME: **3:00 – 4:00 P.M.**

SPEAKER: **Dr. S. James Gates, Chairman**
Physics Department

TOPIC: **Introduction to Strings**

The purpose of this seminar is to provide a forum for those faculty and students interested in learning about some of the most exciting current research level topics in theoretical and mathematical physics.

CONTACT PERSON: **Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750**
Howard University, Washington, D.C. 20059

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: **Wednesday, February 5, 1992**

WHERE: **Physics Department**
                 Room 103

TIME: **3:00 – 4:00 P.M.**

SPEAKER: **Dr. S. James Gates, Chairman**
                 Physics Department

TOPIC: **Introduction to Strings**
                 Part II

The purpose of this seminar is to provide a forum for those faculty and students interested in learning about some of the most exciting current research level topics in theoretical and mathematical physics.

CONTACT PERSON: **Dr. Tepper L. Gill, Director – ComSERC (202) 806–4750**
                       Howard University, Washington, D.C. 20059

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Wednesday, February 12, 1992

WHERE: Physics Department
Room 103

TIME: 3:00 – 4:00 P.M.

SPEAKER: Dr. S. James Gates, Chairman
Physics Department

TOPIC: Introduction to Strings
Part III

The purpose of this seminar is to provide a forum for
those faculty and students interested in learning about
some of the most exciting current research level topics
in theoretical and mathematical physics.

CONTACT PERSON: Dr. Tepper L. Gill, Director – ComSERC (202) 806-4750
Howard University, Washington, D.C. 20059

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Monday, March 30, 1992
WHERE: Physics Department – Room 103
TIME: 3:00 – 4:00 P.M.
SPEAKER: Dr. H. Pierre Noyes, Stanford Linear Accelerated Center (SLAC)
TOPIC: On the Measurement of π

ABSTRACT

Stillman Drake* has discovered the actual *historical* route by which Galileo arrived at his "times squared law" for free fall. What Drake shows is that Galileo found, *by measurement*, that if the time t_ℓ it takes for a pendulum of a specific length ℓ to swing to the vertical through a small arc is 942 units, then the time t_d it takes a body to fall from rest through a distance equal to that length ($d = \ell$) is 850 units. Although Galileo had no way of knowing this, we now believe that this ratio must be given by

$$\frac{t_\ell}{t_d} = \frac{\pi}{2\sqrt{2}} = 1.1107\ldots$$

"anywhere that bodies fall and pendulums oscillate". Consequently, we can now assert that Galileo's measurement of $942/850 = 1.108$ to four places was the first kinematical measurement of π. His measurement agrees with the currently predicted value to considerably about 0.3 percent accuracy!

Inspired by Stillman Drake's definition of *Galilean Units* as those for which $[L]/[T^2] = (\pi^2/8)g$ where g is any finite, constant acceleration measured in units of $[L]$ and $[T]$, we construct a *kinematical* dimensional analysis based only on two universal, dimensionless constants. For the linear relation between $[L]$ and $[T]$ we use *Einsteinian Units* $[L]/[T] = (1)c$. For orbiting masses negligible compared to some mass unit M, we use *Keplerian Units* based on his second law $\frac{[L^2]/[T] = (1/2\pi)(\hbar}{M)}$. Then the unit for orbital angular momentum is $\hbar$, independent of the mass scale. This allows us to define dimensionless coupling constants $f^2 = \beta = v/c$ where v is the orbital velocity. We find that most of relativistic quantum mechanics requires only kinematical units. *Dynamical* units require a mass scale with universal significance, set by the orbital velocity $v = c$ (or $f^2 = 1$). In dimensional form this becomes $M = (1)(\hbar c/G)^{\frac{1}{2}}$. Assuming baryon number conservation, the fact that the proton is the lightest stable baryon allows us to calculate $\hbar c/Gm_p^2 \approx 1.7 \times 10^{38}$ as the Beckenstein number of the proton — the number of bits of information lost in its formation — and connects our units to the elementary particle mass scale.

---

* Stillman Drake, *Galileo: Pioneer Scientist*, University of Toronto Press, 1990; see in particular the first chapter, p. 8 and the last chapter, p. 237.

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Thursday, April 9, 1992

WHERE: Mathematics Department
Room 213 ASB-B

TIME: 3:00 - 4:00 P.M.

SPEAKER: Dr. Leonid Berlyand
Department of Mathematics
Pennsylvania State University

TOPIC: Checkerboard Models in Homogenization
Periodic and Continuum Percolation
Problems

CONTACT PERSON: Dr. Tepper L. Gill, Director - ComSERC (202) 806-4750
Howard University, Washington, D.C. 20059

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Wednesday, April 22, 1992
WHERE: Physics Department – Room 103
TIME: 3:00 – 4:00 P.M.
SPEAKER: Dr. T. Tsang
           Department of Physics and Astronomy
TOPIC: High-Temperature Superconductivity
           (HTSC)

Abstract

After the initial discoveries in 1986-7 by Bednorz and Muller $\left(La_{2-x}Ba_xO_4 , x \approx 0.15 , T_c \approx 35^{o}K\right)$, Chu and Wu $\left(YBa_2Cu_3O_x , x \approx 7 , T_c \approx 92^{o}K\right)$, and others, there have been tremendous research and development efforts on HTSC. Very recently, HTSC was also found in fullerene alkali metal compounds $\left(Cu_{60}Rb_3 , T_c \approx 28^{o}K\right)$. A general discussion on superconductivity will be followed by specific discussions on HTSC electronic structures $(CuO_2$ planes, copper d-electron and oxygen p-electrons, similarities and differences from other copper oxides), HTSC theories (similarities and differences from BCS theory), HTSC anti-ferromagnetism and other topics.

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Wednesday, May 6, 1992
WHERE: Mathematics Department – Room 213
TIME: 3:00 – 4:00 P.M.
SPEAKER: Ruggero Maria Santilli, President, The
               Institute for Basic Research
TOPIC: Isotopic Liftings of Contemporary
               Relativities For Nonlinear, NonHamiltonian
               and Dynamical Systems – Part I:
               Mathematical Foundations

Abstract

I: MATHEMATICAL FOUNDATIONS
Statement of the problem: Lagrange's and Hamilton's interior dynamical problem for extended particles moving within inhomogeneous and anisotropic material media; identification of the most general possible nonlinear, nonlocal (integral) and nonhamiltonian equations of motion; their inequivalence and irreducibility to the conventional exterior equations of motion in vacuum; expected operator counterpart for deep, mutual overlapping of the wavepackets of particles in the structure of stars and of hadrons. Quantitative treatment via the isotopies of contemporary mathematical structures. Outline of: isounits; isofields; isovector and isometric spaces (isoeuclidean, isominkowski and isoriemannian spaces); isotransformations and isorepresentations; Lie–isotopic algebras, groups, and symmetries; isosymplectic, isoaffine and isoriemannian geometries; isoparallel transport and isogeodesics; axioms–preserving isotopies of classical Hamiltonian mechanics (Birkhoffian mechanics); axioms-preserving isotopies of quantum mechanics (hadronic mechanics). Outline of isogravitations as the most general known nonlinear, nonlocal and nonlagrangian representations of interior gravitational systems capable of recovering identically conventional gravitational models for the exterior problem in vacuum and therefore verifying all available experiments. Prediction of new interior gravitational effects.

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Thursday, May 7, 1992
WHERE: Mathematics Department – Room 213
TIME: 3:00 – 4:00 P.M.
SPEAKER: Ruggero Maria Santilli, President, The Institute for Basic Research
TOPIC: Isotopic Liftings of Contemporary Relativities For Nonlinear, NonHamiltonian and Dynamical Systems – Part II: Theoretical Foundations

Abstract

II: THEORETICAL FOUNDATIONS
Construction of the family of isorotational symmetries as the symmetries of all the infinitely possible ellispoidical deformations of the sphere; prove of their local isomorphism to the conventional symmetry; preliminary applications (representation of monotonic decays of angular momenta of interior trajectories such as a space-ship during re-entry; classical deformation theory; generalization of Euler's theorem to deformable rotating bodies; possible deformation of the charge distribution of hadrons under sufficient external forces and/or collisions with consequential alteration of their intrinsic magnetic moments). Construction of the family of isolorentz and isopoincare symmetries as the most general known nonlinear and nonlocal realizations of the abstract conventional groups; proof of their local isomorphism to the conventional symmetries; axiom-preserving isotopies of the basic postulates of Einstein's special relativity; isotopic SU(3); notions of isoparticle as a generalized hadronic constituent under short range nonlocal-nonhamiltonian interactions (isoquark); preliminary applications (symmetries of conventional exterior gravitations; isosymmetries of interior gravitations; quantitative treatment of relativistic particles or electromagnetic waves propagating within inhomogenerus and anisotropic material media: and others). Unification of linear and nonlinear, local and nonlocal, Hamiltonian and nonhamiltonian, exterior and interior, relativistic and gravitational systems in one, single, abstract structure: the isopoincare symmetry. Outline of a possible isograndunification via the embedding of gravitation and strong interactions in the isotopic generalization of the unit of the electroweak theory.

For further information, please contact Ms. Harley in ComSERC @ (202) 806-4750

SEMINAR

THEORETICAL/MATHEMATICAL/PHYSICS

WHEN: Friday, May 8, 1992
WHERE: Mathematics Department – Room 213
TIME: 3:00 – 4:00 P.M.
SPEAKER: Ruggero Maria Santilli, President, The Institute for Basic Research
TOPIC: Isotopic Liftings of Contemporary Relativities For Nonlinear, NonHamiltonian and Dynamical Systems – Part III: Experimental Tests

Abstract

III: EXPERIMENTAL TESTS.
TEST I: Rauch's interferometric experiments on the apparent deformation of the charge distribution/alteration of the magnetic moment of thermal neutrons under intense, external, nuclear fields; quantitative representation of experimental data via the classical isorotational symmetry; reconstruction of the exact rotational symmetry for the deformed charge distribution; operator formulation. TEST II: Quasars' redshifts; isodoppler's law for the red and blue shift of electromagnetic waves propagating within inhomogeneous and anisotropic media; possible partial origin of the quasars' redshift as due to propagation of light within their hyperdense, inhomogeneous and anisotropic atmospheres; numerical values of the isounit of the quasars atmospheres under the limit assumption that they are at rest with respect to the associated, (conventionally expanding) galaxies (Arp measures). TEST III: experimental verification of the existence or lack of existence of a redshift caused by light propagating within the atmosphere of a member of the Solar system (such as Jupiter or Earth); possible limit values of the redshift suggested by the quasars limit values. TEST IV: behaviour of the meanlife of unstable hadrons with speed; isominkowskian unification of the anomalous behaviour between 35 and 100 GeV (Aronson et al. 1983), and the conventional behaviour between 100 and 350 GeV (Grossman et al. 1987); open experimental issues. TEST V: UA1 experimental data on Bose-Einstein correlation; axiomatic insufficiencies of quantum mechanics for the prediction of correlation; direct representation of correlation via isotopies (hadronic mechanics); exact two-body isorelativistic correlation; relativistic limit and 1.67 correlation upper value; comparison with experimental data; possible meaning of Bose-Einstein correlation as an experimental verification of the hystorical legacy on the ultimate nonlocal structure of strong interactions caused by deep mutual overlapping of the wavepackets of particles.

For further information, please contact Mrs. R. Yolanda Harley in ComSERC @ (202) 806-4750

SEMINAR

WHEN: March 10, 1992

WHERE: School of Engineering
Room 3109

TIME: 2:00 - 3:00 P.M.

SPEAKER: Mr. James D. Johnston
AT & T Bell Labs

TOPIC: Digital Speech Processing

Mr. Johnson has been employed in AT&T-BL since 1976, first in the Acoustics Research Department, and then as a Member of Technical Staff in the Signal Processing Research Department. He has been involved in digital signal processing hardware and speech encoding research, focusing on algorithms that could be realized in real time. His current interests are very high quality speech and music coding at 6.kHz, 15kHz, and 20kHz bandwidths – especially those techniques that take advantage of the limits of the human ear, the measurement of bit rate limits to transparent coding of signals that are to be presented to the human ear, methods of noiseless compression that can be combined with perceptually based coders, ad estimation of masking thresholds for arbitrary audio signals.

CONTACT PERSON: Dr. Tepper L. Gill, Director - ComSERC (202) 806-4750
Howard University, Washington, D.C. 20059

SEMINAR

WHEN: **Thursday, April 9, 1992**

WHERE: **Signal Processing Laboratory**
Room 3109 – School of Engineering

TIME: **11:00 – 12:30**

SPEAKER: **Dr. Raymond Chen**
AT & T Bell Laboratories

TOPIC: **Low Bit-Rate CELP Coding of**
Speech

sponsored by the

Computational Science and Engineering Research Center
and the
IEEE SP Washington Chapter

ComSERC is a member of the Army High Performance Computing Research Center (AHPCRC)

SEMINAR

ULTRAFAST LOGIC GATES IN A SOLITON RING NETWORK

Dr. Mohammed N. Islam
AT&T Bell Lab

Date: April 27, 1992

Time: 4:00 - 5:00pm

Place: School of Engineering

Room: 1002

Ultrafast, all optical soliton- dragging and -trapping logic gates satisfy all requirements for a clocked digital optical processor, have potential speeds of 0.2 terabit-per-second, and have switching energies approaching a picojoule. Combinatorial and sequential circuit using these fiber gates will be described, and attempts at implementing the soliton switches in semiconductor waveguides will be reviewed . As one application of these ultrafast devices, the architecture for a soliton ring network with a peak data rate 100 gigabits-per-second will be detailed. I will speculate on the extension of this work to distributed computing systems and discuss technological challenges and future directions for all- optical switching . Much of this work is at an early stage of research, so the concepts and key issues will be stressed rather than the hardware details.

Contact Person : Dr. Tepper L. Gill , Director -ComSERC (202) 806-475(