TITLES AND ABSTRACTS

for

INVITED PRESENTATIONS

Spin phase space and rotational symmetry for molecular rovibrational dynamics

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Certain patterns of high resolution molecular spectra can be understood and predicted easily by appealing to rotational phase portraits and coset spaces associated with phase trajectories.[1,2] Different spectral patterns can be identified with various representations of a global molecular symmetry induced by local subgroup symmetries of selected semiclassical trajectories. The dynamics of localized rotational wavepackets or generalized coherent states may be associated with the spectral fine structure in each pattern. Recent ultrahigh resolution spectra[3] of SF_6 show effects of "spontaneous" rotational symmetry breaking connected with a $S_6 \supset O_h \supset C_{4v}$ subgroup chain. Related rotational effects are predicted for the icosahedrally symmetric molecules including the reported[4] carbon cluster C_{60}.

Models of anharmonic coupled oscillators and local vibrational modes[5,6,7] can be treated similarly by appealing to a quasi-spin phase space associated with the generators of SU(2) algebra. Dynamical symmetry breaking associated with local modes is analogous to the molecular rotational symmetry breaking. Also, the coupling between vibrational and rotational motions may be described using a multi-sheeted rotational phase portrait. Some peculiar quantum level patterns[2] arising in strong Coriolis coupling models can be related to extraordinary phase paths.

1. W. G. Harter and C. W. Patterson, J. Chem. Phys. 80, 4241 (1984).
2. W. G. Harter, J. Stat. Phys. 36, 749 (1984).
3. Christian Bordé (unpublished).
4. H. W. Kroto, J. R. Heath, S. C. O'Brien, R. F. Curl, and R. E. Smalley, Nature 318, 162 (1985).
5. O. S. van Roosmalen, I. Benjamin, and R. D. Levine, J. Chem. Phys. 81, 5986 (1984).
6. O. S. van Roosmalen, F. Iachello, R. D. Levine, and A. E. L. Dieperink, J. Chem. Phys. 79, 2515 (1983).
7. M. E. Kellman, J. Chem. Phys, 83, 3843 (1985).

Review of Recent Developments in the Use of Symmetries in Reactions

F. Iachello
Yale University

Algebraic Methods in Medium Energy Scattering from Nuclei and Molecules. R. D. AMADO, University of Pennsylvania.
The eikonal approximation combined with an algebraic treatment of target dynamics permits a description of medium energy scattering from complex targets including channel coupling to all orders. Representation matrices of the underlying target dynamical symmetry are used to obtain simple closed form expressions for scattering amplitudes for proton-nucleus and for electron-diatomic and electron-triatomic molecule scattering that agree well with experiment.

INVITED PRESENTATIONS
MONDAY, OCT. 20, MANDELL THEATER
2:30 PM
CHAIRMAN: E. H. LIEB

Algebraic Method for Molecular Structure and Dynamics

R.D. Levine

The Fritz Haber Research Center for Molecular Dynamics
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There is considerable current experimental interest in the spectroscopy of highly excited molecules and in the intra- and inter-molecular dynamics of such energy rich species. It is thus no longer sufficient to employ the harmonic, small amplitude approximation for the vibration nor the rigid rotor for the rotation. An algebraic approach where even in the zeroth order the motion is anharmonic will be discussed and compared with the conventional, geometrical, approach. Current trends, future perspectives and open problems will be summarized.

The dynamics of rotating structures, J. E. Marsden, *University of California, Berkeley*. The methods of Hamiltonian dynamics are applied to the problem of coupled rigid bodies and rigid bodies with attatched rods and plates. In particular, the hamiltonian structure is found using the methods of group theoretical reduction, and stability of equilibria is determined by the energy casimir method and some bifurcation results are obtained using the theory of bifurcation with symmetry. Some comments on chaotic dynamics are given and remarks are made about the applicability to fluid and plasma systems.

INVITED PRESENTATIONS

TUESDAY, OCT. 21, MANDELL THEATER

9:00 AM

CHAIRMAN: J. L. BIRMAN

Icosahedral Alloys: Crystals, Quasicrystals, or Glasses?

Paul Heiney

University of Pennsylvania

"DAS PENTAGRAMMA MACHT DIR PEIN?" *)

VIOLATION OF PERIODIC SYMMETRY IN QUASI-CRYSTALS **)

P. KRAMER, Institut für Theoretische Physik der Universität Tübingen, F.R.G.

In November 1984, D. Shechtman, I. Blech, D. Gratias and J.W. Cahn /1/ reported on a phase of the alloy Al-Mn which shows a sharp diffraction pattern of icosahedral point symmetry. This result excludes periodic symmetry and implies a new type of non-periodic order. Theoretical studies on non-periodic space fillings were reported before this discovery by Kramer and Neri /2,3/. The basic concepts of the theory are reviewed, and progress in the theoretical and experimental work on quasicrystals is reported.

/1/ Shechtman, D., et al. Phys.Rev.Lett.53 (1984)1951-1953 /2/ P. Kramer and R. Neri, Int.Coll. on Group Theor. Methods in Physics, Trieste 1983 /3/ P. Kramer and R. Neri, Acta Cryst.A40(1984)580-587

*) J.W. von Goethe, Faust, part 1, verse 1396

**) Work supported by the Deutsche Forschungsgemeinschaft

The Growth of Quantum Crystals

Viet Elser
AT&T Bell Laboratories

INTRODUCTION TO THE PHYSICS OF QUASICRYSTALS

Abstract of Invited Talk for XV International Colloquium on Group Theoretical Methods in Physics

Paul J. Steinhardt
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University of Pennsylvania
Philadelphia, PA 19104

Quasicrystals are solids which exhibit long range quasiperiodic translational order and long range orientational order with symmetry that is disallowed for conventional crystals. Recently, new metallic alloys have been discovered which appear to be examples of icosahedral quasicrystals. The defining structural and symmetry properties of quasicrystals will be briefly introduced. In particular, broken translational symmetry will be shown to lead to extra degeneracy of the ground state and extra hydrodynamic degrees of freedom (phasons) compared with conventional crystals. The physical intepretation of the phasons and their predicted effects on the growth, atomic structure and elastic properties of quasicrystals will be discussed and compared with recent experimental results.

INVITED PRESENTATIONS
TUESDAY, OCT. 21, MANDELL THEATER
2:30 PM
CHAIRMAN: P. CVITANOVIC

Number of Periodic Windows in One-Dimensional Mappings and Group Theory. Bai-Lin Hao, Institute of Theoretical Physics. The number of periodic windows in one dimensional mappings, or the number of zeros of some set of composite functions in a certain range, is related to a combinatorial problem solved by mathematicians long ago. However, to apply their results one must be careful in choosing the correct group, as is shown in the example of the antisymmetric cubic map.

INVITED PRESENTATIONS
WEDNESDAY, OCT. 22, MANDELL THEATER
9:00 AM
CHAIRMAN: B.-L. HAO

Renormalization Approach to Chaos

P. Cvitanovic
Nordita

CHAOS IN THE TRANSITION FROM CLASSICAL TO QUANTUM MECHANICS

Martin C. Gutzwiller
IBM T.J.Watson Research Center, Yorktown Heights, N.Y.10598

Conservative dynamical systems with few degrees of freedom come in four varieties all of which are represented by variations of hydrogen. The isolated atom is superregular in complete analogy to the geodesics on a sphere. The positive ion of the hydrogen molecule is simply regular (integrable, separable) as the geodesics on an ellipsoid. In a magnetic field, the H-atom becomes mildly chaotic as the motion of the moon around the earth. For a donor impurity in a semiconductor, however, with an anisotropic mass-tensor, chaos becomes harsh as for the geodesics on a surface of negative curvature. The connection between classical and quantum behavior can be established only through the trace formula which relates the energy spectrum to the collection of periodic orbits. Group theory is essential in proving the trace formula to be an identity. In the Anisotropic Kepler Problem, one has to settle for less; but the problem now becomes to understand why a sensible spectrum should result from the sum over periodic orbits. The detailed statistical distribution of their lengths seems to be responsible, a property which one could call their third entropy, in addition to their metric and topological entropies.

Quasiperiodicity, Chaos and Turbulence in Mercury and Helium Experiments

A. J. Libchaber
University of Chicago

Characterization of Strange Sets

M. J. Feigenbaum
Cornell University

INVITED PRESENTATIONS
THURSDAY, OCT. 23, MANDELL THEATER
9:00 AM
CHAIRMAN: P. KRAMER

Generalized Symmetries

Peter J. Olver
University of Minnesota

Abstract:

Generalized symmetries (also known as "Lie-Bäcklund transformations") were introduced by E. Noether in her seminal paper on conservation laws, but have only recently come to the forefront of research into the symmetry properties of partial differential equations. This talk will survey the basic theory of generalized symmetries and recursion operators, and discuss a number of their applications to the differential equations of mathematical physics. These will include connections with soliton equations, conservation laws and the general form of Noether's theorem, Hamiltonian systems, and methods of constructing explicit solutions to systems of partial differential equations, including separation of variables and partial invariance. Recent applications to the equations of elasticity, Maxwell's equations, the equations of gas dynamics, etc. will be touched on.

Title to be Announced

A. Deprit
National Bureau of Standards

New Results in the Application of Group Theory to Differential Equations

P. Winternitz
University of Montreal

Dynamical Symmetries in Collective Nuclear Structure Physics

C.-L. Wu
Jilin University

INVITED PRESENTATIONS

FRIDAY, OCT. 24, MANDELL THEATER

9:00 AM

CHAIRMAN: J. MANDULA

Title to be announced

E. Witten

Institute for Advanced Study

Approximate Global Summetries of the Electroweak Interactions, H. Georgi, Harvard University and Boston University. I discuss and exemplify a simple explanation for the approximate symmetries of the electroweak interactions that arises naturally in models in which the quarks, leptons, and Higgs particles are all composite states of strongly interacting fermions.

Title to be announced

L. Sulak

Boston University

Title to be announced

C. N. Yang

S. U. N. Y., Stony Brook