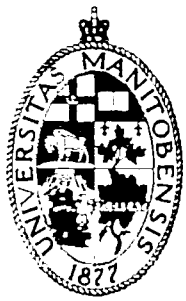
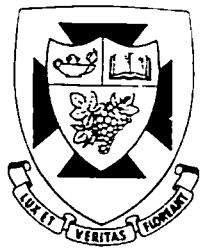


WINNIPEG INSTITUTE FOR THEORETICAL PHYSICS



ANNUAL REPORT

Sept. 1990 - Aug. 1991

WITP ANNUAL REPORT

Sept. 1990-Aug. 1991

CONTENTS:

1. INTRODUCTION

The community of theoretical physicists in Manitoba has grown significantly in the past few years. The combined group of 13 theorists (1 at AECL, Pinawa, 1 at Brandon University, 8 at the University of Manitoba and 3 at the University of Winnipeg) comprises one of the largest active Theoretical Physics groups in the country. This strong research environment has recently been enhanced by the formation of the Winnipeg Institute for Theoretical Physics, using seed money from both the University of Manitoba and the University of Winnipeg. The purpose for the Institute was to increase the cooperation and collaboration between the Theoretical Physicists in Manitoba, thereby strengthening the community, and to initiate and sustain research collaborations between the members of the Institute and first class researchers from all over the world. The activities of the Institute will also help to expose the graduate students of its Members to different people and ideas, through seminars and lecture series, thereby increasing the quality of training provided, and in the long term also attracting further high quality students from Canada and abroad.

The specific functions of the Institute are to fund both short and long term visitors to Winnipeg by recognized national and international experts in various areas of Theoretical Physics, and to coordinate and fund the organization of national and international workshops and/or conferences on topics of interest to the members.

The academic year 1990-91 was the first year of operation of the Institute, and as seen in the following report, it was a very active and successful year. The Institute funded numerous long and short term visitors, who gave a total of 14 seminars throughout the year. In addition an International Workshop on Quantum Cluster Embedding in Crystals was held at the University of Manitoba, and the 4th Canadian Conference on General Relativity and Relativistic Astrophysics was held at the University of Winnipeg. The Institute Director for the 1990/91 academic year was Byron Southern, and Gabor Kunstatter has taken over as Director starting September 1991.

The following pages summarize the activities of the Winnipeg Institute for Theoretical Physics during the 1990/91 academic year. For further information about the Institute and its activities contact the Director, Winnipeg Institute for Theoretical Physics at either address given below:

Physics Department		Physics Department
University of Manitoba		University of Winnipeg
Winnipeg, Manitoba	*or*	Winnipeg, Manitoba
CANADA R3T 2N2		CANADA R3B 2E9
Phone: (204)-474-9817		Phone: (204)-786-9852
Fax: (204)-269-8489		Fax: (204)-786-1824

2. LIST OF MEMBERS (September, 1991)

1. Permanent Members

- B. Bhakar[1], *Ph.D.(Delhi)*
- P.G. Blunden[1], *Ph.D.(Queen's)*
- R.L. Kobes[2], *Ph.D.(Alberta)*
- G. Kunstatter[2], *Ph.D.(Toronto)*
  Director, 1991/92
- P.D. Loly[1], *Ph.D.(London)*
- T.A. Osborn[1], *Ph.D.(Stanford)*
- B.W. Southern[1], *Ph.D.(McMaster)*
  Director, 1990/91
- J.P. Svenne[1], *Ph.D.(M.I.T.)*
- J.M. Vail[1], *Ph.D.(Brandeis)*
- D.W. Vincent[2], *Ph.D.(Toronto)*
- J.G. Williams[3], *Ph.D.(Birmingham)*
- C.H. Woo[4] *Ph.D.(Waterloo)*
- J.A. Zuk[1], *D.Phil.(Oxford)*

[1] University of Manitoba

[2] University of Winnipeg

[3] Brandon University

[4] AECL, Pinawa

2. **Associate Members**

- Y. Achiam *(Visiting Professor from Aug. '91-July '92)*
- C.L. Canton *(Postdoctoral Fellow)*
- V. Cherepanov *(NSERC International Fellow)*
- P. Kelly *(Postdoctoral Fellow)*
- F. H. Molzahn *(Research Associate)*
- A. Mogilner *(Postdoctoral Fellow)*
- A.S. Raskin *(Research Associate)*
- T. Treml *(Postdoctoral Fellow)*

3. **Graduate Students** *(Supervisor in Brackets)*

- R. Epp (Ph.D.), *(Bhakar & Kunstatter)*
- K. Mak (Ph.D.), *(Kobes & Kunstatter)*
- J. Wang (M.Sc.), *(Kobes)*
- Yu Wen (M.Sc.), *(Svenne)*
- R.J. Lee (M.Sc.), *(Southern)*
- Guo Lan (M.Sc.), *(Southern)*
- S. Cyr (Summer), *(Southern)*
- Z. Yang (M.Sc.), *(Vail)*

3. RESEARCH INTERESTS OF PERMANENT MEMBERS

B. Bhakar:

Present activities are directed towards understanding of completely integrable and non-integrable field theories in low [(1+1) and (2+1)] dimensions. Therefore, investigations are being carried out to study the behaviour of spin chain models on a lattice in (1+1) dimensions with nearest neighbour interactions only. These models are closely related to nonlinear sigma models.

P.G. Blunden:

Electromagnetic interactions in complex and few-nucleon systems are being studied. I am particularly interested in the description of electron scattering at large energy and momentum transfers, the so-called quasi-elastic region, in which one or more constituents are knocked out of the nucleus. In this kinematical regime one can explore different aspects of the nuclear response to learn about two-nucleon correlations, two-body electromagnetic currents, the role of nucleon substructure, and the momentum distribution of the initial struck nucleon.

Another area of interest is in a quantum field theory of mesons and hadrons (QHD). Some of the topics under current investigation include: Dirac-Hartree-Fock calculations for the properties of finite nuclei; hadronic and electromagnetic reactions; a relativistic treatment of mesonic currents; and exact and approximate treatments of the negative energy Dirac sea in finite nuclei.

R.L. Kobes:

The general area of research is quantum field theory at finite temperature and density, with applications in both particle and condensed matter physics. We are presently interested in three specific problems: a study of properties of high temperature gauge theories such as the quark–gluon plasma, a general investigation of calculational methods in finite temperature field theory, and a study of the proximity effect between layers of superconducting materials in structures such as superlattices.

G. Kunstatter

Gauge theories provide the theoretical basis for virtually all phenomenological descriptions of the fundamental interactions. They are also playing an increasingly important role in our understanding of certain condensed matter systems. The quantization of gauge theories is however complicated by the presence of unphysical modes in the classical description, which must be factored out in order to expose the true physical content of the theory. My current research uses geometrical techniques to investigate questions concerning gauge dependence in quantized gauge theories such as Quantum Chromodynamics, Chern-Simons theory and Quantum Gravity, both at zero and finite temperature.

P.D. Loly:

Periodic Systems: I now operate two major themes, one with a nearly-free-electron flavour, and the other concerned with excitations in magnets which has more of a tight-binding flavour.

Quantum Well Spectra: Very recently pdf Alex Mogilner and I have resolved the recurring question of zero-energy gaps in 1D bandstructures by using quite general analytical results for the eigenvalues of "oscillatory" matrices. This exciting development facilitates another paper, extending some explicit calculations of the energy bands of a number of earlier "exactly soluble" potentials. In 2D and 3D we will use analogues of the Kronig-Penney potential to study bandstructures of mesoscopic ultrasmall quantum box structures now etched routinely in AlGaAs in semiconductor heterostructures which caught our interest as an application of our multi-dimension nearly-free-electron code.

T.A. Osborn:

A principal research interest is the investigation of quantum (and classical) evolution in a variety of gauge theories. Using the methods of mathematical physics, the goal is to describe the dynamics of these strongly interacting systems by the development of non-perturbative analytically explicit approximate solutions. The usefulness of such an approximate dynamics is that it allows detailed physical insights into the fundamental structure of the system as well as the computation of all observables of interest (such as the stress-energy tensor). For example, the large mass semi-classical expansion of the propagator for an N-body system coupled via the Lorentz force to an arbitrary external electromagnetic field has been recently shown to admit an asymptotic expansion in the reciprocal mass. This expansion is valid to infinite order in the external fields, is manifestly gauge and Lorentz invariant, possesses simple expansion coefficients, and has an a priori determined error bound. The extension of this type of semi-classical description to characterize relativistic quantum theories evolving on Riemannian and pseudo-Riemannian spacetime manifolds and interacting with Yang-Mills fields is currently underway.

B.W. Southern:

The nature of excitations in both regular lattices and disordered systems is being investigated using scaling techniques. Quantum spin chains are being studied in an attempt to understand the differences between integer and half-integer spin systems. A study of the effects of disorder on the nature of phase transitions is also in progress. The disorder can be due to the fact that the degrees of freedom in the problem are not located at the sites of a perfect crystal or due to the fact that the interactions have a distribution of possible values. Both real space renormalization group methods and transfer matrix methods are used to study the relationship between the critical exponents of Ising models on these structures and the geometrical properties, and to explore questions about universality in these systems.

J.P. Svenne:

The investigation on the $\pi - NNN$ system has concerned up to now the absorption channel. Absorption amplitudes have been derived for the pion-induced break-up of the ^3He target into both two clusters and three free nucleons. Both one- and two-body elementary absorption mechanisms have been considered and harmonized with a dynamically correct few-body theory. As a consequence it is now possible to calculate absorption contributions in which the energy and momentum of the incoming pion are shared among all the three nucleons. Finally Weinberg's quasiparticle expansion has been employed for the reduction of the multi-dimensional Faddeev-Alt-Grassberger-Sandhas equations into an effective two-body, Lovelace-type equation. The numerical reliability of Weinberg's expansion has also been studied.

Presently we are investigating the numerical treatment of the equations leading to the above-mentioned three-body contributions and the possible generalization of the present work towards a unitary description of the $\pi NNN - NNN$ System.

John M. Vail:

My research is concerned with developing and applying methods to simulate the properties of solid materials. Reliable simulation is an important complement to experiment in studying material properties where subtle variations of chemical composition, crystal structure, electronic configuration, and disorder are crucial, or where time scales, and temperature and pressure regimes are experimentally inaccessible. In 1984, with collaborators, we made a major advance in the atomistic simulation of point defects in ionic materials by combining accurate electronic structure methods for the defect with total energy analysis of the crystal. The method includes consistent boundary conditions, the quantum-mechanical ion-size effect, and lattice distortion and polarization, and is embodied in an automated user-friendly program. The method has been applied to optical and spin resonance properties of color centers and impurities, derivation of effective interatomic forces, hole trapping by impurities in oxides, and quantum diffusion.

Four projects are currently in progress: (1) simulation of complicated impurity F-type centers, such as $(F_2^+)^*$ in NaF:Mg; (2) overlap effects from the embedding region in the simulation of defects by small clusters (collaboration at Virginia Commonwealth University); (3) simulation of ultrafine particles of insulating materials (collaboration at Michigan Technological University); (4) a study of the effect of impurities on property changes in metals due to irradiation damage (collaboration with AECL, Pinawa).

D. Vincent:

My general research interests lie in gravitation theory and early universe cosmology. I am currently involved with calculations on multidimensional cosmology solutions of Einstein's equations which have relevance to the cosmological constant problem and the Anthropic Principle. I am also investigating bubble solutions in 2+1 gravity using

Ashtekar's gravitational formalism.

J.G. Williams:

One of the developing trends in general relativity has been the interest in global, as opposed to local, properties of spacetime. My current research uses techniques of differential geometry and algebraic topology to study general relativistic metrics that represent homotopically nontrivial light cone configurations on spacetime manifolds that can be either simply or multiply connected. Progress to date includes the discovery of a number of perfect fluid solutions to the classical Einstein equations representing such twists in the light cone field. Work in 2+1 dimensions has demonstrated the existence of similar interesting solutions for the Einstein-Maxwell equations for a fluid with rotation and electric charge. For (2+1)-dimensional relativity, the manifold that forms the range of mapping for the light cone field has no natural group structure and is merely a *set.* Because of this, the homotopy analysis of the metric tensor bundle is considerably more complicated than in the usual (3+1)-dimensional case, and new kinds of topological invariants have been shown to arise. Future effort will be directed towards studying the quantization of scalar fields in these kinds of non-globally hyperbolic spacetimes.

J.A. Zuk

The methods of quantum field theory are applied to problems in both condensed matter and elementary particle physics. In condensed matter physics, attention is focused on conductance and conductivity of electrons in disordered media, where such systems are described by random Hamiltonians. The general technique employs the representation of transport coefficients in terms of a generating functional involving integration over both commuting and anti-commuting variables. The direct ensemble averaging of the generating functional maps the problem onto a theory of interacting graded matrices of the non-linear sigma-model type. Applications include universal conductance fluctuations and Aharonov-Bohm oscillations in mesoscopic systems. Also amenable, is the study of the integer quantum Hall effect from the point of view of localization theory, in terms of an effective non-linear sigma-model with topological term, defined on a supersymmetric coset manifold.

In particle physics, the emphasis is on the construction and analysis of low-energy effective theories of fundamental interactions. Therefore, methods for the derivative expansion of the effective action, and other non-local approximation schemes, are investigated. In particular, attention is focused on fermion contributions to the effective action which can give rise to topological effects such as anomalies, Wess-Zumino terms, charge fractionization, etc. One application of such ideas is the derivation and analysis of a chiral-soliton theory of the nucleon form the large-N_c, low-energy limit of QCD.

4. PUBLICATIONS OF MEMBERS

(a) Refereed Journals

1. **P.G. Blunden** and D.O. Riska, (1991), "The isoscalar electromagnetic current foperator and the nucleon-nucleon interaction," to appear in Nuclear Physics A.
2. **P.G. Blunden** and E.J. Kim, (1991), "One-pion exchange currents in the QHD formalism," (1991), Nucl. Phys. **A531**, 461-477.
3. **V.B. Cherepanov**, (1991), "On the threshold of parametric instability of spin waves in a film with rough surface," J. Appl. Phys., **69**, 5733.
4. **V.B. Cherepanov**, (1991), "On time dependence of spin wave damping in short pulses," J. Appl. Phys., **69**, 6216.
5. **V.B. Cherepanov**, I.V. Kolokolov and V.S. L'vov, (1992), "The saga of YIG or spectra, thermodynamics, interaction and relaxation of magnons in a complex magnet, Phys. Reports (to appear).
6. **R. Kobes**, (1991), "Feynman rules for response functions at thermal equilibrium", Phys. Rev. B (to appear).
7. **R. Kobes**, (1991), "Comment on : Causal structure of the thermal propagator in real time formalisms", Z. Phys. C (to appear).
8. **R. Kobes**, (1991), "Three-point function at finite temperature in the real time formalism", Phys. Rev. Lett. **67**, 1384–1387.
9. **R. Kobes**, (1991), "Retarded functions, dispersion relations, and Cutkosky rules at zero and finite temperature", Phys. Rev. **D43**, 1269–1282.
10. **R. Kobes**, (1990), "Correspondence between imaginary time and real time finite temperature field theory", Phys. Rev. **D42**, 562–572.
11. **R. Kobes, G. Kunstatter** and A. Rebhan, (1991), "Gauge dependence identities and their application at finite temperature", Nucl. Phys. **B355**, 1–37.
12. **R. Kobes, G. Kunstatter** and A. Rebhan, (1990), "QCD plasma parameters and the gauge dependent gluon propagator", Phys. Rev. Lett. **64**, 2992–2995.
13. A. Burnel, **R. Kobes, G. Kunstatter**, and K. Mak, (1990), "Quantization of Yang–Mills fields in a general class of linear gauges", Ann. Phys. **204**, 247–280.
14. P. Ellicott, **G. Kunstatter** and D.J. Toms, (1991) "Geometrical Interpretation of the Functional Measure for Supersymmetric Gauge Theories and of the Gauge Invariant Effective Action", Annals of Physics **205**, 70-109.
15. J. Gegenberg, **G. Kunstatter** and H.P. Leivo, (1990) "Topological Matter Coupled to Gravity in 2+1 Dimensions", Phys. Letts. B252, 381-386.
16. A.N. Melnikov, **A.I. Mogilner**, (1991), "A generalization of the Iorrio-O'Carrol theorem to the case of lattice Hamiltonian," J. Phys. A24, 3671-3676.

17. **A.I. Mogilner**, (1991), "Hamiltonians in Solid State Physics as Multiparticle Discrete Schredinger Operators: Problems and Results," Advances in Soviet Math. 5, 139-194 (AMS Publ., Providence).

18. **A.I. Mogilner**, R.A. Minlos, "Some estimates of the spectrum of quasi-particle system," J. Math Phys. (to be published).

19. F.H. Molzahn, **T.A. Osborn** and S.A. Fulling, (1991), "Multi-scale semiclassical approximations for Schrodinger Propagators on Manifolds," Annals of Physics, 39 pages (in press).

20. A. Saksena, **T.A. Osborn** and F.H. Molzahn, (1991), "An Asymptotic Analysis of Quantum Evolution with Electromagnetic Fields," J. Math. Physics **32**, 938-955.

21. F.H. Molzahn, **T.A. Osborn** and S.A. Fulling, (1990), "Gauge Invariant Asymptotic Expansion for Schrodinger Propagators on Manifolds," Annals of Physics **204**, 64-113.

22. R.A. Corns and **T.A. Osborn**, (1990), "Representations of relativistic propagators for systems with Non-Abelian interactions," J. Math. Phys. **31**, 901-915.

23. A.J.M. Medved, **B.W. Southern** and D.A. Lavis, (1991), "Two-magnon states of the alternating- bond ferrimagnetic chain," Phys. Rev. **B43**, pp. 816-824.

24. M.B. Wango, J. Birchall, J.S.C. McKee and **J.P. Svenne**, (1990), "Evidence for Three-Body Forces on p-d Breakup at 25 MeV?," Canadian Journal of Physics **68**, 1200-1202.

25. J. Meng, P. Jena and **J.M. Vail**, (1990), "Hole Trapping in $Li_xNi_{1-x}O$," Journal of Physics: Condensed Matter **2**, pp. 10371-10377.

26. J. Meng, **J.M. Vail**, A.M. Stoneham and P. Jena, (1990), "Charge-state stability of Ni and Cu impurities in MgO," Physical Review B**42**, pp. 1156-1162.

27. **J.M. Vail**, (1990), "Theory of electronic defects: applications to MgO and alkali halides," invited paper, Journal of Physics and Chemistry of solids **51**, pp. 589-607.

28. K.A. Dunn, T.A. Harriott and **J.G. Williams**, "Toy model for gravitational kinks", J. Math. Phys. (to appear).

29. **J.G. Williams** and P. Zvengrowski, "Kinks in (2+1)- dimensional space-time", J. Math. Phys. (to appear).

30. **J.G. Williams**, K.A. Dunn and T.A. Harriott, (1991), "Kink number in general relativity," Journal of Mathematical Physics, **32** 476-479.

31. **J.G. Williams**, (1991), "Combed hedgehog kink metric in 2+1 dimensions," General Relativity and Gravitation, **23**, 181-187.

32. **J.A Zuk**, (1991), "Regularization of the vacuum energy in the chiral soliton model as an energy- eigenvalue sum," Physical Review **D43**, 1358.

33. I. Adjali, I.J.R. Aitchison and **J.A. Zuk**, (1991), "On an approximation for Casimir energies, with application to the self-consistent soliton of the effective chiral action," Physics Letters **B256**, 497.

(b) **Articles in Books and Conference Proceedings**

1. **R. Kobes**, (1991), "Gauge independence of the plasmon pole", in *The Proceedings of the Brookhaven workshop on hot QCD* (World Scientific, to appear).
2. **R. Kobes**, (1991), "Comparing graphs in the imaginary time and real time formalisms", in *Thermal Field Theories : Proceedings of the 2nd Workshop on Thermal Field Theories and their Applications*, edited by H. Ezawa, T. Arimitsu, and Y. Hashimoto, (Elsevier, Amsterdam, 1991), 153–162.
3. **R. Kobes, G. Kunstatter**, and A. Rebhan, (1991), "Gauge independence of the gluon propagator poles and QCD plasma parameters", in *The Proceedings of the 25th International Conference on High Energy Physics*, edited by K.K. Phua and Y. Yamaguchi, (World Scientific, Singapore, 1991), Vol. I, 414–417.
4. **R. Kobes and G. Kunstatter**, (1990), "Gluon response functions in non-covariant gauges", Lecture Notes in Physics **361**, 272–284.
5. J. Gegenberg, **G. Kunstatter** and H. P. Leivo, "A Solvable Theory of Topological Matter Coupled to Gravity in 2+1 Dimensions", Proceedings of the 25th Rochester Meeting on High Energy Physics, eds. K.K. Phua and Y. Yamaguchi, (World Scientific, Singapore, 1991).
6. J. Gegenberg, P.K. Kelly, **G. Kunstatter**, R.B. Mann, R. McArthur and **D. Vincent**, "The Weyl Anomaly in Algebraically Extended Bosonic Sigma Models", Proceedings of the Third Canadian Conference on General Relativity and Relativistic Astrophysics, eds. A. Coley, F. Cooperstock and B. Tupper (World Scientific, Singapore 1990) p. 127-131.
7. J. Gegenberg and **G. Kunstatter**, "A Two-Dimensional Sigma Model for Conformally Invariant Spherically Symmetric Gravity", Proceedings of the Third Canadian Conference on General Relativity and Relativistic Astrophysics, eds. A. Coley, F. Cooperstock and B. Tupper (World Scientific, Singapore, 1990) p. 117-121.
8. **G. Kunstatter** "Geometrical Approach to the Effective Action", in *Gravitation*, eds. R. Mann and P. Wesson (World Scientific, Singapore, 1991), pp. 356-400.
9. J. Gegenberg, **G. Kunstatter** and H.P. Leivo, "The Gravitational Interaction in 2+1 Dimensions", in *Gravitation*, eds. R. Mann and P. Wesson (World Scientific, Singapore, 1991), pp. 233-245.

10. **G. Kunstatter**, "Path Integral for Gauge Theories: a Geometrical Approach", Proceedings of Journees Relativistes, Cargese, May 1991 (to appear).
11. **G. Kunstatter**, "The Great Plasmon Puzzle Resolved", Proceedings of the Workshop on Heavy Ion Physics, Budapest, June 1991 (to appear).
12. **T.A. Osborn** and F.H. Molzahn, (1991), "The Wigner-Weyl Transform on Tori and Connected Graph Propagator Representations," in *Forty More Years of Ramifications: Spectral Asymptotics and Its Applications,* edited by S.A. Fulling and F.J. Narcowich, Discourses in Mathematics and Its Applications, No. 1, (Department of Mathematics, Texas A&M University, College Station, Texas, pp. 199-236.
13. **B.W. Southern**, R.J. Lee and D.A. Lavis, (1991), "Three-magnon excitations in ferromagnetic spin S. chains, presented at CAP-NSERC Workshop on "Excitations in superlattices and multi-quantum wells," (to appear in Springer Series in Physics).
14. **J.M. Vail**, T. McMullen, J. Meng, and P. Jena, "Simulation of Muonium Quantum Diffusion Including Self-Consistent Electronic Structure in Alkali Halides," Sixth Europhysical Topical Conference: Lattice Defects in Ionic Materials, Groningen, The Netherlands, 3-7 September, 1990, pp. 234-5.
15. **J.M. Vail**, B.K. Rao, and J. Niu, "Determination of the Electronic Structure of Solids from Finite Cluster Calculations," Bulletin of the American Physical Society, **36**, 570 (1991), abstract F27 10.
16. Z. Yang and **J.M. Vail**, "The $(F_2^+)^*$ Center in NaF:Mg," Bulletin of the American Physical Society, **36**, 842 (1991), abstract M35 6.
17. **J.G. Williams and P. Zvengrowski**, (1990), "Homotopy and Lorentz metrics in 2+1 dimensions," Proceedings of the 3rd Canadian Conference on General Relativity and Relativistic Astrophysics pp. 364- 367, edited by A.A. Coley, F.I. Cooperstock and B.O.J. Tupper (World Scientific, Singapore).

(c) Invited Conference Presentations (Unpublished)

1. **R. Kobes**, "Causal properties of Feynman graphs", CAP Congress (Winnipeg, June 1991).
2. **J.M. Vail**, "Description of Local Properties of Solids from Small Clusters." , Workshop on Atomic Clusters and Cluster Reactions, Virginia Commonwealth University, Richmond, VA, May 15, 1991.
3. **J.M. Vail** Invited speaker, Third Soviet Conference on Quantum Chemistry of Solids, Riga, Latvia, USSR. Nov. 26-30, 1990. "Simulation of Impurity Processes in Ionic Crystals by Embedded Quantum Clusters" (J. Meng, Co-author).

5. ACTIVITIES OF INSTITUTE

1. SHORT TERM VISITORS

Name	Affiliation	Period
A. Barvinsky	Inst. for Nucl. Safety, Moscow	Aug.-Oct. 1991
P. Kelly	Toronto	June 1 990
S. Godfrey	Carleton	Nov. 1990
H. Fogedby	Aarhus, Denmark	Jan. 1991
I.V. Kolokolov	Inst. of Nuc. Phys., Novosibirsk	Feb. 1991
V. Chubukov	Inst. for Physics, Moscow	April 1991
B.G. Wybourne	Canterbury, New Zealand	April 1991

2. SEMINARS

Date	Speaker	Title
Oct. 25, 1990	A.I. Mogilner	Bound States of a Few Quasi- Particles
Nov. 1, 1990	S. Godfrey	Z_0 Physics at LEP
Nov. 28, 1990	V. Cherepanov	Time Dependence of Magnon Relaxation in Short Pulses
Jan. 30, 1991	H. Fogedby	Fractal Growth of Lipid Layers and Bacterial Colonies
Jan. 31, 1991	J.G. Williams	Kinks in General Relativity
Feb. 14, 1991	A.I. Mogilner	Some Aspects of the Connection Between Solitons and Bound States of Excitations in Two-and Three-Dimensional Crystals
Feb. 15, 1991	I.V. Kolokolov	Matrix Integration and the Ising model on a Random Surface I
Feb. 18, 1991	I.V. Kolokolov	Matrix Integration and the Ising model on a Random Surface II
Feb. 19, 1991	I.V. Kolokolov	Functional Integration for Quantum Magnets: New Methods and New Results I
Feb. 21, 1991	I.V. Kolokolov	Functional Integration for Quantum Magnets: New Methods and New Results II
Feb. 26, 1991	I.V. Kolokolov	Magnetic Media as a Source and Detector of Axions
Apr. 17, 1991	A.V. Chubukov	Chiral Nematic and Dimer States in Quantum Spin Chains
Apr. 17, 1991	A.V. Chubukov	Phase Transitions in Frustrated Antiferromagnets
Apr. 19, 1991	B.G. Wybourne	Recent Researches in Theoretical Physics

3. WORKSHOPS AND CONFERENCES

Quantum Cluster Embedding in Crystals

University of Manitoba, July 10-24

This workshop was organized after realizing that several groups, widely separated, were making serious progress on this problem independently. It was felt that a detailed exchange of views would expedite furthur progress. The participants were:

- M. Bermejo, V. Luaña and L. Pueyo *(Spain)*
- R. Orlando and C. Pisano *(Italy)*
- L.N. Kantorovich *(Latvia)*
- V.A. Telezhkin *(U.S.S.R.)*
- F.H. Hawthorne and J.M. Vail *(Manitoba)*

The workshop consisted of two phases, in the first of which a representative of each group described a treatment of quantum cluster embedding, and in the second, representatives of four groups described their computer programs. Finally, a discussion was held on problems of mutual interest, from the viewpoint of conducting comparative analyses of the various methods and programs. Because of the smallness of the group, the compatibility of personalities, and the liveliness of all participants, there was a very high level of discussion in every session. The result is a much-enhanced understanding of the various methods, and of desirable directions for further progress.

Proceedings, 39 pages were printed and distributed to about 35 interested parties worldwide. The participants are grateful to the Winnipeg Institute for Theoretical Physics for financial support, and to the Department of Physics at the University of Manitoba for facilities.

The 4th Canadian Conference on General Relativity and Relativistic Astrophysics

University of Winnipeg, May, 1991

The Fourth Canadian Conference on General Relativity and Relativistic Astrophysics, held at the University of Winnipeg, had the difficult task of maintaining the high standards set by previous meetings in the series. As in the past, the purpose of the meeting was to bring Canadian physicists up to date on the latest exciting research developments in general relativity, relativistic astrophysics and cosmology. The small size and informal atmosphere of the Conference was successful in initiating and sustaining much fruitful dialogue and collaboration between the participants. In all, approximately 75 physicists attended the meeting, from all over Canada, as well as from Africa, Ireland, Great Britain and the United States.

The format of the meeting was as follows: There were 10 plenary, review lectures on a variety of current topics, given by both Canadian and international researchers. In addition there were 36 shorter, more technical talks and numerous posters. In order to give the posters the attention that they deserved, there was a special poster session and reception, organized on the second night of the meeting. The technical talks were given in parallel sessions in order to make the most efficient use of the short time available. As much by happy coincidence as by design, the Saturday morning session contained both plenary and technical talks that focussed on a single theme: the nature of time in quantum gravity. All participants who presented papers at the meeting were invited to submit a contribution to the proceedings, to be published by World Scientific later this year. The schedule of talks and a list of participants is given below.

In addition to the substantial support from the Winnipeg Institute for Theoretical Physics, the Conference received funding from:

- The Natural Sciences and Engineering Research Council
- The Canadian Institute for Theoretical Astrophysics
- The University of Winnipeg

The (bi-)local organizing committee for the meeting consisted of Jack Gegenberg (UNB), Dwight Vincent(U. of Winnipeg) and Jeff Williams(Brandon U.). Additional guidance and support was provided by the National Organizing Committee: F. Cooperstock(Victoria), C.C. Dyer(Toronto), R. McLenaghan(Waterloo), B.O.J. Tupper(New Brunswick). The next meeting in this series will be held at the University of Waterloo in May, 1993.

Canadian Conference on General Relativity & Relativistic Astrophysics
Thursday May 16 , 1991

8:45	Opening Remarks - Room 3C00 M. McIntyre - Dean of Arts and Sciences E. Tomchuk - Chairman, Dept. of Physics				
9:00	R.B. Mann	Lowest Dimensional Gravity			
9:45	N. Kaiser	Clustering of Mass on Large Scales			
10:30	1st Floor	Coffee Break	Coffee Break		Coffee Break
	Room A = 1L13			Room B = 1L12	
11:00	B. Dolan	Energy Spectra in Inflationary Models		L. Tarasov	Quantum Aspects of 1+1 Dimensional Gravity
11:20	G.M. Covarrubias	Lie Groups in Cosmology		S. Morsink	Temperature of a 1+1 Dimensional Black Hole
11:40	B. Berger	Remarks on the Dynamics of the Mixmaster Universe		P. Kelly	Expansions of Nonsymmetric Gravitational Theories About a GR Background
12:00	R. Cassidy	Hamiltonian for the Mixmaster Vacuum Universe with Geometry R X S7		J. Palmer	A New Test of Nonsymmetric Gravity: Depolarization of Solar Spectral Lines
12:20		Lunch Break	Lunch Break		Lunch Break
2:00	P. Hickson	Room 3C00	Large Scale Structure		
2:45	A. Ashtekar	Loops, Gauge Fields, and Gravity			
3:30	1st Floor	Coffee Break	Coffee Break		Coffee Break
	Room A = 1L13			Room B = 1L12	
4:10	A. Ashtekar	Loops, Gauge Fields, and Gravity		G. Ludwig	Twisting Type N Vacuum Metrics
4:30	J. Gegenberg	Gravitating Topological Matter		H.P. Kunzle	SU(n)-Einstein-Yang-Mills Fields With Spherical Symmetry
4:50	J. Louko	Gravitational Theta-States in Spatially Flat Quantum Cosmology		A. Das	Collapse of a Spherically Symmetric Anisotropic Fluid
5:10	A. Sikkema	Black Hole Mergers and Mass Inflation in a Bouncing Universe		K.L. Duggal	Ricci Inheritance Symmetry in Fluid Space times

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9:00	R. Webster	Room 3C00	Determination of Dark Matter from Gravitational Lensing		
9:45	J.B. Hartle	Quantum Mechanics from the Perspective of Quantum Cosmology			
10:30	1st Floor	Coffee Break	Coffee Break		Coffee Break
		Room A = 1L13			**Room B = 1L12**
11:00	M.S. Morris	The Wave Equation on a Timehole		S. Richardson	Energy Localization and the Kerr-Newman Metric
11:20	F. Molzahn	Gauge Invariant Derivative Expansion of Schrodinger Propagators on Manifolds		D. Konkowski	Singularities in Colliding Plane Wave Spacetimes
11:40	S.A. Fulling	Group-Theoretical Classification of Polynomial Functions of the Riemann Tensor		D. Salopek	Non-Gaussian Fluctuations for Structure Formation From Nonlinear Gravitational Effects
12:00	G. Williams	Symmetry Operators for Maxwell's Equations in Curved Space-times		M. Morikawa	Luminosity Biasing in Galaxies with Baryonic Dark Matter
12:20		Lunch Break	Lunch Break		Lunch Break
2:00	R. McLenaghan	Room 3C00	Separation of Variables and Constants of Motion for Relativistic Wave Equations on Curved Space-time		
2:45	R. Myers	Two Dimensional Quantum Gravity from Matrix Models			
3:30	1st Floor	Coffee break	Coffee Break		Coffee Break
		Room A = 1L13			**Room B = 1L12**
4:10	W.R. Wood	Broken Weyl Invariance and Geometric Particles		G. Fee	Comparison of Algorithms for the Symbolic Computation of the NP Spin Coef. and Curvature Components
4:30	C. Gauthier	Gravitation et Neutrinos		N. Kaloper	Lorentz Chern-Simons Term and the Breakdown of the Cosmic No-Hair Conjecture
4:50	H. King	What is the Angular Momentum of a Closed Universe?		J. Twamley	Wormholes Without a Conserved Charge
5:10	G. Kunstatter	Dirac Versus Reduced Quantization: A Geometrical Approach		A.R. Lyons	Wormholes in String Theory
5:30		Poster / Wine and Cheese Reception	- Riddell Cafeteria -		Poster / Wine and Cheese Reception

Canadian Conference on General Relativity and Relativistic Astrophysics
Saturday May 18, 1991

		Room A = 1L13		
9:00	J. Friedman	Is Physics Consistant with Closed Timelike Curves?		
9:20	W. Unruh	External Time and the Interpretation of Quantum Gravity		
9:40	G. Hayward	General Laws of Gravitational Thermodynamics		
10:00	E. Woolgar	New Demonstration of the Positive Mass Theorem		
10:40		Coffee Break	Coffee Break	Coffee Break
11:00	K. Kuchar	Room 3C00	Time and Interpretation of Quantum Gravity	
11:45	M. MacCallum	Computer Algebra for Gravity Theorists - Past, Present, and Future		

6. Appendix: E-Mail Addresses and Telephone Numbers

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