

Winnipeg Institute for Theoretical Physics

1 Mandate

The Winnipeg Institute for Theoretical Physics was created to support theoretical physics research in Manitoba. It has carried out this mandate by encouraging collaboration between members of the Institute and by financially supporting workshops, visiting colloquium speakers, and short and long term visits by research collaborators of international standing. The permanent members of this Institute are drawn from Brandon University, the University of Manitoba, and the University of Winnipeg.

The past year was the 17th year of the Institute's existence. As per its mandate, the Institute sponsored a series research colloquia by out-of-province visitors as well as Institute members. One of the major activities of the Institute is the training of Highly Qualified Personnel; to this end, there are a number of research associates, postdoctoral fellows, and graduate students associated with the Institute.

The following pages provide a summary of the research activities of the Institute in carrying out its mandate. In order, this includes

- a list of members of the Institute, as of September, 2007, in Section 2, including
 - permanent members (Section 2.1)
 - associate members (research associates and postdoctoral fellows) (Section 2.2)
 - graduate students (Section 2.3)
 - undergraduate students (Section 2.4)
- a detailed listing of research activities in Section 3, which includes
 - a list of invited speakers for the most recent 2006–2007 academic year in Section 3.1; this number is typical of the number of invited speakers in any given year over the last 5 years
 - a cumulative list of graduate degrees awarded in Section 3.2
 - a list of published research work of permanent members over the last 6 years in Section 3.3
- a financial statement for the Institute in Section 4
- a 5-year financial plan for the Institute in Section 5
- a discussion of plans for the future growth of the Institute in Section 6

2 Current List of Members (September, 2007)

2.1 Permanent Members

- B. Bhakar^{1 4}, *Ph.D. (Delhi)* [Director, Jan. - June 00]
- P.G. Blunden¹, *Ph.D (Queen's)* [Director, 93–94]
- M.E. Carrington², *Ph.D. (SUNY, Stony Brook)*
- T. Chakraborty¹, *Ph.D. (Dilbrugarh University, India)*
- J. D. Fiege¹, *Ph.D. (McMaster)*
- T.D. Fugleberg², *Ph.D. (UBC)*
- J. Hopkinson², *Ph.D. (Rutgers)*
- R. Kobes³, *Ph.D. (Alberta)* [Director, 97–98, 05–07]
- G. Kunstatter³, *Ph.D. (Toronto)* [Director, 91–92]
- P.D. Loly^{1 4}, *Ph.D. (London)* [Director, Fall 99, 00-01]
- T.A. Osborn¹, *Ph.D. (Stanford)* [Director, 92–93, 01-04]
- B.W. Southern¹, *Ph.D. (McMaster)* [Director, 90–91, 07– present]
- J.P. Svenne^{1 4}, *Ph.D. (M.I.T.)* [Director, 95–96]
- G.C. Tabisz^{1 4}, *Ph.D. (Toronto)*
- J.M. Vail^{1 4}, *Ph.D. (Brandeis)* [Director, 98–99]
- D.W. Vincent³, *Ph.D. (Toronto)* [Director, 94–95]
- M. Whitmore¹, *Ph.D. (McMaster)*
- J.G. Williams², *Ph.D. (Birmingham)* [Director, 96–97]

¹University of Manitoba

²Brandon University

³University of Winnipeg

⁴Senior Scholar

2.2 Associate Members

Research Associates

- A. Borodich (Whitmore) July '04– present
- R. E. Cameron (Tabisz) 1995 – present

Postdoctoral Fellows

- W. Chen (Kunstatter/Kobes) April, 2007 – August, 2007
- Antti Gynther (Carrington) September 2006 – August 2007

2.3 Graduate Students

- Kenneth Adebayo (M.Sc.) (Southern)
- Edward Kavalchuk (Ph.D.) (Carrington/Kobes)
- Neil Moore (Ph.D.) (Whitmore)
- Adam Rogers (Ph. D) (Fiege)
- Jonathan Ziprick (M. Sc.) (Kunstatter)

2.4 Undergraduate Research Students 2006-2007

- James Babb (Kobes)
- Dylan Buhr (Kobes)
- Tarik Haroon (Manitoba Science Academy) (Vail)
- Javier Hernandez-Melgar (UM Department of Physics and Astronomy and WITP) (Vail)
- Eric Himbeault, (NSERC summer undergraduate research award) (Southern)
- Darren Leonardo (Kobes)
- Jeff Meyer (Kobes)
- Matthew Morrissette (Fugleberg)
- Todd Sierens, (NSERC summer undergraduate research award) (Southern)
- Shawn Stargardter (Kunstatter)

3 Research Activities

3.1 Seminars

Date	Speaker	Title
Sept 21, 2006	Dr. Jeff Williams	The Road to Relativity
Oct 12, 2006	Dr. Todd Fugleberg	Calculations in Real Time Statistical Field Theory
Oct 19, 2006	Dr. Randy Kobes	Bose-Einstein Condensates and Thermal Field Theory
Oct 26, 2006	Dr. Gabor Kunstatter	Black Holes: The Simplest and Most Complex Objects in the Universe
March 1, 2007	P. Fraser	Nuclear Structure Inputs for Multi-Channel Algebraic Scattering
March 12, 2007	Dr. David Garfinkle	The Nature of General Gravitational Singularities
June 7, 2007	Dr. Stefan Stricker	The AdS/CFT Correspondence
July 17, 2007	Dr. Karl-Peter Marzlin	Slow Photons as Charged Quasi-Particles
Sept 28, 2007	Dr. Karl-Peter Marzlin	Geometric Phases in Quantum Optics

Table 1: 2006–07 Seminars of the WITP

3.2 Graduate Degrees Supervised

1. I. Abu-Ajamieh (2003) “Lateral Compression of Homopolymers and Copolymers at the Air-Liquid Interfaces for Good Solvents”, M.Sc.thesis, (Whitmore)
2. S. Barkanova (2004), “The Electroweak Radiative Corrections and Parity-Violating Electron-Nucleon Scattering”, PhD thesis, (Blunden).
3. J. Bland (2006), Ph.D. thesis (Kunstatter)
4. J. Geehan (2002) “Self-consistent Field Theory of Compressible Bilayers: Mixtures of Two Different Chain Length Phospholipids”, B.Sc. thesis (Whitmore)
5. M. Kenward (2001) “Monte Carlo Simulations of Amphiphiles: A Systematic Study”, M.Sc. thesis, (Whitmore)
6. J. Medved (2000), “Thermodynamics of Charged Black Holes in Two-Dimensional Gravity”. Ph.D. thesis, University of Manitoba, 2001. (University Microfilms), (Kunstatter).
7. T. Melde (2001), “The Three Nucleon System including one Dynamical Pion: A one dimensional test case”. Ph.D. thesis, University of Manitoba, May 2001. (University Microfilms), (Svenne).
8. A. Peles (2004), “Frustrated Magnets: A Monte Carlo Study of Stiffness, Vorticity and Topological Excitations”. Ph.D. thesis, University of Manitoba, 2004. (University Microfilms), (Southern).
9. S. Peles (2001), “Nonlinear Phenomena and Chaos in Periodically Driven Classical Systems”. Ph.D. thesis, University of Manitoba, 2001. (University Microfilms), (Kobes).

10. A. J. Penner (2004), "Nonlinear Analysis of Complicated Physical Systems", MSc thesis, (Kobes).
11. Senchuk, A , "Collision-Induced Light Scattering and Absorption in Atoms and Symmetric : a Spherical Tensor Approach", M.Sc. Thesis, University of Manitoba, September 2006, (Tabisz)
12. Mirsaeed Zelli (2007), "A Monte Carlo Study of a Family of Heisenberg Non-Collinear Magnets", M.Sc. thesis, (Southern).
13. Nan Zheng (2006), "Analysis of Binary Phospholipid Bilayers with a Self-Consistent Theory", M.Sc. thesis, (Whitmore).

3.3 Publications of Permanent Members

P.G. Blunden

1. P.G. Blunden, W. Melnitchouk, and J.A. Tjon, Two-photon exchange and elastic electron-proton scattering, Proceedings of the Workshop on electron-nucleus scattering VIII, Eur. J. Phys. A, 24, Supp. 1 (2005).
2. S. Kondratyuk, P.G. Blunden, W. Melnitchouk, and J.A. Tjon, Delta resonance contribution to two-photon exchange in electron-proton scattering, Phys. Rev. Lett. **95**, 172503 (2005).
3. P.G. Blunden, W. Melnitchouk, and J.A. Tjon, Two-photon exchange in elastic electron-nucleon scattering, Phys. Rev. C. **72**, 034612 (2005).
4. P.G. Blunden and I. Sick, Proton radii and two-photon exchange, Phys. Rev. C. **72**, 057601 (2005).
5. P.G. Blunden, W. Melnitchouk, and J.A. Tjon, Two-photon exchange and elastic electron-proton scattering, Phys. Rev. Lett. **91**, 142304 (2003).
6. S. Barkanova, A. Aleksejevs, and P.G. Blunden, 2002, Radiative corrections and parity-violating electron-nucleon scattering, nucl-th/0212105. Submitted to Physical Review C.

Conference Proceedings and Talks

7. Recent developments in two-photon exchange physics, Invited plenary talk at the Fall meeting of the Division of Nuclear Physics of the American Physics Society, Chicago, October 2004.
8. Two-photon exchange physics: hadronic picture, Invited talk at the ECT Workshop on Two-Photon Physics, Trento, Italy, May 23-27, 2005.

9. Two-photon exchange in electron scattering: hadronic picture, Invited talk at the 2005 Joint Jefferson Lab/Institute for Nuclear Theory Workshop on Precision ElectroWeak Interactions, Williamsburg, VA, Aug 15-17, 2005.
10. Two-photon exchange and elastic electron-proton scattering, Invited talk at Workshop on Electron-Nucleus Scattering VIII, Elba, Italy, June 2004.
11. Two-photon exchange effects in electron-proton scattering, Colloquium at Argonne National Laboratory, April 2004.
12. Two-photon exchange effects in electron-proton scattering, Colloquium at University of Manitoba, November 2003.
13. Two-photon exchange and elastic electron-proton scattering, Talk presented at Fall Meeting of APS Division of Nuclear Physics, Tuscon, AZ, October 2003.
14. P.G. Blunden and A. Aleksejevs, Radiative corrections and parity-violating electron scattering, Workshop on Fundamental Symmetries and Weak Interactions, Institute for Nuclear Theory, Seattle, WA November 26, 2002 (presented by A. Aleksejevs, Ph.D. student).
15. P.G. Blunden, Parity violating effects in the deuteron, Workshop on Fundamental Symmetries and Weak Interactions, Institute for Nuclear Theory, Seattle, WA December 3, 2002.

M. E. Carrington

1. “*Energetic di-leptons from the Quark Gluon Plasma*,” M.E. Carrington, A. Gynther and P. Aurenche - arXiv:0711.3943 (accepted for publication in Phys. Rev. D).
2. “*Leading Order QED Electrical Conductivity using the 3PI Effective Action*,” M. E. Carrington and E. Kovalchuk, Phys. Rev. D **77**, 025015 (2008) - arXiv:0709.0706.
3. “*QED Electrical Conductivity using the 2PI Effective Action*,” M. E. Carrington and E. Kovalchuk, Phys. Rev. **D76**, 045019 (2007) - arXiv:0705.0162.
4. “*Index Summation in Real Time Statistical Field Theory*,” M. E. Carrington, T. Fugleberg, D. S. Irvine and D. Pickering, Eur. Phys. J. **C50** 711 (2007) - arXiv:hep-ph/0608298.
5. “*The Soft Fermion Dispersion Relation at Next-to-Leading Order in Hot QED*,” M. E. Carrington; Phys. Rev. **D75**, 045019 (2007) - arXiv:hep-ph/0610372 .
6. “*The Dynamics of Entanglement in the Adiabatic Search and Deutsch Algorithms*,” K. Choy, G. Passante, D. Ahrensmeier, M.E. Carrington, T. Fugleberg, R. Kobes and G. Kunstatter - arXiv:quant-ph/0605040 (accepted for publication in the Canadian Journal of Physics).
7. “*Statistical Field Theory*,” T. Fugleberg and M.E. Carrington, Proceedings of Theory Canada II, Can. J. Phys. **85** 671 (2007).

8. “*Gauge Invariance of the static fermion mass beying hard thermal loops* ,” M.E. Carrington and E. Mottola, Proceedings of the 7th International Conference on Strong and Electroweak Matter 2006 - SEWM 2006, Nuc. Phys. **A785**, 142 (2007).
9. “*Energy Flow in Acoustic Black Holes*,” K Choy, T Kruk, M.E. Carrington, T. Fugleberg, J. Zahn, R. Kobes, G. Kunstatter and D. Pickering, Phys. Rev. **D73** (2006) 104011.
10. “*Transport Theory Beyond Binary Collisions*,” M.E. Carrington, S. Mrowczynski, Phys. Rev. **D71**, 065007 (2005).
11. “*2PI Effective Action and Gauge Invariance Problems*,” M.E. Carrington, G. Kunstatter and H. Zaraket, Eur. Phys. J. **C42**, 253 (2005).
12. “*The 4PI Effective Action for ϕ^4 Theory*,” M.E. Carrington, Eur. Phys. J. **C35** 383 (2004).
13. “*Dielectric Functions and Dispersion Relations of Ultra-Relativistic Plasmas with Collisions*,” M.E. Carrington, T. Fugleberg, D. Pickering and M.H. Thoma, Can. J. Phys. **82**, 671 (2004).
14. “*Dileptons from Hot, Heavy, Static Photons*,” P. Aurenche, M.E. Carrington and N. Marchal, Phys. Rev. **D68**, 056001 (2003).
15. “*Scattering Amplitudes at Finite Temperature*,” M.E. Carrington, Hou Defu and R. Kobes, Phys. Rev. **D67** 025021 (2003).
16. “*Infrared behaviour of the pressure in $g\phi^3$ theory in 6 dimensions*,” M.E. Carrington, T.J. Hammond and R. Kobes, Phys. Rev. **D65** 067703 (2002).
17. “*Equilibration in an Interacting Field Theory*,” M.E. Carrington, R. Kobes, G. Kunstatter, D. Pickering and E. Vaz, Can. J. Phys. **80** 987 (2002).
18. “*A General expression for Symmetry Factors of Feynman Diagrams*,” C.D Palmer and M.E. Carrington, Can. J. Phys. **80** 847 (2002).
19. “*Covariant approach to equilibration in effective field theories*,” Mark Burgess, M.E. Carrington and G. Kunstatter, Can. J. Phys. **80** 97 (2002).
20. “*A Diagrammatic Interpretation of the Boltzmann Equation*,” M.E. Carrington, Hou Defu, R. Kobes, Phys. Lett. **B523** 221 (2001).
21. “*Nonlinear Response from Transport Theory and Quantum Field Theory at Finite Temperature*,” M.E. Carrington, Hou Defu, R. Kobes, Phys. Rev. **D64** 025001 (2001).
22. “*Spontaneous Symmetry Breaking for Scalar QED with Nonminimal Chern-Simons Coupling*,” D.S. Irvine, M.E. Carrington, G. Kunstatter and D. Pickering, Phys. Rev. **64** 045015 (2001).

23. “*Spontaneous Scale Symmetry Breaking in 2+1 Dimensional QED at Both Zero and Finite Temperature,*” M.E. Carrington, WF Chen and R. Kobes, Eur. Phys. J **C18** 757 (2001).
24. “*Approach to Equilibrium in the Micromaser,*” D. Leary, S. Yau, M.E. Carrington, R. Kobes and G. Kunstatter, Can. J. Phys. **79** 783 (2001).

Papers in Refereed Proceedings

25. “*Gauge Invariance of the static fermion mass beying hard thermal loops ,*” M.E. Carrington, Proceedings of SEWM 2006, to be published in Nuclear Physics A.
26. “*Chapman-Enskog Expansion of the Boltzmann equation and its Diagrammatic Interpretation*”, M.E. Carrington, Hou Defu, R. Kobes, refereed paper published electronically in the proceedings of the XXXI International Symposium of Multiparticle Dynamics, Sept 1-7, 2001, Datong, China.
27. “*Contributions to Transport Theory from Multi-particle Interactions and Production Processes*”, M.E. Carrington, refereed paper published in the proceedings of ‘Strong and Electroweak Matter 2004’ June 16-19, Helsinki, Finland.

T. Chakraborty

1. K.-B. Broocks, B. Su, P. Schrtter, Ch, Heyn, D. Heitmann, W. Wegscheider, V.M. Apalkov, T. Chakraborty, I.E. Perakis, and C. Schller, Linear and ultrafast optical spectroscopy in the regime of the quantum Hall effect, Phys. Stat. Sol. (b) 245, 321 (Review) (2008).
2. Julia A. Berashevich, V.M. Apalkov and T. Chakraborty, Polaron tunneling dynamics in the DNA molecule, J. Phys.: Condens. Matter, (2008).
3. Julia A. Berashevich, Adam. D. Bookatz and T. Chakraborty, The electric field effect and conduction in the Peyrard-Bishop-Holstein model, J. Phys.: Condens. Matter 20, 035207 (2008).
4. Julia A. Berashevich and T. Chakraborty, Mutational hot spots in DNA: Where biology meets physics, Physics in Canada 63, 103 (2007).
5. Julia A. Berashevich and T. Chakraborty, Influence of solvent on the energetics of hole transfer in DNA, J. Phys. Chem. B 111, 13465 (2007).
6. P. Pietiläinen and T. Chakraborty, Spin configurations and activation gaps of the quantum Hall states in graphene, Europhys. Lett. 80, 37007 (2007).
7. Julia A. Berashevich and T. Chakraborty, Energetics of the hole transfer in DNA duplex oligomers, Chem. Phys. Lett. 446, 159 (2007).

8. V. Apalkov, X.-F. Wang and T. Chakraborty, Physics aspects of charge migration through DNA, (Article in Book) Charge Migration in DNA, (Ed.) T. Chakraborty, (Springer), Ch. 5. p. 77–119 (2007).
9. T. Chakraborty (Ed.), (Book) Charge Migration in DNA: Perspectives from Physics, Chemistry and Biology, (Springer) (2007).
10. X.-F. Wang and T. Chakraborty, The physics of spin injection into DNA, Physics in Canada 63, 89 (2007).
11. Hong-Yi Chen, V. Apalkov and T. Chakraborty, The Fock-Darwin states of Dirac electrons in graphene-based artificial atoms, Phys. Rev. Lett. 98, 186803 (2007).
12. V. Apalkov, X.-F. Wang and T. Chakraborty, Collective excitations of Dirac electrons in graphene, Int. J. Mod. Phys. B 21, 1165 (2007).
13. Hong-Yi Chen, V. Apalkov and T. Chakraborty, Spin-orbit Coupling and Tunneling Current in a Parabolic Quantum Dot, Phys. Rev. B 75, 193303 (2007).
14. X.-F. Wang and T. Chakraborty, Coulomb screening and collective excitations in a graphene bilayer, Phys. Rev. B 75, 041404 (R) (2007).
15. Julia A. Berashevich and T. Chakraborty, Energy contribution of the solvent to the charge migration in DNA, J. Chem. Phys. 126, 035104 (2007).
16. X.-F. Wang and T. Chakraborty, Collective excitations of Dirac electrons in a graphene layer with spin-orbit interaction, Phys. Rev. B. 75, 033408 (2007).
17. T. Chakraborty, Graphene: A nanoscale quantum playing field, Physics in Canada 62, 351 (2006).
18. X.-F. Wang and T. Chakraborty, Spin injection into a short DNA chain, Phys. Rev. B 74, 193103 (2006).
19. V. Apalkov and T. Chakraborty, The fractional quantum Hall states of Dirac electrons in graphene, Phys. Rev. Lett. 97, 126801 (2006).
20. X.-F. Wang and T. Chakraborty, Charge transfer via a two-strand superexchange bridge in DNA, Phys. Rev. Lett. 97, 106602 (2006).
21. A. Bagga, P. Pietiläinen and T. Chakraborty, Spin hot spots in vertically-coupled few-electron isolated quantum dots, Phys. Rev. B 74, 033313 (2006).
22. V.M. Apalkov, A. Bagga and T. Chakraborty, Spin-orbit interaction in a quantum cascade transition, Phys. Rev. B 73, 161304 (R) (2006).
23. P. Pietinäinen and T. Chakraborty, Energy levels and magneto-optical transitions in parabolic quantum dots with spin-orbit coupling, Phys. Rev. B 73, 155315 (2006).

24. M. Califano, C.-M. Hu, P. Pietiläinen and T. Chakraborty, Breaking of Larmors theorem in quantum Hall states with spin-orbit coupling, *Phys. Rev. B* 73, 113315 (2006).
25. V. Apalkov and T. Chakraborty, Electronic properties of guanine traps in DNA, *Phys. Rev. B* 73, 113103 (2006).
26. V.M. Apalkov, C. Schüller and T. Chakraborty, Spin transitions in an incompressible liquid Coulomb coupled to a quantum dot, *Phys. Rev. B* 73, 073310 (2006).
27. V.M. Apalkov and T. Chakraborty, Transverse tunneling current through guanine traps in DNA, *Phys. Rev. B* 72, 161102 (R) (2005).
28. M. Califano, P. Pietiläinen and T. Chakraborty, Spin precession in a fractional quantum Hall state with spin-orbit coupling, *Appl. Phys. Lett.* 87, 112508 (2005).
29. P. Pietiläinen and T. Chakraborty, Optical signatures of spin-orbit interaction effects in a Parabolic Quantum Dot, *Phys. Rev. Lett.* 95, 136603 (2005).
30. M. Califano, P. Pietiläinen and T. Chakraborty, Tuning of the gap in a Laughlin Bychkov Rashba incompressible liquid, *Phys. Rev. Lett.* 94, 246801 (2005).
31. P. Pietiläinen and T. Chakraborty, Correlations in a Quantum Dot with Bychkov-Rashba Coupling, *Phys. Rev. B* 71, 113305 (2005).
32. V. M. Apalkov and T. Chakraborty, Electron Dynamics in a DNA Molecule, *Phys. Rev. B* 71, 033102 (2005).
33. T. Chakraborty and P. Pietiläinen, “Correlation effects on Rashba precession in a two-dimensional electron gas” (to be published)
34. C. Schüller, K.-B. Broocks, P. Schrter, Ch. Heyn, D.Heitmann, M. Bichler, W. Wegscheidier, T. Chakraborty, and V.M. Apalkov, “How to probe a fractionally-charged quasihole?”, *Physica E* 22, 131-134 (2004).
35. Schüller, C., Broocks, K.-B., Schröter, P., Heyn, Ch., Heitmann, D., Bichler, M., Wegscheider, W., Chakraborty, T., and Apalkov, V. M., “Optical Probing of a Fractionally Charged Quasihole in an Incompressible Liquid”, *Phys. Rev. Lett.* 91, 116403 (2003).
36. T. Chakraborty and V. M. Apalkov, “Quantum cascade transitions in nanostructures”, *Advances in Physics* 52, 455-521 (2003).
37. T. Chakraborty and V.M. Apalkov, “Magnetic field effects on intersubband transitions in a quantum nanostructure”, *Physica E* 16, 253-258 (2003).
38. D. Smirnov, O. Drachenko, J. Leotin, H. Page, C. Becker, C. Sirtori, V. Apalkov and T. Chakraborty, “Intersubband magnetophonon resonance in quantum cascade structures”, *Int. J. Mod. Phys. B* 16, 2952-2955 (2002).

39. V.M. Apalkov and T. Chakraborty, “Interaction of a quantum dot with an incompressible two-dimensional electron gas”, *Physica E* 14, 289-293 (2002).
40. V. M. Apalkov and T. Chakraborty, “Optical properties of quantum-dot cascade structure”, *Physica E* 14, 294-298 (2002).
41. V. M. Apalkov and T. Chakraborty, “Influence of Disorder and a Parallel Magnetic Field on a Quantum Cascade Laser”, *Appl. Phys. Lett.* 78, 697-699 (2001).
42. V. M. Apalkov and T. Chakraborty, “Magnetic Field induced Luminescence Spectra in a Quantum Cascade Laser”, *Appl. Phys. Lett.* 78, 1973-1975 (2001). [This article has been selected for *Virtual Journal of Nanoscale Science & Technology* 3 (April 9, 2001)].
43. V. M. Apalkov and T. Chakraborty, “Luminescence Spectra of a Quantum-Dot Cascade Laser”, *Appl. Phys. Lett.* 78, 1820-1822 (2001). [This article has been selected for *Virtual Journal of Nanoscale Science & Technology* 3 (April 2, 2001)].
44. T. Chakraborty, K. Niemelä, and P. Pietiläinen, “Spin polarization of quantum Hall states”, in *150 Years of Quantum Many-body Theory*, Eds. R.F. Bishop, K.A. Gernoth, and N. R. Walet (World Scientific, 2001), p. 295.
45. V. M. Apalkov, T. Chakraborty, P. Pietiläinen and K. Niemelä, ”Half-Polarized Quantum Hall States”, *Phys. Rev. Lett.* 86, 1311- 1314 (2001).

Other Refereed Publications

46. Tapash Chakraborty, F. M. Peeters, and U. Sivan (Eds.), “Nano-Physics & Bio-Electronics: A New Odyssey”, 1st ed. (Elsevier, 2002).

J. Fiege

1. Rogers, A. and Fiege, J. D., 2007, *Ap.J.*, *submitted*, “Einstein’s Evolution: Modeling Gravitational Lenses with a Genetic Algorithm”
2. Ward-Thompson et al. and 61 co-authors (including myself), 2007, *PASP*, 119, 555-870, “The JCMT Legacy Survey of Nearby Star-forming Regions in the Gould Belt”
3. Vallée, J. P. and Fiege, J. D., 2007, *AJ*, 133, 1012-1026, “OMC-1: A Cool Arching Filament in a Hot Gaseous Cavity: Geometry, Kinematics, Magnetic Vectors, and Pressure Balance”
4. Vallée, J. P. and Fiege, J. D., 2007, *AJ*, 134, 628-636, “The Cool Dark Globule CB68 and Its Associated Protostar: Geometry, Kinematics, Magnetic Vectors, and Pressure Balance”

5. Vallée, J. P. and Fiege, J. D., 2006, Ap.J., 636, 332-347, “A Cool Filament Crossing the Warm Protostar DR 21(OH): Geometry, Kinematics, Magnetic Vectors, and Pressure Balance”
6. Vallée, J. P. and Fiege, J. D., 2005, Ap.J. 627, 263-276, “A Cool Magnetized Shell Wrapped around the Hot H II Region S106: Geometry, Kinematics, Magnetic Vectors, and Pressure Balance”
7. Vallée J. P., Greaves J. S. and Fiege J. D., 2003, Ap.J., 588, 910-917, “Magnetic Structure of a Dark Bok Globule”
8. Fiege, J. D., Johnstone, D., Redman, R. O., and Feldman, P. A. 2004, Ap.J., 616, 925-942, “A Genetic Algorithm-based Exploration of Three Filament Models: A Case for the Magnetic Support of the G11.11-0.12 Infrared-dark Cloud”
9. Fiege, J. D. 2003, in Turbulence and Magnetic Fields in Astrophysics, ed. E. Falgarone and T. Passot (Berlin: Springer), 299-328, invited review (book chapter): “The Structure and Dynamics of Filamentary Molecular Clouds”
10. Johnstone, D., Fiege, J. D., Redman, R. O., Feldman, P. A., Carey, S. J., 2003, Ap.J.Lett., 588, 37, “The G11.11-0.12 IRDC: Anomalous Dust and a Nonmagnetic Isothermal Model”
11. Matthews B. C., Fiege J. D. and Moriarty-Schieven G. H., 2002, Ap.J., 569, 304-321, “Magnetic Fields in Star-Forming Molecular Clouds. III. Submillimetre Polarimetry of Intermediate Mass Cores and Filaments in Orion B”
12. Matthews B. C., Wilson C. D. and Fiege J. D., 2001, Ap.J., 562, 400-423, “Magnetic Fields in Star-forming Molecular Clouds. II. Depolarization Effect in the OMC-3 Filament of Orion A”
13. Aburihan M., Fiege J.D., Henriksen R.H., and Lery T., 2001, MNRAS, 326, 1217-1227, “Protostellar Evolution During Time Dependent Anisotropic Collapse”

Non-refereed publications

14. Fiege, J. D., 2005, in ASP Conf. Ser. 343, Astronomical Polarimetry: Current Status and Future Directions, ed. A. J. Adamson et al. (San Francisco: ASP), 171-175, “Computational Intelligence Techniques for Submillimetre Polarization Modeling”

Talks & Colloquia

15. “Applications of an Advanced Genetic Algorithm to Data-Modeling Problems in Astrophysics”, Nov. 26, 2007, University of Winnipeg, Winnipeg, MB (colloquium)
16. “Lessons from Natural Systems: Paradigms for Global Optimization”, May 18, 2007, CancerCare Manitoba, Winnipeg, MB (colloquium)

17. “The Ferret Genetic Algorithm: Theory and Applications”, Nov. 22, 2005 , NRC Institute for Biodiagnostics, Winnipeg, MB (colloquium)
18. “Evolution meets Astrophysics: Advanced Genetic Algorithms for Astrophysical Data Modeling”, Aug. 25, 2004, National Research Council, DRAO, Penticton, BC (colloquium)
19. “Computational Intelligence Techniques for Submillimetre Polarization Modeling”, March 15-19, 2004, Astronomical Polarimetry: Current Status and Future Directions, Waikoloa, Hawaii (conference)
20. May 24 - June 4, 2005, Astrobiology and the Origins of Life, Conference & Workshop, McMaster University, Hamilton, ON, “The Ocean and Ice of Europa: Results from a Genetic Algorithm-Powered Planetary Structure Code” (May 27, 2005, conference)
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M. Whitmore

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1. M. D. Whitmore, *Copolymers and Computing: A Decade of Progress*, keynote talk at the High Performance Computing Systems and Applications (HPCS '06), St. John's, NL (2006)
2. M. D. Whitmore, *High Performance Computing: The New and Growing Environment in Canada*, Canadian Association of Physicists Congress, Winnipeg, Manitoba (June, 2004).
3. M. D. Whitmore, *ACEnet: Transforming Research in Atlantic Canada*, High Performance Computing Systems and Applications (HPCS '04), Winnipeg, Manitoba, (May, 2004).
4. M. D. Whitmore, *Modelling and Simulations of Self-Assembly of Block Copolymers*, High Performance Computing Systems and Applications (HPCS '02), Moncton, New Brunswick (2002).

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5. M. D. Whitmore and Nan Zheng, *Self-Consistent Field Theory of Two-Component Phospholipid Membranes*, C.A.P. Congress, St. Catharines (2006).
6. J. G. Spiro, J. Yang, M. A. Winnik, J. P. S. Farinha, J. D. Vavasour and M. D. Whitmore, *Characterization of Nanoscopic Template Materials*, Canadian Materials Science Conference, Vancouver (2005)

7. M. D. Whitmore and R. Baranowski, *Compression of End-Anchored Polymers*, C.A.P. Congress, Vancouver (2005).
8. A. Borodich and M. D. Whitmore, *Compositional Fluctuations in Diblock Copolymer Lamellae Studied with the Method of Averaging in the Weak Segregation Limit*, C.A.P. Congress, Vancouver(2005).
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4 Financial

4.1 Statement of Income and Expenditures

Income

Income Source	Amount
Carry over from 2005	\$6950.00
Total Funds Available	\$6950.00

Table 2: 2006–07 Income

Expenditures

Activity	Amount Spent
Theory Canada I support	\$613.00
M. Karasev	\$2000.00
L. Ferchov	\$214.00
M. Paranjape	\$ 387.00
P. Marzlin	\$ 446.00
J. Hernandez	\$ 1250.00
Printing etc.	\$ 308.00
Total Expenditures (2006-2007)	\$5,218.00
Commitments Theory Canada 4	\$ 500.00
Current funds available	\$ 1232.00

Table 3: 2006–07 Expenditures

In relation to the supporting funds indicated above, it should be pointed out that the members of the Institute use their individual NSERC grants to subsidize Institute activities. Currently the members from the three universities draw upon more than \$350,000 of individual NSERC Research Grants. These funds have a significant fortifying effect on the level of activities in which we are able to engage. The financial contribution of the members associated with the expenses of visiting guest theorists, supports the activities and goals of the Institute, but does not appear in the budget data shown above.

The Institute has neither endowment nor trust fund support. The Institute has no significant space requirements. The occasional long term visitor requires a desk, but these needs have been accommodated by the space available to the physics departments at the

member Universities. The host departments also supply occasional secretarial support such as that required for the preparation of seminar notices and research papers.

4.2 Financial Stability and Growth

The Institute has no substantial fixed costs and for this reason it is intrinsically stable. It can operate in a productive fashion at a variety of funding levels. All of the funds that the Institute receives are transformed directly into its research enhancing activities. The funds allocated to the Institute by supportive administrative bodies such as the Faculties of Science and Graduate Studies at the University of Manitoba are fortified by the individual NSERC research grants of members. This is a strong commitment to the Institute by the Institute members. In view of its overall research productivity, in terms of published papers and supervised graduate students, its capacity for running very successful conferences and workshops, and the demonstrated ability to attract excellent short-term and long-term visiting scientists, the Institute is achieving its goals. The Institute membership includes all of the theoretical physicists in the province. Hence its growth relies solely upon the associate members that it can attract (i.e. graduate students, postdoctoral fellows and research associates). The number and quality of these associate members is dependent on the Institute being able to create a positive research atmosphere. This in turn depends strongly upon the level of funding that the Institute receives. We note that significant financial support has been received from Brandon University, the University of Manitoba, and the University of Winnipeg, which will be reflected in this and the next fiscal year.

The report guidelines suggest that some indication be given of the percentage of time that members spend on Institute research. Since the Institute's programs enhance the ongoing research interests of its members, there is no distinction between individual research and Institute research. The director has spent less than 5% of his time with the administrative aspects of the Institute.

5 5 Year Financial Plan

Plans for the expenditure of funds available to the Institute over the next 5 years will generally follow the pattern of the most recent financial year. This is typical for the Institute over the last 5 years, as can be seen from the Financial Statements in previous Annual Reports, and we expect this to continue in the foreseeable future. Specifically, we expect there to be 3 major areas of expenditures:

- support for 2–3 short-term visitors to the Institute per year, of the order of \$1000–\$1500 per visitor
- contribution to the costs of visitors coming to the member institutions primarily through support from individual NSERC grants, of the order of \$200–\$500 per visitor
- support for the Theory Canada workshops, held in conjunction with the Annual Congress of the Canadian Association of Physicists, of the order of \$700 per year

Miscellaneous costs such as mail, FAX, and printing we expect to continue to be minor, which is of the order of \$800 per year. Based on these figures, we expect the expenses of the Institute to average about \$4,000 per year. A 5-year budget based on these expectations is as follows:

Expenses	
Year	Amount
2008	\$4,000
2009	\$4,000
2010	\$4,000
2011	\$4,000
2012	\$4,000
Total	\$20,000
Expected Income	
2008	\$10,000
2009	
2010	\$10,000
2011	
2012	
Total	\$20,000

Table 4: 5 Year Financial Budget

Income is expected from the three Universities (Manitoba, Winnipeg, and Brandon) in the form of requests to the appropriate Dean of Science and Research Office.

Essentially all of the funds available to the Institute are spent for workshop and colloquium activities and for travel expenses of visiting scientists. The Institute has no technical support staff or administrative staff. All the administrative work is done on a volunteer basis by the members of the Institute.

The Institute's funding is substantially supplemented by contributions from the NSERC grants of individual members in pursuing the Institute's mandate. Currently the members from the three universities draw upon more than \$350,000 of individual NSERC Research Grants. These funds have a significant fortifying effect on the level of activities in which we are able to engage. The financial contribution of the members associated with the expenses of visiting guest theorists, supports the activities and goals of the Institute, but does not appear in the budget data shown above.

The Institute has neither endowment nor trust fund support. The Institute has no significant space requirements. The occasional long term visitor requires a desk, but these needs have been accommodated by the space available to the physics departments at the member Universities. The host departments also supply occasional secretarial support such as that required for the preparation of seminar notices and research papers.

6 Future Growth

Goals of the Institute in the next five years are generally to continue and enhance our original objectives. Specifically,

- We will continue, as finances allow, to bring in short- and long-term visitors for collaborations with specific Institute members. As typical Annual Reports illustrate, on average about 5–8 scientists per year visit the Institute, with most also giving a seminar and/or colloquium while here.
- We plan to make available more opportunities for students (undergraduate, graduate, and post-doctoral) to participate in the activities of the Institute, primarily by encouraging such students to give seminars on their research. As well as giving the students valuable experience in this facet of their education, this will help in establishing close collaborations amongst Institute members.
- The presence of the Institute could be used to promote, particularly across Canada, the study of theoretical physics in Manitoba at the graduate level. We will encourage our respective institutions to use this fact in their recruitment efforts. In this regard, we have posted the ad included in this submission with the CAP (Canadian Association of Physicists), at TipTop (<http://tiptop.iop.org/>), and at the Canadian Undergraduate Physics Conference the past three years. We note that senior scholar members of the Institute normally don't supervise graduate students.
- We plan on making the presence of the Institute more visible in the wider Canadian theoretical physics community. This will be done primarily through attendance of conferences and workshops; an important event in this regard is the recently-established Theory Canada series of workshops, held just before the annual Canadian Association of Physicists General Congress, which the Institute has supported financially for the last two years the workshop has been held. We plan to continue this support in the coming years.
- We also plan on becoming active in outreach programs to the wider community of Winnipeg in areas of interest in theoretical physics. A recent example of this was our involvement in the talk in November, 2005 by Dr. Clifford Will on Einstein, as part of the celebration of 2005 being the World Year of Physics; this talk, which was held at the Winnipeg Art Gallery, was very successful, with about 300 people attending, despite the occurrence of the first major snowstorm of the year on that evening. The Institute does not have sufficient funds to sponsor by itself a major speaker of this calibre to come to Winnipeg to give such a public lecture; we plan instead on working with existing lecture series at the member universities.
- We would also like to follow up on our initial efforts in getting the Institute recognized at Brandon University as a formal Institute. This is important both from the point of view of there being three people at Brandon with research interests in theoretical physics and also from the standpoint of broadening our base within Manitoba. Talks with the Associate Vice-President (Academic and Research) of Brandon University in accomplishing this are currently underway.