CURRICULUM VITAE

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HIGHER EDUCATION

Aug. 1996	Ph.D.	Cornell University, Physics Thesis Advisor: Prof. V. Ambegaokar
Jun. 1991	Univ. Dipl.	Eötvös University, Budapest, Hungary Physics (*summa cum laude*) Thesis Advisor: Prof. A. Zawadowski
1990 – 1991	Fellow Year	Bristol University, Bristol, U.K. Thesis Advisor: Prof. B.L. Gyorffy
1989 – 1990	Senior Year	Eötvös University, Budapest, Hungary
1986 – 1989	Freshman – Junior Years	Bolyai University, Cluj, Romania

PREVIOUS POSITIONS, ACADEMIC, ADMININSTRATIVE, PROFESSIONAL AND OTHER

August 2003 – Present	Organizer/Director	Notre Dame Theory Institute
June 2003 – Aug. 2003	Visiting Scientist	Argonne National Laboratory
January 2003 – June 2003	Visiting Professor	Institute of Physics, Budapest University of Technology and Economics, Budapest, Hungary
June 2002 – Aug. 2002	Visiting Scientist	Argonne National Laboratory
June 2001 – Present	Principal Investigator	Nanoscale: Interdisciplinary Research Team
May 2001 – Aug. 2001	Visiting Scientist	Argonne National Laboratory
Aug. 2000 – Present	Assistant Professor	University of Notre Dame
Sep. 1998 – Aug. 2000	Postdoctoral Research Fellow	Argonne National Laboratory Research Advisors: Prof. A.A. Abrikosov & Dr. Michael R. Norman
Sep. 1996 – Aug. 1998	Postdoctoral Research Fellow	The University of Chicago Research Advisor: Prof. K. Levin

SCHOLARSHIPS AND FELLOWSHIPS

2003 Alfred P. Sloan Fellow

Hungarian Academy of Science – Soros Foundation Fellow, 1990-1991

Bristol Eötvös Exchange Fellowship, 1990-1991

CÉL Foundation Fellow, 1989-1990. (Awarded to outstanding students of the Hungarian minority in Romania.)

DISTINCTIONS, HONORS, AWARDS

2003 Alfred P. Sloan Fellow

Cornell, GPA 4.3 (A+)

The Best Thesis in Theoretical Physics, Bristol University, 1991

Diploma with Distinction (*summa cum laude*), Eötvös University, 1991 (the only one awarded in physics, total of seven in the Faculty of Natural Sciences, for the Class of 1991).

"Outstanding Student of the Faculty of Natural Sciences," Eötvös University, Budapest, 1990

First Prize, TDK Symposium (Scientific Associations of Students) Eötvös University, Dec. 1989

First Prize at the Scientific Symposium of Bolyai University, March 1989

Special Merit Bursary for the maximum GPA (100%) and "Head of Class" title, 1986-1990

PROFESSIONAL MEMBERSHIPS

Member – American Physical Society

PROFESSIONAL ACTIVITIES

Panel Reviewer/Reviewer –	National Science Foundation, Directorates of Materials Research, Computer Science and Engineering Small Business Research Initiative Petroleum Research Fund/American Chemical Society
Guest-Editor – Physica C,	Conference on the Third US-Polish Conference on Superconductivity and Magentism
Referee –	Nature, Physica C, Journal of Physical Chemistry, Journal of the Physics and Chemistry of Solids, The Physical Review B, The Physical Review Letters (including "super-refereeing" dutiesat the request of the Editor for evaluating manuscripts in multiple rounds of the refereeing process)

Session Chair

- Office of Naval Research Workshop, October 2002, Pucon, Chile: Multifunctional Materials, Session on Magnetic Semiconductors
- APS March Meeting 2001, Seattle WA: Session J26. DCMP: High T$_c$ Superconductors VIII: Spin-Charge Separation
- APS March Meeting 2000, Atlanta, GA Session - G11 DCMP/DMP: Superconductivity: Doped Mott Insulator

Organizer – High Tc Superconductivity Theory Workshop, Argonne National Lab, July 2001

UNIVERSITY ACTIVITIES

1. **Notre Dame Theory Institute:** proposed the activity, invited Prof. I. Kondor, Dean of Collegium Budapest – Institute for Advanced Study for consulting on the project, presently coordinating the efforts aimed at founding ND-ASI. Program presently funded at 30K/year for three year by Office of Research.

2. **Argonne National Lab – Notre Dame Collaborative Research Scheme:** proposed and designed the program, co-wrote Request for Proposals document. Program expected to expand to $400K/year in the next Fiscal Years.

3. **Biophysics at Notre Dame:** invited Prof. Gabor Forgacs, George H. Vineyard Professor of Theoretical and Biological Physics Department of Physics and Biology, University of Missouri, to for consulting on how to establish a group of biological physics at Notre Dame.

DEPARTMENTAL COMMITTEES

1. Computer/Network Security Committee (Fall 2000)
2. Course Offering Committee (Spring 2001, Fall 2001)
3. Seminar Organizer: Condensed Matter Seminar Series (Spring & Fall 2002)
4. Strategic Planning (Fall 2002)
5. Graduate Curriculum (Fall 2003)
6. Graduate Recruitment (Fall 2002, Fall 2003) – Representative for Physics and College of Science at the Xavier University Graduate Recruitment Fair

BOOKS AND MONOGRAPHS

None

REFEREED PUBLICATIONS

NOTE:
As of November 2003, the published papers below received in total: **446 citations,**
average: **15.9 citations/paper**

Published articles

1. "Electromagnetic response of a static vortex line in a type-II superconductor: a microscopic study," B. Jankó and J.D. Shore, *Physical Review B: Rapid Communications* **46**, RC9720-9723 (1992).

2. "High order perturbation expansion for the two dimensional Hubbard model using the Gutzwiller wave function," Zs. Gulácsi, M. Gulácsi and B. Jankó, *Physical Review B* **47**, 4168-4173 (1993).

3. "On the coexistence of superconductivity and charge density waves," P. Miller, B. Jankó, and B.L. Gyorffy, *Physica C* **210**, 343-349 (1993).

4. "BCS superconductivity with fixed number parity," B. Jankó, A. Smith, V. Ambegaokar, *Physical Review B* **50**, 1152-1161 (1993).

5. "Parity fluctuations between Coulomb blockaded superconducting islands," B. Jankó and V. Ambegaokar, *Physical Review Letters* **75**, 1154-1157 (1995).

6. "Pseudogap effects induced by resonant pair scattering," B. Jankó, J. Maly, and K. Levin, *Physical Review B: Rapid Communications* **56**, R11 407-R11 410 (1997).

7. "Relationship between the pseudo- and superconducting gaps: Effect of residual pairing correlations below Tc," I. Kosztin, Q. Chen, B. Jankó, and K. Levin, *Physical Review B, Rapid Communications*, **58**, R5936-R5939 (1998).

8. "The cuprate pseudogap: Precursor superconductivity without preformed pairs," J. Maly, B. Jankó, and K. Levin, Proceedings of the 1997 Conference on Spectroscopies in Novel Superconductors, September 14-18, 1997, Cape Cod, MA, *Journal of Physics and Chemistry of Solids*, **59**, 1733-1736 (1998).

9. "Pairing fluctuation theory of superconducting properties in underdoped to overdoped cuprates," Q. Chen, I. Kosztin, B. Jankó, and K. Levin, *Physical Review Letters*, **81**, 4708-4711 (1998).

10. "Pseudogap regime in a BCS Bose-Einstein crossover scenario: Experimental consequences and tests," B. Jankó, I. Kosztin, and K. Levin, *International Journal of Modern Physics B*, **12**, 3009-3015 (1998).

11. "Superconductivity from a pseudogapped normal state: a mode coupling approach to precursor superconductivity," J. Maly, B. Jankó, and K. Levin, *Physical Review B*, **59**, 1354-1357 (1999).

12. "Pairing correlations and the pseudogap state: Application of the 'Pairing Approximation' theory," J. Maly, B. Jankó, and K. Levin, *Physica C*, **321**, 113-133 (1999).

13. "Superconducting transitions from the pseudogap state: d-wave symmetry, lattice, and low dimensionality effects," Q. Chen, I. Kosztin, B. Jankó, and K. Levin, *Physical Review B*, **59**, 7083-7093 (1999).

14. "Incoherent pair tunneling as a probe of the cuprate pseudogap regime," B. Jankó, I. Kosztin, K. Levin, M.R. Norman, and D.J. Scalapino, *Physical Review Letters*, **82**, 4304-4307 (1999).

15. "Ratchet effect in vortex dynamics: Reducing vortex densities in superconductors," C.S. Lee, B. Jankó, I. Derényi, and A.-L. Barabási, *Nature*, **400**, 337-340 (1999).

16. "Theory of Scanning Tunneling Spectroscopy of Magnetic-Field-Induced Discrete Nodal States in a D-Wave Superconductor," B. Jankó, *Physical Review Letters*, **82**, 4703-4706 (1999).

17. "Condensation energy and spectral functions in high-temperature superconductors," M.R. Norman, M. Randeria, B. Jankó, and J.C. Campuzano, *Physical Review B*, **61**, 14742-14750 (2000).

18. "Photoemission and the Origin of High Temperature Superconductivity," M.R. Norman, M. Randeria, B. Jankó, and J.C. Campuzano, Physica C, **341** 2063-2066 (2000).

19. "Dispersion of the neutron resonance in cuprate superconductors," A.V. Chubukov, B. Janko, O. Tchernyshyov, *Phys. Rev. B* **63**, art. no. 180507 (2001).

20. "Influence of vortices on the magnetic resonance in cuprate superconductors," M. Eschrig, M.R. Norman, B. Janko, *Phys. Rev. B* **64,** art. no. 134509 (2001).

21. "Collective interaction-driven ratchet for transporting flux quanta," C.J. Olson, C. Reichhardt, B. Janko and F. Nori, *Phys. Rev. Lett.* **87** art. no. 177002 (2001).

22. "Electronic specific heat in the pairing pseudogap regime," C.P. Moca and B. Janko, *Phys. Rev. B* **65** art. no. 052503 (2002).

23. "Electronic structure of multiquantum giant vortex states in mesoscopic superconducting disks," K. Tanaka, I. Robel and B. Janko, P NATL ACAD SCI USA **99**, 5233-5236 (2002).

24. "Ga1-xMnxAs: A frustrated ferromagnet," G. Zarand and B. Janko, *Phys. Rev. Lett.* **89** art. no. 047201 (2002).

25. "Novel Josephson effects between multi-gap and single-gap superconductors," D.F. Agterberg, E. D. Demler, B. Janko, *Phys. Rev. B* **66** (21): Art. No. 214507 DEC 1 2002.

26. The origin of the pseudogap phase: precursor superconductivity versus a competing energy gap scenario, K. Levin, Q. J. Chen, I. Kosztin, B. Janko, Y.J. Kao, A. Iyengar *J. Phys. Chem. Sol.*, **63** (12): 2233-2236 DEC 2002

27. "Zeeman-splitting induced bound states in diluted magnetic semicondutors." M. Berciu and B. Janko, *Phys. Rev. Lett.* **90** (24): Art. No. 246804 (2003).

28. "Theory of strong electron-phonon superconductivity for MgB2 in the framework of a two-band model," C.P. Moca and B. Janko PHYSICA C 387 (1-2): 122-130 (2003).

29. "Structure and Melting of Two-Species Charged Clusters in a Parabolic Trap", J.A. Drocco, C. Olson-Reichhardt, C. Reichhardt, B. Janko, *Phys. Rev. E* 68 (6): Art. No. 060401 Part 1 DEC 2003

30. "Ratchet superconducting vortex cell automata"C. J. O. Reichhardt, C. Reichhardt, M.B. Hastings, B. Janko, *Physica C* **404** (1-4): 266-272 (2004).

31. "Anomalous behavior of spin wave resonances in GaMnAs thin films". T. Rappoport, P. Redlinski, G. Zarand, X. Liu, J.K. Furdyna, B. Janko, *Phys. Rev. B* **69** Art. No. 125213 (2004).

32. **"**Optical response of a ferromagnetic-diluted magnetic semiconductor hybrid structure" P. Redlinski , T. G Rappoport, J.K. Furdyna, B. Janko, T. Wojtowicz, *Appl. Phys. Lett* **86**, 13103 (2005).

33. "Manipulating spin and charge in a magnetic semiconductor using superconducting vortices" M. Berciu, T.G. Rappoport, B. Janko, *Nature (accepted).*

34. "Pressure induced ferromagnetism in (In, Mn)Sb diluted magnetic semiconductor", M. Csontos, G. Mihaly, B. Janko, T. Wojtowicz, X. Liu, and J.K. Furdyna, *Nature Materials (accepted).*

35. "Scaling theory of magnetoresistance in disordered local moment ferromagnet", G. Zarand, C.P. Moca, and B. Janko, *Phys. Rev. Lett (accepted).*

36. "Positional disorder, spin-orbit coupling and frustration in GaMnAs", G.A. Fiete, G. Zarand, B. Janko, P. Redlinski, C.P. Moca. *Phys. Rev. B, **71,*** 1 (2005).

37. "Binding energy of shallow donors in a quantum well in the presence of a tilted magnetic field", P.Redlinski and B. Janko, *Phys. Rev. B (accepted).*

Articles submitted to refereed journals

38. "Thermodynamic Constraints on the Magnetic Field Dependence of the Neutron Resonance in Cuprate Superconductors" B. Janko (*submitted to Phys. Rev. Letters)*

39. "Signatures of interband scattering in spectroscopic experiments on MgB2," C.P. Moca and B. Janko *(submitted to Phys. Rev. B).*

40. "Superconducting Vortex Logic Antidots", C. Olson, C. Reichhardt, B. Janko (*submitted to Phys. Rev. B.)*

41. "Multiple Shiba states in two-band superconductors," C.P. Moca, G. Zarand, E. Demler, B. Janko (*preprint, submitted to Phys. Rev. Lett.).*

Available Preprints, to be submitted to refereed journals

42. "Mn-Mn dimers in GaAs " P. Redlinski, G. Zarand, B. Janko (*preprint, to be submitted to Phys. Rev. B.).*

Peer Reviewed Publications in Conference Proceedings

43. "Pseudogap phenomena in the superconducting phase of the cuprates," I. Kosztin, Q.J. Chen, B. Jankó, and K. Levin, in *High Temperature Superconductivity*, edited by S.E. Barnes *et al*., AIP Conference Proceedings, **483**, p. 57-62 (American Institute of Physics, Woodbury, New York, 1999).

44. "A BCS-Bose-Einstein crossover theory and its application to the cuprates," Q.J. Chen, I. Kosztin, B. Jankó, and K. Levin, in *High Temperature Superconductivity*, edited by S.E. Barnes *et al*., AIP Conference Proceedings, **483**, p. 22-25 (American Institute of Physics, Woodbury, New York, 1999).

UNREFEREED PUBLICATIONS

None

OTHER PUBLICATIONS

None

INVITED LECTURES AND ADDRESSES

1. Jan 1991 *"Correlations in the repulsive Hubbard model: a Gutzwiller wave function study,"*
University of Warwick, Coventry, UK, (Condensed Matter Seminar)

1. Apr 1991 *"Gutzwiller wave function method for the attractive Hubbard model,"*
ETH Zurich, Switzerland, (Condensed Matter Seminar)

2. May 1991 *"Broken symmetry states in the attractive Hubbard Model: Hartree-Fock versus Gutzwiller variational method,"*
Daresbury Laboratory, Daresbury, UK (Theory Group Seminar)

3. Jan 1996 *"Even-Odd Number Effects in Mesoscopic Superconductors,"*
University of Illinois at Urbana-Champaign, USA,
(Mesoscopic Physics Group Meeting)

4. Jan 1996 *"Coulomb Blockaded Mesoscopic Superconductors,"*
University of Notre Dame, Notre Dame (Condensed Matter Seminar)

5. Feb 1996 *"Number Parity Effects in Superconductors,"*
McMaster University, Hamilton, Canada (Condensed Matter Seminar)

6. Feb 1996 *"Number Parity Effects in Superconductors,"*
University of Toronto, Toronto (Condensed Matter Seminar)

7. Mar 1996 *"Mesoscopic Superconductors with a Fixed Particle Number,"*
University of Maryland, College Park, MD (Condensed Matter Seminar)

8. Jul 1997 *"Pseudogap Effect Via Resonant Pair Scattering,"*
Argonne National Laboratory (Theory Seminar, Material Science Division)

9. Sep 1997 *"The Cuprate Pseudogap and Resonant Pair Scattering,"*
University of Virginia, Charlottesville, VA, USA (Condensed Matter Seminar)

10. Sep 1997 *"ARPES and the cuprate pseudogap:*
Precursor superconductivity without preformed pairs,"
SNS97 Conference, Cape Cod, MA (Invited Talk)

11. Oct 1997 *"Experimental Tests of Resonant Pair Scattering,"*
University of Notre Dame (Condensed Matter Seminar)

12. Nov 1997 *"The Pseudogap Phase in Cuprate Superconductors,"*
University of Chicago (Computations in Science Seminar)

13. Feb 1998 *"Pseudogap Regime in a BCS BEC Crossover Scenario:*
Experimental Consequences and Tests,"
New3SC-1 Conference, Baton Rouge, LA (Invited Talk)

14. Mar 1998 *"Pseudogap Effect Via Resonant Pair Scattering,"*
1998 March Meeting, Los Angeles (Invited Talk)

15. Mar 1998 *"Pseudogap Effects Induced by Resonant Pair Scattering,"*
Clarkson University (Colloquium)

16. July 1998 *"Pseudogap due to pairing correlations,"* Aspen Center for Physics (Seminar)

17. Sep 1998 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
Argonne National Laboratory (Theory Seminar, Material Science Division)

18. Sep 1998 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
University of Illinois at Urbana-Champaign (STCS Special Seminar)

19. Sep 1998 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
llinois Institute of Technology (Physics Department Colloquium)

20. Jan 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
University of Chicago (Computations in Science Seminar)

21. Feb 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
University of Wisconsin, Madison (Solid State Seminar)

22. Feb 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
University of California, Los Angeles
(Special Condensed Matter Theory Seminar)

23. Feb 1999 *"Magnetic-field-induced nodal states in a d-wave superconductor,"*
University of California, Riverside (Condensed Matter Theory Seminar)

24. Feb 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
Stanford University, Stanford (Interdisciplinary Research Group Seminar)

25. Feb 1999 *"Magnetic-field-induced nodal states in a d-wave superconductor,"*
Argonne National Laboratory (Theory Group Seminar)

26. Apr 1999 *"Magnetic-field-induced nodal states in a d-wave superconductor,"*
University of Alberta
(Physics Department)

27. Apr 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
University of Alberta
(Theoretical Physics Institute)

28. May 1999 *"Ratchet Effect in Vortex Dynamics,"*
Argonne National Laboratory (Theory Group Seminar)

29. May 1999 *"Magnetic-field-induced nodal states in a d-wave superconductor,"*
New3SC-2 Conference, Las Vegas, Nevada (Invited Talk)

30. Sep 1999 *"Pair Correlations in the Cuprate Pseudogap,"*
Institute of Physics, Budapest (Theoretical Physics Seminar)

31. Oct 1999 *"Ratchet Effect in Vortex Dynamics,"*
University of Notre Dame (Condensed Matter Seminar)

32. Oct 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"*
SUNY Buffalo (Condensed Matter Seminar)

33. Feb 2000 *"Antiferromagnetism and Superconductivity in Cuprates,"*
University of Notre Dame (Departmental Colloquium)

34. Feb 2000 *"Antiferromagnetism and Superconductivity in Cuprates,"*
University of California, Riverside (Condensed Matter Seminar)

35. Feb 2000 *"Antiferromagnetism and Superconductivity in Cuprates,"*
University of Missouri-Rolla (Departmental Colloquium)

36. April 2000 *"Condensation energy and the neutron resonance in cuprates"*
University of Cluj, Romania (Departmental Seminar)

37. May 2000 "*Pseudogap Effects in Cuprate"*
Ohio State University (Condensed Matter Seminar)

38. Jan 2001 *"Consensation energy in cuprate superconductors"*
New3SC-3 Conference, Honolulu, Hawaii (Invited talk)

39. March 2002 "Copenhagen: A play by Michael Frayn" (Invited public lecture)
The Morris Performing Arts Center, in South Bend, IN

40. July 2002 "*Interband Scattering effects in MgB2"*
Third International US-Polish Conference, Ladek Zdroj, Poland (Invited Talk)

41. Oct 2002 "*Diluted Magnetic Semiconductors and Zeeman localization*"
Pucon, Chile (Invited talk)
ONR Workshop on Multifunctional Materials

42. Nov 2002 "*Magnetic field induced Zeeman localization*"
University of Cincinnati, Ohio (Invited Talk, Seminar)

43. Nov 2002 "*Zeeman localization in magnetic semiconductor hybrids*"
University of Chicago, Illinois (Invited Talk, Seminar)

44. May 2003 "*Strong correlation effects in diluted magnetic semiconductors"*
Institute of Physics, Budapest University of Technology and Economics
(Invited talk, Theoretical Physics Seminar)

45. June 2003 "*Permalloy-Magnetic Semiconductor Hybrids"*
Argonne LDRD Symposium

46. Nov 2003 University of Notre Dame
(colloquium)

47. Nov 2003 Argonne National Laboratory,
"Conference on Nanoscale Magnetism and Superconductivity"
(invited talk)

48. Dec 2003 National Science Foundation, NSF-NIRT Grantees meeting
(invited talk)

49. Jan 2004 University of Missouri, Columbia – departmental colloquium

50. Feb 2004 IEEE Conference on Nanoscale Devices and System Integration Hyatt Regency, Miami, Florida International University February 15-19, 2004 (invited talk)

51. Nov 2004 CTC-Plasma 2004 Tsukuba, Japan (invited talk)

52. Dec 2004 LDSD 2004, Cancun, Mexico (invited talk)

53. Sept 2005 Vortex VI, Crete, Greece (invited talk)

Contributed Talks

1. Sep 1990 *"Analytical study of the d-dimensional Hubbard model with the Gutzwiller wave function,"* SERC Course in Condensed Matter Theory, Chester, UK (Talk)

2. Mar 1992 *"Electromagnetic response of vortex core states in a type-II superconductor,"* March Meeting of the American Physical Society (Work presented by J. Shore)

3. Aug 1993 *"Electromagnetic response of vortex core states in a type-II superconductor,"* LT-20 Satellite Conference on Vortices, Oregon, USA (Poster)

4. Mar 1995 *"Parity fluctuations between Coulomb blockaded superconducting islands,"* March Meeting of the American Physical Society, San Jose, California (Talk)

5. Mar 1996 *"Quaisparticle Motion in Coulomb Blockaded Superconducting Nanostructures,"* March Meeting of the American Physical Society, St. Louis, Missouri (Talk)

6. Mar 1997 *"Photoemission and Tunneling in the Cuprate Pseudogap Regime: Effects of Precursor Superconductivity,"* March Meeting of the American Physical Society, Kansas City, Missouri (Talk)

7. Sep 1997 *"Pseudogap Effects Induced by Resonant Pair Scattering,"* Spectroscopies in Novel Superconductors 1997, Cape Cod, Massachusetts (Poster)

8. Mar 1998 *"Pseudogap Phenomena in d-wave Superconductors via Resonant Pair Scattering,"* March Meeting of the American Physical Society, Los Angeles, California (Work presented by Q. Chen)

9. Mar 1998 *"Pseudogap Effects Above and Below Tc: A Resonant Pair Scattering Approach,"* March Meeting of the American Physical Society, Los Angeles, California (Work presented by I. Kosztin)

10. Mar 1999 *"Theory of Small Pair Superconductors: Application to the Cuprates,"* Centennial Meeting of the American Physical Society, Atlanta, Georgia (Presented by Q. Chen)

11. Mar 1999 *"Theory of Small Pair Superconductors: Between BCS Theory and BEC,"* Centennial Meeting of the American Physical Society, Atlanta, Georgia (Presented by I. Kosztin)

12. Mar 1999 *"Incoherent Pair Tunneling as a Probe of the Cuprate Pseudogap,"* Centennial Meeting of the American Physical Society, Atlanta, Georgia (Talk)

13. Mar 1999 *"Core line photoemission spectroscopy of cuprates: a test for spin-charge separation,"* Centennial Meeting of the American Physical Society, Atlanta, Georgia (Presented by N. Shannon)

14. Mar 1999 *"Ratchet effect in vortex dynamics: Reducing vortex densities in superconductors,"* Centennial Meeting of the American Physical Society, Atlanta, Georgia (Presented by A.-L. Barabási)

15. *"Electronic Specific Heat in the Pairing Pseudogap Regime,"* M2SC Houston (Poster)

16. Mar 2000 *"Thermodynamic Constraints on Cuprate Magnetic Excitations,"* March Meeting of the American Physical Society, Minneapolis, MN (Talk)

17. Mar 2001 "*Influence of the magnetic field on the cuprate neutron resonance,"* March Meeting of the American Physical Society, Seattle, WA (talk)

18. Mar 2001 "*Dispersion of the neutron resonance in cuprate superconductors"* March Meeting of the American Physical Society, Seattle, WA (talk presented by O. Thernyshyov)

19. Mar 2001 *"Disordered Ratchet for Transporting Superconducting Vortices,"* March Meeting of the American Physical Society, Seattle, WA (talk presented by C. J. Olson)

20. Mar 2001 *"Signatures of the Neutron Resonance in Two-Particle Tunneling,"* March Meeting of the American Physical Society, Seattle, WA (talk presented by E. Kim)

21. Mar 2002 *"Multiple Shiba states in MgB_2 due to two-band superconductivity,"* March Meeting of the American Physical Society, Seattle, WA (talk presented by C.P. Moca)

22. Mar 2002 *"Electronic structure of multiquantum giant vortex states in mesoscopic superconducting disks,"* March Meeting of the American Physical Society, Seattle, WA (talk presented by I. Robel)

23. Mar 2002 "*Linear magnetic field dependence of the spin wave resonances in Ga_1-xMn_xAs thin films"*, March Meeting of the American Physical Society, Austin, TX (talk presented by Tatiana Rappoport)

GRANTS AND SPONSORED PROGRAMS

1. **Source:** Alfred P. Sloan Foundation
   Total amount: $40, 000
   Principal Investigator: B. Janko

2. **Source:** Notre-Dame-Argonne Collaborative Research Fund
   Project title: Ferromagnetic Semiconductor Nanostructures
   Principal Investigator: B. Jankó
   University collaborator: J.K Furdyna
   National Laboratory Collaborators: U. Welp, W.K. Kwok
   Total Amount: $200,000 for FY 2003-2004

3. **Source:** Individual Investigator Program of **"Director's Competitive Grants"**, Argonne National Laboratory, Department of Energy, Basic Energy Sciences.
   Project Title: *"Vortex Cellular Automata"*
   PI: M. Iavarone
   Co- Principal Investigator: B. Janko, C. Olson, C. Reichhardt
   Total amount: $190,000 for FY2003-2004, renewable for another $85,000 for FY 2005

4. **Source:** The National Science Foundation-National Nanoscale Initiative
   Project Title: "*Nanoscale Interdisciplinary Research Team: Formation and properties of spin-polarized quantum dots in magnetic semiconductors by controlled variation of magnetic fields on the nanoscale*"
   Principal Investigator: B. Jankó
   University Co-Investigators: J.K. Furdyna, M. Dobrowolska, A. Chang, V. Metlushko
   National Laboratory Collaborators: G.W. Crabtree, W.K. Kwok
   Total Amount: $1,800,000 for FY2002-2006 + 30,000 International Collaboration Supplement

5. **Source:** Individual Investigator Program of **"Director's Competitive Grants"**, Argonne National Laboratory, Department of Energy, Basic Energy Sciences.
   Project Title: *"Spin Polarized Nanostructures at Interfaces of Superconductors and Diluted Magnetic Semiconductors: New Prospects for Tunable Quantum Arrays"*
   Principal Investigator: B. Jankó
   Collaborating Investigators: G.W. Crabtree, W.K. Kwok, U. Welp
   Total Amount: $150,000 for FY2002-2003, renewable for another $85,000 for FY2004

6. **Source:** Individual Investigator Program of **"Director's Competitive Grants"**, Argonne National Laboratory, Department of Energy, Basic Energy Sciences.
   Project Title: *"Ratchet effect for manipulating trapped flux"*
   Principal Investigator: B. Jankó
   Collaborating Investigators: G.W. Crabtree, W.K. Kwok, U. Welp
   Total Amount: $130,000

7. **Source:** Individual Investigator Program of **"Director's Competitive Grants"**, Argonne National Laboratory, Department of Energy, Basic Energy Sciences.
   Project Title: *"Nanoscale Information Storage Using Superconducting Vortices"*
   Principal Investigator: G.W. Crabtree,
   Co-Principal Investigator: B. Jankó, G. Karapetrov
   Total Amount: $130,000

PATENTS

54. A.-L. Barabási, **B. Jankó**, C.S. Lee, I. Dérenyi,
"Reducing vortex densities and transporting vortices in superconductors"
United States Patent No. 6,469,880

RESEARCH ACCOMPLISHMENTS

Diluted Magnetic semiconductors [24,27,33]
In this series of papers, several published by **The Physical Review Letters**, we argue that in contrast to the presently accepted view in the field, the ferromagnetic state of diluted magnetic semiconductors is highly unusual, with a high degree of orientational frustration and memory effects reminiscent of spin glasses. Several experimental features can be explained rather naturally within this framework. Our recent **Physical Review Letters** on permalloy-magnetic semiconductor hybrids has been selected for the June 30, 2003 issue of the **Virtual Journal of Nanoscale Science & Technology**. The Virtual Journal is an edited compilation of links to articles from participating publishers, covering a focused area of frontier research. [Invited talks No. 41-52]

Novel superconductor: MgB_2 [25,28,31,34]
Thermodynamic and some spectroscopic measurements seem to indicate that the recently discovered superconducting phase of MgB_2 might be the first genuine *two-band* superconductor, while other experiments do not support this possibility. In order to settle this issue, we propose scanning tunneling spectroscopy of a magnetic impurity embedded in MgB_2. We find that the number of Shiba bound states around the impurity is *exactly* equal to the number of electronic bands involved in the superconducting phase. [Invited talk No. 40]

Vortex states in mesoscopic disks and magic numbers in confined magnetic colloids [23,29]
Recent magnetization measurements indicate that mesoscopic superconductors exhibit a new, so-called giant vortex phase. We have obtained for the first time the microscopic electronic structure of giant vortices under a large variety of conditions. Our results have several unusual features directly observable by scanning tunneling spectroscopy: multiple bound states in the core, and Tomasch-like interference effects. The Magnetism and Superconductivity Group at Argonne National Lab is currently performing experiments to look for these features.

Condensation Energy in High Tc Superconductors
Identifying the source of condensation energy is the most fundamental problem in the field of high T_c superconductivity that can be solved without a microscopic model. My collaborators and I have recently pointed out that spectroscopic probes, such as angle-resolved photoemission, tunneling, etc., can be used not only to extract the condensation energy, but also to identify whether the transition is kinetic or potential energy driven. This last observation could be crucial for revealing the mechanism of condensation. [Invited talks No. 33-38]

Thermodynamic Constraints on the Cuprate Magnetic Excitations[19,20,22,30]
Paper No. [18] is testing in detail the recently proposed link between the neutron resonance and the specific heat anomaly observed in cuprate superconductors. Using specific heat data and theoretical calculations, I have shown, that thermodynamic measurements strongly constrain the magnitude, temperature and especially the magnetic field dependence of the neutron resonance. My prediction of strong field dependence prompted both leading neutron scattering groups (led by H.A. Mook and Ph. Bourges, respectively) to look for this effect experimentally. ***The confirmation of this prediction by Mook et al. has recently been published by NATURE (LONDON)***. In collaboration with M. Eschrig and

M. Norman [20], we gave a detailed numerical study of the magnetic field dependence of the resonance. [Invited talks No. 33-38]

Discrete nodal states in a layered superconductor with gap nodes[16]
In this work, *published in The Physical Review Letters, I proposed* an experiment that would probe the *existence*, the *number* and the *position* of gap nodes on the Fermi surface of a layered superconductor. *Predicted* that the low temperature *local* tunneling conductance on the Wigner-Seitz cell boundaries of the vortex lattice would show peaks spaced as $\pm \sqrt{n}$, $n = \{0, 1, 2, ...\}$. Away from the cell boundaries each peak is expected to split, in general, into a number of peaks, corresponding to the number of nodes in the order parameter. The experimental search for this effect is performed by S. Pan and J.C. Davis [UC Berkeley] [Talks No. 24, 26, 28, 30, including an **Invited Talk at the New3SC-2 Conference (Las Vegas, May 1999).**]

Ratchet effect in vortex dynamics[15,21]
Co-invented and designed specially patterned superconducting devices which show, under specific conditions, practically zero trapped flux density. These results **were reported in Nature**. The Technology Transfer Office of Notre Dame University has recently *decided to pursue the patent* registration and maintenance process of this invention. Experimental efforts to detect the vortex ratchet effect are in progress at four institutions (S. Ruggiero [U Notre Dame], J. McElfresh [Purdue], C. Lobb [U Maryland] and G.W. Crabtree & W.-K. Kwok [ANL]). Work featured in several research and technology news publications: *"Inside R & D Alert", "Microelectronics Technology Alert", and "High Tech Ceramics News"*. (Invited talk No. 28).

Pair spectroscopy of the cuprate pseudogap [13-14]
In this Physical Review Letter, the incoherent pair tunneling experiment is predicted to detect the presence of pair correlations in the cuprate pseudogap state. I *organized* the collaborative work between researchers at The University of Chicago, Argonne National Laboratory, and University of California, Santa Barbara. The proposal already *triggered experimental projects* led by Eckstein, van Harlingen and Goldman, as well as theoretical collaboration with Goldbart and collaborators. Invited to present this work at eight institutions (Invited talks No. 18-22,24,27,32), including an **Invited Talk at the New3SC-2 Conference (Baton Rouge, February 1998)**.

Pseudogap effects induced by resonant pair scattering [6-13,26]
Developed a diagrammatic, self-consistent and conserving crossover theory that correctly reproduces the BCS and BEC limits and provides a detailed spectroscopic description of the intermediate state [6-9]. *This framework produced one of the most detailed description of the underdoped cuprate regime, including a semiquantitative agreement with the cuprate phase diagram, published recently in The Physical Review Letters [10].* Extension to the superconducting phase [11] allowed for a direct comparison between theoretical spectral properties, and the experimental results from angle-resolved photoemission, tunneling [12] and diamagnetic susceptibility [13]. Work presented in nine invited lectures (Invited talks No. 9-17), including an **Invited Talk at the APS March Meeting 1998 (Los Angeles), and SNS'97 (Boston)**.

Parity Fluctuation Between Superconductors [5]
Predicted a novel quantum many-body effect, called number parity fluctuation, that occurs when two superconductors of different number parity are connected by a tunnel junction. In this *Physical Review Letter* an explanation is suggested for the unusually large quasiparticle tunneling rate observed in Cooper pair pumps (fabricated and operated by Mooji and collaborators), and other nanoscale devices containing ultrasmall Josephson junctions. This process could also provide a mechanism for the damping of Coulomb blockade oscillations observed experimentally by Delsing *et al*. in one dimensional junction arrays. Work presented at five departments (Invited talk No. 8-4).

BCS Theory with Parity Constraint [4]
Developed the first detailed theory of quantum statistics of fermions with constrained number parity, interacting via the superconducting interaction. This theory triggered a substantial amount of follow-up work and was cited so far by 17 subsequent papers. Besides providing the *first rigorous explanation* of the even/odd free energy difference observed experimentally before this paper was published by Tinkham and coworkers, this work *predicted the parity dependence of the super-conducting energy gap, observed two years later* by Ralph and collaborators. Work presented in five invited talks (Talk No. 8-4).

Strongly Correlated Lattice Fermions with Arbitrary On-Site Interaction [2,3]
Generalized the one dimensional variational method of Vollhardt and coworkers to *arbitrary* dimension *d*, band filling *n*, on-site interaction strength *U*, and variational parameter *g*. In Ref. 3 we investigate the attractive ("negative-U") Hubbard model and find at half-filling a degenerate superconductor (S) charge-density-wave (CDW) state. Work presented in three invited talks (Talk No. 3-1).

Electromagnetic Response of Vortex Core States [1]
Derived the selection rules that govern the absorption and scattering of electromagnetic radiation by quasiparticles in a vortex core. The vortex core absorbs only light with circular polarization opposite to that of the quaisparticle core states. This work, *cited in five theoretical and five experimental papers*, became especially useful to the experimental group of Drew and collaborators, who found evidence for this dipole transition. They also detected different chiralities in various frequency intervals, which needs further investigation.

MASTER'S THESES DIRECTED

None

DOCTORAL DISSERTATIONS DIRECTED

In progress, none completed

UNDERGRADUATE STUDENTS SUPERVISED

Jeffrey Drocco, ***Recipient of Goldwater Scholarship*** for our research, endorsed by Notre Dame for Rhodes and Marshall scholarships

OUTREACH-HIGH SCHOOL STUDENT MENTOR

Emily Bell, Siemens Fellow

GRADUATE STUDENTS SUPERVISED

Andras Libal,
Albert Shi-Shin Lin

Pascu Moca
Tatiana Rappoport
Istvan Robel
Sandor Volkan Kacso
Yilin Wu

POSTDOCTORAL RESEARCH ASSOCIATES ADVISED

Dr. Peter Gurin
Dr. Pawel Redlinski

OTHER NOTABLE CONTRIBUTIONS

1. Organized since 1999 the Theory Visitors Program at the Materials Sciences Division of Argonne National Lab: applied and secured funding, arranged the appointment and coordinated the visit of 8-12 condensed matter theorists each summer, several of them women and minority. Participants (selection): G. Zarand (Harvard), E. Demler (Harvard), O. Tchernyshyov (Princeton), M. Berciu (Princeton), E. Carlson (UCLA), C. Olson (Los Alamos Nat'l Lab), C. Reichhardt (Los Alamos), I. Kosztin (Univ. Illinois, Urbana Champaign), Tanaka (U. Alberta), A. H. MacDonald (IU-Bloomington).

2. Organized multidisciplinary research teams to perform research on
    a. the use of quantum dots in imaging dynamic biological processes at molecular level,
    b. using photosynthetic reaction centers as active circuit elements,
    c. vortex ratchet devices, nanoscale memory storage devices, hybrid materials, vortex cellular automata and vortex computing,

3. Lectured and provided the audience historical background before the opening show of Michael Frayn's play "*Copenhagen"* at The Morris Performing Arts Center, in South Bend, IN.