

Oleg Tchernyshyov

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Professor

Department of Physics and Astronomy

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Education

Ph. D., 1998, Columbia University, Physics. Adviser: T. D. Lee.

M. S., 1990, Moscow Institute of Physics and Technology, Physics.

Employment

Current: Professor of Physics, Johns Hopkins University.

2008-15: Associate professor of Physics, Johns Hopkins University.

2002-08: Assistant professor of Physics, Johns Hopkins University.

2001-02: Postdoctoral fellow, Princeton University. Adviser: S. L. Sondhi.

1998-2001: Postdoctoral fellow, Institute for Advanced Study. Adviser: F. Wilczek.

Awards and honors

Fellow of the Japan Society for the Promotion of Science, 2014.

Outstanding referee for the American Physical Society, 2014.

CAREER Award, National Science Foundation, 2004.

Research funding

09/2014-08/2017: Institute for quantum matter, DOE, \$4,200,000, 6 PIs

09/2011-08/2014: Magnetism on the nanoscale, NSF, \$285,000, 1 PI.

09/2011-08/2014: Institute for quantum matter, DOE, \$3,900,000, 6 PIs.

10/2005-09/2013: Materials Research Science and Engineering Center, NSF, \$8,073,826, 11 PIs.

10/2008-08/2011: Institute for quantum matter, DOE, \$4,070,433, 5 PIs.

07/2004-12/2009: CAREER: Strongly correlated spin liquid in frustrated magnets, NSF, \$400,000, 1 PI.

01/2004-12/2006: Spin liquid in frustrated magnets, Research Corp., \$35,000, 1 PI.

Professional service

- Member of the editorial board, Physical Review Letters, 2014-20.
- Member of the science review committee, Oak Ridge National Lab, 2015-18.

- International conference Highly Frustrated Magnetism: 2018, Davis, CA, advisory committee; 2016, Taipei, Taiwan, program committee; 2014, Cambridge, UK, advisory committee; 2012, Hamilton, Canada, program committee; 2010, Baltimore, local organizer; 2008, Braunschweig, Germany, advisory committee.
- Magnet Lab theory winter school, Tallahassee, 2015, organizer.
- Programs in magnetism, Aspen Center for Physics, 2014, 2004, organizer.
- Program in magnetism, Kavli Institute for Theoretical Physics, 2007, organizer.
- Experiments evaluation committee, TRIUMF, Vancouver, 2012-15, member.
- APS March Meetings focus sessions on magnetism, 2015, 2012, 2010, 2008, organizer.
- Referee for Nature, Science, Physical Review, Physics Reports, Journal of Physics, Philosophical Transactions of the Royal Society, Journal of Applied Physics etc.

Mentorship of students and postdoctoral fellows

Undergraduate students (5):

- Derek Rietz, current.
- Christopher Mogni, B.S. 2014, UC Berkeley, graduate student.
- Benjamin Ponedel, B.S. 2013, UC Berkeley, graduate student.
- Yichen Shen, B.S. 2012, MIT, postdoctoral fellow.
- Kathleen Merit, B.A. 2007, Buck Consultants, senior associate.

Graduate students (13):

- Michael Bjerngaard, current.
- Sayak Dasgupta, current.
- Haoyu Wang, current.
- Shu Zhang, current.
- Anirban Ghosh, Ph.D. 2017, MathWorks, technical writer.
- Se Kwon Kim, Ph.D. 2014, UCLA, postdoctoral fellow.
- Yuan Wan, Ph.D. 2014, Oxford University, postdoctoral fellow.
- Imam Makhfudz, Ph.D. 2013, École normale supérieure de Lyon, visitor.
- Olga Petrova, Ph.D. 2013, École normale supérieure de Paris, France, junior research chair.
- Zhihao Hao, Ph.D. 2011, Scotia Bank, Toronto, Canada.
- Paula Mellado, Ph.D. 2010, Adolfo Ibáñez University, Chile, associate professor.
- Gia-Wei Chern, Ph.D. 2008, University of Virginia, assistant professor.
- David J. Clarke, Ph.D. 2008, University of Maryland at College Park, research associate.

Postdoctoral fellows (3):

- Hitesh Changlani, current.
- Jiadong Zang, 2012-15, University of New Hampshire, assistant professor.
- Oleg Tretiakov, 2005-07, Tohoku University, Japan, assistant professor.

Teaching

Johns Hopkins University:

- F2017: Condensed Matter Physics I, 3 hours/week, 171.405/621, 17 students.
 F2017: Quantum Mechanics I, 4 hours/week, 171.605, 17 students.
 F2016: Advanced Condensed Matter, 3 hours/week, 171.762, 15 students.
 F2016: Condensed Matter Physics I, 3 hours/week, 171.405/621, 7 students.
 S2016: Quantum mechanics II, 4 hours/week, 171.304, 17 students.
 F2015: Phase transitions and critical phenomena, 3 hours/week, 171.704, 13 students.
 S2015: Quantum mechanics II, 4 hours/week, 171.304, 17 students.
 F2014: leave of absence.
 S2014: Quantum mechanics II, 4 hours/week, 171.304, 12 students.
 F2013: Phase transitions and critical phenomena, 3 hours/week, 171.412/704, 13 students.
 S2013: Advanced statistical mechanics, 3 hours/week, 171.703, 23 students.
 F2012: Quantum mechanics, 4 hours/week, 171.605, 13 students.
 S2012: Advanced condensed matter, 3 hours/week, 171.762, 12 students.
 F2011: Advanced statistical mechanics, 3 hours/week, 171.703, 36 students.
 S2011: Phase transitions and critical phenomena, 3 hours/week, 171.412/704, 19 students.
 F2010: General physics for biological sciences majors, 4 hours/week, 171.103, 248 students.
 S2010: Advanced condensed matter, 3 hours/week, 171.762, 12 students.
 F2009: General physics for biological sciences majors, 4 hours/week, 171.103, 247 students.
 S2009: Advanced statistical mechanics, 3 hours/week, 171.703, 24 students.
 F2008: General physics for biological sciences majors, 4 hours/week, 171.103, 238 students.
 S2008: Phase transitions and critical phenomena, 3 hours/week, 171.412/704, 12 students.
 F2007: leave of absence.
 S2007: Advanced condensed matter, 3 hours/week, 171.762, 9 students.
 F2006: Classical mechanics I, 4 hours/week, 171.105, 15 students.
 S2006: Advanced statistical mechanics, 3 hours/week, 171.703, 7 students.
 F2005: Classical mechanics I, 4 hours/week, 171.105, 19 students.
 S2005: Advanced condensed matter, 3 hours/week, 171.762, 11 students.
 F2004: Condensed matter physics, 3 hours/week, 171.405/621, 16 students.
 S2004: Advanced statistical mechanics, 3 hours/week, 171.703, 12 students.
 F2003: Condensed matter physics, 3 hours/week, 171.405/621, 13 students.
 S2003: teaching relief.
 F2002: Phase transitions and critical phenomena, 3 hours/week, 171.412/704, 10 students.

Perimeter Institute:

- F2015: Condensed Matter Physics Core Course, 10 hours/week, 25 students.

Publications

- [85] N. J. Laurita, Y. Luo, R. Hu, M. Wu, S. W. Cheong, O. Tchernyshyov, and N. P. Armitage, “Anomalous exchange interactions between RE^{+3} and Mn^{+3} moments in multiferroic h- $REMnO_3$,” arXiv:1706.04141.
- [84] A. Scheie, J. Kindervater, S. Säubert, C. Duvinage, C. Pfleiderer, H. J. Changlani, S. Zhang, L. Harriger, S.M. Koochpayeh, O. Tchernyshyov, and C. Broholm, “Reentrant phase diagram of $Yb_2Ti_2O_7$ in $\langle 111 \rangle$ magnetic field,” Phys. Rev. Lett. (accepted for publication); arXiv:1703.06904.
- [83] H. Ochoa, S.K. Kim, O. Tchernyshyov, and Y. Tserkovnyak, “Gyrotropic elastic response of skyrmion crystals to current-induced tensions,” Phys. Rev. B **96**, 020410 (2017); arXiv:1702.03347.
- [82] A. Ghosh, K.S. Huang, and O. Tchernyshyov, “Annihilation of domain walls in a ferromagnetic wire,” Phys. Rev. B **95**, 180408 (2017); arXiv:1702.02248.
- [81] H. Wang, H.J. Changlani, Y. Wan, and O. Tchernyshyov, “Quantum spin liquid with seven elementary particles,” Phys. Rev. B **95**, 144425 (2017); arXiv:1702.01359.
- [80] S. Dasgupta, S.K. Kim, and O. Tchernyshyov, “Gauge fields and related forces in antiferromagnetic soliton physics,” Phys. Rev. B **95**, 220407 (2017); arXiv:1701.05137.
- [79] F. Hellman, A. Hoffmann, Y. Tserkovnyak, G. Beach, E. Fullerton, C. Leighton, A. MacDonald, D. Ralph, D. Arena, H. Durr, P. Fischer, J. Grollier, J. Heremans, T. Jungwirth, A. Kimmel, B. Koopmans, I. Krivorotov, S. May, A. Petford-Long, J. Rondinelli, N. Samarth, I. Schuller, A. Slavin, M. Stiles, O. Tchernyshyov, A. Thiaville, and B. Zink, “Interface-induced phenomena in magnetism,” Rev. Mod. Phys. **89**, 025006 (2017); arXiv:1607.00439.
- [78] K. D. Belashchenko, O. Tchernyshyov, A. A. Kovalev, and O. A. Tretiakov, “Magnetoelectric domain wall dynamics and its implications for magnetoelectric memory,” Appl. Phys. Lett. **108**, 132403 (2016); arXiv:1601.02471.
- [77] S. K. Kim, O. Tchernyshyov, and Y. Tserkovnyak, “Thermophoresis of an antiferromagnetic soliton,” Phys. Rev. B **92**, 020402(R) (2015); arXiv:1503.07854.
- [76] O. Tchernyshyov, “Conserved momenta of a ferromagnetic soliton,” Ann. Phys. **363**, 98-113 (2015); arXiv:1503.02329.
- [75] P. Mellado, O. Petrova, and O. Tchernyshyov, “Projective symmetry of partons in the Kitaev honeycomb model,” Phys. Rev. B **91**, 041103(R) (2015); arXiv:1409.7460.
- [74] O. Petrova, P. Mellado, and O. Tchernyshyov, “Unpaired Majorana modes on dislocations and string defects in Kitaev’s honeycomb model,” Phys. Rev. B **90**, 134404 (2014); arXiv:1406.6407.

- [73] S. K. Kim, Y. Tserkovnyak, and O. Tchernyshyov, “Propulsion of a domain wall in an antiferromagnet by magnons,” *Phys. Rev.* **90**, 104406 (2014), Editors’ Suggestion; arXiv:1406.6051. Erratum: *Phys. Rev. B* **91**, 099904 (2015).
- [72] I. Rousochatzakis, Y. Wan, F. Mila, and O. Tchernyshyov, “Quantum dimer model for the spin-1/2 kagome Z_2 spin liquid,” *Phys. Rev. B* **90**, 100406(R) (2014); arXiv:1308.0738.
- [71] L. D. Pan, S. K. Kim, A. Ghosh, C. M. Morris, K. A. Ross, E. Kermarrec, B. D. Gaulin, S. M. Koohpayeh, O. Tchernyshyov, and N. P. Armitage, “Low-energy electrodynamics of novel spin excitations in the quantum spin ice $\text{Yb}_2\text{Ti}_2\text{O}_7$,” *Nat. Commun.* **5**, 4970 (2014); arXiv:1406.3576.
- [70] M. Asmat-Uceda, X.M. Cheng, X. Wang, D.J. Clarke, O. Tchernyshyov, and K.S. Buchanan, “A comparison of numerical simulations and analytical theory of the dynamics of interacting magnetic vortices,” *J. Appl. Phys.* **117**, 123916 (2015).
- [69] C. M. Morris, R. Valdés Aguilar, A. Ghosh, S. M. Koohpayeh, J. Krizan, R. J. Cava, O. Tchernyshyov, T. M. McQueen, and N. P. Armitage, “A hierarchy of bound states in the 1D ferromagnetic Ising chain CoNb_2O_6 investigated by high resolution time-domain terahertz spectroscopy,” *Phys. Rev. Lett.* **112**, 137403 (2014); arXiv:1312.4514.
- [68] O. Petrova, P. Mellado, and O. Tchernyshyov, “Unpaired Majorana modes in the gapped phase of Kitaev’s honeycomb model,” *Phys. Rev. B* **88**, 140405(R) (2013); arXiv:1307.1668.
- [67] S. K. Kim and O. Tchernyshyov, “Pinning of a Bloch point by an atomic lattice,” *Phys. Rev. B* **88**, 174402 (2013); arXiv:1301.6452.
- [66] Z. H. Hao and O. Tchernyshyov, “Spin-1/2 Heisenberg antiferromagnet on kagome: a Z_2 spin liquid with fermionic spinons,” *Phys. Rev. B* **87**, 214404 (2013); arXiv:1301.3261.
- [65] Y. Wan and O. Tchernyshyov, “Phenomenological Z_2 lattice gauge theory of the spin-liquid state of the kagome Heisenberg antiferromagnet,” *Phys. Rev. B* **87**, 104408 (2013); arXiv:1301.5008.
- [64] I. Makhfudz, B. Krüger, and O. Tchernyshyov, “Inertia and chiral edge modes of a skyrmion magnetic bubble,” *Phys. Rev. Lett.* **109**, 217201 (2012); arXiv:1208.3123.
- [63] G.-W. Chern and O. Tchernyshyov, “Magnetic charge and ordering in kagome spin ice,” *Phil. Trans. Roy. Soc. A* **370**, 5718 (2012); arXiv:1109.0275.
- [62] Y. Wan and O. Tchernyshyov, “Quantum strings in quantum spin ice,” *Phys. Rev. Lett.* **108**, 247210 (2012); arXiv:1201.5314.
- [61] Y. Shen, O. Petrova, P. Mellado, S. Daunheimer, J. Cumings, and O. Tchernyshyov, “Dynamics of artificial spin ice: continuous honeycomb network,” *New J. Phys.* **14**, 035022 (2012); arXiv:1112.1857.
- [60] O. Petrova and O. Tchernyshyov, “Spin waves in a skyrmion crystal,” *Phys. Rev. B*

84, 214433 (2011); arXiv:1109.4990.

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[45] G.-W. Chern, D. Clarke, H. Youk, and O. Tchernyshyov, “Halfvortices in flat nanomag-

nets,” in *Quantum Magnetism, NATO Science for Peace and Security Series B: Physics and Biophysics* (Springer, 2008); arXiv:1007.2158.

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[42] M. B. Stone, C. Broholm, D. H. Reich, P. Schiffer, O. Tchernyshyov, P. Vorderwisch, and N. Harrison, “Field-driven phase transitions in a quasi-two-dimensional quantum anti-ferromagnet,” *New J. Phys* **9**, 31 (2007); arXiv:cond-mat/0611463.

[41] Y. L. Iudin, Y. P. Kabanov, V. I. Nikitenko, X. M. Cheng, D. Clarke, O. A. Tretiakov, O. Tchernyshyov, A. J. Shapiro, R. D. Shull, and C. L. Chien, “Asymmetric domain nucleation and unusual magnetization reversal in ultrathin Co films with perpendicular anisotropy,” *Phys. Rev. Lett* **98**, 117204 (2007).

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[39] A. Concha, J. W. McIver III, P. Mellado, D. Clarke, O. Tchernyshyov, and R. L. Leheny, “Wrinkling of a bilayer membrane,” *Phys. Rev. E* **75**, 016609 (2007); arXiv:cond-mat/0611507.

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- Rev. Lett. **96**, 027205 (2006); arXiv:cond-mat/0508249.
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- [2] O. V. Tchernyshyov, “On coherent erasure of long-lived photon echo,” *Laser Phys.* **2**, 567 (1992).
- [1] O. V. Tchernyshyov, “Frequency-domain description of long-lived photon echo,” *Laser Phys.* **1**, 535 (1991).

Invited talks

- [107] Condensed matter seminar, University of Delaware, October 2017.
- [106] Third Conference on Condensed Matter Physics, Shanghai, China, June 2017.
- [105] Gordon Research Conference, Hong Kong University of Science and Technology, Hong Kong, June 2017.
- [104] Condensed matter seminar, Tohoku University, Japan, February 2017.
- [103] Workshop “Theory of Correlated Topological Materials,” University of Tokyo, Japan, February 2017.
- [102] Physics colloquium, University of New Hampshire, December 2016.
- [101] Workshop “Spin Caloritronics,” Utrecht, Netherlands, July 2016.
- [100] Workshop “Topological Patterns and Dynamics in Magnetic Elements and in Condensed Matter,” Dresden, Germany, June 2016.
- [99] Theoretical physics seminar, University of Oxford, UK, May 2016.
- [98] Applied mathematics seminar, University of Bristol, UK, April 2016.
- [97] Lecture course Condensed Matter Core, Perimeter Scholars International, Perimeter Institute, Waterloo, Canada, November 2015.
- [96] Condensed matter seminar, Perimeter Institute, Waterloo, Canada, November 2015.
- [95] International Workshop Spintronics with Antiferromagnets, Tohoku University, Sendai, Japan, November 2015.
- [94] Condensed matter seminar, University of Nebraska, November 2015.
- [93] Physics colloquium and condensed matter seminar, University of Minnesota, Minneapolis, October 2015.
- [92] Workshop Frontiers of Condensed Matter Physics, Vancouver, Canada, May 2015.
- [91] Physics colloquium, University of Missouri, Columbia, April 2015.
- [90] DOE Materials Sciences and Engineering Division Magnetism Workshop, Washington, DC, April 2015.
- [89] Physics colloquium, University of Utah, January 2015.
- [88] Theory Winter School New Trends in Frustrated Magnetism, MagLab, Tallahassee, January 2015.
- [87] International workshop Frontiers in Condensed Matter Physics, Korea Institute for Advanced Study, Seoul, Korea, December 2014.

- [86] Condensed matter seminar, University of Okinawa, November 2014.
- [85] Condensed matter seminar, Tohoku University, October 2014.
- [84] Condensed matter seminar, University of Tokyo, October 2014.
- [83] International workshop New Horizons of Strongly Correlated Physics, University of Tokyo, June 2014.
- [82] Condensed matter seminar, University of Massachusetts, Amherst, April 2014.
- [81] Condensed matter seminar, Brookhaven National Lab, November 2013.
- [80] International workshop Spintronics: Progress in Theory, Materials, and Devices, Kavli Institute for Theoretical Physics, Santa Barbara, October 2013.
- [79] Condensed matter seminar, University of California, Berkeley, September 2013.
- [78] Condensed matter seminar, University of California, Irvine, September 2013.
- [77] Princeton Summer School in Condensed Matter Physics, Princeton University, August 2013.
- [76] Summer program Disorder, Dynamics, Frustration and Topology in Quantum Condensed Matter, Aspen Center for Physics, Aspen, July 2013.
- [75] Condensed matter seminar, Princeton University, April 2013.
- [74] Condensed matter seminar, University of Virginia, April 2013.
- [73] International conference Nonlinear Schrödinger Equations and Applications, Crete, Greece, April 2013.
- [72] Condensed matter seminar, National High Magnetic Field Lab, December 2012.
- [71] Condensed matter seminar, Ohio State University, October 2012.
- [70] International workshop New States of Matter and Their Excitations, Oak Ridge National Lab, Oak Ridge, September 2012.
- [69] Super PIRE: International Consortium for Proving Novel Superconductors, Washington, August 2012.
- [68] International conference Highly Frustrated Magnetism 2012, Perimeter Institute, Waterloo, Canada, June 2012.
- [67] Condensed matter seminar, Los Alamos National Lab, February 2012.
- [66] International conference Geometrically Frustrated Magnets: From Spin Ice to Kagome Planes, International Institute of Physics, Natal, Brazil, December 2011.
- [65] Condensed matter seminar, New York University, December 2011.

- [64] International workshop Novel Quantum States in Condensed Matter, Yukawa Institute, Kyoto, Japan, November 2011.
- [63] Condensed matter seminar, University of Tokyo, November 2011.
- [62] Condensed matter seminar, Columbia University, November 2011.
- [61] Condensed matter seminar, Brookhaven National Lab, November 2011.
- [60] International meeting Emergent Magnetic Monopoles in Frustrated Magnetic Systems, Royal Society International Center, Buckinghamshire, UK, October 2011.
- [59] International conference Magnetic North II, St Johns, Canada, June 2011.
- [58] International workshop Exotic Magnetism in High Magnetic Fields, Max Plank Institute, Dresden, Germany, June 2010.
- [57] Condensed matter seminar, Max Planck Institute for Solid State Research, Stuttgart, June 2010.
- [56] Condensed matter seminar, University of Toronto, March 2010.
- [55] Condensed matter seminar, University of Waterloo, March 2010.
- [54] Condensed matter seminar, Washington University in St. Louis, March 2010.
- [53] International workshop Novel Physics on the Kagome Network, University of Paris, Paris, France, January 2010.
- [52] Condensed matter seminar, Microsoft Station Q, Santa Barbara, October 2009.
- [51] Condensed matter seminar, University of Basque Country, Bilbao, Spain, July 2009.
- [50] Topological Order: From Quantum Hall Systems to Magnetic Materials, Max Plank Institute, Dresden, Germany, July 2009.
- [49] Condensed matter seminar, Argonne National Lab, June 2009.
- [48] Condensed matter seminar, University of Utah, May 2009.
- [47] Condensed matter seminar, University of Wisconsin, Madison, May 2009.
- [46] Condensed matter seminar, Texas A&M University, April 2009.
- [45] March Meeting of the American Physical Society, Pittsburgh, PA, March 2009.
- [44] Asian magnetism conference, Busan, Korea, December 2008.
- [43] International conference Ordering Phenomena in Transition Metal Oxides, University of Augsburg, Augsburg, Germany, October 2008.
- [42] Condensed matter seminar, University of California, Riverside, November 2007.
- [41] International summer school Highly Frustrated Magnets and Strongly Correlated Sys-

tems, Trieste, Italy, August 2007.

[40] March Meeting of the American Physical Society, Denver, CO, March 2007.

[39] Condensed matter seminar, University of Virginia, March 2007.

[38] Condensed matter seminar, University of Pittsburgh, 2007.

[37] Condensed matter seminar, University of Waterloo, 2007.

[36] International conference Low-Energy Electrodynamics of Solids, Tallinn, Estonia, July 2006.

[35] Condensed matter seminar, Case Western Reserve University, 2006.

[34] Condensed matter seminar, University of Maryland, College Park, 2006.

[33] Condensed matter seminar, NIST, Gaithersburg, 2006.

[32] March Meeting of the American Physical Society, Los Angeles, CA, March 2005.

[31] Condensed matter seminar, Princeton University, 2005.

[30] Condensed matter seminar, Brown University, 2005.

[29] Condensed matter seminar, MIT, 2005.

[28] Condensed matter seminar, University of Virginia, 2005.

[27] Condensed matter seminar, NIST (Gaithersburg), 2005.

[26] Condensed matter seminar, Oak Ridge National Lab, 2005.

[25] International workshop Frustrated Magnetism, Montauk, NY, September 2004.

[24] International conference Exotic Order and Criticality in Quantum Matter, Kavli Institute for Theoretical Physics, Santa Barbara, CA, June 2004.

[23] Condensed matter seminar, University of Colorado, Boulder, December 2003.

[22] International workshop Theory, Modeling, and Neutron Scattering, NIST, Gaithersburg, MD, August 2003.

[21] Summer program Competing Orders and Quantum Criticality in Correlated Electrons, Bosons and Spin Systems, Aspen Center for Physics, July 2003.

[20] March Meeting of the American Physical Society, Austin, TX, March 2003.

[19] Condensed matter seminar, University of Virginia, January 2003.

[18] Condensed matter seminar, Columbia University, New York, NY, September 2002.

[17] International workshop Physics of Frustration, Santa Fe, June 2002.

[16] Condensed matter seminar, SUNY, Stony Brook, 2001.

- [15] Condensed matter seminar, MIT, 2001.
- [14] Condensed matter seminar, Boston University, 2001.
- [13] Condensed matter seminar, University of California, Los Angeles, 2001.
- [12] Condensed matter seminar, University of California, Riverside, 2001.
- [11] Condensed matter seminar, University of California, San Diego, 2001.
- [10] Condensed matter seminar, Princeton, 2001.
- [9] Condensed matter seminar, Cornell University, 2001.
- [8] Condensed matter seminar, Brookhaven National Lab, 2001.
- [7] Condensed matter seminar, Yale University, 2001.
- [6] Condensed matter seminar, University of Michigan, Ann Arbor, 2001.
- [5] Condensed matter seminar, University of Illinois, Chicago, 2000.
- [4] Condensed matter seminar, Ohio State University, Columbus, 2000.
- [3] Condensed matter seminar, Université de Sherbrooke, 1998.
- [2] Condensed matter seminar, NEC Institute, Princeton, 1998.
- [1] International summer school High-Temperature Superconductivity, Telluride, 1997.