

W. Vincent Liu

Curriculum Vitae

[as of December 2015]

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Visa Status: *U.S. permanent resident*

EDUCATION

- Ph.D. in Physics, University of Texas at Austin, May 1999
Advisor: **Steven Weinberg** (*Nobel laureate*)
Thesis: “Applications of effective field theory to condensed matter”
Awarded: “Best Dissertation in Physics” in the class of 1998–99.
- M.S. in Physics, Beijing Normal University, China, 1994
- B.S. in Physics, Jilin University, China, 1991
Awarded: “Outstanding University Graduate” (top 5%)

EMPLOYMENT

<i>Sep 2014–</i>	Professor, University of Pittsburgh
<i>Sep 2009– Aug 2014</i>	Associate Professor, University of Pittsburgh
<i>Sep 2004–Aug 2009</i>	Assistant Professor of Physics, University of Pittsburgh
<i>Aug 2001– Aug 2004</i>	Postdoctoral Fellow, Department of Physics, Massachusetts Inst of Tech (MIT) Supervisor: Frank Wilczek (<i>Nobel laureate</i>) Affiliated with: Patrick A. Lee and Xiao-Gang Wen
<i>Aug 1999–Aug 2001</i>	Postdoctoral Research Associate, Condensed Matter Theory Group, Department of Physics, University of Illinois at Urbana-Champaign. Supervisors: Eduardo Fradkin and Mike Stone

HONORS, AWARDS, & MEMBERSHIPS

- Member, National Advisory Board, Kavli Institute for Theoretical Physics China (KITPC), Chinese Academy of Sciences, Beijing, 06/2011 –
- 2007 “Outstanding Young Researcher Award”, Overseas Chinese Physics Association
<http://www.ocpaweb.org/new/oyraaward/oyraaward.html>
- “Best Dissertation in Physics” Award in the class of 1998-99, Department of Physics, University of Texas at Austin

VISITING FELLOWSHIPS

<i>8/23/2010—6/10/2011</i>	General Member (on sabbatical leave with pay from KITP), Kavli Institute for Theoretical Physics (KITP), University of California, Santa Barbara
<i>2009–2013</i>	Visiting Overseas Professorship of Chinese Academy of Sciences, with funds provided by China’s State Administration of Foreign Experts Affairs. Part of 5-year cold atom physics International Partnership Project, sponsored jointly by Wuhan Institute of Physics and Mathematics and Shanghai Institute of Optics and Fine Mechanics

6/24–7/1/2006	Visiting Professor, APCTP (Asia Pacific Center for Theoretical Physics, Pohang, Korea). (with full support for local expenses & international travel)
8/01–8/13/2005	Visiting Fellow, Institute of Nuclear Theory, University of Washington, Seattle, WA. (with financial support)

RESEARCH PROGRAM INVITATIONS (as invited participant, fellow or scientist)

11/02–11/20/2015	KITP Program “Many-Body Physics with Light,” Kavli Institute for Theoretical Physics, University of California, Santa Barbara
9/14–10/02/2015	KITP Program “New Phases and Emergent Phenomena in Correlated Materials with Strong Spin-Orbit Coupling”, Kavli Institute for Theoretical Physics, University of California, Santa Barbara
10/8–11/2/2012	KITP Program “Quantum Dynamics in Far from Equilibrium Thermally Isolated Systems”, Kavli Institute for Theoretical Physics, University of California, Santa Barbara
6/24–7/20/2007	Paris “Quantum Gases” Program, Centre Emile Borel, Institut Henri Poincaré, Paris, France.
4/30–5/25/2007	KITP Program “Strongly Correlated Phases in Condensed Matter and Degenerate Atomic Systems”, Kavli Institute for Theoretical Physics, University of California, Santa Barbara.
2/08–2/16/2006	KITP Mini-Program “Supersolid State of Matter”, Kavli Institute for Theoretical Physics, University of California, Santa Barbara.
4/27–5/7/2015	INT Program “Frontiers in Quantum Simulation with Cold Atoms”, University of Washington, Seattle.
5/10–6/12/2004	KITP Program “Quantum Gases”, Kavli Institute for Theoretical Physics, University of California, Santa Barbara.
6/30–7/20/2002	Trento BEC Summer Program, European Centre for Theoretical Studies in Nuclear Physics and Related Areas (ECT*), Trento, Italy. (with daily financial support)
various times	Aspen Center for Physics, Invited Participant for various programs (and one work group): 8/24–9/6/2014; 8/11–25/2013; 8/10–8/23/2008; 5/29–6/11/2006; 5/29–6/18/2005; 6/29–13/2003; 6/14–27/1999.

SCIENTIFIC SERVICES, ORGANIZED CONFERENCES, ETC

- Co-Advisor, *KITPC Program* “Spin-orbit-coupled quantum gases”, Aug 1-19, 2016, <http://www.kitpc.ac.cn/?p=ProgDetail&id=PS20160801&i=main> and *KITPC Conference* “Synthetic Topological Quantum Matter”, Aug 1-5, 2016, <http://www.kitpc.ac.cn/?p=ProgDetail&id=CS20160801&i=main> Kavli Institute for Theoretical Physics China, Beijing, China. Coordinators: G. Juzeliunas, W. M. Liu, X.-J. Liu, B. A. Malomed, H. Pu, S. Yi, C. Zhang. Advisors: W. V. Liu, I. Spielman
- Co-organizer and Proposal Submitter, KITPC Program “Precision Many-body Physics of Strongly correlated Quantum Matter”, May 5 - June 13, 2014, Kavli Institute for Theoretical Physics China, Beijing, China. Organizers: Xi Dai, Thierry Giamarchi, Tin-Lun (Jason) Ho, W. Vincent Liu, Boris Svistunov, Matthias Troyer, Biao Wu, Tao Xiang, Martin Zwierlein

<http://www.kitpc.ac.cn/?p=ProgDetail&id=PP20140505&i=main>

- Co-organizer, KITPC Symposium “Precision Tests of Many-Body Physics with Ultracold Quantum Gases”, June 9-13, 2014, Kavli Institute for Theoretical Physics China, Beijing, China.
<http://www.kitpc.ac.cn/?p=ProgDetail&id=CP20140609&i=main>
- Co-organizer, Pitt Quantum Initiative (PQI) Symposium on “Quantum Matter”, 18-19 April 2013, University of Pittsburgh. <http://pqi.pitt.edu/events>
- Co-organizer, Symposium on “Novel Topological Quantum Matter”, February 25-26, 2013, University of Texas at Dallas campus, sponsored by U.S. Army Research Office (ARO)
<http://www.utdallas.edu/nsm/quantum/index.html>
- Lead coordinator, KITP Conference, “Frontiers of Ultracold Atoms and Molecules,” Kavli Institute for Theoretical Physics, UCSB, Santa Barbara, Oct 11–15, 2010, Coordinators: Ofir Alon, Immanuel Bloch, W. Vincent Liu, William Phillips
<http://www.kitp.ucsb.edu/activities/dbdetails?acro=BOPTILATT.C10>
- Lead coordinator (primary contact), KITP Program, “Beyond Standard Optical Lattices,” Kavli Institute for Theoretical Physics, UCSB, Santa Barbara, Sep 13, 2010–Dec 10, 2010
Coordinators: Ehud Altman, Maciej Lewenstein, W. Vincent Liu
Scientific Advisors: Immanuel Bloch, Sankar Das Sarma, Mikhail Lukin, William D. Phillips
<http://www.kitp.ucsb.edu/activities/dbdetails?acro=BOPTILATT10>
- Co-Organizer (with P. Zoller, Fei Zhou, et al), KITPC Program, “Condensed Matter Physics of Cold Atoms,” Kavli Institute for Theoretical Physics China (KITPC), Chinese Academy of Sciences, Beijing, China, Sep 21–Nov 6, 2009. International coordinators: W. Vincent Liu, Chang-Pu Sun, Fei Zhou, Peter Zoller. Local coordinators : Wu-ming Liu, Biao Wu, Su Yi, Yue Yu <http://www.kitpc.ac.cn/program.jsp?id=PC20090921>
- Referee for *Nature*, *Nature Physics*, *Nature Communications*, *Physical Reviews* and *Physical Review Letters*, and *Annals of Physics*.
- Proposal Reviewer for (U.S.) NSF, ARO (Army Research Office), AFOSR, and PECASE (Presidential Early Career Awards for Scientists and Engineers).
- Name list of Overseas Reviewing Experts of Chinese Academy of Sciences, 2015.

PRESS PUBLICITY

1. On Skymions at Oxide Interface, reported in Editor’s Research Highlights, *Nature Nanotechnology* 9, 245 (APRIL 2014).
<http://www.nature.com/nnano/journal/v9/n4/full/nnano.2014.83.html#heterostructures-skyrmions-at-the-interface>
2. On Kaufman Foundation “New Initiative Grants” Award, July 2013:
 - **Pitt Dietrich School of Arts and Sciences** Announcement: “Physics Professors Win Charles E. Kaufman Foundation Grant”, <http://www.as.pitt.edu/node/751>
 - **Pittsburgh Post-Gazette** report, “Kaufman Foundation awards initial science grants”, <http://www.post-gazette.com/stories/local/region/kaufman-foundation-awards-initial-science-grants-696885/>
3. On supervised PhD student winning KITP Graduate Fellowship in UC Santa Barbara, 2013

- **Pitt Dietrich School of Arts and Sciences** Announcement: “STUDENT NAMED KAVLI INSTITUTE FOR THEORETICAL PHYSICS GRADUATE FELLOW”, <http://www.as.pitt.edu/node/759>
4. On Discovery of Topological Semimetal phase in Optical Lattices, Nov 2011
 - **University of Pittsburgh Press** Release, Nov 2011: “Pitt Discoveries in Quantum Physics Could Change Face of Technology”, http://www.news.pitt.edu/Nature_QuantumPhysics.
 - **U of Maryland JQI** News: “Topological Matter in Optical Lattices”, <http://jqj.umd.edu/news/topological-matter-optical-lattices>
 - reported by **Phys.org**, **Science Daily**, etc.
 5. On the concept of Interior Gap/Breached Pair Superconductivity, proposed with Frank Wilczek (Herman Feshbach Professor of Physics at MIT, 2004 Noble Prize in Physics): **Phys. Rev. Focus Press News**, January 2005, “Odd Particles Out”. The Focus story at <http://focus.aps.org/story/v15/st1>.

INVITED CONFERENCE PRESENTATIONS & COLLOQUIUMS

<i>31 Aug-4 Sep 2015</i>	Invited talk, International workshop on “Synthetic Quantum Magnetism”, Max Planck Institute for the Physics of Complex Systems (MPIPKS), Dresden, Germany
<i>14 Nov 2014</i>	Colloquium, Department of Physics, College of William & Mary, Williamsburg, VA
<i>6 Nov 2014</i>	Colloquium, Department of Physics, SUNY Buffalo
<i>14-17 Jun 2014</i>	Invited talk, 6th International Symposium on Cold Atom Physics - ISCAP VI, Taiyuan, China.
<i>24-25 Sep 2013</i>	Army Science Planning & Strategy Meeting: Quantum Information and Sensing, Bolger Conference Center in Potomac, Maryland (Washington DC sub), invited talk: “Topological orbital physics of cold atoms in novel lattice geometries — a possible future direction for the Army”
<i>8-10 Jul 2013</i>	“Cold Atoms” Summer School of Department of Physics, Tsinghua University, Beijing. Pedagogical lecture: “Selected Topics in Modern Many-Body Theory”
<i>28-30 Jun 2013</i>	7th Cross-Strait and International Conference on Quantum Manipulation, Institute of Physics, Chinese Academy of Sciences (CAS), Beijing. Invited speaker: “Topological phases of fermions in the p-orbital band of optical lattices”
<i>19-21 Jun 2013</i>	International Workshop on “Quantum Many-Body Systems in Low Dimensions”, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, Wuhan, China. Invited long talk: “Orbital phase transitions in low dimensional beyond-standard optical lattices”
<i>25-26 Feb 2013</i>	Symposium on ‘Novel Topological Quantum Matter’, University of Texas at Dallas campus: Discussion Leader for Session “Future Directions”
<i>4 Feb 2013</i>	Nordita Workshop “Pushing the Boundaries with Cold Atoms”, NORDITA, KTH and Stockholm University, Stockholm, Sweden, Feb 1-10, 2013. Invited Speaker/Participant: “Topological phases of fermions in the p-orbital band of optical lattices”
<i>6 Dec 2012</i>	Tsinghua University, Department of Physics Colloquium: “Orbital dance beyond standard optical lattices”, Beijing, China

- 24 Oct 2012 U Texas at Dallas Physics Colloquium: “Orbital dance beyond standard optical lattices,” Dallas, TX
- 17 Oct 2012 KITP Santa Barbara “Quantum Dynamics” Program Talk: “Topological orbital phases beyond standard optical lattices,” UC Santa Barbara
- 26 Apr 2012 Kent State University, Department of Physics Colloquium: “Ultracold atoms tuned to many-body regimes previously impossible”, Kent, OH
- 23-27 June 2012 The 5th International Symposium on Cold Atom Physics (ISCAP-V), Three Gorges, China. Invited talk: “Topological orbital gases in optical lattices”
- 14 Oct 2011 University of New Brunswick, Department of Physics, Colloquium: “Ultracold atoms tuned to new many-body regimes”, Fredericton, Canada
- 18-22 July 2011 Advanced Workshop on “Non-standard superfluids and insulators”, ICTP, Trieste, Italy, invited talk: “p-band superfluid and insulator phases in optical lattices”
- 13 July 2011 Universitaet Hamburg, Institute of Laser Physics, Colloquium of the Center for Optical Quantum Technologies: “Ultracold atoms in the unprecedented regimes of condensed matter”
- 3-8 Jan 2011 International Conference “Frontiers of Condensed Matter Physics”, Stockholm, Sweden, January 3-8, 2011, invited talk: “Ultracold spin-imbalanced Fermi gases in low dimensions”
- 22 July 2010 NORDITA Workshop “Quantum solids, liquids, and gases,” Stockholm, Sweden, 19 July —27 Aug, 2010. Invited talk: “p-orbital ultracold particles and Bose-Einstein crystal.”
- 6 July 2010 CAS 4th International Symposium on Cold Atom Physics, July 5-8, 2010, Zhoushan Islands, Zhejiang, China. Sponsored by Center for Cold Atom Physics (Shanghai), Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences. More than 260 participants. Invited talk: “Novel p-orbital quantum phases in cold atom optical lattices”
- 11-13 Nov 2009 Workshop on “Ab-initio Modeling of Cold Gases,” CECAM/ETH, Zurich, Switzerland, November 11-13, 2009. Invited talk: “Cold atoms and molecules in elongated Wannier orbitals.”
- 8 Sep 2009 Conference: Bose-Einstein Condensation 2009, Frontiers in Quantum Gases, Sant Feliu de Guixols (Costa Brava), Spain, 05-11 September 2009. Invited short talk: “Analytic thermodynamics and thermometry of 1D imbalanced Fermi gases at strong interaction.”
- 20 Mar 2009 APS March Meeting, Pittsburgh, PA, March 16-20, 2009. Invited talk in the invited session on “Novel orbital quantum phases in cold atom optical lattices”: “Non-zero momentum Bose-Einstein condensation of orbital atoms.”
- 8 Jan 2009 PQE 2009: 39th Winter Colloquium on the Physics of Quantum Electronics, Snowbird, Utah, January 4-8, 2009. Invited talk in the “Optical Lattice” Session: “Crystalline superfluidity of cold atoms in lattice p-bands.”
- 19 Aug 2008 Aspen Center for Physics. Summer Workshop, “Frontiers in Strongly Correlated Systems,” Invited talk: “Orbital physics of optical lattices.”
- 10 July 2007 Henri Poincare Institute, Paris, France, Quantum Gases Program Talk: “Some unconventional phases of cold atomic matter with or without an optical lattice”.

- 7 June 2007 APS DAMOP/DAMP (38th Annual Meeting of APS Division of AMO), 5-9 June 2007, Calgary, Canada. Invited speaker in the “Optical Lattices” session: “Orbital phases of cold atoms in the lattice p-orbital band”
- 8 May 2007 KITP, U. California Santa Barbara. “Strongly Correlated Phases in Condensed Matter and Degenerate Atomic Systems” Program Invited Talk: “Exploring New Phases of Cold Atomic Matter with or without an Optical Lattice”.
- 28 & 29 Jun 2006 APCTP (Asia Pacific Center for Theoretical Physics, Pohang, Korea), Focus Program on Search for Exotic State of Dense Matter. Two lectures on “Exotic superfluids for ultracold atomic gases”. (with all international travel expenses paid by the program)
- 19-23 Sep 2005 Univ of Washington Institute for Nuclear Theory in Seattle, Workshop on Pairing in Fermionic Systems—Beyond BCS, Session Talk: “Breached pair superfluidity”
- 16 June 2005 Aspen Center for Physics, Program on Ultracold Atomic Gases (May 29–June 18, 2005), Blackboard Discussion Session Talk: “Anomalous quantum flow of atoms near p-wave resonance”.
- 18-21 Apr 2005 OCTS at Ohio State University, Strongly Interacting Quantum Gases Conference: “Anomalous quantum mass flow of atoms near p-wave resonance”
- 21-25 Mar 2005 APS March meeting, Los Angeles, invited talk: “Quantum phases and an anomaly of interacting fermionic atoms”
- 24 Feb 2004 University of Texas at Austin. Department of Physics Special Colloquium: “Exotic superfluidity of cold atomic gases”.
- 10 July 2002 BEC 2002 Summer Program at Trento, Italy. Program invited talk: “New states of matter in cold atoms”.

INVITED SEMINARS

- 3 Dec 2015 City University of New York (CUNY) City College of Tech, Brooklyn, NY. Center for Theoretical Physics Seminar: “Chiral Bose and Fermi phases in orbital optical lattices”
- 28 Apr 2015 Seattle INT Program talk: “Chiral Bose and Fermi phases in optical lattices, Program “Frontiers in Quantum Simulation with Cold Atoms”, Institute for Nuclear Theory, University of Washington, Seattle
- 2 Sep 2014 Invited Short Blackboard Talk, in “Gauge Fields in Condensed Matter, Ultracold atoms and beyond” Program, Aspen Center for Physics
- 21 May 2014 Renmin University of China, Department of Physics Seminar: “Orbital phases beyond standard optical lattices”
- 25 Oct 2013 Florida State University and National High Magnetic Lab, Tallahassee, Florida. Condensed Matter Physics Seminar: “Orbital phases in beyond-standard optical lattices”
- 26 Oct 2012 UC Santa Cruz Condensed Matter Seminar: “Topological phases of fermions in the higher orbital bands of optical lattices,” Univ of California, Santa Cruz, CA
- 20 June 2012 Peking University, International Center for Quantum Materials Weekly Seminar: “Topological Orbital States in Optical Lattices,” Beijing, China.

- 10 Apr 2012 Washington State University, Department of Physics Colloquium: “Ultra-cold atoms in new quantum matter regimes,” Pullman, WA
- 27 Sep 2011 Penn State University, Department of Physics, CAM Seminar: ”Novel p-band superfluid and insulator phases in optical lattices,” University Park, PA.
- 17 Feb 2011 Brown University, Department of Physics, Condensed Matter Seminar: “Ultracold spin-imbalanced Fermi gases in low dimensions”
- 14 Dec 2010 Boston College, Department of Physics, Condensed Matter Seminar: “Beyond the s-orbital band of optical lattices: from finite-momentum $px+ipy$ Bose-Einstein condensation to topological semi-Fermi liquids”
- 27 July 2010 Department of Physics, Ludwig-Maximilians-Universität (LMU), Munich, Germany. Quantum Optics Group Seminar: “p-orbital ultracold particles and Bose-Einstein crystal”
- 25 Feb 2010 Department of Physics, Univ of Maryland, College Park. CNAM Condensed Matter Colloquium: “Exotic superfluidity of spin imbalanced fermions: from three to one dimension”
- 17 Nov 2009 Institute for Quantum Optics and Quantum Information (IQOQI), Austrian Academy of Sciences, Innsbruck, Austria. Quantum Optics Seminar: “Orbital phases in optical lattices.”
- 7 Nov 2008 Department of Physics, Purdue University. Condensed Matter and Biological Physics Seminar: “Crystalline superfluidity of ultracold Bose and Fermi gases.”
- 22 Aug 2007 National Institute of Standards and Technology (NIST), Gaithersburg. Quantum Information/BEC (QIBEC) Seminar: “Orbital order in optical lattices.”
- 14 Dec 2006 UMass Amherst. Department of Physics Condensed Matter Seminar: “Exotic condensed matter phases of ultracold atoms”.
- 6 Mar 2006 University of Toronto. Department of Physics Condensed Matter Physics Seminar: “Novel phases and anomaly of ultracold atoms in Feshbach resonance”.
- 16 Nov 2005 Johns Hopkins University. Department of Physics & Astronomy Condensed Matter Seminar: “Novel pairing and quantum anomaly in ultracold atomic gases”.
- 7 Nov 2005 University of British Columbia. Department of Physics & Astronomy Theory Seminars: “Breached pair superfluidity for cold fermionic atoms”.
- 19 Feb 2004 University of Pittsburgh. Department of Physics & Astronomy Condensed Matter Seminar: “Exotic superfluidity of cold atomic gases”.
- 16 Feb 2004 Purdue University. Department of Physics Special Nanoscience Seminar: “Exotic superfluidity of cold atomic gases”.
- 7 Oct 2003 Cornell University. Laboratory of Atomic and Solid-State Physics Seminar: “Breached Pairing Superfluidity: A Possible New State of Matter in Cold Fermi Atoms”.
- 23 Jan 2003 Yale University. Condensed Matter Seminar: “Quantum phase transition and interior gap superfluidity of cold Fermi atoms in optical lattices”.

- 26 Dec 2002* Tsinghua University, Beijing. Lecture in Center for Advanced Study: “Interior gap superfluidity and quantum phase transition”.
- 10 Oct 2002* Harvard University. Condensed Matter Theory Seminar: “New states of matter in cold atoms: I. topological spin-disordered superfluids; II. interior gap superfluidity”.
- 12 Jan 2001* Bell Labs, Lucent Technologies. Condensed Matter Seminar on Friday: “Stripes in doped Mott insulators: in-phase or anti-phase?”
- 17 Feb. 1999* Institute for Theoretical Physics, University of California at Santa Barbara. Special Seminar: “Bose–Einstein condensation and broken U(1) symmetry”.
- 4 Feb. 1999* Harvard University. Condensed Matter Theory Seminar: “Effective field theory approach to Bose-Einstein condensation”.
- 23 Sep. 1998* Ohio State Univ. HEP/Astro Seminar: “Effective field theory approach to Bose-Einstein condensation”.

RESEARCH GRANTS (total awarded to Liu: > \$3.0M)

- Title: “Topological phases of ultracold atoms beyond standard optical lattices ”
Agency: **Air Force Office of Scientific Research (AFOSR)**
Grant No: FA9550-16-1-0006
Amount: **\$1,421,812**
Period: 11/15/2015 - 11/14/2020
PI: W. Vincent **Liu (lead PI)**
Co-PI: Erhai Zhao (George Mason Univ)
- Title: “Topological Quantum Wire Emulators.”
Agency: Kaufman Foundation of The Pittsburgh Foundation, New Initiative research grant program
Period: 8/1/2013 - 7/31/2015
Grant No.: UN2013-66930
Amount: \$242,310 (initial) + \$57,690 (supplement) (total for 2 PIs)
PI: S. Frolov
Co-PI: W. V. **Liu (\$150,000)**
- Title: Quantum Phases of Matter in Optical Lattices
Agency: DARPA DARPA-BAA-11-65, Modification 1, 18 month extension of ‘Optical Lattice Emulator’ Program (OLE), 11/15/2012–05/14/2014
No.: W911NF-07-1-0464
Amount: \$2,169,500 – (11 PIs)
PI: Randall G. Hulet (Rice University)
Co-PIs: Carlos J. Bolech (Rice), David M. Ceperley (UIUC), Brian L. DeMarco (UIUC), Jason Ho (Ohio State), David A. Huse (Princeton), W. Vincent Liu (Pittsburgh), Erich J. Mueller (Cornell), Han Pu (Rice), Nandini Trivedi (Ohio State), David Weiss (Penn State)
(Liu \$140,000)
- Title: Optical Lattice Gases of Interacting Fermions
Agency: Air Force Office of Scientific Research (AFOSR)
No: FA9550-12-1-0079
Amount: **\$749,900**
Period: 03/15/2012 – 03/14/2015, no cost extension to 09/14/2015
PI: W. Vincent **Liu (lead PI)**, Co-PI: Erhai Zhao (George Mason Univ)
- Title: Exotic Phases of Ultracold Gases
Agency: Army Research Office (ARO)
No: W911NF-11-1-0230
Amount: **\$690,590**
Period: 4/1/2011–3/31/2015, extension 5/14/2016 (4-year plan: \$640,616); Sep-Dec 2012 (Teaching buy-out Supplemental: \$49,974)
PI: W. Vincent **Liu - single PI**
- Title: Optical Lattice Simulations of Correlated Fermions
Agency: DARPA ‘Optical Lattice Emulator’ Program (OLE), awarded through ARO
Period: 07/01/2007–06/30/2009 (phase 1)–06/30/2012 (phase 2)–06/30/2013 (no cost)

No.: W911NF-07-1-0464

Amount: \$6.8M+ (estimate) – (10 PIs)

PI: Randall G. Hulet (Rice University)

Co-PIs: Carlos J. Bolech (Rice), David M. Ceperley (UIUC), Brian L. DeMarco (UIUC), Jason Ho (Ohio State), David A. Huse (Princeton), W. Vincent Liu (Pittsburgh), Erich J. Mueller (Cornell), Han Pu (Rice), Nandini Trivedi (Ohio State)

(Liu \$600,677)

- Title: Exotic phases of ultracold atoms
Agency: Army Research Office (ARO)
No: W911NF-07-1-0293
Amount: **\$325,402 total**
Period: 05/2007-05/2010 (\$290,035); extended 05/2010-05/2011 (Add-on \$35,367)
PI: W. Vincent Liu - **single PI**
- Ralph E. Powe Junior Faculty Enhancement Award, ORAU (Oak Ridge Associated Universities), 2006-07 PI: W. Vincent **Liu (\$ 10,000)**

STUDENTS AND POSTDOCS

Supervised PhD (and MS) Students

- Xiaopeng Li (PhD 2013). Mellon predoctoral fellowship, twice, 2010-11 and 2011-12. Selected as KITP Santa Barbara Graduate Fellow for Spring 2013 by nomination. Invited speaker for 2013 APS March Meeting. Now JQI Postdoc Fellow in U of Maryland since Oct 2013.)
- Zixu Zhang (PhD, 2012), now physicist in finance, Morgan-Stanley.
- Hsiang-Hsuan Hung, 2007-2008 (M.S.) Recommended him for transfer to UCSD (2008-2011), then postdoc at UIUC. Now postdoc associate at U of Texas at Austin.
- Vladimir Stojanovic (PhD 2008, CMU student). In group 2005-2008 for research. Graduate program of Dept of Physics, Carnegie-Mellon University (CMU), co-advisor: Prof. Michael Widom. Postdoc at University of Basel 2009-2013; now postdoc fellow at Harvard.

Exchange and Other Students

- Lijun LANG (exchange student from Institute of Physics, Chinese Academy of Sciences, Beijing, China. At Pitt 2013-2014)
- Jin-Long YU (exchange student from Tsinghua University, China. At Pitt Feb -July, 2013)
- Chiu Man Ho, official a high energy physics/cosmology student of Prof. Dan Boyanovsky. Worked with me in condensed matter/cold atom physics from 2004-2007. Postdoc in UC Berkeley (2007-2009), and then in Vanderbilt University (2009–).

Current Postdocs

- Ahmet Keles (PhD, Univ of Washington Seattle, 2014), joint postdoc with Prof. Erhai Zhao/George Mason U, Sep 2014 –
- Maksims Arzamasovs (PhD, University of Birmingham , 2014), Nov 1, 2014 –
- Haiyuan Zou (PhD. Univ of Iowa, 2014), Aug 2014 –
- Bo Liu (PhD, Peking University, 2013), January 2013 –

Former Postdocs

- Zhifang Xu (PhD, Tsinghua U, 2009), Nov 2013 – Apr 2015. Now Full Professor of Physics, in Huazhong University of Science and Technology, Wuhan, China.
- Zhenyu Zhou (PhD, Washington U St Louis, 2013), joint postdoc with Prof. Erhai Zhao/George Mason U, Sep 2013 – May 2015.
- Dr. Chungwei Lin (PhD, Columbia University, 2008), at Pittsburgh Nov 2009–Nov 2011, now postdoc at University of Texas at Austin
- Dr. Erhai Zhao (PhD, Northwestern University, 2005), Sep 2007–Aug 2009 in Pittsburgh. Now Associate Professor, School of Physics, Astronomy, and Computational Sciences, George Mason University, Fairfax, VA, USA

PUBLICATIONS (citation numbers as of Sep 2013)

A. Selected Significant Publications

1. M. Lewenstein and W. V. Liu, “Orbital Dance,” a “News & Views” article, *Nature Physics* **7**, 101 (FEB 2011).
2. K. Sun, W. V. Liu*, A. Hemmerich, S. Das Sarma, “Topological semimetal in a fermionic optical lattice,” *Nature Physics* **8**, 6770 (2012) [* corresponding author]
3. W. V. Liu and F. Wilczek, “Interior gap superfluidity,” *Phys. Rev. Lett.* **90**, 047002 (2003). arXiv: cond-mat/0208052. (Citations: **384** Google Scholar; **251** Web of Science)
4. M. M. Forbes, E. Gubankova, W. V. Liu, and F. Wilczek, “Stability criteria for breached pair superfluidity,” *Phys. Rev. Lett.* **94**, 017001 (2005). arXiv: hep-ph/0405059. (Citations: **156** Google Scholar; **98** Web of Science) [Reported in **Phys. Rev. Focus** (January 5, 2005)]
5. W. V. Liu, C. Wu, “Atomic matter of non-zero momentum Bose-Einstein condensation and orbital current order,” *Phys. Rev. A* **74**, 013607 (2006). cond-mat/0601432. (Citations: **111** Google Scholar; **71** Web of Science)

B. Other Publications

6. X. Li, W. V. Liu, “Physics of higher orbital bands in optical lattices: a review”, arXiv:1508.06285
7. Bo Liu, Xiaopeng Li, Randall G. Hulet, W. V. Liu, “Detecting π -phase superfluids with p -wave symmetry in a quasi-1D optical lattice”, arXiv:1505.08164
8. Bo Liu, Xiaopeng Li, W. V. Liu, “Orbital hybridized topological Fulde-Ferrel superfluidity in a noncentrosymmetric optical lattice”, arXiv:1505.07444
9. Z. Zhou, E. Zhao, and W. V. Liu, “Spin-Orbital Exchange of Strongly Interacting Fermions in the p Band of a Two-Dimensional Optical Lattice”, *Phys. Rev. Lett.* **114**, 100406 (2015)
10. Z.-F. Xu, X. Li, P. Zoller, W. V. Liu, “Spontaneous Quantum Hall Effect in an Atomic Spinor Bose-Fermi Mixture”, *Phys. Rev. Lett.* **114**, 125303 (2015)
11. B. Liu, X. Li, L. Yin, W. V. Liu, “Weyl Superfluidity in a Three-Dimensional Dipolar Fermi Gas”, *Phys. Rev. Lett.* **114**, 045302 (2015)
12. X.-J. Liu, Z.-X. Liu, K. T. Law, W. V. Liu, T. K. Ng, “Chiral Topological Orders in an Optical Raman Lattice”, arXiv:1405.3975
13. B. Liu, X. Li, B. Wu, W. V. Liu*, “Chiral superfluidity with p -wave symmetry from an interacting s -wave atomic Fermi gas”, *Nature Communications* **5**:5064 (2014) [* corresponding author]
14. X. Li, W. V. Liu, Leon Balents, “Spirals and skyrmions in two dimensional oxide heterostructures”, *Phys. Rev. Lett.* **112**, 067202 (2014). News: Selected as **Research Highlight** by Editor of **Nature Nanotechnology** **9**, 245 (2014) [doi:10.1038/nnano.2014.83]
15. X. Li, A. Paramekanti, A. Hemmerich, W. V. Liu*, “Formation and detection of a chiral orbital Bose liquid in an optical lattice”, *Nature Communications* **5**:3205 (2014) [* corresponding author]

16. X. Li and W. V. Liu, “Orbital coupled dipolar fermions in an asymmetric optical ladder”, *Phys. Rev. A* **87**, 063605 (2013)
17. X. Li, E. Zhao, W. V. Liu*, “Topological states in a ladder-like optical lattice containing ultracold atoms in higher orbital bands,” *Nature Communications* **4**:1523 (2013) [* **corresponding author**]
18. Y. Xu, Z. Chen, H. Xiong, W. V. Liu, Biao Wu, “Stability of p -orbital Bose-Einstein condensates in optical checkerboard and square lattices”, arXiv:1211.5848, *Phys. Rev. A* **87**, 013635 (2013)
19. X. Li, Z. Zhang, W. V. Liu, “Time reversal symmetry breaking of p -orbital bosons in a one-dimensional optical lattice,” arXiv:1110.3364, *Phys. Rev. Lett.* **108**,175302 (2012)
20. Z. Zhang, X. Li, W. V. Liu, “Stripe, checkerboard, and liquid-crystal ordering from anisotropic p -orbital Fermi surfaces in optical lattices,” *Phys. Rev. A* **85**, 053606 (2012)
21. Xiaopeng Li, Erhai Zhao, W. V. Liu, “Effective action approach to the p -band Mott insulator and superfluid transition,” *Phys. Rev. A* **83**, 063626 (2011).
22. P. Hauke, E. Zhao, K. Goyal, I. H. Deutsch, W. V. Liu, M. Lewenstein, “Time-reversal symmetry breaking of fermions in the p -band of an optical lattice,” *Phys. Rev. A* **84**, 051603(R) (2011).
23. C. Lin, X. Li, W. V. Liu, “ $U(1)\times U(1)/Z_2$ Kosterlitz-Thouless transition of the Larkin-Ovchinnikov phase in an anisotropic two-dimensional system,” *Phys. Rev. B* **83**, 092501 (2011).
24. Z. Zhang, W. V. Liu, “Finite temperature damping of collective modes of a BCS-BEC crossover superfluid,” *Phys. Rev. A* **83**, 023617 (2011).
25. X. Li, W. V. Liu, and C. Lin, “Bose-Einstein supersolid phase for a novel type of momentum dependent interaction,” *Phys. Rev. A* **83**, 021602(R) (2011).
26. Z. Zhang, H.-H. Hung, C. M. Ho, E. Zhao, W. V. Liu, “Modulated pair condensate of p -orbital ultracold fermions,” *Phys. Rev. A* **82**, 033610 (2010)
27. K. Sun, E. Zhao, W. V. Liu, “Topological phases of dipolar particles in elongated Wannier orbitals,” *Phys. Rev. Lett.* **104**, 165303 (2010).
28. C. Lin, E. Zhao, W. V. Liu, “Liquid crystal phases of ultracold dipolar fermions on a lattice,” *Phys. Rev. B* **81**, 045115 (2010). (**Editor’s selection** for the January 2010 issue of Virtual Journal of Atomic Quantum Fluids)
29. E. Zhao and W. V. Liu, “An effective field theory for one-dimensional polarized Fermi gases,” *J. Low Temp. Phys.* **158**, 36 (2010).
30. E. Zhao, X.-W. Guan, W. V. Liu, M. T. Batchelor, M. Oshikawa, “Analytic thermodynamics and thermometry of Gaudin-Yang Fermi gases,” *Phys. Rev. Lett.* **103**, 140404 (2009). (**Editor’s selection** for the October 2009 issue of Virtual Journal of Atomic Quantum Fluids)
31. E. Zhao, W. V. Liu, “Theory of quasi-one dimensional imbalanced Fermi gases,” *Phys. Rev. A* **78**, 063605 (2008).
32. V. M. Stojanovic, C. Wu, W. V. Liu, S. Das Sarma, “Incommensurate superfluidity of bosons in a double-well optical lattice,” *Phys. Rev. Lett.* **101**, 125301 (2008). arXiv:0804.3977

33. E. Zhao, W. V. Liu, “Orbital order in Mott insulators of spinless p-band fermions”, *Phys. Rev. Lett.* **100**, 160403 (2008). arXiv:0801.0589
34. C. Wu, W. V. Liu, J. Moore, S. Das Sarma, “Prediction of quantum stripe ordering in optical lattices”, *Phys. Rev. Lett.* **97**, 190406 (2006). cond-mat/0606743
35. V. M. Stojanovic, W. V. Liu, Y. B. Kim, “Unconventional interaction between vortices in a polarized Fermi gas”, *Annals of Physics* **323**, 989 (2008). On the arxiv: Short version: cond-mat/0611295; long version: arXiv:0710.2522.
36. W. V. Liu, “Effective theory of excitations in a Feshbach resonant superfluid”, *Phys. Rev. Lett.* **96**, 080401 (2006). arXiv: cond-mat/0508139
37. W. V. Liu, “Anomalous quantum mass flow of atoms in p-wave resonance”, *Phys. Rev. A* **72**, 053613 (2005). arXiv: cond-mat/0503622
38. W. V. Liu, F. Wilczek, and P. Zoller, “Spin-Dependent Hubbard Model and a Quantum Phase Transition in Cold Atoms”, *Phys. Rev. A* **70**, 033603 (2004). arXiv: cond-mat/0404478.
39. E. Gubankova, W. V. Liu, F. Wilczek, “Breached pairing superfluidity: Possible realization in QCD,” *Phys. Rev. Lett.* **91**, 032001 (2003). arXiv: hep-ph/0304016.
40. C. Wu, W. V. Liu, and E. Fradkin, “Competing orders in coupled Luttinger liquids”, *Phys. Rev. B* **68**, 115104 (2003). [arXiv: cond-mat/0206248.]
41. W. V. Liu, F. Wilczek, “Comment on ‘Superfluidity in the interior-gap states’ by Wu–Yip”. arXiv: cond-mat/0304632.
42. W. V. Liu, F. Wilczek, “Spin-orbit ordering, momentum space coexistence, and cuprate superconductivity”, arXiv: cond-mat/0312685.
43. C. Wu and W. V. Liu, “Thermodynamic properties of the d-density wave order in cuprates”, *Phys. Rev. B* **66**, 020511(R) (2002). arXiv: cond-mat/0201120.
44. W. V. Liu and X.-G. Wen, “Spin-disordered superfluid state for spin-1 bosons with fractional spin and statistics”. arXiv: cond-mat/0201187.
45. W. V. Liu and E. Fradkin, “Antiferromagnetic spin ladders effectively coupled by one-dimensional electron liquids”, *Phys. Rev. Lett.* **86**, 1865 (2001). cond-mat/0008394 .
46. W. V. Liu, “New skyrmions in the attractive Hubbard model with broken SO(4) symmetry”, *Phys. Lett. A* **260**, 94 (1999). arXiv: cond-mat/9903355 .
47. W. V. Liu, “Parity breaking and phase transition induced by a magnetic field in superconductors”, *Nucl. Phys. B* **556**, 563 (1999). arXiv: cond-mat/9808134.
48. W. V. Liu, “Effective field theory approach to Bose-Einstein condensation”, *Int. J. Mod. Phys. B* **12**, 2103 (1998) (**invited review** article). cond-mat/9711250
49. W. V. Liu, “Theoretical study of the damping of collective excitations in a Bose-Einstein condensate,” *Phys. Rev. Lett.* **79**, 4056 (1997).

50. W. V. Liu and W. C. Schieve, “Comment on ‘Collective Excitations of a Bose-Einstein Condensate in a Magnetic Trap’ ”, arXiv: cond-mat/9702122.
51. W. V. Liu and W. C. Schieve, “Quantum chaotic attractor in a dissipative system”, *Phys. Rev. Lett.* **78**, 3278 (1997). arXiv: chao-dyn/9703012 .
52. W. Liu, Y. N. Lu, and E. J. Ding, “Dynamical phase transitions and self-organized criticality in a theoretical spring-block model”, *Phys. Rev. E*, **51**, 1916 (1995).
53. Y. N. Lu, W. Liu, and E. J. Ding, “Hysteresis in a theoretical spring-block model”, *Phys. Rev. Lett.* **72**, 4005 (1994).