Ashvin Vishwanath

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Research Area: Condensed Matter Theory: Research interests - magnetism, superconductivity and topology in quantum materials. Field theory approaches to novel phases and phase transitions.

Education/Training:

Indian Institute of Technology, Kanpur	MSc.	1996	Physics
Princeton University [Thesis Advisor: F. D. M. Haldane]	Ph.D.	2001	Physics

Research and Professional Experience:

2016 – present Professor, Department of Physics, Harvard University.
2012 – 2016 Professor, Physics, UC Berkeley.
2008 – 2012 Associate Professor, Physics, UC Berkeley.
2004 – 2008 Assistant Professor, Physics, UC Berkeley.
2001 - 2004 Pappalardo Postdoctoral Fellow. MIT, USA.

Honors and Awards:

- Europhysics Prize 2016. Citation: *"for the theoretical prediction… of a magnetic skyrmion phase in MnSi, a new state of matter."*
- Simons Investigator Award 2015-2025
- Guggenheim Fellowship 2014.
- ICTS-Infosys Chandrasekhar Lecturer 2020.
- Clarivate Analytics Highly Cited Researcher 2017-2020.
- Distinguished Alumnus Award, Indian Institute of Technology, Kanpur 2018.
- APS Fellow 2013
- Distinguished Visiting Research Chair, Perimeter Institute 2012-2021.
- A. P. Sloan Fellowship, 2004.

Significant Professional Activities:

1. **Director**: Simons Collaboration on Ultra Quantum Matter 2019-.

2. **Co-organizer:**
   a. Boulder School for Condensed Matter Physics 2008*, 'Strongly Correlated Systems',*
   b. KITP Workshop on *"Quantum Spin Liquids and Frustrated Magnetism",* Fall 2012.
   c. KITP Workshop on *"Topological Quantum Matter", Fall 2016.*
   d. Winter Conference at Aspen (2018) *"Dualities"*.
   e. Simons Conferences on *Ultra Quantum Matter* (Feb 2018, August 2018).

Mentoring:

Graduate students (current):

Patrick Ledwith, Saranesh Prembabu, Ruihua Fan,

Nat Tantivasadakarn, Dan Borgnia, Xue-Yang Song, Shang Liu.

Postdocs (current - including joint):

Grisha Tarnopolski, Eslam Khalaf, Ruben Verresen, Yahui Zhang,
Dan Parker, Xueda Wen, Junyeong Ahn.

Former Graduate Students:

Fa Wang (Pappalardo Fellow, MIT. => Associate Professor, Peking U.)
Thesis: Geometrical frustration in quantum and classical antiferromagnets.

Frank Yi Zhang (Stanford=> Bethe Fellow, Cornell=> Assistant Professor, PKU)
Thesis: Theory of Topological Phenomena in Condensed Matter Systems

Pavan Hosur (Stanford=> Assistant Professor U. of Houston)
Thesis: Consequences of non-trivial band topology in condensed matter systems

Haruki Watanabe (Pappalardo Fellow, MIT => Assistant Prof. U. of Tokyo)
Thesis: Spontaneous Symmetry Breaking in Nonrelativistic Systems

Itamar Kimchi (Pappalardo Fellow, MIT => Boulder=> Assistant Professor, GeorgiaTech)
Thesis: Spin-Orbit Coupled Quantum Magnetism in the 3D-Honeycomb Iridates

Philipp Dumitrescu (UTAustin=>Postdoc Flatiron Institute)
Thesis: Strongly Correlated Electron Systems Near Criticality: From Nodal Semimetals to High-Temperature Superconductors

Yasaman Bahri (Google Brain)
Thesis: Quantum Phenomena in Interacting Many-Body Systems: TopologicalProtection, Localization, and Non-Fermi Liquids

Hoi Chun Adrian Po (Pappalardo Fellow: MIT)
Thesis: Keeping it Real: An Alternative Picture for Symmetry and Topology in Condensed Matter Systems

Charles Zhaoxi Xiong (Voleon Group)
Thesis: Classification and Construction of Topological Phases of Quantum Matter

Jong Yeon Lee (Postdoc: KITP Santa Barbara)
Thesis: Fractionalization, Emergent Gauge Dynamics and Topology in Quantum Matter

Former Postdocs (including joint):

Daniel Podolski (Associate Professor, Technion, Haifa)
Arun Paramekanti (Associate Professor, U. Toronto)
Benedikt Binz (Senior Specialist at FINMA)
Ying Ran (Associate Professor, Boston College)
Shinsei Ryu (Professor, Chicago)

Pouyan Ghaemi (Assistant Professor, CUNY)
Ari Turner (Assistant Professor, Technion)

Tarun Grover (Assistant Professor, UC San Diego)
Lukasz Fidkowski (Associate Professor, University of Washington)
Sid Parameswaran (Assistant Professor, Oxford)

Xie Chen (Associate Professor, Caltech)
Yuan Ming Lu (Associate Professor, Ohio State)
Andrew Potter (Assistant Professor, UT Austin)
Maksym Serbyn (Assistant Professor IST, Austria)
Snir Gazit (Assistant Professor, Jerusalem)

Norman Yao (Assistant Professor, UC Berkeley)
Yi Zhuang You (Assistant Professor, UC San Diego)
Yinchen He (Assistant Professor, Perimeter)
Chong Wang (Assistant Professor, Perimeter)
Vedika Khemani (Assistant Professor, Stanford University)

Sagar Vijay (Assistant Professor, UC Santa Barbara)
Zheng Zhu (Assistant Professor, KITS Beijing)
Hassan Shapourian (Postdoctoral Researcher, Microsoft Station Q)
Yingfei Gu (IFQ Postdoctoral Scholar, Caltech)

Publications:

[1] Y.-H. Zhang & A. Vishwanath, *Type-II t-J model in superconducting nickelate* $Nd_{1-x}Sr_xNiO_2$, Physical Review Research, 2 (2020), pp. 023112.

[2] D. Wang, F. Tang, H. C. Po, A. Vishwanath and X. G. Wan, *XFe_4Ge_2 (X = Y, Lu) and Mn3Pt: Filling-enforced magnetic topological metals*, Physical Review B, 101 (2020).

[3] X. Y. Song, Y. C. He, A. Vishwanath and C. Wang, *From Spinon Band Topology to the Symmetry Quantum Numbers of Monopoles in Dirac Spin Liquids*, Physical Review X, 10 (2020).

[4] Y. Z. You and A. Vishwanath, *Superconductivity from valley fluctuations and approximate SO(4) symmetry in a weak coupling theory of twisted bilayer graphene*, NPJ Quantum Materials, 4 (2019).

[5] D. Wang, F. Tang, J. L. Ji, W. Q. Zhang, A. Vishwanath, H. C. Po and X. G. Wan, *Two-dimensional topological materials discovery by symmetry-indicator method*, Physical Review B, 100 (2019).

[6] G. Tarnopolsky, A. J. Kruchkov and A. Vishwanath, *Origin of Magic Angles in Twisted Bilayer Graphene*, Physical Review Letters, 122 (2019).

[7] F. Tang, H. C. Po, A. Vishwanath and X. G. Wan, *Comprehensive search for topological materials using symmetry indicators*, Nature, 566 (2019), pp. 486-+.

[8] F. Tang, H. C. Po, A. Vishwanath and X. G. Wan, *Topological materials discovery by large-order symmetry indicators*, Science Advances, 5 (2019).

[9] F. Tang, H. C. Po, A. Vishwanath and X. G. Wan, *Efficient topological materials discovery using symmetry indicators*, Nature Physics, 15 (2019), pp. 470-+.

[10] X. Y. Song, C. Wang, A. Vishwanath and Y. C. He, *Unifying description of competing orders in two-dimensional quantum magnets*, Nature Communications, 10 (2019).

[11] H. C. Po, L. J. Zou, T. Senthil and A. Vishwanath, *Faithful tight-binding models and fragile topology of magic-angle bilayer graphene*, Physical Review B, 99 (2019).

[12] S. Liu, A. Vishwanath and E. Khalaf, *Shift Insulators: Rotation-Protected Two-Dimensional Topological Crystalline Insulators*, Physical Review X, 9 (2019).

[13] J. Y. Lee, Y. Z. You, S. Sachdev and A. Vishwanath, *Signatures of a Deconfined Phase Transition on the Shastry-Sutherland Lattice: Applications to Quantum Critical SrCu2(BO3)(2<bold>) </bold>*, Physical Review X, 9 (2019).

[14] J. Y. Lee, E. Khalaf, S. Liu, X. M. Liu, Z. Y. Hao, P. Kim and A. Vishwanath, *Theory of correlated insulating behaviour and spin-triplet superconductivity in twisted double bilayer graphene*, Nature Communications, 10 (2019).

[15] J. Y. Lee, J. Ahn, H. Y. Zhou and A. Vishwanath, *Topological Correspondence between Hermitian and Non-Hermitian Systems: Anomalous Dynamics*, Physical Review Letters, 123 (2019).

[16] E. Khalaf, A. J. Kruchkov, G. Tarnopolsky and A. Vishwanath, *Magic angle hierarchy in twisted graphene multilayers*, Physical Review B, 100 (2019).

[17] P. Hosur, S. A. Parameswaran and A. Vishwanath, *Charge Transport in Weyl Semimetals (vol 108, 046602, 2012)*, Physical Review Letters, 123 (2019).

[18] L. Fidkowski, H. C. Po, A. C. Potter and A. Vishwanath, *Interacting invariants for Floquet phases of fermions in two dimensions*, Physical Review B, 99 (2019).

[19] J. H. Chu, J. Liu, H. Zhang, K. Noordhoek, S. C. Riggs, M. Shapiro, C. R. Serro, D. Yi, M. Mellisa, S. J. Suresha, C. Frontera, E. Arenholz, A. Vishwanath, X. Marti, I. R. Fisher and R. Ramesh, *Possible scale invariant linear magnetoresistance in pyrochlore iridates Bi2Ir2O7*, New Journal of Physics, 21 (2019).

[20] L. J. Zou, H. C. Po, A. Vishwanath and T. Senthi, *Band structure of twisted bilayer graphene: Emergent symmetries, commensurate approximants, and Wannier obstructions*, Physical Review B, 98 (2018).

[21] Y. Z. You, Y. C. He, C. K. Xu and A. Vishwanath, *Symmetric Fermion Mass Generation as Deconfined Quantum Criticality*, Physical Review X, 8 (2018).

[22] Y. Z. You, Y. C. He, A. Vishwanath and C. K. Xu, *From bosonic topological transition to symmetric fermion mass generation*, Physical Review B, 97 (2018).

[23] N. Y. Yao, M. P. Zaletel, D. M. Stamper-Kurn and A. Vishwanath, *A quantum dipolar spin liquid*, Nature Physics, 14 (2018), pp. 405-410.

[24] N. Y. Yao, M. P. Zaletel, D. M. Stamper-Kurn and A. Vishwanath, *A quantum dipolar spin liquid (vol 14, pg 405, 2018)*, Nature Physics, 14 (2018), pp. 523-523.

[25] X. Yang, S. H. Jiang, A. Vishwanath and Y. Ran, *Dyonic Lieb-Schultz-Mattis theorem and symmetry protected topological phases in decorated dimer models*, Physical Review B, 98 (2018).

[26] H. Watanabe, H. C. Poe and A. Vishwanath, *Structure and topology of band structures in the 1651 magnetic space groups*, Science Advances, 4 (2018).

[27] C. Wang, A. Vishwanath and B. I. Halperin, *Topological order from disorder and the quantized Hall thermal metal: Possible applications to the v=5/2 state*, Physical Review B, 98 (2018).

[28] N. Tantivasadakarn and A. Vishwanath, *Full commuting projector Hamiltonians of interacting symmetry-protected topological phases of fermions*, Physical Review B, 98 (2018).

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[32] N. Ma, G. Y. Sun, Y. Z. You, C. K. Xu, A. Vishwanath, A. W. Sandvik and Z. Y. Meng, *Dynamical signature of fractionalization at a deconfined quantum critical point*, Physical Review B, 98 (2018).

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[34] J. Y. Lee, A. M. Turner and A. Vishwanath, *Building symmetry-enriched topological phases from a bipartite lattice construction and anyon condensation*, Physical Review B, 98 (2018).

[35] V. Khemani, A. Vishwanath and D. A. Huse, *Operator Spreading and the Emergence of Dissipative Hydrodynamics under Unitary Evolution with Conservation Laws*, Physical Review X, 8 (2018).

[36] E. Khalaf, H. C. Po, A. Vishwanath and H. Watanabe, *Symmetry Indicators and Anomalous Surface States of Topological Crystalline Insulators*, Physical Review X, 8 (2018).

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[38] S. Gazit, F. F. Assaad, S. Sachdev, A. Vishwanath and C. Wang, *Confinement transition of Z(2) gauge theories coupled to massless fermions: Emergent quantum chromodynamics and SO(5) symmetry*, Proceedings of the National Academy of Sciences of the United States of America, 115 (2018), pp. E6987-E6995.

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[41] G. Affeldt, T. Hogan, J. D. Denlinger, A. Vishwanath, S. D. Wilson and A. Lanzara, *Doping-dependent correlation effects in (Sr1-xLax)(3)Ir2O7*, Physical Review B, 97 (2018).

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[43] M. P. Zaletel, Y. M. Lu and A. Vishwanath, *Measuring space-group symmetry fractionalization in Z(2) spin liquids*, Physical Review B, 96 (2017).

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[46] A. C. Potter, C. Wang, M. A. Metlitski and A. Vishwanath, *Realizing topological surface states in a lower-dimensional flat band*, Physical Review B, 96 (2017).

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[49] H. C. Po, A. Vishwanath and H. Watanabe, *Symmetry-based indicators of band topology in the 230 space groups (vol 8, 50, 2017)*, Nature Communications, 8 (2017).

[50] H. C. Po, L. Fidkowski, A. Vishwanath and A. C. Potter, *Radical chiral Floquet phases in a periodically driven Kitaev model and beyond*, Physical Review B, 96 (2017).

[51] T. Morimoto, H. C. Po and A. Vishwanath, *Floquet topological phases protected by time glide symmetry*, Physical Review B, 95 (2017).

[52] M. A. Metlitski, A. Vishwanath and C. K. Xu, *Duality and bosonization of (2+1)-dimensional Majorana fermions*, Physical Review B, 95 (2017).

[53] Y. M. Lu, G. Y. Cho and A. Vishwanath, *Unification of bosonic and fermionic theories of spin liquids on the kagome lattice*, Physical Review B, 96 (2017).

[54] Y. C. He, F. Grusdt, A. Kaufman, M. Greiner and A. Vishwanath, *Realizing and adiabatically preparing bosonic integer and fractional quantum Hall states in optical lattices*, Physical Review B, 96 (2017).

[55] S. Gazit, M. Randeria and A. Vishwanath, *Emergent Dirac fermions and broken symmetries in confined and deconfined phases of Z(2) gauge theories*, Nature Physics, 13 (2017), pp. 484-490.

[56] L. Fidkowski and A. Vishwanath, *Realizing anomalous anyonic symmetries at the surfaces of three-dimensional gauge theories*, Physical Review B, 96 (2017).

[57] G. Affeldt, T. Hogan, C. L. Smallwood, T. Das, J. D. Denlinger, S. D. Wilson, A. Vishwanath and A. Lanzara, *Spectral weight suppression near a metal-insulator transition in a double-layer electron-doped iridate*, Physical Review B, 95 (2017).

[58] Y. Zhang, D. Bulmash, P. Hosur, A. C. Potter and A. Vishwanath, *Quantum oscillations from generic surface Fermi arcs and bulk chiral modes in Weyl semimetals*, Scientific Reports, 6 (2016).

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[60] A. K. Yadav, C. T. Nelson, S. L. Hsu, Z. Hong, J. D. Clarkson, C. M. Schlepuetz, A. R. Damodaran, P. Shafer, E. Arenholz, L. R. Dedon, D. Chen, A. Vishwanath, A. M. Minor, L. Q. Chen, J. F. Scott, L. W. Martin and R. Ramesh, *Observation of polar vortices in oxide superlattices*, Nature, 530 (2016), pp. 198-+.

[61] H. Watanabe and A. Vishwanath, *Electric Field-Induced Skyrmion Crystals via Charged Monopoles in Insulating Helimagets*, Journal of the Physical Society of Japan, 85 (2016).

[62] H. Watanabe, H. C. Po, M. P. Zaletel and A. Vishwanath, *Filling-Enforced Gaplessness in Band Structures of the 230 Space Groups*, Physical Review Letters, 117 (2016).

[63] A. C. Potter, M. Serbyn and A. Vishwanath, *Thermoelectric Transport Signatures of Dirac Composite Fermions in the Half-Filled Landau Level*, Physical Review X, 6 (2016).

[64] A. C. Potter, T. Morimoto and A. Vishwanath, *Classification of Interacting Topological Floquet Phases in One Dimension*, Physical Review X, 6 (2016).

[65] H. C. Po, H. Watanabe, M. P. Zaletel and A. Vishwanath, *Filling-enforced quantum band insulators in spin-orbit coupled crystals*, Science Advances, 2 (2016).

[66] H. C. Po, L. Fidkowski, T. Morimoto, A. C. Potter and A. Vishwanath, *Chiral Floquet Phases of Many-Body Localized Bosons*, Physical Review X, 6 (2016).

[67] H. C. Po, Y. Bahri and A. Vishwanath, *Phonon analog of topological nodal semimetals*, Physical Review B, 93 (2016).

[68] P. J. W. Moll, N. L. Nair, T. Helm, A. C. Potter, I. Kimchi, A. Vishwanath and J. G. Analytis, *Transport evidence for Fermi-arc-mediated chirality transfer in the Dirac semimetal Cd3As2*, Nature, 535 (2016), pp. 266-+.

[69] M. A. Metlitski and A. Vishwanath, *Particle-vortex duality of two-dimensional Dirac fermion from electric-magnetic duality of three-dimensional topological insulators*, Physical Review B, 93 (2016).

[70] Y. M. Lu and A. Vishwanath, *Classification and properties of symmetry-enriched topological phases: Chern-Simons approach with applications to Z(2) spin liquids*, Physical Review B, 93 (2016).

[71] J. Liu, D. Kriegner, L. Horak, D. Puggioni, C. R. Serrao, R. Chen, D. Yi, C. Frontera, V. Holy, A. Vishwanath, J. M. Rondinelli, X. Marti and R. Ramesh, *Strain-induced nonsymmorphic symmetry breaking and removal of Dirac semimetallic nodal line in an orthoperovskite iridate*, Physical Review B, 93 (2016).

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[73] S. D. Geraedts, M. P. Zaletel, R. S. K. Mong, M. A. Metlitski, A. Vishwanath and O. I. Motrunich, *The half-filled Landau level: The case for Dirac composite fermions*, Science, 352 (2016), pp. 197-201.

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[75] P. T. Dumitrescu, M. Serbyn, R. T. Scalettar and A. Vishwanath, *Superconductivity and nematic fluctuations in a model of doped FeSe monolayers: Determinant quantum Monte Carlo study*, Physical Review B, 94 (2016).

[76] M. Cheng, M. Zaletel, M. Barkeshli, A. Vishwanath and P. Bonderson, *Translational Symmetry and Microscopic Constraints on Symmetry-Enriched Topological Phases: A View from the Surface*, Physical Review X, 6 (2016).

[77] F. Burnell, X. Chen, A. Kitaev, M. Metlitski and A. Vishwanath, *Time reversal invariant gapped boundaries of the double semion state*, Physical Review B, 93 (2016).

[78] Y. Zhang, T. Grover and A. Vishwanath, *General procedure for determining braiding and statistics of anyons using entanglement interferometry*, Physical Review B, 91 (2015).

[79] M. P. Zaletel and A. Vishwanath, *Constraints on Topological Order in Mott Insulators*, Physical Review Letters, 114 (2015).

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[82] I. Kimchi, R. Coldea and A. Vishwanath, *Unified theory of spiral magnetism in the harmonic-honeycomb iridates alpha, beta, and gamma Li2IrO3*, Physical Review B, 91 (2015).

[83] J. P. Hinton, S. Patankar, E. Thewalt, A. Ruiz, G. Lopez, N. Breznay, A. Vishwanath, J. Analytis, J. Orenstein, J. D. Koralek and I. Kimchi, *Photoexcited states of the harmonic honeycomb iridate gamma-Li2IrO3*, Physical Review B, 92 (2015).

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