William Thomas Mark Irvine

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Born: L'Aquila, Italy
Italian and English: mother-tongue,
French and Spanish: working knowledge

Last updated: Oct 2014

Education

University of California at Santa Barbara Ph.D, Physics (2003-2006)
Mostly quantum optics theory exploring single-photon $\chi^{(2)}$ processes in semiconductor nanostructures

University of Oxford D.Phil, Physics (2001-2004)
Mostly experiments in single-photon quantum optics

Imperial College, London Master of Science (1997-2001) First Class Honours, ARCS.
Work on Quantum Jumps in Mg^{25+} with R.C. Thompson and Consistent Histories with C.J. Isham.

Research Appointments

University of Chicago Assistant professor (Physics) 2011-.

University of Leiden Visiting Professor (2010)
Collaboration with V.Vitelli

Center for Soft Matter Research, NYU PostDoc with P.M. Chaikin (2007-2010)
Experiments on topological defects in colloidal crystals on curved surfaces and in applied optical potentials; Theoretical work on electromagnetic knots; Experiments and modeling on a lock and key colloidal system.

Extended stays

Weizmann Institute, Israel Feinberg foundation visiting faculty (Coming in 2014-2015)
Newton Institute, Cambridge, UK "Topological Dynamics" Visiting Fellow (Dec 2012)
Kavli Institute for Theoretical Physics, Santa Barbara "Knotted Fields" (Jun.-Jul. 2012)
Aspen Center for Physics "Interfaces, Topological Defects and Flexible Packings" (Jul. 2008)

Honors

NSF CAREER Award (2014)
Packard fellow (2012)
Sloan fellow (2012)
Lindemann fellow (2007) – Postdoctoral fellowship from the English speaking union
Tyndall prize (2001) – Imperial College best thesis: "Consistent histories" with C.J. Isham
Nuffield Foundation Award (2000) – For undergraduate research carried out at Oxford.
Northern Telecom Prize (1999) – Imperial college undergraduate performance in experiment

Synergistic activities

Organizer, Boulder summer school 2015
(Together with C. Marchetti, M. Bowick, V.Vitelli and L. Radzihovsky)

Symposium organizer, XXI International Materials Research Congress, Cancun, Mexico, 2012
(Together with V.Vitelli and S. Smoukov)

Supervisor of minority students from Chicago REU program - (1 in Summer 2011, 2 in Summer 2012)

Guest editor, Soft Matter, Themed Issue on The Geometry and Topology of Soft Materials
(Together with V.Vitelli)

Program Organizer, KITP workshop on "Knotted fields", Santa Barbara, June-July 2012
(Together with R. Kamien, M. Dennis and R. Kusner)

Supervisor of high-school student from PREM Program (Summer 2011)

Referee for: Nature Physics, Nature Materials, Physical Review Letters , Applied Physics Letters, Europhysics Letters, Proceedings of the Royal Society, Proceedings of the National Academy of Sciences

List of publications

Published:

1. **Helicity conservation by flow across scales in reconnecting vortex links and knots**
   Martin Scheeler*, Dustin Kleckner*, Davide Proment Grodon Kindlmann and **W.T.M. Irvine**
   Proceedings of the National Academy of Sciences (In press)
   Featured on the cover

2. **"Soft" Epitaxy at the Nanoscale: the Role of Size, Shape and Strain**
   S.M. Rupich, F.C. Castro, **W.T.M. Irvine** and D.V. Talapin
   Nature Communications (In press)

3. **The life of a vortex knot**
   Dustin Kleckner, Martin W. Scheeler, and **W.T.M. Irvine**
   Physics of Fluids **26**, 091105 (2014)

4. **Liquid crystals: Tangled loops and knots**
   W.T.M. Irvine and Dustin Kleckner
   Nature Materials 13, 229-231 (2014)

5. **Orientation-dependent measures of chirality**
   Efi Efrati and **W.T.M. Irvine**
   Physical Review X **4**, 011003 (2014)

6. **The Life of a Vortex Knot**
   Dustin Kleckner, Martin Scheeler and **W.T.M. Irvine**
   APS DFD Gallery of Fluid Motion (2013)
   Winner of the Milton van Dyke Award (Video)

7. **Knotting light**
   Hridesh Kedia, Iwo Byalinizky-Birula, Daniel Peralta-Salas and **W.T.M. Irvine**
   Physical Review Letters **111** 150404 (2013)
   Featured on the cover

8. **Dislocation Reactions, Grain Boundaries and Irreversibility in Two Dimensional Lattices using Topological Tweezers**
   W.T.M. Irvine, Andrew D. Hollingsworth, David G. Grier and Paul M. Chaikin
   Proceedings of the National Academy of Sciences 110 **39** 15544-15548 (2013)

9. **The geometry and topology of soft materials**
   Vincenzo Vitelli and **W.T.M. Irvine**
   Soft Matter **9** 8086 (2013)

10. **Creation and dynamics of knotted vortices in fluids**
    D. Kleckner, **W.T.M. Irvine**
    Nature Physics **9** 253-258 (2013)
    Featured on the cover

11. **Geometric background charge: dislocations on capillary bridges**
    W.T.M. Irvine, and V. Vitelli
    Soft Matter **8** 10123 (2012)

12. **Interstitial fractionalization in curved space**
    W.T.M. Irvine, M. Bowick and P.M. Chaikin
    Nature Materials **11** 948951 (2012)

13. **Cubic crystals from cubic colloids**
    Laura Rossi, Stefano Sacanna, **W.T.M. Irvine**, Paul M. Chaikin, David J. Pine, and Albert Philipse
    Soft Matter **7** 4139 (2011)
    Featured on the cover

14. **Lock and Key Colloids through Polymerization-Induced Buckling of Monodisperse Silicon Oil Droplets**
S. Sacanna, **W.T.M. Irvine**, L. Rossi, P.M. Chaikin, and D.J. Pine
Soft matter **7** 1631 (2011)
Featured on the cover

15. **Pleated crystals on curved surfaces**
W.T.M. Irvine, V. Vitelli and P.M. Chaikin
Nature **468** 947-951 (2010)

16. **Linked and knotted beams of light, conservation of helicity and the flow of null electromagnetic fields**
W.T.M. Irvine
Journal of Physics A: Mathematical and Theoretical **43** 385203 (2010)

17. **Lock and key colloids**
S. Sacanna, **W.T.M. Irvine**, P.M. Chaikin and D.J. Pine
Nature **464** 575-578 (2010)

    Lock and Key Colloids and Method of Manufacture, Patent Pending.

18. **Calculating the Modes of Diffraction Limited Optical Cavities**
D. Kleckner, **W.T.M. Irvine**, S. Oemrawsingh and D. Bouwmeester
Physical Review A **81** 043814 (2010)

19. **Polychromatic photonic quasicrystal cavities**
S.M. Thon, **W.T.M. Irvine** and D. Bouwmeester
Physical Review Letters **104** 243901 (2010)

20. **Strong coupling through optical positioning of a quantum dot in a photonic crystal cavity**
S.M. Thon, M.T. Rakher, H. Kim, J. Gudat, **W.T.M. Irvine**, P.M. Petroff, and D. Bouwmeester
Applied Physics Letters **94** 111115 (2009)

21. **Linked and knotted beams of light**
W.T.M. Irvine and D. Bouwmeester
Nature Physics **4** 716 (2008)

    Featured on the cover

22. **High Finesse Opto-Mechanical Cavity with a Movable Thirty-Micron-Size Mirror**
D. Kleckner, W. Marshall, M.J.A. de Dood, N. Dinyari B. Pors, **W.T.M. Irvine** and D. Bouwmeester
Physical Review Letters **96** 173901 (2006)

23. **Strong coupling between single photons in semiconductor micro-cavities**
W.T.M. Irvine, K. Hennesey and D. Bouwmeester
Physical Review Letters **96** 057405 (2006)

24. **Bloch theory of entangled photon generation in non-linear photonic crystals**
W.T.M. Irvine, M.J.A. de Dood and D. Bouwmeester
Physical Review A **72** 043815 (2005)

25. **Realisation of Hardy's thought experiment**
W.T.M. Irvine, J.H. Hodelin, C. Simon and D. Bouwmeester
Physical Review Letters **95** 030401 (2005)

26. **Nonlinear Photonic Crystals as a Source of Entangled Photons**
M.J.A. de Dood, **W.T.M. Irvine** and D. Bouwmeester
Physical Review Letters **93** 040504 (2003)

27. **Optimal Quantum Cloning on a Beam-splitter**
W.T.M. Irvine, A. Lamas Linares, M.J.A. de Dood and D. Bouwmeester
Physical Review Letters **92** 047902 (2003)

28. **Robust Long-Distance Entanglement and a Loophole-Free Bell Test with Ions and Photons**,
C. Simon and **W.T.M. Irvine**,
Physical Review Letters **91** 110405 (2003)

29. **Generalised Bell Inequalities With Parametric Down-Conversion**
A. Lamas Linares, **W.T.M. Irvine**, J.C. Howell and D. Bouwmeester
Quantum Information and Computation on line **3** Special 471 (2003)

30. **Quantum jumps in singly ionized magnesium**
H.F. Powell, M.A. van Eijkelenborg, **W. Irvine**, D.M. Segal and R.C. Thompson
Journal of Physics B **34** 1 (2001)

In the news

Knotted light:

Tying Knots in Light, Scientific American, October 17th (2013)
Physicists tie light into knots IOP Physics World, October 16th (2013)
Maxwell's Knots American Physical Society Research Spotlight, October (2013)
Holograms tie optical vortices in knots Physics Today, Vol. 63, 18 (2010)
Light's Ring-around the rosey Optics & Photonics Focus, Vol. 3 (2008)
A Knot of Light Science News (2008)
Physicists hope to tie light beams in knots PhysOrg (2008)

Knotted Vortices:

Get Knotted, New Scientist, October 4th (2014)
Knotty Thrills, NOVA PBS Video Short, July 15th (2014)
Could Knots Unravel Mysteries of Fluid Flow? Quanta Magazine, December 9th (2013)
La mystrieuse chorgraphie des anneaux de fume, Sciences et Avenir, December 7th (2013)
Physicists twist water into knots, Nature News, March 3rd (2013)
Fluid dynamics: Lord Kelvin's vortex rings, Nature Physics News and Views, Vol. 9, 207-208 (2013)
Physicists Tie Water Into Knots, NPR Science Friday, March 15th (2013)
Physicists create vortex knot – akin to 'tying a smoke ring', Wired, March 13th (2013)
Physicists Twist Water into Knots, Scientific American, March 6th (2013)
Unraveling the Physics of Invisible Knots, AAAS News, March 3rd (2013)
A vortex knot caught on camera, Physics Today, Vol. 66, 5 (2013)
Knot Physics Experiment Uses Water To Create Amazing 'Knotted Vortex' Loop, Huffington Post Science, July 31st (2013)
Vortex Loops could untie knotty physics problems, UChicago News, March 4th (2013)

Curved crystals and topological tweezers:

Breaking up in a curved plane, Nature Materials News and Views, Vol. 11, 912 (2012)
Self-healing Curved Crystals, NSF Discoveries, Sep. 30 (2012)
Pleats are in fashion, Nature Physics *Thesis* Vol. 7, 95 (2011)
It's a wrap, Nature Physics Research Highlights Vol. 7, 6 (2011)
Pleated crystals, Nature News and Views, Vol. 468, 906 (2010)

Lock and Key colloids:

Reconfigurable Colloids, Nature News and Views, Vol. 464, 496 (2010)
Colloidal Assembly, Nature Materials Research Highlights, Vol. 9, 378 (2010)
The key to colloid assembly, Chemistry World (2010)
Locks and keys build tiny structures, Physics World (2010)
Dai colloidi nuovi materiali auto-assemblanti, Le Scienze (2010)

Entangled photons and photonic crystals

From patchy particles to entangled photons Nature Materials , Vol.**3**, 582 (2004)

Invited talks and seminars

Upcoming

University of California, Santa Barbara Physics colloquium (Spring 2015)
"TBA"

Brown Physics colloquium (Spring 2015)
"TBA'

EPFL Physics colloquium (Spring 2015)
"TBA"

University of Michigan Physics colloquium (Fall 2014)
"TBA"

2014

Mechanical Engineering Seminar, Princeton (Fall 2014)
"The life of a vortex knot: Linking, coiling and twisting across scales"

Applied mathematics colloquium, Princeton (Fall 2014)
"Conservation of knottiness in real and idalized fluids"

Carnegie Mellon University Physics Colloquium (Fall 2014)
"The life of a vortex knot: Linking, coiling and twisting across scales"

Physics colloquium, Ecole Normale Superieure, Lyon (October 2014)
"The life of a vortex knot: Linking, coiling and twisting across scales"

Lorentz workshop on "Topological Mechanics: from Metamaterials to Robots", Leiden (October 2014)
"The life of a vortex knot and a mechanical topological insulator"

Center for Soft Matter Research Colloquium, NYU (September 2014)
"The life of a vortex knot: Linking, coiling and twisting across scales"

I2CAM School, South Africa (June 2014)
"Vortex dynamics and topological fluids" (3 Lectures)

Dynamics at Interfaces, Okinawa (June 2014)
"Unraveling knotted fields"

Perimeter Institute (May 2014)
"Unraveling Knotted Fields"

I2CAM/FAPERJ School, Brazil (May 2014)
"Vortex dynamics and topological fluids" (3 Lectures)

Physics Colloquium, Northwestern (April 2014)
"Unraveling Knotted Fields"

Physics Colloquium, University of Chicago (April 2014)
"Unraveling Knotted Fields"

2013

University of Oregon Physics Department Colloquium (7^{th} Nov 2013)
"Unraveling Knotted Fields"

Harvard Applied Physics Colloquium (1^{st} Nov 2013)
"Unraveling Knotted Fields"

Yale Physics Club (21^{st} Oct 2013)
"Unraveling Knotted Fields"

Georgia Tech Soft matter seminar (Aug 2013)
"Unraveling Knotted Fields"

NYU Physics department colloquium (Oct 2013)
"Unraveling Knotted Fields"

RCC Speaker series, UChicago (Mar 2013)
"Unraveling Knotted Fields"

UMass Physics Colloquium (Mar 2013)
"Colloidal crystals in curved space: Pleating and fractionalization by topological defects"

NIM Winterschool, Austria (Mar 2013)
"Colloidal crystals in curved space: Pleating and fractionalization by topological defects"

Syracuse University Condensed matter and Biological physics seminar (7-8^{th} Feb 2013)
"Colloidal crystals in curved space: Pleating and fractionalization by topological defects"

Syracuse University Physics department colloquium (7-8^{th} Feb 2013)
"Knots in Light and Fluids"

University of Boulder Physics department colloquium (Feb 2013)
"Knots in Light and Fluids"

University of Boulder Seminar (Feb 2013)
"Colloidal crystals in curved space: Pleating and fractionalization by topological defects"

2012

ENS de physique statistique, Seminar, Paris (Dec 2012)
"Knots in light and fluids"

Newton Institute, Cambridge (Dec 2012)
"Knots in light and fluids"

Rockerfeller University (27^{th} Nov 2012)
"Knots in light and fluids"

Newton Institute and DAMTP, Cambridge (Sep 2012)
"Knots in light and fluids"

Modern Perspectives on Thin Sheets: Geometry, Elasticity, and Statistical Physics (Sep 2012)
"Colloidal crystals in curved spaces: Topologcal tweezing, pleating and fractionalization"

KITP workshop on Knotted fields (June-July 2012)
"Linked and Knotted Fields: Light and Hydrodynamics"

SIAM Conference on Nonlinear Waves and Coherent Structures, Seattle, invited talk (June 2012)
"Design and evolution of vortex filaments with non-trivial topologies"

Colloidal Dispersions in External Fields (CODEF III, Bonn, Germany) (March 2012)
"Colloidal crystals in optical fields and curved spaces: Topologcal tweezing, pleating and fractionalization"

Brandeis Physics colloquium (January 2012)
"Knotted fields"

2011

Princeton Center for Theoretical Science (December 2011)
"Knotted fields"

Statistical Physics of the Mechanical Properties of Amorphous Solids, Cuarnavaca Mexico (Nov. 2011).
"Colloidal crystals in curved spaces: Topologcal tweezing, pleating and fractionalization"
"Linked and knotted beams of light"

Harvard University,Weitzfest (October 2011)
"Colloidal crystals in optical fields and curved spaces: Topologcal tweezing, pleating and fractionalization"

Harvard University, Applied Physics colloquium (April 2011)
"Colloidal crystals in optical fields and curved spaces: Topologcal tweezing, pleating and fractionalization"

University of Chicago, Physics colloquium (2011)
"Curved crystals and knotted fields"

Aspen center for physics - Geometry and the imagination, Invited Talk (2011)
"Colloidal crystals on curved surfaces: Pleats and fractionalization"

< **2011**

Technion, Biological physics seminar (2010)
"Colloidal crystals in curved spaces: Pleating and fractionalization"

University of Leiden, Joan van der Waals colloquium (2010)
"Colloidal crystals in optical fields and curved spaces: Topologcal tweezing, pleating and fractionalization"

APS March meeting, Invited Talk (2010)
"Topological defects in colloidal Wigner crystals on curved surfaces"

University of Chicago, Special MRSEC seminar (2009)
"Light, soft matter and geometry"

University of Chicago, Special MRSEC seminar (2009)
"Linked and knotted beams of light"

University of Chicago, Special seminar (2009)
"Light, soft matter and geometry"

Leiden University, Seminar (2009)
"Optical and geometrical control of colloidal monolayers"

Syracuse University, Soft matter and biological physics Seminar (2008)
"Two-dimensional crystallography at an oil-water interface"

Syracuse University, Journal club talk (2008)
"Linked and knotted beams of light"

Courant institute for mathematical sciences., Applied mathematics laboratory seminar (2008)
"Linked and knotted beams of light"

Leiden University, Quantum optics Group seminar (2008)
"Pinning of a two dimensional lattice of colloids"

California Institute of Technology, Vahala group seminar (2008)
"Single photons in nonlinear photonic crystals"

California NanoSystems Institute, Brown Bag seminar (2006)
"Single photons in nonlinear photonic crystals"

Institute for quantum computation, Waterloo, Seminar (2006)
"Entagled photons from nonlinear photonic crystals and Hardy's thought experiment"

Conferences/Summer schools

APS March Meeting, Houston, March 2015

DFD Meeting, San Francisco, November 2014.

2014 US Kavli Frontiers of Science symposium, Irvine, November 2014.

Topological Mechanics: from Metamaterials to Robots, Leiden, October 2014.

DFD Meeting, Pittsburgh, November 2013.

APS March Meeting, Baltimore, March 2013.

Topological dynamics - Newton Institute , Cambridge, Dec 2012.

DFD Meeting, San Diego, Nov 2012.

Topological dynamics - Newton Institute, Cambridge, Sep 2012.

Modern perspectives in thin sheets (Lorentz Center workshop), Leiden, Sep 2012.

CODEF III, Bonn, Germany, March 2012.

APS March meeting, Boston, March 2012.

Soft Matter and Innovation (Weitzfest), Boston, Oct 2011.

Materials and the imagination, Aspen, January 2011.

APS March meeting, Portland, March 2010.

APS March meeting, Pittsburgh, March 2009.

IACIS International Conference on Surface and Colloid Science and ACS Colloid & Surface Science Symposium 2009.

Physics@FOM, Veldhoven 2009.

Interfaces, Topological Defects and Flexible Packings: Applied Geometry in Condensed-Matter , Aspen Center for Physics, July 2008.

APS March meeting, New Orleans, March 2008.

Packing Problems, Classical Ground States and Glasses, Princeton, April 2007.

Caltech Active-Nanophotonic Devices, May 2006.

CLEO/QELS and PhAST, Long Beach, May 2006.

CNID review meeting, Santa Barbara, May 2006.

Quantum Physics of Nature, Vienna, 2005.

APS March meeting, Los Angeles, 2005.

Strings, Particles and Cosmology, IAS, Princeton. Summer school 2002.

IQEC 2000, Nice.