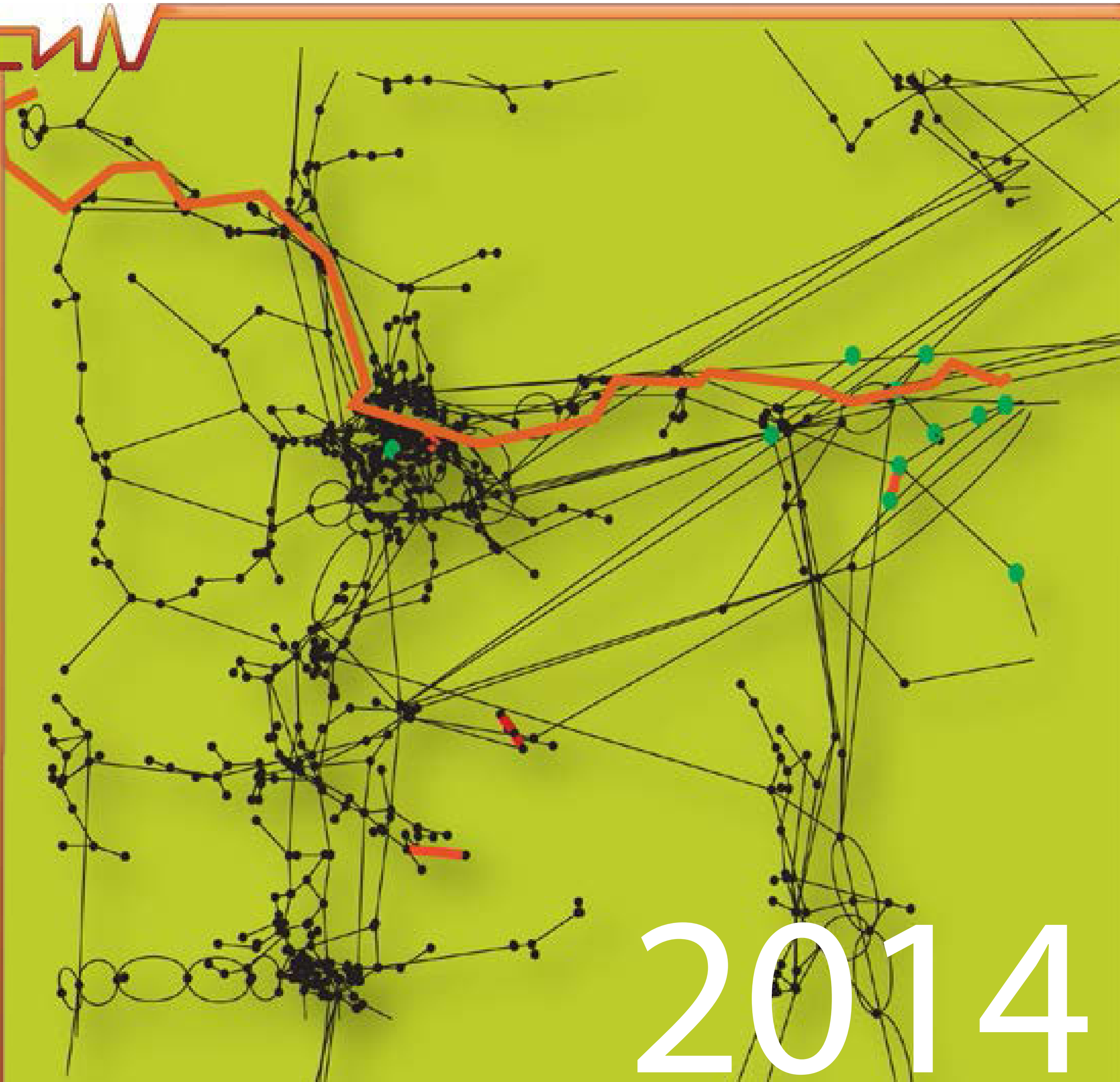

2014

Year in Review

Center for Nonlinear Studies

Conferences

2014

Systems Approaches in Immunology and Infectious Diseases,
January 10-11

Information Science for Materials Discovery and Design,
February 4-7

Eastern Coastal Infrastructure and Climate Change: Science Impacts, Planning, and Response,
February 25-28

Second Conference on Data Analysis,
March 5-7

34th CNLS Annual Conference: Mesoscale Science Frontiers,
May 13-16

Excited States Processes 2014,
June 9-12

"Explosions I Have Known" Stirling Colgate's Legacy in Science,
August 11-13

2015

Grid Science Winter School and Conference,
January 11-16

Toward an Integrated Understanding of Drug Resistance, February 18-20

New Algorithms for Complex Data,
March 19-20

Plasma Energization: Exchanges Between Fluid and Kinetic Scales,
May 4-6

CNLS 35th Annual Conference: International Workshop on Electronic Structure Approaches and Applications to Quantum Matter,
May 18-22

Emergent Paradigms in Nonlinear Complexity: From PT Symmetry to Nonlinear Dirac Systems,
June 8-10

Grand Challenges in Geological Fluid Mechanics,
September 2-4

Notable People

Ulam Scholar

The Center for Nonlinear Studies presents **Dr. Gregory Voth** of the University of Chicago as the Stanislaw M. Ulam Distinguished Scholar for FY14. This is an annual award which enables a noted scientist to spend a year carrying out research at the Center for Nonlinear Studies at Los Alamos. The Ulam Scholarship honors the memory of the brilliant Polish-American mathematician Stan Ulam, who was among the founders of what has now become "nonlinear science."

Dr. Gregory Voth has developed leading expertise in the development and application of integrated theoretical and computational methods to study problems involving complex condense-phase systems, including proteins, membranes, liquids and renewable energy materials. He has pioneered an approach known as "multiscale coarse graining," which reduces the "resolution" of molecular-scale entities into simpler structures while retaining key information about their interactions. The resulting computer simulations based on this method can accurately and efficiently explain and predict the multiscale properties of large assemblies of complex molecules such as lipids and proteins. Voth's many awards and honors include election to the inaugural class of fellows of the American Chemical Society in 2009, and in 2012, election as a fellow of the Biophysical Society.

Kac Lecturer

The 2014 Mark Kac Memorial Lectures were presented by **Susan Coppersmith** of the University of Wisconsin-Madison. She is the Robert E. Fassnacht and Vilas Professor in the Department of Physics. She is a theoretical condensed matter physicist who has worked on a broad range of problems in the area of complex systems, and has made substantial contributions to the understanding of subjects including glasses, granular materials, the nonlinear dynamics of magnetic flux lattices in type-II superconductors, and quantum computing. She presented three lectures at CNLS on April 24-28, 2014: Investigation of a Quantum Adiabetic Algorithm for Search Engine Ranking, Progress Towards Quantum Dot Spin Qubits in Silicon, and A Hybrid Spin-Change Quantum Dot Qubit in Silicon.

Distinguished Quantum Lecturer

The 2014 Distinguished Quantum Lectures were presented by **William Phillips** of the National Institute for Standards and Technology as well as a distinguished professor at the Joint Quantum Institute at the University of Maryland. He won the 1997 Nobel Prize in Physics in conjunction with Dr. Steven Chu and Dr. Claude Cohen-Tannoudji for development of methods to cool and trap atoms with laser light. Dr. Phillips' research topics include laser cooling and trapping of neural atoms, atomic-gas Bose-Einstein condensates, and Quantum information with single-atom qubits. At CNLS he presented three lectures on February 18th and 19th: Almost Absolute Zero: The Story of Laser Cooling and Trapping, Why Condensed Matter Physicist Should Pay Attention to Atomic Physics, and Spinning Atoms with Light: A New Twist on Atom Optics.

Notable Publications

Number Fluctuations of a Dipolar Condensate: Anistropy and Slow Approach to the Thermodynamics Regime

Cooled to a few billionths of a degree above absolute zero, small samples of atoms in a quantum gas can become superfluid and lose all resistance to flow. When the constituent atoms possess magnetic dipoles, much like small bar magnetics, the resulting interactions have been predicted to result in exotic "roton" excitations. Our results demonstrate how the existence of roton excitations may be verified in future experiments by the measurement of atom-number fluctuations within sample cells; these sample cells are small sub-volumes of the superfluid. Remarkably, we find that the fluctuations within an elongated sample cell vary significantly by a rotation of its orientation, even while the average number within the cell remains constant.

Research conducted by David Baillie of Simon Fraser University, Russell Bisset of T-1 and CNLS, and Christopher Ticknor of T-1. Published in Physical Review Letters. (DOI: 10.1103/PhysRevLett.113.265301)

Heat Transport in the Geostrophic Regime of Rotating Rayleigh-Bernard Convection

Convection is the physical mechanism by which heat is transported in a fluid medium. Prominent examples include the thermal transport by large scale circulation from the warmer equatorial region to the colder polar zones. In many geophysical systems including the Earth's atmospheres and oceans as well as the outer core of the Earth's interior, rotation plays an important role in determining the heat transport rate. In this work, we explored the heat transport in a regime where the flow is largely geostrophic, i.e., the rotation induced Coriolis force balances the pressure gradient. Although this parameter region is difficult to access experimentally and numerically, we used a unique cryogenic helium apparatus to extend previous measurements of rotating convection by almost 100 times in dimensionless rotation rate. We determined the phase diagram and put limits on the heat transport scaling behavior for rotating convection in this new range with important implications for future study of this geophysically exciting problem.

Research conducted by Robert Ecke of CNLS and Joseph Niemela of the International Centre for Theoretical Physics. Published in Physical Review Letters. (DOI: 10.1103/PhysRevLett.113.114301)

Realizing Three-Dimensional Artificial Spin Ice by Stacking Planar Nano-Arrays

Artificial spin ice is a frustrated magnetic two-dimensional nano-material, recently employed to study variety of tailor-designed unusual collective behaviours. Recently proposed extensions to three dimensions are based on self-assembly techniques and allow little control over geometry and disorder. We present a viable design for the realization of a three-dimensional artificial spin ice with the same level of precision and control allowed by lithographic nano-fabrication of the popular two-dimensional case. Our geometry is based on layering already available two-dimensional artificial spin ice and leads to an arrangement of ice-rule-frustrated units which is topologically equivalent to that of the tetrahedra in a pyrochlore lattice. Consequently, we show, it exhibits a genuine ice phase and its excitations are, as in natural spin ice materials, magnetic monopoles interacting via Coulomb law.

Research conducted by Gia-Wei Chern of T-4 and CNLS, Charles Reichhardt of T-4, and Cristiano Nisoli of T-4. Published in Applied Physics Letters. (DOI: 10.1063/1.4861118)

Chance-Constrained Optimal Power Flow: Risk-Aware Network Control under Uncertainty

This paper describe a chance-constrained optimization framework that takes into consideration the uncertainty in output of renewable generation sources. By assuming that the output of these sources is a normally distributed random variable (with known mean and variance), a convex optimization problem can be formulated to ensure that the grid operates within desired specifications, with high probability. To provide for flexible operation, power generated at the nonrenewable plants is adjusted according to the output of the renewable plants, according to a linear control law. The convex problem is difficult to solve using package software, so the authors describe a specialized cutting-plane method and report results on a large test set based on a national-scale grid.

Research conducted by Daniel Bienstock of Columbia University, Michael Chertkov of T-4 and CNLS, and Sean Harnett of T-4 and CNLS. Published in SIAM Review. (DOI: 10.1137/130910312)

Congratulations

LANL Conversions

Kipton Barros received his doctorate from Boston University in 2009. After a postdoctoral position at Northwestern University, Kipton joined CNLS in 2010 as a joint CNLS/T-4 Postdoctoral Research Associate mentored by Turab Lookman. At CNLS, he worked on physics based materials modeling focusing on: multi-scale modeling of materials and defects, techniques for large scale parallel computation, and linking MD, phase field crystal, and phase field models. In the summer of 2014, Kipton was hired as a LANL staff member with the Physics of Condensed Matter and Complex Systems group, T-4.

Leon Heller Prize Winner

Adolfo Del Campo, formerly of T-4 and CNLS, is the recipient of the 2014 Leon Heller Postdoctoral Publication Prize in Theoretical Physics. Adolfo was a J. Robert Oppenheimer Distinguished Fellow, co-mentored by Wojciech Zurek and Eddy Timmermans (T-4). During his time at LANL, he published a dozen papers in leading journals, including Physical Review Letters and Nature Communications. He won the award for his paper, "Shortcuts to Adiabaticity by Counteradiabatic Driving," published in Physics Review Letters in 2013. Adolfo is now an Associate Professor of Physics at the University of Massachusetts.

Ondřej Čertík received his doctorate from the University of Reno in 2012. He then joined CNLS in 2013 as a joint CNLS/T-1 postdoc mentored by Lee Collins. At CNLS he worked on Computational Physics focusing on: density functional theory, electronic structure calculations, finite element method and symbolic manipulation. He was hired as a staff member into CCS-2 in the fall of 2014.

Nathan Lemons received his doctorate from Central European University in 2008. He joined CNLS in October 2011 as a joint T-5/CNLS postdoc under the mentorship of Aric Hagberg. At CNLS he worked on graph algorithms, combinatorics of networks, and extremal combinatorics. In the fall of 2014, Nathan was hired as a LANL staff member with the Applied Mathematics and Plasma Physics group, T-5.

Upcoming Events

2015 Ulam Scholar

Panagiotis Kevrekidis of the University of Massachusetts will be at CNLS October 2014 through September 2015.

2015 Distinguished Quantum Lecturer

Debbie Jin of the University of Colorado Boulder will be presenting her lectures December 8-9, 2014.

2015 Kac Lecturer

Mehran Kardar of the Massachusetts Institute of Technology will be presenting his lectures April 20-22, 2015.