Langenhop Lecture and SIU Pure Mathematics Conference

Department of Mathematics
Southern Illinois University Carbondale
Carbondale, Illinois, USA

May 14–15, 2019

Geometry

Charles Delman (Eastern Illinois University)

Shoichi Fujimori (Okayama University, Japan)

Louis H. Kauffman (University of Illinois at Chicago)

Jerzy Kocik (Southern Illinois University Carbondale)

Robert Owczarek (University of New Mexico)

Zbigniew Oziewicz (Universidad Nacional Autonoma de Mexico)

Bill Page (NewSynthesis.org)

Jonathan Schneider (University of Illinois at Chicago)

Houston Schuerger (University of North Texas)

David Simpson (Univeristy of Illinois at Chicago)

Tuesday, May 14, 2019

Kwangho Choiy(Chair)

Algebra & Number Theory	**Neckers 240**
David Leep	8:50-9:35
Lisa Kaylor	9:40-10:00
Ralf Schmidt	10:05-10:50
Rodney L. Keaton	10:55-11:15
Dylon Chow	11:20-11:40

Dubravka Ban(Chair)

Algebra & Number Theory	**Neckers 240**
Shuichiro Takeda	1:00-1:45
Daniel Shankman	1:50-2:10
Wai Kiu Chan	2:15-3:00
Lenny Fukshansky	3:05-3:25
Ravindra Girivaru	3:30-3:50

Jerzy Kocik(Chair)

Combinatorics & Geometry	**Nckers 440**
Shoichi Fujimori	9:00-9:45
Charles Delman	9:50-10:35
Louis Kauffman	10:40-11:25

Jerzy Kocik(Chair)

Combinatorics & Geometry	**Nckers 440**
Indu Satija	1:00-1:45
Zbigniew Oziewicz	1:50-2:35
Bill Page	2:40-3:10
Robert Owczarek	3:15-3:45

Wesley Calvert(Chair)

Logic	**Nckers 440**
Henry Townsner	9:00-9:20
Gabriel Conant	9:30-9:50
Alexi Block Gorma	10:00-10:20
Carl Mummert	10:30-10:50
Oscar Levin	11:00-11:20

Wesley Calvert(Chair)

Logic	**Nckers 440**
James Freitag	1:00-1:25
Simon Cho	1:30-1:50
Rose Weisshaar	2:00-2:20
Ivan Ongay Valverde	2:30-2:50
Nadja Hempel	3:00-3:20

(1) Registration on Monday begins at 8:00 at the atrium of Neckers, followed by a welcome session 8:30-8:45 in Neckers Room 240.
(2) The Langenhop Lecture is in Guyon Auditorium of Morris Library.
(3) The lunch is 11:30-1:00 pm.

Tuesday, May 15, 2019

Andrew Earnest(Chair)

Algebra & Number Theory	**Neckers 240**
Anna Haensch	8:30-8:50
Lakshika Gunawardana	8:55-9:15
Yeongseong Jo	9:20-9:40
Chathurika Athapattu	9:45-10:05
Bogdan Petrenko	10:10-10:55
Benjamin Hutz	11:00-11:20
Jireh Loreaux	11:25-11:45

Kwangho Choy(Chair)

Algebra & Number Theory	**Neckers 240**
Haohao Wang	1:30-2:00
Henri Shurz	2:00-2:30

Jerzy Kocik(Chair)

Combinatorics & Geometry	**Nckers 440**
Mark Ellingham	9:00-10:00
Dinush Panditharathna	10:00-10:30
Coffee Break	10:30-11:00
John McSorley	11:00-11:30

Jerzy Kocik(Chair)

Combinatorics & Geometry	**Nckers 440**
Indu Satija	1:00-1:45
Zbigniew Oziewicz	1:50-2:35
Bill Page	2:40-3:10
Robert Owczarek	3:15-3:45

Wesley Calvert(Chair)

Logic	**Nckers 156**
Philipp Hieronymi	8:30-8:50
Rachael Alvir	9:30-9:50
Michael Cotton	10:00-10:20
Wim Ruitenburg	10:30-10:50
Tyler Brown	11:00-11:20
Valentina Harizanov	

Wesley Calvert(Chair)

Logic	**Nckers 156**
Damir Dzhafarov	1:00-1:20
Hunter Chase	1:30-1:50
Rumen Dimitrov	2:00-2:20
Gihanee Senadheera	2:30-2:50

Geometric Abstracts

Persistently Foliar Composite Knots

Charles Delman
Department of Mathematics & Computer Science
Eastern Illinois University
Rachel Roberts
Department of Mathematics
Washington University

A number of current conjectures concern the relation of foliations of 3-manifolds to their Heegard-Floer Homology. The initial connection arises from contact geometry: a taut, co-oriented foliation can be deformed to obtain two tight contact structures, one positive and one negative, resulting in Heegard-Floer homology of non-minimal rank. A manifold with Heegard-Floer homology of minimal rank is called an L-space, since this is the case for lens spaces and other elliptic manifolds. Thus, the existence of a taut co-oriented foliation in a 3-manifold implies it is not an L-space. Conjecturally, the converse is also true for irreducible manifolds.

Thus far, the evidence from Dehn surgery on knots is consistent with this conjecture. We posit the L-space Knot Conjecture: if a knot has no reducible or L-space surgeries, then it is persistently foliar, meaning that for each rational boundary slope there is a taut, co-oriented foliation meeting the boundary of the knot complement in circles of that slope. These foliations may be capped off by disks to obtain a taut, co-oriented foliation in every manifold obtained by Dehn surgery on that knot.

In particular, composite knots never have L-space surgeries. I will explain constructions that establish the L-space Knot Conjecture for connected sums of fibered knots and connected sums of alternating knots, among others. All such knots are persistently foliar.

Deformations of periodic minimal surfaces and their limits

Shoichi Fujimori
Department of Mathematics
Okayama University, Japan

A minimal surface in Euclidean 3-space $\mathbf{R}^3$ is said to be *periodic* if it is connected and invariant under a group Γ of isometries of $\mathbf{R}^3$ that acts properly discontinuously and freely. Γ can be chosen to be a rank three lattice Λ in $\mathbf{R}^3$ (the triply periodic case), a rank two lattice $\Lambda \subset \mathbf{R}^2 \times \{0\}$ generated by two linearly independent translations (the doubly periodic case), or a cyclic group Λ generated by a screw motion symmetry (the singly periodic case). The geometry of a periodic minimal surface can usually be described in terms of the geometry of its quotient surface in the flat three manifold $\mathbf{R}^3/\Lambda$. Hence a triply periodic minimal surface (TPMS) is a minimal surface in a flat torus $\mathbf{T}^3$, a doubly periodic minimal surface (DPMS) is a minimal surface in $\mathbf{T}^2 \times \mathbf{R}$, and a singly periodic minimal surface is a minimal surface in $S^1 \times \mathbf{R}^2$.

A (non-flat) properly immersed TPMS in $\mathbf{R}^3$ can be considered as a compact minimal surface of genus $g \geq 3$ in $\mathbf{T}^3$. We will focus on the genus-three case. It is known that a compact oriented minimal surface of genus three in a flat three-torus is hyperelliptic, that is, it can be represented as a two-sheeted branched covering of the sphere.

In this talk, we study deformations and limits of a family of compact oriented embedded TPMS of genus three and show several results obtained in joint work with Norio Ejiri and Toshihiro Shoda. We exhibit various graphics of examples as well.

Majorana Fermions, Braiding and the Dirac Equation

Louis H. Kauffman
Department of Mathematics
University of Illinois at Chicacgo

This talk will discuss how the Dirac equation arises from Clifford algebraic considerations and how examining the action of the Dirac operator on a plane wave gives rise to an algebraic reformulation of the Dirac equation (equivalent to the original) that has solutions in terms of nilpotent elements of the Clifford algebra. These nilpotent elements can be regarded as annihilation operators for a fermion. We point out how the nilpotents decompose into Majorana operators and discuss how this point of view is related to the braiding of Majorana Fermions and to the original work of Majorana on the Dirac equation. We also discuss how this work is related to the ground-breaking work of Peter Rowlands and how it is related to the author's program for elucidating discrete physics in terms of non-commutative algebra.

Two-dimensional quantum geometry and Przytycki's invariant of rooted trees

Robert Owczarek
Department of Mathematics
University of New Mexico Los Alamos
and
Department of Mechanical Engineering
University of New Mexico Albuquerque

In this talk, I present connections between quantum geometry of Chekhov-Fock algebra, which is is a "quantization" of the Poisson algebra defined by the Weil-Petersson Poisson structure, and Przytycki's invariant of rooted trees. I also discuss an extension of the Przytycki's invariant to unicellular maps that are higher genus counterparts of rooted trees.

Abstract for LLMC on Geometry

Zbigniew Oziewicz
Universidad Nacional Autonoma de Mexico
Facultad de Estudios Superiores Cuautitlan - oziewicz.zbigniew@gmail.com

This is an abstract of a lecture at Conference on Pure Mathematics LLMC, May 14-15, 2019. For the Session Geometry organized by Dr. Jerzy Kocik. The philosophy of conceptual Geometry needs category theory. The historical Geometry was reborn by Grassmann and Clifford algebras, and presently Geometry can be identified with Heinrich Brandt' groupoid category. This lecture will be devoted to motivate and explain above statements also from historical perspective. Four-element group with unique unit, versus four-element groupoid with two units illustrate the essential distinction of a Brand's groupoid from familiar concept of a group category.

The Center of the Algebra of Observers

William S. Page

The primitive elements of the finite algebra of observers[1] are idempotent operators that may be represented as projectors in the Minkowski geometry of relativity. But formally these operators are metric-free and provide an alternative to the notion of time-like vector fields. Binary products in the algebra correspond to relative velocities in the geometry. The structure of the algebra respects the associative composition of velocities.

The center of the algebra is determined and related expressions are calculated explicitly using a computer algebra system [2]. The algebra is Frobenius, given certain constraints on the scalar coefficients.

References

[1] Zbigniew Oziewicz. *Relativity Groupoid Instead of Relativity Group* International Journal of Geometric Methods in Modern Physics, vol. 4, no. 5, p 739-749, 2007. `https://doi.org/10.1142/S0219887807002260`

[2] Waldemar Hebisch, `hebisch@math.uni.wroc.pl` Wrocław University. AXIOM project fork: *FriCAS - an advanced computer algebra system* `http://fricas.sourceforge.net/`

Three variants of Welded Knot Theory

Jonathan Schneider
Department of Mathematics, Statistics, & Computer Science
University of Illinois Chicago

Welded Knot Theory was originally conceived by Rourke & Fenn in terms of (framed) braids, and was subsequently expanded by Kauffman, Rourke and Fenn into a quotient of Virtual Knot Theory. Satoh and Rourke have shown that the theory is modeled by toral surfaces or

fiberwise-embedded toral surfaces. The latter model, however, requires a slight refinement of the theory, which we call "Roto-Welded Knot Theory". This refinement omits the virtual I-move, and thus represents a partial return to the original braid concept. In this talk I will compare Welded, Roto-Welded, and Framed Welded Knot Theories. In particular, only Roto-Welded admits a proven complete topological model.

The Measure Game

Logan Crone, Lior Fishman, Steve Jackson, & Houston Schuerger
Department of Mathematics
University of North Texas
David Simmons
Department of Mathematics
University of York

In this talk we introduce a game (a similar game was introduced independently by Rosendal) which plays a role for measure analogous to the Banach-Mazur game for category. We establish the basic connections between this game and measure, and then use the game to prove fundamental measure theoretical results such as Fubini's theorem and the Borel-Cantelli lemma. The proofs we give are all direct combinatorial arguments using the game, and do not depend on known measure theoretic arguments.

The Application of Ribbon Hopf Algebras to 1-1 Tangles

David Simpson
University of Illinois / Chicago

We examine the relation between Ribbon Hopf Algebras and 1-1 Tangles – knot diagrams that are cut at a point with the ends pulled apart. We briefly describe these unusual algebras, and investigate the behavior of one such algebra, introduced in the 1992 paper "On Kauffman's knot invariants arising from finite-dimensional Hopf algebras" by David Radford. The invariant structure and method of computing it are then discussed, with emphasis on the magnitude of calculations involved, and practical methods of overcoming computational constraints in attaining results in reasonable time. We compile the first-ever results for knots of 3-10 crossings using one this algebra.