Mathematical Physics Seminars
2008 - 2009

9 October 2008

Speaker: Sophie Jackson (Reader in Biophysical Chemistry, University of Cambridge)

Title: How do knotted proteins fold?

Abstract: For a long time, it was thought that it was impossible for a polypeptide (protein) chain to both knot and fold into a specific three-dimensional structure. However, since their discovery earlier this decade, protein structures which contain topological knots in their polypeptide chains have now been identified for almost 400 proteins. These unusual proteins represent a novel challenge for both the experimental and computational protein folding communities, and raise a number of important questions such as how do such structures fold and what is the role of the knot in the protein structure and function? The talk will be broken up into four main sections. First, I will give some background on protein structure in general, including the structures of knotted proteins and their knotted topologies. This will be followed by a brief introduction to the protein folding problem and what has been learnt from 20 years of study of small model systems. The experimental program of work and results that my own group have obtained in the last five years on the folding pathways of three knotted protein structures will be described and, finally, recent computational efforts at simulating the folding pathways of knotted proteins will be discussed.

16 October 2008

Speaker: John DS Jones (Professor of Mathematics, Warwick University)

Title: String Topology

6 November 2008 WIMCS Colloquium - 12:30pm

Speaker: Carloz Nunez (Reader in Physics, Swansea University)

Title: The Duality between Gauge Fields and Strings

Speaker: Man-Duen Choi (Professor of Mathematics, University of Toronto)

Title: The magic of non-commutative computations

Speaker: Denjoe O'Connor (School of Theoretical Physics, Dublin Institute for Advanced Studies)

Title: Geometry in Transition

20 November 2008

Speaker: Balázs Szendroi (Faculty Lecturer, Mathematics Institute, University of Oxford and Martin Powell Fellow, St Peter's College, Oxford)

Title: Deformed partition functions and Poincare polynomials of moduli spaces

I will discuss the topological string partition function of some local Calabi--Yau threefolds, and some recently introduced deformations thereof, giving a tentative interpretation of the latter as Poincare polynomials of certain highly singular moduli spaces associated to the threefolds.

4 December 2008

Speaker: Dr R Behrend (Cardiff)

Title: Osculating Paths and Oscillating Tableaux

11 December 2008

Speaker: Geoffrey L Sewell (Emeritus Professor in Mathematical Physics Department of Physics, Queen Mary College, London)

Title: Relativistic statistical thermodynamics of moving bodies

I provide an operator algebraic solution of the long standing question of temperature transformations under Lorentz and Galilei boosts. The key ingredients of my treatment are (a) the Tomita-Takesaki modular theory and (b) the connection between the Kubo-Martin-Schwinger conditions and the Zeroth law of Thermodynamics. On this basis, I prove that, in both the relativistic and nonrelativistic settings, a state cannot satisfy the thermal equilibrium conditions for different inertial frames that are in uniform motion relative to one another. This implies that the concept of temperature is restricted to states of bodies in their rest frames and thus that there is no law of temperature transformation under either Lorentz or Galilei boosts.

13 and 14 January 2009 WIMCS Mathematical Physics Lectures

Speaker: Professor Tim Porter (Bangor, Wales).

Title: Categorification and bundles

The aim of the talks will be to illustrate some of the aspects of categorification in the case of bundles. This will lead from bundles and vector bundles via sheaves to stacks, gerbes, 2-bundles and eventually to 2-vector bundles. On the way I hope to indicate some of the links with higher category theory and non-Abelian cohomology.

22 January 2009- 1pm Operator Algebras Seminar

Speakers: Dr Simon Wassermann (Glasgow), Dr Wilhelm Winter (Nottingham) and Dr Rolf Gohm (Aberystwyth).

1.00 Wilhelm Winter (Nottingham)
Title: The classification of C*-algebras associated to minimal uniquely ergodic dynamical systems.

2.15 Rolf Gohm (Aberystwyth)
Title: Non-commutative Markov Chains and Multi-analytic Operators

3.30 Simon Wassermann (Glasgow)
Title: Masas in UHF algebras

29 January 2009

Speaker: Professor Piotr Chrusciel (Oxford)

Title: Black holes: an introduction

After a crash course on general relativity and the Einstein equations, I will review the current experimental and theoretical understanding of black holes.

12 February 2009

Speaker: Dr Joost Slingerland (Dublin Institute for Advanced Studies)

Title: Phase transitions and domain walls in 2+1 dimensional topological field theory

Recently there has been much interest in 2+1 dimensional physical systems with "topological order". At low energies, the phases of such systems can be described by topological field theory, in particular their excitations may have nontrivial braiding and fusion interactions described by a suitable braided tensor category. Using a knowledge of just this fusion and braiding as a starting point, one may ask whether it is still possible to make useful statements about phase transitions that may occur. I will argue that this is indeed the case for phase transitions caused by an analogue of bose condensation, and indicate how one may obtain the spectrum, fusion and braiding of the condensed phase. This leads to some interesting conjectures in topological field theory, including conjectured analogues of constructions known from Conformal Field Theory, notably the coset construction.

26 February 2009 WIMCS Colloquium

Speakers: Professor Ken Brown (Glasgow) and Professor Richard Szabo (Edinburgh)

3:00pm (Professor Szabo): Instantons and enumerative geometry

4:30pm (Professor Brown): Small infinite non-commutative groups

The facetious title is intended partly for disguise, partly for motivation - a more "academic" title might be "Classification of affine prime Hopf algebras of Gelfand-Kirillov dimension one". But the talk will not assume prior knowledge of any of the terms in the posh title. Rather, I will aim to explain the above terms, motivate the problem, and explain what is known.

5 March 2009

Speaker: Dr Akihiro Ishibashi (KEK)

Title: A uniqueness theorem for charged rotating black holes in five-dimensional minimal supergravity

We show that a charged rotating black hole in five-dimensional Einstein-Maxwell-Chern-Simons theory is uniquely characterized by the mass, charge, and two independent angular momenta, under the assumptions of the existence of two commuting axial isometries and spherical topology of horizon cross-sections. Therefore, such a black hole must be described by the Chong-Cveti\v{c}-L\"u-Pope metric.

12 March 2009

Speaker: Dr Ingo Runkel (King's College, London)

Title: Algebraic structures in conformal field theory

It turned out to be fruitful to isolate questions in CFT which can be formulated in a purely categorical fashion. The way left and right moving degrees of freedom can be combined to a consistent theory is an example of this, the relevant structure being a commutative symmetric Frobenius algebra. This is true independently of whether CFT is formulated via sewing of surfaces or nets of operator algebras. Another example is modular invariance, which has a surprising alternative formulation as a certain maximality condition.

17 March 2009 - 2pm Operator Algebras Seminar

Speakers: Professor George A Elliott (Copenhagen and Toronto) and Dr Michael Dritschel (Newcastle)

Title (Professor Elliott): A brief survey of classification theory

The theory of operator algebras has shown that classification of mathematical objects first of all cannot be expected to be achieved in terms of the simplest possible labels, such as numbers, but one can often hope to

achieve it in terms of a more complicated parameter, such that the values of the parameter corresponding to two isomorphic objects are no longer necessarily equal---this may not even make sense!---but are isomorphic. (In other words, the parameter values belong to their own category---either an abstract category---very general results of this kind can be proved---or even, as can be proved in important cases, an interesting concrete category. Sometimes the concrete invariant can be defined directly, but sometimes, it seems, it can only be seen as a concrete manifestation of an abstract one---in other words, by showing that a certain abstract category is equivalent to a certain concrete one.)

Title (Dr Drirschel): Completely bounded kernels

Given a set X and two C^*-algebras A and B, a kernel k is defined as a function from $X\times X$ to $L(A, B)$, the bounded linear maps from A to B. The kernel k is positive if for all finite sets $F = \{(x_j , a_j)\} \subset X \times A$, the matrix \begin{equation*} (k(x_i, x_j)[a_ia^*_j])_{F\times F} \qquad\qquad(*) \end{equation*} is nonnegative. If the same is true whenever we replace $X\times A$ by $X\times M_n(A)$ and k by $k\otimes 1_n$ for any $n\in \mathbb N$, then k is said to be completely positive (the two concepts coincide when $A = B = \mathbb C$). Completely positive kernels have several equivalent characterisations, including the existence of a so-called Kolmogorov decomposition. Constantinescu and Gheondea, generalising results of Laurent Schwartz, considered kernels k where the matrix in ($*$) is merely selfadjoint with $L(A, B) = B(H)$, H a Hilbert space, and found necessary and sufficient conditions for the decomposability of such kernels as the difference of (completely) positive kernels. A result of Haagerup implies that when A and B are von Neumann algebras such decompositions in terms of completely positive kernels will fail if B is not injective. In this talk we discuss decomposability of self adjoint kernels as differences of completely positive kernels when A and B are C^*-algebras, characterising decomposable kernels. We also discuss the case when the matrix in ($*$) is a only a completely bounded map, giving an analogue of the Wittstock decomposition for such kernels.

14 May 2009

Speaker: Dr Dorothy Buck (Imperial)

Title: DNA Knots and How They Arise

DNA molecules often have a circular, or topologically constrained, central axis. The topology of this axis can influence which proteins interact with the underlying DNA. Subsequently, there are proteins, topoisomerases, whose primary function is to change the DNA axis topology. Additionally, there are protein families that change the axis topology as a by-product of their interaction with DNA.

This informal talk will describe typical DNA conformations, and the families of proteins that change these. We will present one example illustrating how 3-manifold topology has been useful in understanding certain DNA-protein interactions, and discuss the most common topological techniques used to consider these biological questions.

(No prior biological knowledge necessary)

21 May 2009

Speaker: Dr Danny Stephenson (Glasgow)

Title: The basic bundle gerbe on unitary groups, revisited

Let G be the unitary group U(n) or more generally one of the groups U_p(H) consisting of unitary operators on an infinite dimensional Hilbert space H which differ from the identity by an element of the Schatten ideal L^p. For these groups G, the degree three integer cohomology group H^3(G,Z) of G is canonically isomorphic to the integers Z. The generator of H^3(G,Z) = Z can be realized geometrically as the `basic bundle gerbe'. Building on work of Meinrenken and Mickelsson we will give a construction of this basic bundle gerbe. We will explain how the holomorphic functional calculus can be used to describe the geometry of this gerbe. This is joint work with Michael Murray.