The IMS September Meeting 2008 at CIT, Cork
Abstracts of Invited Lectures

Singular Sturm - Liouville Boundary
Value Problems on the Line

Daphne Gilbert (DIT)

We consider the relationship between the asymptotic behaviour of solutions of the singular Sturm-Liouville equation and spectral properties of the corresponding self-adjoint operators. In particular, we review the main features of the theory of subordinacy by considering two standard cases, the half-line operator on $L_2([0, \infty))$ and the full-line operator on $L_2(R)$. It is assumed that the coefficient function q is locally integrable, that 0 is a regular endpoint in the half-line case, and that Weyl's limit point case holds at the infinite endpoints. We note some consequences of the theory for the well-known informal characterisation of the spectrum in terms of bounded solutions. We also consider extensions of the theory to related differential and difference operators, and discuss its application in conjunction with other asymptotic methods to some typical problems in spectral analysis.

An Input-Output Model of the Irish Economy

Patrick Quill (CSO)

This talk presents the supply and use framework applied by the national accounts section of CSO. This framework is employed to balance different measures of GDP, to give meaningful estimates of transactions within the economy in a given year as well as to integrate national accounts aggregates with business survey results. A matrix transformation converts the use table into an input-output table. Methods used for expanding the number of rows and columns are examined. The Leontief Inverse is defined and interpreted. Techniques for analysing input-output tables over time are discussed.

Mock modular forms

Sander Zwegers (UCD)

Ramanujan wrote his last letter to Hardy in January of 1920, a few months before his death, telling him about a new class of functions he had discovered which he called "mock theta functions". Many people have studied these functions, including famous mathematicians like Watson, Selberg and Andrews, who found many wonderful identities concerning them. However, for a long time, no natural definition was known that described what these functions are intrinsically and hence could give a natural explanation for the identities between them. More recently, an interpretation was found for these mock theta functions within the theory of modular forms, which enables us to give a natural definition.

This interpretation has opened the way to further progress and to the construction of infinitely many new examples.

In this talk we will describe Ramanujan's original examples and the nature of their modularity, and discuss some of the further progress that has been made.

Project Maths - developments in post-primary mathematics education

Bill Lynch (NCCA)

Following a review of post-primary mathematics education, changes in mathematics syllabuses at second level get under way in a small group of schools from September 2008, with roll-out to all schools commencing in September 2010. Project Maths is a new initiative in curriculum development, which sees a phased, incremental approach to syllabus revision in tandem with, and informed by, professional development and support for teachers in introducing a changed approach to the teaching and learning of mathematics. The project is aimed at both Junior Certificate and Leaving Certificate mathematics and also takes into consideration the links between mathematics in the primary school and that in the first year at second level.

This presentation looks briefly at the background to Project Maths and the proposals that have been adopted for its introduction. The structure and format of the revised syllabuses at different levels are described, together with the revised assessment arrangements that

are seen as key to reinforcing and supporting changed methodology in the classroom. The changed approach sees greater emphasis being placed on the students understanding of the mathematical concepts involved, together with a focus on the development of problem-solving skills and strategies rather than reliance on rote learning of procedures. An overview is given of the timescale for the project, with detail being provided on the two revised syllabus strands which are being introduced in 24 schools from September. Finally, the programme of teacher professional development and support which has been put in place is described, as well as an outline of the resources being developed to support the project.

Linking Probability and Statistics
Jerome Sheahan (NUIG)

Probability and statistics books introduce, but generally treat in an isolated manner, terms like 'sample space', 'population', 'random variable' and 'distribution'. By differentiating and linking these concepts, we hope to de-mystify and unify the undergraduate and graduate level teaching of the (scientifically opposite) fields of probability and statistics. On the way, we give recent developments on a number of issues in mathematical modelling, including the question of whether probability is the only way of modelling random variation, and we give the latest results on a famous probability problem with an unexpected answer.

The geometry and complexity of finitely presented groups
Martin Bridson (Oxford)

I'll begin with a general discussion about why one should regard groups as objects that belong not so much to algebra as to mathematics as a whole. I'll discuss why finite presentability is a natural constraint to impose on groups, and I will explain why Dehn's decision problems are so fundamental to the understanding of groups. Following a brief sketch of the universe of finitely presented groups, I'll focus on a fascinating class of groups closely related to free groups – limit groups – where one finds particularly deep connections between geometry, topology, algebra and logic.

Where algebra and topology meet: a cautionary tale

ROBIN HARTE (TCD)

In a sense the Kuratowski axioms reduce topology to algebra. In another sense one of the cornerstones of Banach algebra theory ushers in a curious topology for rings.

On the powers of a nilpotent algebra

CORA STACK (IT TALLAGHT)

An algebra R over a field K is said to be nilpotent if $R^n = 0$ some $n \geq 1$. It is widely accepted that the structure of nilpotent algebras is not well understood. A better understanding of the structure is crucial if further significant breakthroughs are to be made in the theory of these algebras. Questions in nilpotent algebras have also a very important bearing on other questions in more general ring theory, group theory, coding theory etc. In this talk I will discuss and prove some recent results in the structure theory by considering certain relationships between the various powers R^i of the algebra R.

Castles Martians and Algorithms

NIALL SMITH (CIT)

In 2007 Blackrock Castle in Cork opened its interactive science center to the public. Based upon the theme of "The Search for Life in the Universe" and called "Cosmos at the Castle", the award-winning center informs visitors about our present knowledge of the universe, and examines the likelihood that we may not be alone. The Castle also houses Ireland's first robotic observatory, operated by researchers' from CIT's Astronomy & Instrumentation Group. The group recently launched its PlanetSearch Programme. This talk will summarise the Blackrock Castle Observatory project, describe our experiences to date and our plans for the future. The project website is `http://www.bco.ie`

Understanding spike trains

CONOR HOUGHTON (TCD)

Axons connect neurons; axons are thin, membrane-walled tubes the interior fluid of which is at a lower voltage to the exterior. Axons support the propagation of what are called spikes, brief voltage pulses of

stereotypical profile and amplitude. In the brain information propagates between neurons in the form of spike trains, sequences of spikes. It is not known in any detail how information is coded in spike trains, this is a difficult problem because the spike trains themselves are unreliable, the same stimulus acting on a neuron leads to different spike trains from trial to trial. Here I will describe how defining a metric on the space of spike trains can help determine properties of the information coding.

The use of technologies to create an active mathematical environment for students
Ciaran Mac an Bhaird (NUIM)

One of the main challenges in third level Mathematics education is how to address the issue of the weak mathematical background of incoming students. The numbers of students with poor understanding of core mathematical material seems to be constantly increasing. Recent reports have expressed concern with the mathematical competences of Irish students at second level (State Examinations Commission, 2005; NCCA, 2006), and low attainment in Mathematics is often cited as a contributing factor in low enrollment and low retention rates in science and technology courses (Task Force on the Physical Sciences, 2002).

Students have widespread access to complex technologies including advanced computer software, state of the art mobile phones and ipods. We should take advantage of their interest in such technologies, and incorporate as much Mathematics as possible into similar environments.

Such initiatives aim to equip students with the mathematical skills they need to succeed at university. The Mathematics Support Centre (MSC) and the Department of Mathematics in NUI Maynooth are actively engaged in introducing new methods of mathematical teaching including the use of podcasting, screencasting and touchscreen technologies. Students, especially weaker students, have been shown to respond very positively to these innovations. We will discuss all the feedback from these developments, as well as the challenges that face anyone hoping to follow a similar path. There will also be a brief demonstration of some of the software and equipment that we use.

On the Lawson Conjecture
Mrtin Kilian (UCC)

While there are no compact minimal surfaces in Euclidean 3-space, Lawson showed in 1970 that the curvature of the 3-sphere allows for embedded

compact minimal surfaces of arbitrary genus. In particular, in collaboration with Hsiang he investigated minimal tori in the 3-sphere, and conjectured that the only embedded minimal torus in the 3-sphere is a torus which possesses a 2-parameter family of isometries, the so-called Clifford torus. In recent work in collaboration with M.U. Schmidt, I proved that Lawson's conjecture indeed holds, and in this talk I will give an outline of the proof, which uses modern methods from the theory of integrable systems.