# The 3rd Joint Meeting of The British Society for the History of Mathematics and The Canadian Society for History and Philosophy of Mathematics

**Clare College, Cambridge**

**9-11 July 2004**

## PROGRAMME

## Friday 9 July

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10.30-1.00pm **CSHPM business meetings** (NB the conference starts at 2 pm)

10.30-11.30am CSHPM Executive Council meeting

11.45-1.00pm CSHPM Annual General Meeting

1.00-2.00pm Lunch (not provided by Clare College)

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2.00 pm **Formal Welcome and Introductions**
*June Barrow-Green, President BSHM*
*Rob Bradley, Vice-President CSHPM*

2.15 pm **A Chinese Rhind papyrus:**
**The *Suan shu shu* and the beginnings of Chinese mathematics**
*Christopher Cullen, Needham Research Institute, Cambridge*

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3.00-4.00 pm **PARALLEL SESSION 1: ANCIENT MATHEMATICS**

3.00 pm The Historiography of Egyptian Mathematics – Past, Present, Future
*Annette Imhausen, University of Cambridge*

3.30 pm Studies of Mohist Mathematics
*Ma Li, Linköpings Universitet*

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3.00-4.00 pm **PARALLEL SESSION 2: THE WORK OF H. J. S. SMITH**

3.00 pm Henry Smith: The plurality of worlds
*Keith Hannabuss, University of Oxford*

3.30 pm Henry Smith's Work in Linear Algebra
*Rod Gow, University College Dublin*

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| 3.00-4.00 pm | **PARALLEL SESSION 3: RECENT DEVELOPMENTS** |
| 3.00 pm | Fermat's Last Theorem revisited<br>*Israel Kleiner, York University* |
| 3.30 pm | The sampling theories from de la Vallée-Poussin to Shannon<br>*Roger Godard, Royal Military College of Canada* |

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| 4.00-4.30 pm | TEA |

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| 4.30-6.00 pm | **PARALLEL SESSION 1: ANCIENT MATHEMATICS** |
| 4.30 pm | Sequences and Series in Old Babylonian mathematics<br>*Duncan Melville, St. Lawrence University* |
| 5.00 pm | Mathematics in Plato's Thought<br>*Hardy Grant, York University* |
| 5.30 pm | Mathematical Problems in Proclus' Commentary on Euclid<br>*Alain Bernard, Centre Koyré* |

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| 4.30-6.00 pm | **PARALLEL SESSION 2: THE WORK OF H. J. S. SMITH** |
| 4.30 pm | Henry Smith and the English School of Elliptic Functions<br>*Lawrence D'Antonio, Ramapo College* |
| 5.00 pm | C.J. Hargreave's and H.J.S. Smith's Sieve Methods<br>*Francine F. Abeles, Kean University* |
| 5.30 pm | H.J.S. Smith and the Fermat Two Squares Theorem<br>*W.N. Everitt, University of Birmingham* |

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| 4.30-6.00 pm | **PARALLEL SESSION 3: RECENT DEVELOPMENTS** |
| 4.30 pm | Tea, Decision Making and the LEO Computer - A Very British Blend<br>*Janet Delve, University of Portsmouth* |
| 5.00 pm | Technology transfer in the 1940s<br>*David Anderson, University of Portsmouth* |
| 5.30 pm | Grete Herman and Von Neumann's No-Hidden Variables Theorem<br>*Miriam Lipschutz-Yevick, Rutgers University* |

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| 6.00-7.00 pm | FREE TIME |

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| 7.00 pm | DINNER |

## Saturday 10 July

8.00 am BREAKFAST

9.00 am **Taking Latitude with Ptolemy: Al-Kashi's Final Solution to the Determination of the Positions of the Planets**
*Glen Van Brummelen, Bennington College*

9.45-10.45 am **PARALLEL SESSION 1: PHILOSOPHY OF MATHEMATICS**

9.45 am From Geometric divisibility to Algebraic sequence:
The two mathematical structures of Zeno's Dichotomy Paradox
*Jean-Louis Hudry, University of Edinburgh*

10.15 am The Origins of the Frege-Russell Ambiguity Thesis
*Risto Vilkko, University of Helsinki*

9.45-10.45 am **PARALLEL SESSION 2: 17TH/18TH CENTURY MATHEMATICS**

9.45 am Thomas Harriot's Treatise on Figurate Numbers,
Finite Differences, and Interpolation Formulas
*Janet L. Beery, University of Redlands*

10.15 am Descartes's Opaque Mathematics
*Jay Kennedy, University of Manchester*

9.45-10.45 am **PARALLEL SESSION 3: 19TH CENTURY MATHEMATICS**

9.45 am A Glimpse of Duncan F. Gregory through His Letters
*Patricia Allaire, Queensborough Community College*

10.15 am Why Did Boole Invent Invariant Theory?
*Paul Wolfson, West Chester University*

10.45-11.15 am COFFEE

11.15 am-12.15 pm **PARALLEL SESSION 1: PHILOSOPHY OF MATHEMATICS**

11.15 am Detaching Philosophy From Logic
*Guiseppina Ronzitti, University of Genoa*

11.45 am Informal Incompleteness: Rules, Philosophy, and Law
*Jonathan P. Seldin, University of Lethbridge*

11.15 am-12.15 pm **PARALLEL SESSION 2: 17TH/18TH CENTURY MATHEMATICS**

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| 11.15 am | "A City particularly favour'd by the Celestial Influences": The inaugural Gresham College lectures of Wren and Barrow<br>*Tony Mann, University of Greenwich* |
| 11.45 am | Lord Stanhope's Papers on the Doctrine of Chances<br>*David R. Bellhouse, University of Western Ontario* |

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11.15 am-12.15 pm **PARALLEL SESSION 3: 19TH-CENTURY MATHEMATICS**

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| 11.15 am | The Second *Mémoire* of Évariste Galois<br>*Peter Neumann, University of Oxford* |
| 11.45 am | Cayley and the abstract group concept<br>*Munibur Rahman Chowdhury, University of Dhaka* |

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12.15-1.00 pm FREE TIME

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1.00 pm LUNCH

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2.00-3.30 pm **PARALLEL SESSION 1: PHILOSOPHY/PSYCHOLOGY OF MATHEMATICS**

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| 2.00 pm | Meaning and Mathematics: Obsessions of a Bohemian Priest<br>*Steve Russ, University of Warwick* |
| 2.30 pm | On the constructive content of Hilbert's epsilon calculus and substitution method<br>*Mehrnoosh Sadrzadeh, Université du Québec à Montréal* |
| 3.00 pm | The Psychology of Mathematicians<br>*Ioan James, University of Oxford* |

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2.00-3.30 pm **PARALLEL SESSION 2: 17TH/18TH CENTURY MATHEMATICS**

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| 2.00 pm | Harriot, Warner and Descartes and the end of species in algebra.<br>*Muriel Seltman, University of Greenwich* |
| 2.30 pm | Accidental greatness: Some of Euler's serendipitous discoveries<br>*Ed Sandifer, Western Connecticut State University* |
| 3.00 pm | Three Bodies? Why not Four? The Motion of the Lunar Apsides<br>*Robert Bradley, Adelphi University* |

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| 2.00-3.30 pm | **PARALLEL SESSION 3: 19TH CENTURY MATHEMATICS** |
| 2.00 pm | Cauchy's definition of limit<br>*R.P. Burn, University of Exeter* |
| 2.30 pm | The Concept of the Infinitely Thin Pencil<br>and the Rise of the Optometric Community<br>*Eisso J. Atzema, University of Maine* |
| 3.00 pm | A footnote to the Four Colour Theorem<br>*Tony Crilly, Middlesex University* |

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| 3.30-4.00 pm | TEA |

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| 4.00-6.00 pm | **I.C.H.M. SPECIAL SESSION IN HONOUR OF THE RETIREMENT OF IVOR GRATTAN-GUINNESS:**<br>**THE HISTORY OF 19TH-CENTURY ANALYSIS** |
| 4:00 pm | Mikhail Ostrogradsky's 1850 Paper on the Calculus of Variations<br>*Craig Fraser, University of Toronto* |
| 4.30 pm | Weierstrass's Foundational Shift in Analysis: His Introduction of the Epsilon-Delta Method of Defining Continuity and Differentiability<br>*Michiyo Nakane, Seijo University* |
| 5.00 pm | French Research Programs in Differential Equations in the<br>Late Nineteenth Century<br>*Thomas Archibald, Acadia University* |
| 5.30 pm | Why did Cantor see his Set Theory as 'an extension of<br>mathematical analysis'?<br>*Ivor Grattan-Guinness, Middlesex University* |

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| 6.00-7.00 pm | FREE TIME |

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| 7.00 pm | RECEPTION |
| | followed by |
| 7.30 pm | CONFERENCE DINNER |
| | followed by |
| 9.00 pm (approx.) | ENTERTAINMENT (details to be confirmed) |

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## Sunday 11 July

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| 8.00 am | BREAKFAST |

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9.00-10.00 am **Parallel Session 1: Mathematics Education**

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| 9.00 am | The Teaching and Study of Mercantile Mathematics in New England during the Colonial and Early Federal Periods:<br>Sources, Content, and Evolution<br>*Joel Silverberg, Roger Williams University* |
| 9.30 am | Geometry Teaching in the 1860s and 1870s: Two Case Studies<br>*Robin Wilson, The Open University* |

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9.00-10.00 am **Parallel Session 2: Mathematical Communities and Connections**

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| 9.00 am | Guarding the gates: The development of mathematical refereeing for the Royal Society in the 19th century<br>*Sloan Despeaux, Western Carolina University* |
| 9.30 am | From Cambridge to Cambridge: The Mathematical Significance of John Farrar's European Sojourns<br>*Amy K Ackerberg-Hastings, University of Maryland University College* |

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9.00-10.00 am **Parallel Session 3: 19th & 20th Century Developments**

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| 9.00 am | Percy A MacMahon: a good soldier spoiled<br>*Paul Garcia, The Open University* |
| 9.30 am | A Delicate Collaboration: A. Adrian Albert and Helmut Hasse and the Principal Theorem in Division Algebras in the Early 1930s<br>*Della Fenster, University of Richmond* |

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| 10.00-10.30 am | COFFEE |

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10.30-11.30 am **Parallel Session 1: Mathematics Education**

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| 10.30 am | Humanizing Mathematics:<br>Using History to Introduce Non-Specialist Students to Mathematics<br>*Joel and Christine Lehmann, Valparaiso University* |
| 11.00 am | History of Mathematics Resources for Key Stages 3 and 4<br>*Snezana Lawrence* |

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10.30-11.30 am **PARALLEL SESSION 2: MATHEMATICAL COMMUNITIES AND CONNECTIONS**

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| 10.30 am | Benjamin Peirce and the Question of American Scientific Identity<br>*Deborah Kent, University of Virginia* |
| 11.00 am | The emergence of regional research traditions in Scandinavian mathematics<br>*Henrik Kragh Sørensen, Agder University College* |

10.30-11.30 am **PARALLEL SESSION 3: 19TH & 20TH CENTURY DEVELOPMENTS**

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| 10.30 am | Raymond Clare Archibald: A Historian's Historian<br>*James J. Tattersall, Providence College* |
| 11.00 am | Summoning the nerve: the curious history of British algebra<br>*Gavin Hitchcock, University of Zimbabwe* |

11.30-11.45 am SHORT BREAK (so that the final talk may start promptly on time)

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| 11.45 am | **Connections, American and mathematical: Thomas Harriot and John Pell**<br>*Jackie Stedall, University of Oxford* |

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| 12.30 pm | **Closing Remarks**<br>*June Barrow-Green, President BSHM*<br>*Rob Bradley, Vice-President CSHPM* |

1.00 pm LUNCH

The meeting finishes with the closing remarks by the two Presidents. Sunday lunch is included in the full conference accommodation/meals charge. Other conference participants and any guests of participants are welcome to join us for any meals provided that this has been arranged with the conference organisers (John Earle c.j.earle@exeter.ac.uk) in advance.

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BRITISH SOCIETY FOR THE HISTORY OF MATHEMATICS

CSHPM SCHPM

# The 3rd Joint Conference of The British Society for the History of Mathematics and The Canadian Society for History and Philosophy of Mathematics

**Clare College, Cambridge**
**9-11 July 2004**

# ABSTRACTS

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## FRIDAY 9 JULY - AFTERNOON

### A Chinese Rhind papyrus: the *Suan shu shu* and the beginnings of Chinese mathematics

Christopher Cullen

The *Suàn shù shū* 筭數書 is an ancient Chinese collection of writings on mathematics approximately seven thousand characters in length, written on 190 bamboo strips. It was discovered together with other writings in 1983 when archaeologists opened a tomb at *Zhāngjiāshān* 張家山 in *Húběi* 湖北 province. From documentary evidence this tomb is known to have been closed in 186 BC, early in the Western *Hàn* 漢 dynasty. The occupant of this tomb appears to have been a minor local government official, who had begun his career in the service of the *Qín* dynasty, but started work for the *Hàn* in 202 BC: see Péng Hào (2001) 11-12.The work discussed here was not the only one deposited in this tomb: in addition to material containing administrative regulations there were also writings on medicine and therapeutic gymnastics, all of which have been published and widely discussed elsewhere. The *Suàn shù shū* itself is certainly the oldest Chinese excavated text with substantial mathematical content. Moreover, it is considerably older than any other Chinese mathematical text now extant. Its importance for the history of world mathematics is therefore indisputable. Its role in the history of East Asian mathematics is comparable to that of the Ahmose (or Rhind) papyrus in the history of the mathematics of the ancient cultures bordering on the Mediterranean (see Chace (1979) and Gilling (1972)).

This paper outlines the nature and significance of this text, and indicates some of the ways in which it changes our views of the beginning of the ancient Chinese mathematical tradition. It suggests that the complex relations of the *Suàn shù shū* to what was previously the earliest known example of Chinese mathematical literature can be understood as exemplifying a more general process of change in the form and transmission of technical literature in the early imperial age.

### The Historiography of Egyptian Mathematics – Past, Present, Future.

Annette Imhausen

Ancient Egyptian mathematics has been studied since the 19th century, and the major sources were published by 1930. Since then, virtually no new mathematical texts have been found, and the current *opinio communis* among historians of mathematics seems to be that we know everything there is to know (unless new sources are found).

Having studied Egyptian texts (mathematical and other) for about ten years now, my point of view is rather different. While I agree that earlier work (especially the editions of sources) has been very successful, there are still a number of important aspects that have not been taken into account. Thus, I argue that our present knowledge of Egyptian mathematics is selective and, even without the finding of new papyri, can be significantly improved. In the course of a more detailed and better-grounded analysis of the sources, some conclusions of earlier works, which by now have become accepted as general truths, will have to be revised.
In this presentation I will outline past achievements as well as past omissions, present works and our current state of knowledge on the subject, and indicate areas of study that may deserve to be explored in the future.

**Studies of Mohist Mathematics**
Ma Li

This paper is based on a careful study of Mohist mathematics, attempting to show the less known aspects of traditional Chinese mathematics.

**Henry Smith: The plurality of worlds**
Keith Hannabuss

Henry Smith was widely known and admired as an essayist, a skilful politician, and a member of two Royal Commissions, by many who knew little of his mathematical work. Smith made important contributions to several areas, including projective geometry, for which he was awarded the Steiner Prize of the Berlin Academy, and the theory of integration, where he described "Cantor sets" eight years before Cantor's own work. His main mathematical interest, however, was number theory, where his normal form for integer matrices provided the natural tool for handling Diophantine equations and a uniform approach to decompositions of positive numbers as sums of squares.

**Henry Smith's Work in Linear Algebra**
Rod Gow

Henry Smith's most famous work in linear algebra is his paper of 1861 in which he introduced the Smith normal form of an integral matrix. Smith also employed methods of linear algebra to investigate integral quadratic forms, extending earlier work of Gauss and Eisenstein.

In this paper, we draw attention to the novelty of these linear algebra techniques and try to explain their significance.

**Fermat's Last Theorem revisited.**
Israel Kleiner

On the tenth anniversary of Wiles' proof of Fermat's Last Theorem, it is perhaps not inappropriate to revisit the theorem, give a brief sketch of the history of attempts to prove it, leading to Wiles' proof, and note what lies ahead.

**The sampling theories from de la Vallée-Poussin to Shannon.**
Roger Godard

In 1908, Ch.-J. de la Vallée-Poussin published an important article «*sur la convergence des formules d'interpolation entre données équidistantes*». His interpolation formula is one of the roots for Shannon-Whittaker's sampling theorem. This last theorem is one of the most powerful results in signal processing. Then we discuss more recent sampling expansions and the applications of convolution theories to sampling problems.

**Sequences and Series in Old Babylonian mathematics**

Duncan Melville

One of the key characteristics of Mesopotamian mathematics is a passion for lists and tables. Following such organizational principles, it is a natural development to consider problems involving sequences and series. In this paper, we survey examples of such problems from Old Babylonian mathematics and analyze their contexts and procedures.

**Mathematics in Plato's Thought**

Hardy Grant

It is a commonplace that among the great philosophers Plato assigned unusual significance to mathematics. I shall attempt an overview, taking into account both the intellectual context and the social milieu. My central theme will be the place of mathematics in the origin and subsequent career of the theory of Forms – a more complex and interesting tale than it might seem. As time allows I shall try to touch on related issues, especially Plato's conception of the role of mathematics in education.

**Mathematical Problems in Proclus' Commentary on Euclid**

Alain Bernard

Proclus' *Commentary on Euclid's Elements* is one of the main ancient sources that explains the notion of *problem*. In Greek, *problema* and the related verb *proballein* refer not only to the constructive aspect of ancient mathematical practice, but also to the rhetorical practice of challenge and challenging. It is this rhetorical background that served late Neoplatonists like Proclus in providing a metaphysical interpretation of the procedures of problem-setting and problem-solving in Greek mathematics. In this talk, I shall examine Proclus' understanding of the notion of *problem* in the light of its rhetorical connotations. This will enable me to compare his metaphysical interpretation of the term *problem* with its employment in the mathematical parts of his *Commentary*. This analysis thus yields an understanding of how Proclus incorporated three different traditions with each other: philosophical exegesis, mathematical commentaries and rhetorical practice.

This talk elaborates upon issues that I have discussed at the 2003 annual conference of the CSHPM (Halifax). Then I mainly focused on the rhetorical background of Proclus' metaphysical interpretation of *problem*. Here I will show how this previous analysis may help us to better understand the style and nature of Proclus' mathematical intepretations.

**Henry Smith and the English School of Elliptic Functions**

Lawrence D'Antonio

Elliptic functions form a major theme in 19th-century mathematics. In this period we see applications of elliptic functions to areas as diverse as number theory, geometry, complex analysis, and mathematical physics. English mathematicians play a significant, if underappreciated, role in the development of this theory. In particular we consider the contributions of Arthur Cayley, J.W.L. Glaisher, and Henry Smith (who was of course Irish). The period under consideration roughly extends from 1860, when Smith published his highly influential "Report on the Theory of Numbers" up through 1907 when Glaisher published his remarkable paper on the representations of a number as a sum of an even number of squares. These contributions, building on the earlier work of Jacobi and Eisenstein, are compared to those of Continental mathematicians such as Hermite, Kronecker, and Weber.

**C.J.Hargreave's and H.J.S. Smith's Sieve Methods**
Francine F. Abeles

Formulas for the sieve of Eratosthenes originate in Adrien-Marie Legendre's book, *Theorie des nombres* (1798) where he gave the combinatorial expression known as the principle of inclusion and exclusion. In this paper I will discuss both the work of C.J. Hargreave (1854) who presented the first modern sieve formula for the number of primes between an integer and its square based on Legendre's expression, and the work of H.J.S. Smith (1857) who produced the first formula to calculate a sequence of primes from the sieve.

**H.J.S. Smith and the Fermat Two Squares Theorem**
W.N. Everitt

**Tea, decision making and the LEO computer - A very British blend**
Janet Delve

The British teashop and cake manufacturers J. Lyons and Company were established in 1894 and by 1947 they were the country's leading caterer. They mechanised cake production to maximise efficiency but always ensured that quality was safeguarded. A hallmark of their work was inventiveness, which pervaded all areas of their enterprise. Before the Second World War they had developed a very sophisticated clerical system, which impressed John Pinkerton when he was shown round at interview. Pinkerton, a recent Cambridge postgraduate, had electronics experience from working with radar during the war and was going to be working on the LEO, (Lyons Electronic Office) an engineered version of the EDSAC computer which Maurice Wilkes was constructing at Cambridge at the time.
Mr T. R. Thompson and Mr J. R. M. Simmons were the leading intellects in the development of clerical methods in Lyons and indeed were the leaders of office management practice in Britain at that time. In 1947 Mr Thompson and Oliver Standingford undertook a typical business trip to the United States to discover the latest in office management practice there. Apparently after discussion with Herman H. Goldstine and John Von Neumann, Standingford suggested the new 'giant brains' (electronic computers) could be used in the office. He also discovered these computers were being developed at Cambridge University and as both Simmons and Thompson were Cambridge mathematics graduates they had a natural entrée to this new field. Douglas Hartree introduced them to Wilkes and soon a small grant of money was made by Lyons to help Wilkes with his construction of EDSAC 1. While the construction of EDSAC and subsequently LEO was vital, the implementation of LEO for office work was a novel area, which needed much careful thought and preparation.

Lyons' business consisted of a very large number, typically thirty to forty thousand in a week, of comparatively small transactions, each worth around five or six pounds. There was no wholesaler in between Lyons and the retailer and the tea and bakery departments each sold their merchandise directly to the shops, which sold them directly to the public. Their profit margins were very small and clerical inefficiency could result in their finely balanced system tipping the wrong way and producing a loss. They hoped electronic computing would secure business efficiency for them and eradicate any clerical uncertainty.

Pinkerton realised clerical work and scientific work would make different demands on these new electronic computers in terms of; the volume of data, data input and output and also the classes of data needed. He established that a minimum of three classes of input and two of output were needed which led to the invention of parallel channels of input and parallel channels of output with buffering on these channels. Not all their efforts were successful, however. Lyons collaborated with Standard Telephones and Cables to produce a binary to sterling (or decimal) converter, which did not work satisfactorily but was perhaps the first instance of a computer being fed by magnetic tape.

According to Pinkerton the first job done on Leo I on a regular basis was called Bakery Sales Evaluation and involved taking the value of the goods sent into the bakery dispatch, comparing them with the value of the goods sent out and checking them against the anticipated sales. The Bakery Sales Evaluation program has been well-covered in the literature, along with the payroll program. Another early program which has been neglected so far is the Lyons Tea Blending Job, which was run by Frank Land and Betty Newman. The program controlled all aspects of tea stock control and classification and provided vital and previously unavailable information to senior management. In effect this was a decision support system, maybe the first of its kind. My paper investigates all aspects of this Tea Blending Job, and is based on archival material from Lyons and interviews with Frank Land and David Caminer.

**Technology transfer in the 1940s.**

David Anderson

It is a commonplace to observe that Colossus, because it was developed in conditions of strictest secrecy at Bletchley Park during World War II and was kept secret for many years afterwards, played almost no role in influencing the future direction of computer development in the UK or more widely. I argue to the contrary that there are good grounds for supposing the subsequent development of the Manchester Baby (the S.S.E.M.) under the direction of Freddie Williams and Tom Kilburn owed a very great debt to the work of Alan Turing and Max Newman. I suggest that the influence of these Bletchley Park pioneers may have been so extensive that it deserves to be seen as an exercise in technology transfer. I further suggest that this should lead us to re-assess the importance of Colossus.

I am indebted to the library of St. John's College, Cambridge and the Science Museum, London for their assistance in preparing this talk.

**Grete Herman and Von Neumann's No-Hidden Variables Theorem**

Miriam Lipschutz-Yevick

Grete Herman in her thesis [1] (1935) pointed out a specific flaw in Von Neumann's proof of the impossibility of dispersion-free states in Quantum Mechanics. His proof made use of a restrictive postulate, which implied the conclusion. Her subsequent article [2] (1935) in *Naturwissenschaften* maintains the same view, i.e. the possibility of additional characteristics defining the physical system – alongside the φ function – which would determine the previously non-predictable outcomes. However the name of Von Neumann is not mentioned in the latter publication nor is it in the 1935 discussion on this subject between himself, Hermann and Von Weiszenacker reported by Heisenberg in his *Physics and Beyond.* Grete's comments were generally ignored [3], but finally validated (without mention of her) by Bell's 1966 paper. Question: Why did Grete (or the Editor) in *Naturwissenschaften* as well Heisenberg in his report refrain from the mention of Von Neumann? Why did the physics community (and certainly the popular expositions) ignore this challenge to the completeness of Quantum Mechanics? How would acknowledgment of the importance of Grete's article have affected research during the intervening three decades?

[1] Abhandlungen der Fries'schen Schule, Neue Folge 6 Band, p99.
[2] Die Naturwissenschaften 42, p271
[3] See for instance James Albertson, Am.J.Phys. 1961, v 29, p478. This article replicates Von Neumann's errors (Ballentine,Reviews of Modern Physics, p 375).

# SATURDAY 10 JULY - MORNING

## Taking Latitude with Ptolemy: Al-Kashi's Final Solution to the Determination of the Positions of the Planets

Glen Van Brummelen

Although the model to determine planetary longitudes in Ptolemy's *Almagest* produced elegant and satisfactory longitude computations, his model for latitudes was, seemingly, too complicated to allow for easy handling mathematically. As a result Ptolemy was forced into making several approximations, leading to an unsatisfactory mathematical theory of latitudes. While several innovations were proposed to deal with the computation of latitudes in medieval Islam, hardly any of them dealt with the core mathematical issues. Jamshid al-Kashi, perhaps the greatest computational astronomer in the Ptolemaic tradition, achieved a complete solution to the problem in his *Khaqani Zij* in the early 15th century. We shall survey various Muslim contributions and describe al-Kashi's solution in detail.

## From Geometric divisibility to Algebraic sequence: The two mathematical structures of Zeno's Dichotomy Paradox

Jean-Louis Hudry

References to Zeno's Dichotomy Paradox are multiple in philosophy of mathematics, yet the explanation of this paradox invariably refers to an algebraic sequence of numbers. The present paper aims to show that the use of a modern mathematical formalism does not make sense of Zeno's original paradox. The reason is that an algebraic structure by itself is not paradoxical contrary to the geometric structure originally implied by the Dichotomy. Indeed, Zeno's genuine story presupposes the infinite divisibility of a physically extended motion, and this leads to a paradox insofar as the infinite process of division prevents the runner from reaching the end of the run. That is, to move from A to B means to reach a halfway point $A_1$, then to move from $A_1$ to B implies reaching a second halfway point $A_2$, and so on. It follows that the runner must traverse infinitely divisible intervals, which is physically nonsensical. In this sense, the infinite divisibility of motion implies the impossibility for a runner to move through a finite distance. It is a paradox only because the geometric process of infinite divisibility is applied to a physical extension. Note that Aristotle avoids Zeno's paradox by distinguishing the infinitely divisible motion, defined as a potential division in thought, from the finite motion understood as an actual physical process.

By contrast, the modern interpretation of the Dichotomy relies on an algebraic structure, i.e. a convergent infinite sequence of real numbers, which is intrinsically devoid of physical meaning. In other words, an extensionless sequence of numbers does not make sense, by definition, of a physical concept of extension (whether a motion, time or distance). While Zeno's original story rests on the geometric divisibility of an extended motion, the modern mathematical formalism does not contain any reference to an extension, and cannot thereby be paradoxical. The only way to reintroduce a paradox is to postulate a correspondence between an algebraic sequence and a physical process. It is exactly what the theory of supertask suggests by defining the arithmetical limit of an infinite sequence as the physical completion of an infinite sequence of tasks (called a supertask; see Thompson 1952, Benacerraf 1962). The thought experiment of a supertask constitutes a Zeno-like paradox, insofar as the mathematical limit, unreachable by definition, prevents any physical completion of the infinite sequence of tasks. Consequently, to interpret Zeno's Dichotomy paradox through a modern mathematical formalism implies the *ad hoc* postulate that the extensionless sequence of numbers pertains to an extended motion. On the contrary, Zeno's original story does not require this *ad hoc* postulate, since the geometric principle of infinite divisibility pertains, by definition, to an extension, i.e. a divisible motion.

**The Origins of the Frege-Russell Ambiguity Thesis**
Risto Vilkko

One of the cornerstones of the theory of quantifiers is the distinction between the allegedly different meanings of verbs for being. According to received wisdom, such verbs are multiply ambiguous between the "is" of predication, the "is" of existence, the "is" of identity, and the "is" of subsumption. This view, also known as the Frege-Russell ambiguity thesis, is built into the notations that have been used in logic since the turn of the 20th century, in that the allegedly different meanings are expressed differently in the usual logical notations. But then again, it turns out that no logician assumed such distinction before the 19th century.

How did this fundamental change come about? It is often said that Kant rejected the idea that existence is a predicate. In a strictly literal sense, this marks no difference from Aristotle, for whom existence could not be the essence of anything. However, Kant's claim was far stronger than what the slogan "existence is not a predicate" expresses. He argued that existence cannot even be a part of the force of a predicate term for it does not add anything to the concept expressed by the predicate. This does not mean that Kant embraced the Frege-Russell thesis. What it means is that after Kant the notion of existence became homeless, as far as the logical representation of different propositions in syllogistic logic was concerned.

It is only natural that during the early and mid-19th century this situation was perceived independently and more or less simultaneously by several philosophers and logicians. One way of trying to deal with it was to make the Frege-Russell distinction, or some part of it. This indicates that Frege's new logic was not in all respects a unique discovery that could have been made by a genius like Frege at any time. His groundbreaking results – including the distinctions between allegedly different senses of being – were achieved very much in a particular historical situation. This paper investigates preliminary traces of the Frege-Russell thesis in the work of such early and mid-19th century British mathematicians and philosophers as Richard Whately, George Bentham, William Hamilton, John Stuart Mill, Augustus De Morgan, and George Boole.

**Tables for calculating planetary longitudes in Islamic astronomical handbooks**
Benno van Dalen

More than one hundred extant medieval Islamic astronomical handbooks (in Arabic called zij, pronounced as "zeech") contain sets of tables for calculating the positions of the Sun, Moon and the five planets visible to the naked eye. Nearly all of these tables are ultimately based on the geometrical planetary models expounded by Ptolemy in the Almagest (ca. AD 150), but Muslim astronomers made improvements in the underlying parameters and made the tables more convenient to use. In this talk, an overview of some of the most important adjustments will be given and it will be shown how an inventory of the properties of planetary tables can be used to draw historical conclusions about relationships between astronomical handbooks.

**Thomas Harriot's Treatise on Figurate Numbers, Finite Differences, and Interpolation Formulas**

Janet L. Beery

Thomas Harriot (1560-1621) may be best known as the navigator and scientist for Sir Walter Ralegh's 1585-1586 expedition to the Virginia Colony, but he also was the leading English mathematician of his day. Harriot made groundbreaking discoveries in a wide range of mathematical sciences, including algebra, geometry, navigation, astronomy, and optics. He published only one work during his lifetime, *A Briefe and True Report of the New Found Land of Virginia* (1588), but, at his death, left thousands of manuscript pages of mathematics, including at least two sets that appear to have been ready for press, a very complete theory of equations and a much shorter treatise entitled *De Numeris Triangularibus et inde De Progressionibus Arithmeticis*. We shall examine the contents of this latter treatise and related manuscript pages in some detail. We also shall discuss what became of the treatise in the hands of Nathaniel Torporley (1564-1632), the friend Harriot put in charge of editing and publishing his mathematical papers after his death.

**A Glimpse of Duncan F. Gregory through His Letters.**

Patricia Allaire

All that remains of a personal/mathematical correspondence between Duncan F. Gregory (1813-1844) and Trinity classmate Samuel S. Greatheed are several letters from Gregory. These few documents provide a tantalizing peek at Gregory as he worked through some of his mathematical ideas, struggled with publication of the *Cambridge Mathematical Journal,* caught up on the latest Cambridge gossip, and gave Greatheed tongue-in-cheek advice on marriage and family life.

**Why Did Boole Invent Invariant Theory?**

Paul Wolfson

An early paper of George Boole initiated the subject of invariant theory. This talk will address Boole's principal mathematical motivation—the solution of polynomial equations—in creating this area of research.

**Descartes's Opaque Mathematics**

Jay Kennedy

Klein, Mahoney, Gaukroker, Mancuso and others have described the shift in the 'metaphysics of mathematics' during the seventeenth century when mathematicians evolved from a focus on geometrical objects to symbolic equations expressing relations. This is especially marked by the radical differences between Descartes's Regulae and his Géometrie. I here advance a revisionist reading of the obstacles to his early method and of the later suppression of the metaphysics, and claim this provides new insights into the mathematization of physics carried out by Descartes and his followers.

**Informal Incompleteness: Rules, Philosophy, and Law**
Jonathan P. Seldin

Starting in 1930, a number of results have been proved in mathematical logic and theoretical computer science which imply that there are limits in our ability to use rules to characterize important ideas.

The first such result, Gödel's Incompleteness Theorem, implies that there is no set of rules which will completely characterize those sentences which are true in a completely formalized system of mathematical logic strong enough to include the elementary theory of whole numbers. Another result with a similar proof, the undecidability of the halting problem, says that given an idealized computer with no limitations of time and memory but which otherwise works the way our real computers do, it is not possible to write a program which will decide for a given input program and input data whether the computation will eventually come to a halt or will go on forever in an infinite loop. The limitation here is not so much in the writing of rules, but in the ability we or our computers have to use those rules to obtain a complete characterization of the ideas involved.

In this talk, I propose to discuss the possibility that this kind of incompleteness limits our ability to use rules in settings that are not completely formalized. There are two main areas I propose to address:

1. Philosophy. Many philosophical arguments are deductive in form, and although they are usually not completely formalized their form suggests that they could be formalized. This, in turn, suggests that it may not be possible to completely characterize in this way certain subjects. I have already suggested in [2] that the scientific method cannot be completely characterized by means of a set of rules, and that this fact may explain some disputes in the philosophy of science. I also propose to look at ethics: many people, both philosophers and philosophical laymen, argue about ethics as if right and wrong are a matter of obeying a set of rules. But if we cannot use any set of rules to completely characterize right and wrong, how should we think about this? A greater understanding of these issues could make a difference in the way philosophical argument is carried out, and it might also help us better understand science and ethics.

2. Law. The legal systems of the kind we have in Canada and the United States require the use of rules, as Justice David Souter once pointed out [1]. But if it is impossible for us to use rules to characterize some ideas, does this not impose limitations on what can be achieved via the legal system? And given the relationship between Gödel's Incompleteness Theorem and what computers can do, is it possible that some ideas developed by computer programmers might be applied to improve the operation of the legal system and make it more efficient? Improving the working of the legal system could have major benefits for society.

BIBLIOGRAPHY

1. John Milne, "Souter Note Helped Sink '81 Bill on Abortion: Letter Seen Offering No Clue to Personal Views," *Boston Globe*, page 1, July 26, 1990.

2. Jonathan P. Seldin, " Gödel, Kuhn, Popper, and Feyerabend," in Ian

Jarvie, Karl Milford, and David Miller (eds), *Karl Popper: A Centenary Assessment, proceedings of Karl Popper 2002*, Vienna, 3-7 July 2002, to appear.

**"A City particularly favour'd by the Celestial Influences": the inaugural Gresham College lectures of Wren and Barrow**
Tony Mann

Christopher Wren was appointed to the Chair of Astronomy at Gresham College in 1657; Isaac Barrow became Professor of Geometry in 1662. This presentation will discuss how their inaugural lectures present the subject of mathematics, and particularly British mathematics, in the context of their personal situations and of inaugural lectures by other British mathematicians of the time.

**Lord Stanhope's Papers on the Doctrine of Chances**
David R. Bellhouse

The Centre for Kentish Studies holds the mathematical manuscripts of Philip Stanhope (1714–1786), 2nd Earl Stanhope. The manuscripts are catalogued under U1590 C20 and cover a wide range of mathematical topics. The current work focuses only on Stanhope's work in probability. Stanhope's work is mainly derivative from de Moivre's *Doctrine of Chances* and Montmort's *Jeux de Hazard*. Among the notes on these two authors there is some "new" work that includes an alternate solution to the theory of runs and a simplified solution to a special case of the duration of play. In addition, the manuscript collection contains Stanhope's transcription of an incorrect solution to the theory of runs by Thomas Bayes. There is also some correspondence with Sir Alexander Cuming that touches on George Berkeley's criticism of Isaac Newton's development of the calculus. This correspondence illustrates the lack of understanding of the theory of limits in the mid-eighteenth century. Stanhope was an active and capable mathematician working in the mainstream of the probability theory of his day.

**Arthur Cayley and the abstract group concept**
Munibur Rahman Chowdhury

We critically re-examine in considerable detail Cayley's first three papers on group theory (1854-59), with special reference to his formulation of the (abstract) group concept. We show convincingly (we hope) that Cayley, writing his first paper on November 2, 1853, was in full and conscious possession of the abstract group concept, and that – as far as finite groups are concerned – his definition was complete and unequivocal, refuting opinion expressed by some earlier writers.

Already in the first paper Cayley classified the abstract groups of orders up to 6, and suggested that there might exist composite numbers $n$ such that the only abstract group of order $n$ is the cyclic group of that order. We also discuss Cayley's motivation for generalizing the then current concept of a permutation group. Cayley extended the classification to groups of order 8 in the third paper. There he also initiated the study of groups in terms of generators and relations (a procedure usually attributed to Walter Dyck), and in this way constructed the abstract dihedral group of order $2n$. However, these pioneering studies were swept away by the then burgeoning surge of permutation groups, and apparently went completed unheeded by his contemporaries.

**The Second Mémoire of Évariste Galois.**

Peter Neumann

The Second Mémoire of Évariste Galois is a difficult and much misunderstood manuscript. Its first part deals with primitive equations that are soluble by radicals, its second with the structure of what we now recognise as the two-dimensional affine group over the integers modulo a prime number *p*. In this lecture I shall concentrate only on the first part and focus on three significant questions—what did Galois mean by 'primitive', is the argument he gives for his main theorem correct, and how was this material received between 1846 (when it was first published by Liouville) and 1870?

## SATURDAY 10 JULY - AFTERNOON

**Meaning and Mathematics: Obsessions of a Bohemian Priest**
Steve Russ

The facts that Bernard Bolzano (1781 - 1848) was both a Bohemian and a priest are historically significant. Philosophies of mathematics – such as logicism, formalism, intuitionism, constructivism, and structuralism – are not obviously related to fruitful new mathematics. Bolzano developed a 'theory of science' (a kind of logic) in which 'meanings', the objective contents of subjective thoughts and propositions, were the main constituents. This was the forerunner of major ideas of Frege and of Popper's 'third world'. It led Bolzano, through a careful analysis of the concepts of geometric object, number, and function, to numerous fruitful results. The talk will describe his work on measurable numbers and on a remarkable generalisation of the function concept in the early 1830s.

**On the Constructive Content of Hilbert's epsilon calculus and substitution method**
Mehrnoosh Sadrzadeh

In the first part of the paper, we shall briefly survey the fate of Hilbert's epsilon calculus and epsilon substitution method in the 1930s (e.g., [1], [5]) to recent work by Mints and others (e.g., [7], [8]). About ten years ago John Bell [2], [3] et David DeVidi [4] showed that the Law of Excluded Middle, $A(x) \vee \neg A(x)$ and the principle $\neg\forall x A(x) \rightarrow \exists x \neg A(x)$ can be derived from $A(x) \rightarrow A(\varepsilon x A)$ merely with the help of the 'principle of extensionality' for ideal objects $\forall x\ [A(x) \cong B(x)] \rightarrow \varepsilon x A = \varepsilon x B$. This principle allows one to circumvent the use of the 'principle of bivalence' and results by Bell and DeVidi imply that, while one can derive the Law of Excluded Middle within it, Hilbert's epsilon calculus is still constructive. We wish to investigate this. First, we shall briefly comment on Kreisel's work in the 1950s [6]. Then, we shall present a new sequent calculus for epsilon and tau symbols (due to the second author), that has an Heyting algebraic model, and give some results concerning it.


[1] W. Ackermann, 'Zur Widerspruchfreiheit der Zahlentheorie', *Mathematische Annalen*, vol. 117 (1940), 162-194.

[2] J. Bell, 'Hilbert's ε–operator and Classical Logic', *Journal of Philosophical Logic*, vol. 22 (1993), 1-18.

[3] J. Bell, 'Hilbert's ε–operator in Intuitionistic Type Theories', *Mathematical Logic Quarterly*, vol. 39 (1993), 323-337.

[4] D. DeVidi, 'Intuitionistic ε– and τ–calculi', *Mathematical Logic Quarterly*, vol. 41 (1995), 523-546.

[5] D. Hilbert & P. Bernays, *Grundlagen der Mathematik*, 2 vols., Berlin, Springer, sec. ed., 1968.

[6] G. Kreisel, 'On the Interpretation of Non-Finitist Proofs', *Journal of Symbolic Logic*, vol. 16 (1951), 241-267 & vo. 17 (152), 43-58.

[7] G. Mints, 'Strong Termination for the Epsilon Substitution Method', *Journal of Symbolic Logic*, vol. 61 (1996), 1193-1205.

[8] G. Mints, S. Tupailo & W. Buchholz, 'Epsilon Substitution Method for Elementary Analysis', *Archive for Mathematical Logic*, vol. 35 (1996), 103-130.

**The Psychology of Mathematicians**
Ioan James

In the arts and sciences, there is evidence of a strong link between manic-depression and creativity, and between autism and creativity. Depression seems more common among mathematicians than manic-depression, but Cantor and Sylvester were certainly manic-depressives. People with the Asperger syndrome, a mild form of autism, are drawn towards certain occupations, particularly those of an impersonal nature. The proportion of Asperger people among mathematicians is strikingly high. Famous mathematicians who are Asperger possibilities include Isaac Newton, Joseph-Louis Lagrange, Carl Friedrich Gauss, Karl Weierstrass, Arthur Cayley, Henri Poincaré, G.H. Hardy, Bertrand Russell, Emmy Noether, R.L. Moore, Ramanujan, Paul Erdős, Norbert Weiner, A.N. Kolmogorov, John von Neumann, Kurt Gödel, André Weil, Alan Turing, John Nash and Richard Borcherdt; one might add Lewis Carroll and Eamonn de Valera. Historians of mathematics who would like to know more may care to begin by consulting:

Herschman, D.J. and Lieb, J. *Manic Depression and Creativity*. Prometheus, Buffalo NY, 1998.
Fitzgerald, Michael. *Autism and Creativity*. Brunner-Routledge, Hove and New York NY, 2004.
Fitzgerald, Michael and James, Ioan. *The Psychology of Mathematicians*. Mathematical Association of America, Washington DC, (to appear).

**Viète, Warner, Harriot and the end of species in algebra**
Muriel Seltman

Harriot's algebra, especially the solution of numerical polynomial equations, owed a lot to Viète as did Walter Warner, who was largely responsible for producing the *Artis Analyticae Praxis*.

The Definitions at the start of the *Praxis* use such concepts as Logistice Speciosa, Analysis, Synthesis, Zetetic, Exegetic and Poristic in a way that echoes Viète's use of these terms. Pages in the Harriot MSS also use them.

It will be argued that, although Harriot and Warner use Viète as a jumping-off ground, their applications of these concepts actually transcends that of Viète. However, because his notation was based exclusively upon numbers, Harriot never had to get to grips with the issue of homogeneity. This was left to Descartes.

**Accidental greatness: Some of Euler's serendipitous discoveries**
Ed Sandifer

Euler discovered that mixed partial derivatives are equal while studying families of curves. He invented $f(x)$ notation to guarantee an expression would be homogeneous. He proved the

Sum-Product formula for the zeta function to demonstrate the usefulness of a clever technique that he had developed to evaluate a now-forgotten series. We look at some of the discoveries Euler made while looking for something else. These examples highlight the differences between what Euler thought his important problems were and what we now might think his important problems were.

**Three Bodies? Why not Four? The Motion of the Lunar Apsides.**

Robert Bradley

Popular modern accounts of Newton's work frequently give the impression that the problems of planetary motion were solved once and for all in the *Principia*. In fact, giving an account of observed celestial phenomena based entirely on Newton's laws was a problem that engaged the scientific community well into the 18th century, and the two thorniest three-body problems (Sun-Earth-Moon and Sun-Jupiter-Saturn) were fodder for mid-century prize competitions of the European academies. A theory of the moon was particularly elusive: in 1747 Clairaut even announced that he had demonstrated Newton's gravitational theory to be false, a claim he later retracted.

In this talk, I will survey the celestial mechanics of Euler and d'Alembert in the 1740s and 1750s and their attempts to explain the phenomena using Newton's mechanics. I will use illustrations from their correspondence, including a discussion of the possibility that the moon consists of two disconnected bodies.

**The Infinitely Thin Pencil and the Rise of the American Optometric Community**

Eisso J. Atzema

In 1845, the Swiss-French mathematician Charles Sturm (1803-1855) published his "Mémoire sur la Théorie de la Vision" in which he introduced the concept of the so-called *infinitely thin pencil* as part of his explanation of the functioning of the eye. The ideas set forth in this paper received a warm reception within the mathematical community. After some initial resistance, Sturm's ideas were also taken up within the emerging field of ophthalmologic optics. In the 1860s, Sturm's model of the infinitely thin pencil became a theoretical corner stone of the new subfield of optometry.

In my talk, I will sketch the contents of Sturm's memoir on vision and the reception of Sturm's ideas in the field of optometry. Particularly, I will discuss how the concept of the infinitely thin pencil was used both for its practical use and for the status its mathematical sophistication provided within the physiological community at large.

**A footnote to the Four Colour Theorem**

Tony Crilly

In this talk I attempt to reconstruct the events which surrounded the resuscitation and the proof of the four colour theorem made by A. Cayley and A. B. Kempe in the period 1878-1882. It is now well known that Kempe's proof had a gap, but his analysis contained an important idea and it was a considerable achievement for the young mathematician. In my reconstruction I use newly discovered manuscripts and correspondence between the circle of scientists and mathematicians involved.

**Cauchy's definition of limit**
R.P. Burn

This talk will consider two points:
1. Cauchy's contribution to an epsilon-N definition of limit of a sequence.
2. The emergence of the standard definition of the limit of a sequence in the period 1875-1900.

**Mikhail Ostrogradsky's 1850 Paper on the Calculus of Variations**
Craig Fraser

Mikhail Ostrogradsky (1801-1862) published a paper in 1850 in the memoirs of the St. Petersburg Academy of Sciences which presented in a general mathematical setting some results from contemporary dynamical theory. From a modern viewpoint, his work may be seen as the mathematical development of certain ideas of William Hamilton and Carl Jacobi. Of special interest is the generality with which Ostrogradsky formulated his investigation. The paper describes what Ostrogradsky achieved in variational mathematics and examines his work from the historical viewpoint of the foundations of analysis.

**Weierstrass's Foundational Shift in Analysis: His Introduction of the Epsilon-Delta Method of Defining Continuity and Differentiability**
Michiyo Nakane

Today epsilon-delta inequalities are strongly associated with names of A. L. Cauchy and K. Weierstrass. Cauchy actually used them in proving some theorems in his calculus textbooks of the 1820s. But it was Weierstrass in an 1861 lecture on analysis at Berlin's Gewerbeinstitut who first developed the calculus using definitions written in terms of epsilons and deltas. Since Cauchy defined the fundamental notions of analysis using the limit concept and infinitesimally small quantities, Weierstrass could not have arrived at his new definitions simply by generalizing Cauchy's results. This paper focuses on the historical process leading from Cauchy to Weierstrass. In this period mathematicians, who described basic concepts of analysis using both epsilon-delta inequalities and infinitesimally small quantities, began to formulate the notions of uniform convergence and uniform continuity. This paper shows that it was the intention of distinguishing differentiability from continuity, and not the use of epsilon-delta techniques as such, that was the crucial factor in Weierstrass's contribution to this development.

**French Research Programs in Differential Equations in the Late Nineteenth Century**
Thomas Archibald

With the renewed development of the French mathematical community in the period after 1870, the theory of differential equations, long of interest to French mathematicians, was carried forward in a number of directions. The well-known innovations of Poincaré in the qualitative theory of ODEs are only the best-known representative of a varied and nuanced set of research programmes. In this paper, we examine in overview some of these developments and those involved in them, with the end in mind of unravelling the threads interconnecting them, their mutual influences, and their effect on early twentieth-century work. One aim of the paper is to assess the accuracy of the picture provided by Painlevé, Goursat, Flocquet, and Vessiot in the differential equations articles of the *Encyclopédie des sciences mathématiques*.

**Why did Cantor see his set theory as 'an extension of mathematical analysis'?**

Ivor Grattan-Guinness

As is well known, Cantor's set theory met a certain amount of opposition, and a lot of indifference, from mathematical colleagues during its development from 1870 to 1895. While especially the theory of actually infinite numbers would have excited shock and awe, and the pretensions of general sets some quizzicality, the reasons are not so easy to detect. For from the start Cantor took as the basic concept of his theory the notion of the limit point of a set of points, which was a (marvellously powerful) extension of the theory of limits, staple food for the analysis of his time. This lecture will muse around this topic.

<u>**SUNDAY 11 JULY – MORNING**</u>

**The Teaching and Study of Mercantile Mathematics in New England during the Colonial and Early Federal Periods: Sources, Content, and Evolution.**
Joel Silverberg

The author has located and analyzed over one hundred manuscript "cyphering books" written by students in the southern New England colonies and states, dating from 1720 to 1835. Two-thirds of these manuscripts reflect a course of study in mercantile or commercial mathematics that was taught in private venture schools, incorporated schools and academies, and in colleges and universities in America throughout most of the eighteenth and early nineteenth centuries.

The texts from which these students were taught have been identified and progress from English works imported into the American colonies, to English works reprinted by American printers, and eventually to works written and published by Americans. A study of the manuscripts and the published works sheds light on both the origins of this tradition, and the evolution of the tradition in American hands, especially following the break with England.

In this presentation I will examine the nature of this curriculum and present evidence that its roots lie in academies founded during the Restoration of the British monarchy following the collapse of Cromwell's Protectorate. I will also examine the ways in which American authors changed the ways in which this mathematics was taught the during the first half-century of the American experiment in response to changing views on the nature and role of education in the fledgling republic, the introduction of "federal money", and the adaptation of new pedagogical approaches from continental Europe.

**Geometry teaching in the 1860s and 1870s: Two Case Studies**
Robin Wilson

Rote learning of Euclid's *Elements* in English schools came increasingly under fire in the 1860s, leading to the foundation of the Association for the Improvement of Geometrical Teaching (now the Mathematical Association) in 1871. In this talk, I look at two people on different sides of the English divide – Thomas Archer Hirst and Charles Lutwidge Dodgson (Lewis Carroll).

**Guarding the gates: The development of mathematical refereeing for the Royal Society in the 19$^{th}$ century**
Sloan Despeaux

As the first journal of its kind in Britain, the *Philosophical Transactions of the Royal Society of London* and its publication procedures set a standard for other scientific societies to follow.

In particular, these societies quickly emulated the refereeing process established by the Royal Society in 1832. This refereeing process gave mathematical members of the Royal Society active roles in controlling the content and quality of the mathematics published in the *Philosophical Transactions*. Mathematical referees could guide and encourage the research in their discipline while they set limits on the type and depth of mathematics appearing in the journal. While they were generally committed to the advancement of mathematics, these referees were also vulnerable to society politics and secondary interests. For better or worse, this group of mathematicians helped build and keep the gates guarding a journal in which publication led to distinction. This talk will investigate the history of the Royal Society refereeing process and its relationship to nineteenth-century British mathematics. The referees, through the text of their reports, will reveal the agendas of professionalization, internationalization, and politics that were closely intertwined in the refereeing process.

**From Cambridge to Cambridge: The Mathematical Significance of John Farrar's European Sojourns.**
Amy K Ackerberg-Hastings

Although the preparation of his mathematics textbooks took place only in the United States, Harvard mathematics and natural philosophy professor John Farrar (1779-1853) spent a total of seven years in Europe attempting to recuperate from the nervous ailments that ended his career. These trips included visits to the University of Cambridge, examinations of the Royal Observatory at Greenwich and the Observatory at Armagh, and stays in the homes of such notables as Mary Somerville and Maria Edgworth. Through the use of Farrar's correspondence, Eliza Farrar's memoirs, and British manuscript records, this paper will reconstruct who Farrar knew, how he came to know them, and the mathematical conversations they might have had. Such a reconstruction provides insight into the connections between nineteenth-century American mathematicians and European mathematical and scientific communities.

**Percy A MacMahon: a good soldier spoiled.**
Paul Garcia

Major MacMahon was a famous and well-respected figure in the world of late Victorian and Edwardian mathematics. He began his career as an officer in the Royal Artillery, but was forced by circumstances to become a mathematician. A keen billiards player and man-about-town, he wrote over 120 papers and four books, two of which are still in print and cited regularly. An interest in puzzles led him to patent three of his own, and write a very unusual book in which he anticipated the work of the Dutch artist Escher by over a decade. He rose to prominence initially for a discovery in Invariant Theory, which led him quickly into Symmetric Functions and Partition Theory, from which he almost single-handedly invented modern Combinatory Analysis.

**A Delicate Collaboration: A. Adrian Albert and Helmut Hasse and the Principal Theorem in Division Algebras in the Early 1930's**
Della Fenster

Traditionally, the words “collaboration,” and “principal theorem in division algebras in the 1930's” are associated with the celebrated German trio of mathematicians, Richard Brauer, Helmut Hasse and Emmy Noether. Indeed, Brauer, Hasse, and Noether formed one of the collaborative efforts that led to the proof of the principal theorem in linear algebras in the 1930’s, that is, the classification of normal division algebras over an algebraic number field. This paper, however, highlights the other joint work linked with the proof of this theorem, namely that of A. Adrian Albert and Hasse. This work shows, among other results, that in the genesis of mathematical ideas, there is often no greater motivation than another mathematician interested in—and seriously pursuing—the same problem.

**Humanizing Mathematics: Using History to Introduce Non-Specialist Students to Mathematics**

Joel Lehmann and Christine Lehmann

In American universities and colleges, students from disciplines outside mathematics and the physical sciences often undertake a single course in mathematics as part of their “general education” requirement for a bachelor’s degree. For such students, mathematics may be an object of distaste or anxiety, or both. The history of mathematics can be an effective way of countering those attitudes and allowing non-specialist students the opportunity to see mathematics as a human activity rather than a monolithic institution comprising only abstract facts and techniques.

This presentation will focus on one such course and will concentrate on its structure and its audience, a selection of student activities, and student responses, both academic and evaluative.

**History of Mathematics Resources for Key Stages 3 and 4**

Snezana Lawrence

Aims and objectives of the project: The prevailing modern view of mathematical ability is one which entails creativity and transcends the more limited concept of technical ability. There is, however, little widely available material which, in a simple and accessible way, introduces the secondary school age children to the world of ‘creative’ mathematics. This project will work to contribute to developing the base of knowledge in mathematical education by concentrating particularly on introducing the historical context into the study of mathematics at Key Stages 3 and 4.

The proposed project does not deal with the historical aspect of mathematical sciences in an anecdotal way, but instead seeks to reinvigorate the creative search for mathematical truth through giving the tools and examples from the history of mathematics. The approach adopted would hopefully inspire young mathematicians to whom the project is dedicated, to recognise the creative nature of mathematical enquiry and to gain an insight into the various techniques of research, analysis and synthesis of mathematical thought through the study of the subject’s history. This would be achieved through producing material on:

1. Reoccurring topics in mathematics through history
2. Development of mathematical techniques relevant to KS3 and KS4 mathematics.

This approach should serve as a basis to help:

1. Development of an ability to spot crucial issues through examples of mathematical discoveries from the past
2. Development of an ability to trace interest in a mathematical topic through individual research.
3. Disseminating the outcomes.
In my talk I will show how I plan to satisfy these aims.

**Benjamin Peirce and the Question of American Scientific Identity**
Deborah Kent

This paper will consider Harvard mathematician Benjamin Peirce and his energetic participation in mid-nineteenth-century efforts to develop and define national scientific administration in the United States. Peirce worked within the framework of general science structure-building particularly to promote research-level mathematics within the educational context, in the public forum, and among his colleagues. Although supported by a nucleus of like-minded scientists, Peirce also encountered opposition as he reformed the Harvard mathematical curriculum, agitated the Neptune controversy, and pursued investigations in abstract algebra.

**The emergence of regional research traditions in Scandinavian mathematics**
Henrik Kragh Sørensen

In the second half of the 19th century, the social conditions and cognitive contents of mathematics transformed in fundamental ways reflecting the increasing modernity in society at large. Aspects of these transformations include processes of professionalisation, institutionalisation and internationalisation. In Scandinavia, in the early 19th century located at (or outside) the periphery of European mathematics, these processes also manifested themselves in gradually emerging regional research traditions, which are the topic of the present paper.

I will start this paper by briefly outlining the state of Scandinavian mathematics around 1850. This description will focus on the networking of mathematicians and present an overview of their research interests. Based on this, I will analyse the choices made and tactics employed by Scandinavian mathematicians regarding areas of research in the second half of the 19th century. As the possibilities for research were more limited in Scandinavia than in the mathematical centres of Göttingen and Paris, such choices had to be made, mostly tacitly. I will demonstrate how certain individuals and role models – in their effort to professionalize mathematics – set the agenda for subsequent research. Through rhetoric, certain topics were cultivated as part of a regional or national tradition – this occurring in a period where national identity was also moulding, in particular in Norway. Some of these topics developed into research traditions, which found legitimisation in regional rather than international criteria. Scandinavian mathematicians had one eye on the international developments and one on the ambition to create the possibility for excellent research in their regional context.

The history of regional research traditions is intimately linked to the professionalisation of academic mathematics, in particular to the emergence of a group identity as 'research mathematicians'. I will draw this connection by way of examples taken from the national mathematical societies, the international conferences, and the national journals.

**Raymond Clare Archibald: A Euterpean Historian of Mathematics**
James J. Tattersall

In the early the twentieth century, one historian stood head and shoulders above his peers. He was an international authority on the history and bibliography of mathematics and science. He was affable, learned, and meticulous, a characteristic of his many interests and acquaintances, which knew no national boundaries. He had a remarkable memory and was assiduous in his work to an extreme. He knew more about mathematical books and their value than anyone in North America. As a public benefactor, he founded and oversaw the development of three major library collections at Mount Allison University, Brown University, and the American Mathematical Society. He loved music and was a musician of exceptional skill who could have easily become a classical violinist and remained an enthusiastic amateur. We note some of the many accomplishments and contributions of this outstanding historian of mathematics.

**Summoning the nerve: the curious history of British algebra**
Gavin Hitchcock

Cultural background and personal motivations are explored in the convoluted story of the transition, via the birth of symbolic algebra, to a cosmos of multiple yet meaningful algebras, which in turn led to the emergence of abstract algebra and axiomatics. We seek to answer the questions of why it was the British, passionately concerned with underlying meaning and conceptual clarity, who brought about the great shift, and also why they did not (and probably could not) go on to complete the separation of form from matter and make the next major leap into abstraction. The talk aims to focus attention on the provisionality of mathematical concepts and theories in development, exemplified by Peacock's symbolic algebra as ushering in an important epoch whose climate permitted and encouraged colonization of new algebraic worlds, and Hamilton's quaternions as a crucial transitional form in the evolution of vector analysis.

**Connections, American and mathematical: Thomas Harriot and John Pell**
Jackie Stedall

Thomas Harriot and John Pell both had connections with north America. Harriot was one of the first Englishmen to visit the continent; Pell later planned to do so but, as with so many of Pell's plans, nothing came of it. Pell was only ten years old when Harriot died but he later understood, used, and interpreted Harriot's work better than any other English mathematician.

A brief look at Pell's knowledge of Harriot's mathematics will demonstrate the kind of mathematics that was being used and discussed in England in the early seventeenth century. It will also show some of the informal ways in which mathematics was communicated through manuscripts and word of mouth.