ICHM

ICHM Co-Sponsored *AMS-MAA Special Sessions on History of Mathematics*

Seattle, Washington (USA); January 6-8, 2016

By Adrian Rice

This set of lectures comprised a three-day Special Session on the History of Mathematics at the Joint Meeting of the American Mathematical Society and the Mathematical Association of America held at the Washington State Convention Center in Seattle, USA. The session was organized by Patti Hunter (Westmont College), Sloan Despeaux (Western Carolina University), Deborah Kent (Drake University) and Adrian Rice (Randolph-Macon College) and featured 29 speakers from a total of six countries, including the United States. In response to the favorable feedback received after the previous meeting, the sessions again included three moderated panel discussions on themes arising from some of the talks. This year the themes were:

- Issues in the history of 19th-century mathematics,
- Contemporary challenges facing the historian of medieval, Renaissance, and early modern mathematics,
- The internationalization of mathematics in the 20th century.

The following speakers presented talks at the meeting:

Geometry's Indisputability: From Hero to Hobbes
Jacqueline Feke, University of Waterloo, Canada

In the first and second centuries, Hero of Alexandria and Claudius Ptolemy claimed that geometry was indisputable. Although philosophers had prized mathematics highly for centuries, Hero and Ptolemy cast geometrical proofs as superior to the work of philosophers. According to Hero, the statesman must employ geometry in order to distribute land precisely. According to Ptolemy, philosophers may seek knowledge but only mathematics can provide sure and incontrovertible knowledge to its practitioners. Moreover, the mathematical proofs that convey this knowledge are indisputable. After Ptolemy, only ten cases in the Greek corpus echo this claim to geometry's indisputability, but I argue that it had an overlooked and long-lasting effect. Proclus, the fifth-century Neoplatonist, appropriated it, and I argue that he took it one step further. While Hero and Ptolemy used it to position mathematics as superior to philosophers' discourses, Proclus employed it to transform them. He constructed his Elements of Theology and Elements of Physics in the style of a geometrical proof, and early-modern philosophers followed Proclus' lead. In this paper, I trace the influence of Hero and Ptolemy's portrayals of geometry's indisputability to the work of Descartes, Spinoza, and Hobbes.

The *Vis Viva* Controversy: a Tercentenary Celebration

Lawrence A. D'Antonio, Ramapo College of New Jersey

What is the nature of force? What is the proper measure of force and is force conserved? These questions found traction in the late 17th and early 18th centuries. The controversy begins in 1686 with Leibniz proposing *vis viva* as an alternative measure of force to the Cartesian law of the quantity of motion. In this talk we will follow the dispute through the work of Wallis, Huygens, Boscovich, and ending with d'Alembert who asserted that the previous controversy was simply "une dispute de mots." This talk celebrates two tercentenaries, the death of Leibniz in 1716 and the birth of d'Alembert in 1717.

Some Aspects of the History of the Cycloid

Maria Zack, Point Loma Nazarene University

The cycloid is a simple curve with an interesting history. Many well-known mathematicians of the seventeenth and eighteenth centuries studied the cycloid. These include Roberval, Descartes, Pascal, Wallis, Huygens, Newton and Leibniz and a few Bernoullis. This talk will consider the work done on the cycloid by a few of these individuals and examine how their work connects to the development of some of the fundamental ideas of calculus.

75 Years of Apology: G.H. Hardy's *A Mathematician's Apology*

Daniel S. Silver, University of South Alabama

The year 2015 was the 75th anniversary of the appearance of G.H. Hardy's *A Mathematician's Apology*. When its second edition appeared in 1967, one well-known critic predicted that "it won't make a nickel for anyone." We explore the history of the book as well as the controversy that continues to surround it.

Wetzel's problem, Paul Erdős, and the continuum hypothesis: a mathematical mystery

Stephan Ramon Garcia, Pomona College

In 1963, Paul Erdős provided a stunning solution to Wetzel's Problem in complex variables. But who was Wetzel and how did his problem find its way to Erdős? Tracing the path that this problem took, from its birth to its resolution, was a mathematical mystery. A burnt-out car on the streets of Chicago appeared to mark the end of the trail. An enigmatic manuscript, written by unknown hands, prompted even more questions. . .

Programming Before Computers

Thomas Drucker, University of Wisconsin–Whitewater

The importance of a mathematician's contributions to the development of the subject is not always appropriately measured by the number of theorems proved. Instead, a program can involve a wider vision, and many of the details are left to others to carry out. Frege's program for the logicization of arithmetic has continued to have an influence, even when there were flaws in his own attempt to carry it out. Leibniz's program for the mechanization of reason did not get nearly so far as Frege's, but it has also retained its importance, especially with regard to motivation. This talk will look at these two programs and their continuing influence, while comparing them with other research programs that were more conspicuously successful in detail.

ICHM

Visualizing a constructive cubic solution: Omar Khayyam meets Oliver Byrne

Deborah Kent, Drake University

Although a geometric solution to a cubic equation may seem peculiar to modern eyes, the study of cubic equations was initially motivated by geometric problems. Twenty-first century readers tend to lack fluency in reading proofs of this type without rewriting them in familiar algebraic notation. This presentation employs Oliver Byrne's application of colour and space to showcase one of Omar Khayyam's geometric constructions of a solution to a cubic. This graphical approach removes the modern reliance on algebraic notation and focuses instead on a visualization that emphasizes ratios, conic sections, and dimensional reasoning.

The Long Birth of Modern Algebra for Undergraduates

Walter J. Meyer, Adelphi University

Modern Algebra is usually thought to begin with Galois in the early 19th century—although it is reasonable to say it was not yet very modern back then. However one might quibble on that matter, plenty was known about groups and rings, and some things about fields as well, by the beginning of the 20th century, quite enough for undergraduate courses. But we have assembled data from the Cajori Two Project to show that undergraduate courses did not appear in appreciable numbers till after World War II. (Our data confirms a personal impression noted by G. D. Birkhoff.) This may seem like a long time, but another interpretation is possible. However you view it, it is natural to wonder what made these courses appear when they did. This paper is a data-based investigation, resting on work by historians of mathematical research, on the Cajori Two curriculum survey, and on consideration of the external factors impinging on mathematics in the 20th century.

The Construction of Edmond Halley's 1701 Map of Magnetic Declination

David R. Bellhouse and Lori L. Murray, University of Western Ontario, Canada

During two voyages of the HMS Paramore, Edmond Halley collected data on magnetic declination at various points in the Atlantic Ocean. Magnetic declination is the angular difference between magnetic north and geographical or true north for any point on the earth's surface. Following these voyages, in 1701 Halley published a map showing isogones, or lines of equal magnetic declination, over the Atlantic Ocean. Such a map was presented as a possible solution to finding longitude at sea. Halley did not reveal the data analytic techniques that he used in his map construction and they remain unknown to this day. Using some mathematical tools of his day, namely arithmetical averages and Newton's divided difference method to fit a line to data, a plausible method for the map's construction is given. Not enough data was collected that would allow for the construction of all the isogones on the published map. A method is suggested whereby Halley imputed data for his map construction.

The inner imagination without sensory media: Jakob Steiner and the figure in geometry

Jemma Lorenat, Pitzer College

The transition away from figure-based reasoning during the long nineteenth century is often framed in terms of intuition and rigor. However, the use of the figure could also be attacked from the perspective of intuition, as shown in the geometer Jakob Steiner's injunction that certain geometric considerations could only be properly understood when viewed purely through the inner imagination without any intermediary sensory medium—such as a drawn representation or figure. Steiner reinforced his commitment to the inner imagination by occasionally teaching geometry with the lights out and the

curtain drawn, so students would have to see figures internally. Yet in his publications Steiner often used illustrated figures to introduce new definitions, describe constructive procedures, or simplify statements of theorems. This talk will consider Steiner's evolving approach to figures in three comparative contexts: his early articles in the *Journal für die reine und angewandte Mathematik* and the *Annales des mathématiques pures et appliquées* (1826–1832), his famous monograph *Systematische-Entwicklung der Abhängigkeit geometrischer Gestalten von Einander* (1832), and his posthumously published *Vorlesungen über synthetische Geometrie* (1867).

Cauchy's Work on Complex Analysis in the 1820s

Craig Fraser, University of Toronto, Canada

In 1814 August-Louis Cauchy commenced the serious study of problems in analysis involving complex variables. The subject would engage him for the next forty years. During the 1820s a theory of functions of a complex variable began to come together in his extensive work on analysis. The paper examines Cauchy's evolving understanding of complex analysis during this period, paying particular attention to how he presented the subject material in his didactic treatises of 1821, 1823 and 1829. Topics to be explored include the identity of the theory of complex variables as a distinct part of analysis, and the role that geometric conceptions played in Cauchy's investigation.

Riemann's Model of Nobili's Rings

Tom Archibald, Simon Fraser University, Canada

In 1825, Leopoldo Nobili observed coloured rings on a metal plate that had been coated with an electrolyte, a current being passed through the liquid from a point electrode to the plate. The phenomenon attracted the attention of several researchers, among them Emil du Bois-Reymond, Edmond Becquerel, and Bernhard Riemann. In this paper we discuss the differences between the models they employed, their relationship to contemporary mathematico-physical theory, and their relation to experiment. Riemann's work shows one of the ways in which we observe directly the influence of his studies with Dirichlet, and indirectly the influence of Fourier. It also provides an early example of a method for modelling a problem with a partial differential equation that was to become standard, in part via Riemann's lectures.

Quadratic forms, Fermat's Last Theorem and Bernoulli numbers from Cauchy to Kummer (1830–1850)

Jenny Boucard, Centre François Viète, Université de Nantes, France

In 1847 Kummer announced a proof of Fermat's Last Theorem (FLT). The proof was part of Kummer's work on reciprocity laws and was applied to a class of numbers which he called regular numbers. To achieve these results, Kummer used the earlier works of Gauss, Jacobi and Dirichlet among others. 1847 was also a year in which were held several discussions on FLT in the Parisian milieu. Lamé and Cauchy are for example regularly cited in historical accounts, usually for their failed attempts to make progress on FLT. Through the *Journal of Pure and Applied Mathematics*, Liouville provided communication between these two groups of scholars whose research would appear a priori isolated.

In this paper, we will focus on the preceding period, when many results were obtained about Gauss sums, quadratic forms, indeterminate equations, and other mathematical objects. It will enable us to put into perspective the exchanges held between these scholars in 1847. We will analyze a corpus of texts published after 1830 by Cauchy, Kummer, Dirichlet or Jacobi. We will emphasize the links between the various actors involved and their results. We will show that several mathematical results were in circulation in these research areas and used from different perspectives.

Determining the Discriminant

Fernando Q. Gouvêa, Colby College, and Jonathan Webster, Butler University

Both number fields and polynomials have invariants called "discriminant". We will discuss the history of this concept from before it had a name to the work of Dedekind, who established its importance. If time allows, we also discuss the problem of the "inessential divisors", discovered by Dedekind and finally solved by Hensel.

Some remarks on Dedekind and Weber's edition of Riemann's *Gesammelte Werke*

Emmylou Haffner, Archives Henri Poincaré, Université de Lorraine, France

In 1876, the collected works of Bernhard Riemann were published, with additional manuscripts from his Nachlass, by Richard Dedekind and Heinrich Weber. The edition of Riemann's works was a long and difficult work, which took Dedekind and Weber more than two years to complete. Indeed, as the letters exchanged by Dedekind and Weber tell us, the state of Riemann's manuscripts made it necessary for them to thoroughly work through the manuscripts, sometimes struggling to understand what Riemann was doing. We will consider some elements of their correspondence and highlight key points to understand the process of edition through which Dedekind and Weber went, such as the steps followed to unfold Riemann's texts until publishable versions could be obtained. We will suggest that it is important, here, to elucidate to what extent Weber and Dedekind's very thorough editing work led to publish adapted or even rewritten versions of Riemann's texts, and to clarify whether Dedekind and Weber's reading of Riemann could have had an influence on our own reading, through their re-appropriation of Riemann's texts that accompanied the edition of the manuscripts.

The Contributions to Mathematics of Piet Hein

Toke Knudsen, State University of New York at Oneonta

The Danish polymath Piet Hein (1905–1996) was a poet, author, inventor, scientist, mathematician, and world citizen. He is most famous for his grooks (Danish, *gruk*), short, subtle poems, often accompanied by drawings, of which he wrote over 7000 in Danish and English. His main mathematical preoccupation was combinatorics, and he invented several remarkable games and puzzles, including Hex and the Soma cube. His name is also associated with the superellipse and the superegg. Even though Piet Hein did impressive work in mathematics he is better known as a scientist, and a general study of his mathematics is lacking. This presentation will provide an overview of Piet Hein's life and contributions to mathematics.

Medieval Mathematics in Three Languages

Victor J. Katz, University of the District of Columbia

When one thinks of medieval mathematics in Europe, the first ideas that come to mind are the introduction of the Hindu-Arabic number system with its algorithms as well as the first beginnings of algebra based on Latin translations from the Arabic. But there was far more mathematics developed and discussed in the European Middle Ages, not only in Latin but also in Arabic and Hebrew. In this talk we will particularly consider Hebrew and Arabic writings that involved sophisticated geometric and combinatorial ideas. The geometry often had its origins in Greek work, some of which had nearly been lost to Europe, while the combinatorial ideas, based on some fundamental religious concepts, were original to Muslim and Jewish authors.

Francesco Maurolico and the problem of filling space with regular polyhedra (1529)

Veronica Gavagna, University of Salerno, Italy

In 1528, the mathematician Francesco Maurolico (1494–1575) lectured on Euclid's *Elements* on behalf of the Senate of Messina. The unsatisfactory level of the available editions of the *Elements* convinced him to provide a new edition, based on the known traditions but supplemented by some original contributions. Maurolico's reworking of Books XIII-XV, devoted to regular polyhedra, is particularly interesting for the increased number of new propositions. Maurolico's deep interest in these solids is also testified by *De impletione loci*, a work on the problem of filling space with regular polyhedra written in 1529. The goal of this writing is to confute the Averroes' remark (influenced by Aristotle) on the possibility of filling space with regular tetrahedra. The novelty is that Maurolico's approach to this problem was definitively mathematical and not philosophical: he measured the dihedral angles of the regular polyhedra and tested all the suitable combinations of the solids. Last but not least, in his studies on regular polyhedra Maurolico emphasized the discovery of a relationship among edges, faces and vertices that sounds like a version of Euler's polyhedron formula.

Rheticus, Maurolico, and the Birth of the Secant Function

Glen R. Van Brummelen and James Byrne, Quest University, Canada

In 1551 Georg Rheticus published a small but remarkable set of trigonometric tables introducing all at once the secant, cosecant, and cotangent functions. His approach and terminology, later partly adopted by Viète, varies substantially from the common parlance of the time. Seven years later Francesco Maurolico published his own secant table, following a different tradition established by Regiomontanus. Later in the century, within the context of the emergence of trigonometry textbooks, this led to accusations of plagiarism. We examine the content and setting of both works, including an analysis of the tables themselves that leads to a resolution of the dispute four centuries later.

The Mathematics of Thomas Harriot

Janet L. Beery, University of Redlands

Englishman Thomas Harriot (*c*.1560–1621) may be best known today for having spent the winter of 1585–86 working to establish the Virginia Colony in America. However, in his own time he was known as an innovative mathematician and scientist, albeit one who never quite seemed to get around to publishing his work. The publication of Harriot's manuscript work on mathematics and science has been a dream of his friends and followers for over 400 years. Modern digitization and the efforts of Matthias Schemmel and Jacqueline Stedall have finally made that dream a reality. We review Harriot's publication history, assess the current state of Harriot scholarship, and suggest directions for the future.

The Effectiveness of Mathematics as Applied to Science

Ronald E. Mickens, Clark Atlanta University

We present arguments suggesting that mathematics and science may be "equivalent", and this conclusion can then be used to justify why mathematics is expected to be applicable to science. A brief summary of the history of prior efforts on this issue will be presented. This topic continues earlier work of mine on the relationship between science and mathematics.

What makes a student the "best"?

Della Dumbaugh, University of Richmond

Saunders Mac Lane has referred to A. Adrian Albert as Leonard Dickson's "best" student. How did Mac Lane determine this designation of "best"? In this talk, we consider the careers of three students of Leonard Dickson, A. Adrian Albert, Ko-Chuen Yang and Mina Rees, in order to explore how students are classified—or not—as "best" and how we might rethink that designation.

Recognizing Ricci

Judith R. Goodstein, Einstein Papers Project, Caltech

The names of the Italian mathematicians Ricci and Levi-Civita have been enshrined in the theory of general relativity since Einstein seized on the absolute differential calculus as the indispensable mathematical tool for expressing his uniquely determined gravitational equations. The physicist's long-standing indifference to mathematics changed abruptly as he struggled with the theory, methods, and notation of the calculus developed and refined by Gregorio Ricci-Curbastro, together with Tullio Levi-Civita at the University of Padua, before the end of the nineteenth century. While mathematicians and physicists are familiar with the Ricci tensor, by and large they know very little about the mathematician for whom this symbol in differential geometry is named. This talk is a brief introduction to the story of his life.

American Women Mathematics Doctorates, 1940–1959

Margaret A.M. Murray, University of Iowa

In this talk, I describe recent research toward a comprehensive picture of the roughly 200 women who earned PhDs in mathematics from American institutions during the years 1940–1959. This work builds significantly on my book *Women Becoming Mathematicians* (MIT Press, 2000), and reveals a more complex picture of the careers of the women mathematicians of this generation.

Polish Math House of the Interwar Period: Stefan Banach

Andrzej Lenard, San Diego, California

After regaining its independence in 1918, Poland experienced an outburst of extraordinary mathematicians. Immediately they created several world-leading mathematical centers at Polish universities in Warszawa, Lvov, Krakow, Poznan and Vilnus, which competed in achievements and significant mathematical publications among themselves. Young, often self-taught mathematicians like Banach, Sierpinski, Ulam, Tarski, Knaster, Steinhaus and many more, practiced mathematics in a most unorthodox, original way. Their work resulted in world-recognition and their minds were used to help to win World War II. Some migrated to the USA and contributed to the Manhattan Project; others were used in the Allied army to break the Enigma codes; most, however, stayed in Poland and faced the slaughter of the intellectual class by Germans and Soviets. This presentation is fully dedicated to Stefan Banach. As well as his life and achievements, I also focus on the educational curricula he learned as a student and taught as a teacher.

"The first man whom you meet on the street": tracing back a well-known quotation by Hilbert

June Barrow-Green, The Open University, United Kingdom, and Reinhard Siegmund-Schultze, University of Agder, Norway

In his famous lecture at the ICM in Paris in 1900, David Hilbert included a quotation on mathematical understanding which he attributed to "an old French mathematician" but with no hint as to whom he meant. This talk will discuss the quotation and describe the journey taken to trace its origin, a journey which starts in Paris and ends up—via Bradford and Brussels—in Montpellier, and passes by some misattributions along the way.

The "patriotic duty not to nationalize science": aspects of the internationalization of mathematics in the late 19th and early 20th centuries

Laura E. Turner, State University of New York at New Paltz

The development of mathematics during the late 19th and early 20th centuries is marked by a newfound drive and commitment to so-called "international" activity, be it through publishing in international journals, participating in international congresses, or less formal forms of communication and cooperation between representatives of different nations. In this talk, we focus on the roots of these behaviours, the reasons for which they were considered important and beneficial, and even the notion of international itself. In particular, we link these themes to broader discourses of civilization and nation-building, to the idea of the "peaceful competition" between peoples and nations and the power this engendered, and the deeply nationalistic, almost warlike character of some international exchanges themselves, undergone in the effort to cultivate and project a particular identity of mathematics to foreign contemporaries.

Russian participation in the early International Congresses of Mathematicians

Christopher Hollings, University of Oxford, United Kingdom

The picture of Russian/Soviet attendance at the International Congresses of Mathematicians is a very varied one, with strong delegations at some congresses (particularly the ones of the later Soviet era) and conspicuous absences from others (those of 1936 and 1950 most especially). In this talk, I will examine Russian attendance of the early ICMs, namely, those that took place before the October Revolution. We will see that in this period, many Russian mathematicians were active and enthusiastic participants at such international events.

Making a Name in Mid-century Mathematics: Individuals, institutions, and the American reaction to Nicolas Bourbaki

Michael J. Barany, Princeton University

Nicolas Bourbaki is widely considered one of the most influential mathematicians of the twentieth century, though he is just as widely held to be merely the pen name shared initially by a radical group of French mathematicians from the mid-1930s. His personhood or lack thereof has tended to be treated as a curiosity, illustrative of the distinctive approach to mathematics that came to be associated with his name but in itself presenting little more than a provocation or a challenge of nomenclature. My presentation examines Bourbaki's reception in the 1940s, when the enigmatic mathematician's personhood became a visible and contentious problem in an international mathematical community responding to the Second World War and then rebuilding in its aftermath. Placing in context Bourbaki's two failed attempts to join the American Mathematical Society, I develop an account of the reconfiguration of individuals and institutions in mid-century international mathematics that ties together the effort to revive the International Mathematical Union and International Congresses of Mathematicians, the changing funding landscape for elite mathematics, and the changing role of publications and reviews in establishing and connecting research communities.