Mathematical Association of America History of Mathematics Special Interest Group



Volume VIII, Number 2

September 2018

# **Greetings from the HOM SIGMAA Chair**

#### Dates to Remember:

- January 16 19, 2019, JMM in Baltimore, MD
- July 6-8, 2020, joint CSHPM & BSHM meeting at St. Andrews in Scotland

# Inside this issue:

Student Contest Winners	2
Save the Date	3
JMM 2019	3
Elections	4
Calendar	5
TRIUMPHS turns 3	6
<i>Convergence</i> of- fers Online Math- ematics History	9
HOM on Display - Irish Maths	11
Agnesi Contest	15
Essay Contest Flyer	17

Happy Fall 2018 HOM SIGMAA! Another school year is upon us. How does this keep happening? I make great plans for what I want to get done over the summer, and then the next thing I know I am scurrying to get my course syllabus ready in time. As many of you know I moved yet again. My husband retired from the Army after a 23 year career. He has taken a tenure position at his alma mater, Eastern Michigan University, and we are back in our home state of Michigan. We built a house (no



more moves!), got a second rabbit and a puppy. I did get a few work things done though. Dick Jardine and I are wrapping up work on yet another, and we vow our last, MAA Notes volume on resources for using the history of mathematics in the classroom. This one is full of ideas for History of Mathematics courses. The title will be *The Courses of History*, get the double entendre? As with our previous Notes volumes, we could not have done it without the beautiful contributions of many HOM SIGMAA members. This leads to my next request, which is your input and help.

The HOM SIGMAA has been hoping to launch two more writing prizes, but various circumstances have postponed that for several years. I still hope to get that going. If you would like to be on a small planning committee for annual expository writing prizes for an article and a book, please contact me directly at <u>ashellge@emich.edu</u>.

I have reached out to the Math Circles SIGMAA (SIGMAA MCST) suggesting we team up to encourage educators to create materials for and conduct math circles for students or teachers with historical content. Our first aim is to hold a contributed paper session on this at Math Fest 2019 in Cincinnati. This is a good way to both gauge interest as well as generate interest. If you are interested in creating materials for history of mathematics related math circles, or to beta test such materials, please contact me. We hope to post the materials on one or both of our websites when the time comes.

As usual, if you have any ideas or suggestions for what our SIGMAA can do to promote the history of mathematics and it uses in teaching, or what we can do for

#### **Greetings from the HOM SIGMAA Chair (continued from page 1)**

our members, please let us know. We always have extra funds at the end of the year and usually send extra funds to the Archives of American Mathematics to support their work. But we are always looking for ways to use our funds to benefit our community and members. Send me your thoughts on this as well. No Champaign Caribbean Cruises however, not that the executive board did not already consider that. (No Dan, we really can't.)

Have a great year, do lots of math history, and I will hopefully see many of you in Baltimore.

Amy Shell-Gellasch HOM SIGMAA Chair

# Winners of the 2018 Student Writing Contest

First place in the 2018 HOM SIGMAA Student Writing Contest goes to Calle Lane from The University of Missouri – Kansas City, "Race to Refraction: The Repeated Discovery of Snell's Law."

There were two second place winners:

Christen Peters from Lee University, "The Reality of the Complex: The Discovery and Development of Imaginary Numbers."

Rachel Talmadge also from University of Missouri – KC, (Way to go Richard Delaware HOM SIGMAA member and math history teacher extraordinaire!) "Francois Viete Uses Geometry to Solve Three Problems."

All three winners will be given an interesting math history book as well as a membership to the MAA and CSHPM.

Copies of the winning papers are now available on the HOM SIGMAA website: <u>http://sigmaa.maa.org/</u> <u>hom/contests/student/</u>

You can also find them on Convergence: <u>https://www.maa.org/press/periodicals/convergence/hom-sigmaa-2018-student-paper-contest-winners</u>

In addition, thanks to Dorothee Blum for running this year's contest, and the judges who helped out. Unfortunately Dorothee must step down as Prize coordinator for her final year. Amy Shell-Gellasch will be reprising her role and running the writing contest next year. So look for emails about the contest this fall and how you can help.

Congratulations to our winners, their faculty supervisors, and all students who submitted for the contest.

#### Thank you to Dorothee and the contest judges for your service!

The flyer for this academic year's contest can be found at the end of the newsletter.

# SAVE THE DATE!!!

#### HOM SIGMAA NEWS

The Canadian Society for History and Philosophy of Mathematics (CSHPM) and the British Society for the History of Mathematics (BSHM) are having their next joint meeting at St. Andrews in Scotland (home of Mac Tutor!) July 6-8, 2020. HOM SIGMAA has been invited to be involved and we have accepted. Most likely HOM SIGMAA will sponsor a session.



Please put Scotland, July 2020 on your calendars!



# 2019 JMM, Baltimore, MD, January 16 - 19

### Schedule of History Events at JMM 2019

Our **reception**, **business meeting**, and guest lecture are as usual scheduled for the first day of the conference, in this case Wednesday, January 16, 2019. The reception will start at 6:15 p.m. and the guest lecture will start at 7:15 p.m. The guest lecturer is Dr. Karen Parshall, Professor of Mathematics and History at the University of Virginia.

#### MAA Session on Ethnomathematics: Ideas and Innovations in the Classroom

#### Friday January 18, 2019, 8:00 -11:00 am, Room 301, BCC

Ethnomathematics, the study of mathematical aspects of the cultures of indigenous peoples, has been an active subject area for many decades. As more institutions strive to present multicultural offerings to their students, courses dedicated to or incorporating ethnomathematics are becoming more popular. This session features talks that present ideas for incorporating ethnomathematics into mathematics courses, ethnomathematics focused courses, ideas for undergraduate research in ethnomathematics, as well as new ethnomathematical research that can be brought into the classroom. Well-tested ideas and innovations in ethnomathematics for its use in teaching are welcome. Sponsored by the History of Mathematics SIGMAA. Final deadline for abstract submissions is September 25, 2018 at 11:59pm Eastern Time.

Organizers:

Janet Beery, University of Redlands Antonia Cardwell, Millersville University of Pennsylvania Ximena Catepillan, Millersville University of Pennsylvania ximena.catepillan@millersville.edu Amy Shell-Gellasch, Eastern Michigan University

#### MAA Minicourse #10: Object Based Learning and the Smithsonian Learning Lab

#### Part A: Thursday, January 17, 1:00-3:00 pm, Holiday Ballroom 1

#### Part B: Saturday, January 19, 1:00-3:00 pm, Holiday Ballroom 1

Allowing students to handle and study physical objects (object based learning) in the classroom enhances interest and understanding. However it is not always convenient or possible to bring physical objects into the classroom. In those cases, images, videos, even audio can provide the same pedagogical benefits. In this four-hour minicourse, we will explore methods and resources for using object based learning in the classroom. Participants will then create a free Smithsonian Learning Lab login, learn how to access Smithsonian materials, and how to create a course collection of annotated materials from the Smithsonian collections and beyond for use in a class they teach.

#### Presented by: Amy Shell-Gellasch, Eastern Michigan University

# **HOM SIGMAA Elections**

Every fall the members of HOM SIGMAA elect at least one new member to our Executive Board. Each of the five executives - Chair, Secretary/Treasurer, Program Coordinator, Prize Coordinator, and Electronic Resources Coordinator - serve a three-year term, appropriately staggered so as to preserve continuity of governance. This year, we need to elect a Chair and Electronic Resources Coordinator, as their terms are set to expire at the conclusion of the January 2019 meeting of the MAA in Baltimore.

The Chair presides at all HOM SIGMAA business meetings, organizes and directs the activities of the SIG-MAA, acts as its chief spokesperson, and is the liaison with the MAA Committee on SIGMAAs and with other organizations. Amy Shell-Gellasch, who has been involved in the governance of HOM SIGMAA since its first years, is now completing her first term as Chair.

The Electronic Resources Coordinator is responsible for dissemination of information to the HOM SIGMAA membership, primarily through electronic media, assisting the Secretary/Treasurer in recording and disseminating activities of the SIGMAA with the membership. Colin McKinney, our current coordinator is completing his first term in this position.

As immediate Past Chair of HOM SIGMAA, it is my responsibility to organize these elections with the MAA staff. To this end, I am soliciting from you, the members, names of candidates you think would be ide-

al to stand for election to these posts. Please send your nominations of to me at <u>otero@xavier.edu</u>, by Friday, September 28, 2018.

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lects

--Danny Otero

Past Chair, HOM SIGMAA



Two stamps in honor of Maria Gaetana Agnesi and the 300<sup>th</sup> anniversary of her birth have been released this year — one by Italy and one by the Vatican

For those interested in stamps, there is a group that

mathematics and mathematicians on stamps — the Mathematical Study Unit of the American Topical Association, http://

www.mathstamps.org/.

There is a checklist of topics on stamps, but one must be a member to access the list



CITTÀ del VATICAL

#### **2018 HOM SIGMAA Executive** Committee

Chair: Amy Shell-Gellasch, Eastern Michigan University

Email: ashellge@emich.edu

Secretary/Treasurer: Cynthia Huffman, Pittsburg State University

Email: cjhuffman@pittstate.edu

Program Coordinator: Toke Knudsen, SUNY Oneonta

Email: toke.knudsen@oneonta.edu

Electronic Resources Coordinator: Colin McKinney, Wabash College

Email: mckinnec@wabash.edu

Prize Coordinator: Amy Shell-Gellasch, Eastern Michigan University

Email: ashellge@emich.edu

Past Chair: Daniel Otero, Xavier University

Email: otero@xavier.edu

# Fall 2018 Meeting and Conference Calendar

#### **ARITHMOS Reading Group**

November 10-11, Western Connecticut State

Readings in the History of Mathematics from Original Sources seminars are 24-hour workshops on the classics of mathematics, read in the original or in a English translation. A dozen pages of mathematics is typically covered per session, which usually runs from 2 –6 p.m. on the first day, and 9 a.m. to 12:30 p.m. on the second. Organized by Rob Bradley and Chuck Rocca, ARITHMOS meets three to five times per year at Western Connecticut State University. The next meeting is scheduled for November 10-11. For more information, visit <u>http://</u> www.arithmos.org/.

#### **ORESME Reading Group**

October 12-13, Xavier University, Cincinnati, OH

The 40th meeting of the ORESME (Ohio River Early Sources in Mathematical Exposition) Reading Group will be held at Xavier University in Cincinnati on October 12-13, 2018. This meeting will continue a reading begun at ORESME's last meeting in January 2018 of the first four chapters of *Theorie Der Algebraischen Zahlen (Theory of Algebraic Numbers)*, published in 1908 by Kurt Hensel (1861-1941), in an English translation produced by Danny Otero for this purpose. The work includes Hensel's first substantial presentation of his *p*adic numbers, which received a mixed reception at their introduction but have since become an important tool in investigations in number theory. Contact Dan Curtin (<u>curtin@nku.edu</u>) or Danny Otero (<u>otero@xavier.edu</u>) for details.

#### The Canadian Society for History and Philosophy of Mathematics (CSHPM)

Session on History and Philosophy of Mathematics, Canadian Mathematical Society meeting, Dec. 7-10, Vancouver

CSHPM is sponsoring a session on History and Philosophy of Mathematics at the winter Canadian Mathematical Society meeting in Vancouver on December 7-10. More information may be found at <u>https://cms.math.ca/</u> <u>Events/winter18/</u>.

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#### The Canadian Society for History and Philosophy of Mathematics (CSHPM)

Early June 2019, University of British Columnbia

The first few days of June 2019, CSHPM will have its annual meeting as part of HSSFC's (Humanities and Social Sciences Federation of Canada) Congress. Exact dates are not yet confirmed, but the location is the University of British Columbia and the special session theme is History of Mathematical Astronomy. See <a href="http://www.cshpm.org/meeting/">http://www.cshpm.org/meeting/</a> and <a href="http://www.ideas-idees.ca/events/congress">http://www.ideas-idees.ca/events/congress</a>.

#### **Euler Society**

The Euler Society is planning sessions for MathFest 2019 and 2020. For the latest newsletter of the Euler Society, check out <u>https://us17.campaign-archive.com/?</u> u=4770bbac3a258cb9bd347ac13&id=9f22b873a9.

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#### Convergence Calendar

Visit <u>https://www.maa.org/press/periodicals/</u> <u>convergence/convergence-calendar</u> for a list of events and meetings around the world which relate to the History of Mathematics.

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#### Save these dates for future MAA meetings!

Winter 2019	Baltimore, MD	Jan. 16-19
Summer 2019	Cincinnati, OH	July 31-Aug3
Winter 2020	Denver, CO	Jan. 15-18
Summer 2020	Philadelphia, PA	July 29-Aug1
Winter 2021	Washington, DC	January 6-9
Summer 2021	Sacramento, CA	August 4-7
Winter 2022	Seattle, WA	January 5-8
Summer 2022	Washington, DC	August 3-6

# **TRIUMPHS turns 3!**

# Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources

#### Janet Barnett, Colorado State University - Pueblo

As a member of HOM SIGMAA, you have most likely heard about the TRIUMPHS project over the past three years. Perhaps you have attended a talk or workshop by a TRIUMPHS author, site-tester or researcher at JMM, MathFest, or your local MAA section meeting. Or you may have read one or more of the TRIUMPHS mini-Primary Source Projects (mini-PSPs) that have thus far appeared in *Convergence*. And you undoubtedly have received an invitation to serve as a formal site-tester of TRIUMPHS' curricular materials through the HOM SIGMAA listserv. But perhaps you've not yet responded to a TRIUMPHS call for site-testers – if so, then it's not yet too late!

A five-year, seven-university NSF-funded collaboration, TRIUMPHS has been busy during its first three years developing, testing, and evaluating ready-to-use classroom materials based on primary historical sources for teaching undergraduate mathematics courses ranging from pre-calculus and elementary statistics to abstract algebra, analysis and topology. Student and instructor data collected in TRIUMPHS site-testers' classrooms are also informing the project's extensive evaluation-with-research study about the effects of teaching and learning mathematics via primary historical sources on both students and faculty. To date, over 60 instructors at nearly as many institutions have engaged their students in studying mathematics directly from the works of historical authors via a TRIUMPHS PSP. Here are just a few of the benefits of using PSPs that these instructors have reported.

- Certainly students were more likely to discuss their own difficulties in interpreting problems from the PSP than they are in discussing difficulties on the other problems in our class. (Since it was acknowledged that these were "different" problems.) So hearing the students' concerns and difficulties was beneficial.
- I think the students also learned some virtues of persistence, since there was more "groping around in the dark," and they didn't believe that I had the absolute right answer ready to deploy. (As opposed to the course notes, which I wrote myself.)
- Many students remarked that they really liked reading from a primary source (as opposed to the textbook, I presume) because it made the math seem more humane. I interpreted this as evidence that reading the primary source helped students begin to break down their static views of mathematics.
- As an instructor, I experienced that students can do more than what we think. It's hard for calculus I students to read and understand math articles, but they did it!
- Both the students and I gained a deeper understanding and appreciation of the historical development of basic ring theory. The students also gained a deeper understanding of the concepts.
- I didn't anticipate it, but implementation of the PSP led to several conversations about how mathematics is developed, what research mathematicians do, and going on to do graduate studies in mathematics.
- It gave both me and my students a chance to pause amidst the early onslaught of analysis definitions and theorems to discover what motivated them historically. This course can be relentless in its pace, and this time spent, however brief, on background was enlightening to my students.

Four of the most recent full-length PSPs that are now available for use in your own classroom are highlighted in the remainder of this article. TRIUMPHS is eager to have new (and repeat!) site-testers use these and other PSPs in the TRI-UMPHS collection. You can find the entire current PSP collection of 25 full-length PSPs and 16 shorter mini-PSPs, as well as information about serving as a formal site-tester, on the <u>TRIUMPHS website</u>. To learn more about TRIUMPHS research on the effects of student engagement with PSPs, please also visit <u>TRIUMPHS @ FSU</u>.

#### Determining the Determinant: A PSP for Linear Algebra

#### Author: Danny Otero, Xavier University

The standard first course in linear algebra typically begins with units on solving systems of linear equations via Gaussian elimination and a study of the structure of the solution sets of such systems. This is followed by an introduction to vectors, matrices and their arithmetic, which provide a powerful symbolic language in which to describe these concepts algebraically as well as to discover new ones. By this time, students in a semester-long course are near the mid-semester date. Most courses will then introduce the matrix determinant as a mysterious number associated with a square matrix, together with a handful of intricate formulas for computing determinants, formulas that (strangely) seem to depend on the size of the matrix. In contrast, the PSP *Determining Determinants* illustrates how the determinant concept emerged from efforts in the eighteenth and nineteenth centuries to solve systems of linear equations in many variables, a complicated problem that ultimately required attention to issues of the notation and representation of equations, as well as careful development of the auxiliary notion of a "derangement" or "permutation."

In 1750, Gabriel Cramer (1704-1752) published his landmark *Introduction à l'A nalyse des Lignes Courbes Algébriques* (*Introduction to the Analysis of Algebraic Curves*). In an appendix to this work, Cramer tackled the solution of linear systems more systematically, providing the formula for the solution to such a system that is today known as Cramer's Rule. More significantly, he pointed out the rules for formation of the determinantal expressions that appear in the formulas for the solution quantities, using the term "derangement" to refer to the complex permuting of variables and their coefficients that gives structure to these expressions. These ideas reached maturity in an 1812 memoir by Augustin-Louis Cauchy (1789-1857) in which he provided a full development of the determinant and its permutational properties in an essentially modern form. Cauchy used the term "determinant" (adopted from Gauss) to refer to these expressions and even adopted an early form of matrix notation to express the formulas for solving a linear system.

The PSP *Determining Determinants* begins by presenting Cramer's Rule (in Cramer's own words) to first connect the student's knowledge of solving systems of linear equations to the algebraic expression of the determinant, at least in low-degree cases. Then, using Cauchy's masterful memoir, the general determinant is laid out and its fundamental properties described, the most important of which being the product rule  $\det AB = \det A \det B$ .

# *<u>The Radius of Curvature According to Christiaan Huygens</u>: A PSP for Calculus III Author: Jerry Lodder, New Mexico State University*

The PSP *The Radius of Curvature According to Christiaan Huygens* is written for a calculus course covering the curvature of plane curves, usually taught in conjunction with understanding motion (velocity and acceleration) of vector-valued functions. Many calculus textbooks define curvature as the magnitude of the rate of change of the unit tangent vector with respect to arc length, although such an opaque definition offers little insight into what curvature was designed to capture, not to mention its rich historical origins. This project offers Christiaan Huygens's (1629-1695) highly original work on the radius of curvature and its use in the construction of an isochronous pendulum clock. A perfect time-keeper, if one could be constructed to operate at sea, would solve the longitude problem for naval navigation during the Age of Exploration.

Amazingly, Huygens identified the path of the isochrone as a cycloid, a curve that had been studied intensely and independently during the seventeenth century. To force a pendulum bob to swing along a cycloidal path, Huygens constrained the thread of the pendulum with metal or wooden plates. He dubbed the curve for the plates an evolute of the cycloid and described the evolutes of curves more general than cycloids. Given a curve and a point B on this curve, consider the circle that best matches the curve at B. Suppose that this circle has center A. Segment AB became known as the radius of curvature of the original curve at B, and the collection of all centers A as B varies over the curve form the evolute. Note that the radius of curvature AB is perpendicular to the original curve at B. For an object moving along this curve, AB helps in the identification of the perpendicular component of the force necessary to cause the object to traverse the curve. This is the key insight into the meaning of curvature, and the core of the PSP *The Radius of Curvature According to Christiaan Huygens*.

# <u>Otto Hölder's Formal Christening of the Quotient Group Concept</u>: A PSP for Abstract Algebra Author: Janet Heine Barnett, Colorado State University – Pueblo

Today's undergraduate students are typically introduced to quotient groups only after meeting the concepts of equivalence, normal subgroups and cosets. Not surprisingly, the historical record reveals a different course of development. Although quotient groups implicitly appeared in the work done by Evariste Galois (1811-1832) on algebraic solvability in the 1830s, that work itself pre-dated

the development of an abstract group concept. Even the 1854 paper in which Arthur Cayley (1821-1895) gave the first definition of an abstract group was premature, and went essentially ignored by mathematicians for decades. Permutation groups were extensively studied during that time, however, with implicit uses of quotient groups naturally arising within it. Camille Jordan (1838-1922), for example, used the idea of congruence of group elements modulo a subgroup to produce a quotient group structure. Thus, when Otto Hölder (1859-1937) gave what is now considered to be the first "modern" definition of quotient groups in 1889, he was able to treat the concept as neither new nor difficult.

The PSP *Otto Hölder's Formal Christening of the Quotient Group Concept* draws on excerpts from Hölder's paper as a means to introduce students in a first course on abstract algebra to the concepts of a normal subgroup, a quotient group, the Fundamental Homomorphism Theorem and related elementary results. Excerpts from earlier works by Cauchy, Cayley and Jordan in which precursors of these ideas appeared are also treated in three optional and independent appendices. No prior familiarity with normal subgroups, quotient groups, or group homomorphisms is assumed in the project. To the contrary, this PSP is designed to serve as students' first introduction to these three concepts and their related theory, following their study of more elementary group theory. In addition to being fully self-contained with respect to the study of group homomorphisms, the project's treatment of the Fundamental Homomorphism Theorem requires no prior study of group isomorphisms.

#### Nearness without distance: A PSP for Topology

#### Author: Nick Scoville, Ursinus College

Point-set topology is often described as "nearness without distance." Although this phrase is intended to convey some intuitive notion of the study of topology, the student is often left feeling underwhelmed after seeing this idea made precise in the definition of a topology. This Primary Source Project develops topology, starting with a question in analysis, into a theory of nearness of points, an evolution that took place over several decades. Motivated by a question of uniqueness of a Fourier expansion, Georg Cantor (1845-1918) developed a theory of nearness based on the notion of limit points over several papers beginning in 1872 and lasting over a decade. Emil Borel (1871-1956) then took Cantor's ideas and began to apply them to a more general setting, Finally, Felix Hausdorff (1868–1842) developed a coherent theory of topology in his famous 1914 book *Grundzüge der Mengenlehre (Basics of Set Theory)*. By studying these works of Cantor, Borel, and Hausdorff, students completing this project are introduced to the ways in which we can have nearness of points without a concept of distance.

This project is meant to have the student work through multiple problems in order to build up to the modern axioms for a topology. It is meant to be one of the first things that a student of topology sees. Students will be exposed to limit points, the derived set, open sets, closed sets, and continuous functions. The main goals of the project are not only for students to learn this material, but almost just as important, to "bridge the gap" between topology and other mathematics. Students often have a hard time understanding what it is they are doing when they are doing topology, and why they are doing what they are doing. The hope is that this project will naturally lead the student into the ideas and concepts in topology so that the "why" is no longer a question.

#### Acknowledgments

The development of this article has been partially supported by the National Science Foundation's Improving Undergraduate STEM Education Program under Grants No. 1523494, 1523561, 1523747, 1523753, 1523898, 1524065, and 1524098. Any opinions, findings, and conclusions or recommendations expressed in this project are those of the authors and do not necessarily reflect the views of the National Science Foundation.





From left to right: David Pengelley, Diana White, Danny Otero, Dominic Klyve, Janet Barnett, Kathy Clark, Nick Scoville

# MAA Convergence

# **Offers Online Mathematics History**

Janet Beery, University of Redlands

Editor, MAA Convergence

*MAA Convergence* is both an online journal on the history of mathematics and its use in teaching and an ever-expanding collection of online resources to help its readers teach mathematics using its history. Founded in 2004 by well-known mathematics historians and educators Victor Katz and Frank Swetz, *Convergence* brings you a variety of interesting articles and teaching tools.

We highlight here some of our newest articles and resources for use in your classroom. "The Root of the Matter: Approximating Roots with the Greeks" is one of our many articles with interactive features. Authors Matt Haines and Jody Sorensen provide applets for use in geometry and linear algebra courses. In "More Classroom Activities Based on Ancient Indian Rope Geometry," Cynthia Huffman and Scott Thuong provide activities and applets for students at all levels or for anyone who wishes to better understand the *Śulba-sūtra* of Baudhāyana.



Left: A particular case of a geometric view of Theon's side and diagonal numbers from the article by Matt Haines and Jody Sorensen.

Right: Construction of a trapezoid of area equal to that of a rectangle from an applet by Scott Thuong and Cynthia Huffman.



Adding to "A Series of Mini-projects from **TR**ansforming Instruction in Undergraduate Mathematics via **P**rimary **H**istorical **S**ources," the TRIUMPHS team has introduced two mini-Primary Source Projects (mini-PSPs) so far this year:

- "Euler's Rediscovery of *e*," by Dave Ruch, and
- "How to Calculate Pi: Machin's Inverse Tangents," by Dominic Klyve.

Watch for new projects in this series in Convergence!



Above: Students' Cuisenaire rod models of the identity "Eight times any triangular number plus one makes a square."

Two recent articles about history of mathematics courses in particular are:

• "Cuisenaire Art: Modeling Figurate Number Sequences and Gnomonic Structures in a History of Mathematics Classroom," by Günhan Caglayan, and



• "A Writing Intensive General Education History of Mathematics Course," in which author Amy Shell-Gellasch offers strategies for engaging students who *think* they don't like math or aren't good at it.

In "*The Ladies' Diary*: A True Mathematical Treasure," author Frank Swetz shows, tells, and explains why the annual *Ladies' Diary*, published in England from 1704 to 1841, "was a milestone in the history of modern mathematics education."

Two recent *Convergence* articles highlight mathematics in Edo Period Japan (1603-1868):

- "Elementary Soroban Arithmetic Techniques in Edo Period Japan" presents abacus techniques from the *Taisei Sankei* (circa 1700).
- "Japanese Mathematics in the Edo Period" features images from 12 books of the period including a wide range of mathematics.

Below: This Meiji Period soroban (Japanese abacus) represents a step in the transition from abaci with two beads above the bar and five below to those with one bead above and four below. (Photo courtesy of Rosalie Hosking of an abacus in her collection.)



Our "Index to Mathematical Treasures" includes hundreds of images for use in your classroom from dozens of libraries and sources. Our chief "treasure hunter" is *Convergence* founding editor Frank Swetz.

See all of these articles and more at MAA Convergence:

# http://www.maa.org/press/periodicals/convergence

Join us at the Convergence of mathematics, history, and teaching!

Janet Beery, Editor, MAA Convergence

### **HOM on Display**

A feature of the HOM SIGMAA Newsletter is a review of a museum or library with an exhibit or collection related to the History of Mathematics. If you would like to submit an article for HOM on Display, please send it to Cynthia Huffman at cjhuffman@pittstate.edu. The HOM on Display for this issue is a look at a virtual library focusing on Irish mathematics and mathematicians:

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#### The Annals of Irish Mathematics & Mathematicians

#### http://cardcolm.org/AIMM.html

#### by Colm Mulcahy, Professor of Mathematics, Spelman College

Everyone knows that Irish mathematician (and physicist-in-all-but-name) <u>William Rowan Hamilton</u> discovered quaternions—in the city where he spent his entire career as an academic at Trinity College Dublin—thus injecting noncommutativity into algebra decades before matrix multiplication was conceived. There is an annual star-studded <u>Hamilton walk</u>



each 16<sup>th</sup> October commemorating the event. Hamilton was professor of astronomy at TCD (starting before he graduated) and was also Royal Astronomer of Ireland. Hamilton was also the first foreign member of US Academy of Sciences. Few people—even in Ireland—know that within two months of Hamilton's October 1843 breakthrough, John Graves, another Irish mathematician and TCD graduate who mostly worked as a jurist in England, had extended quaternions to octonions (Cayley got the credit for a long time). Quaternions—an apparently abstract and useless construction—turned out to have applications to mechanics, computer graphics, and quantum physics. Octonions are in the news these days because of their possible use in physics.



Also in the 1840s, Wicklow's <u>Oliver Byrne</u> published <u>The First Six Books of the Elements</u> of <u>Euclid in which Coloured Diagrams and Symbols Are Used instead of Letters for the</u> <u>Greater Ease of Learners</u>, an astonishing volume way ahead of its time. Its innovative pages burst with glorious color, the graphics foreshadowing Mondrian, and the Bauhaus and De Stijl movements. Byrne has been celebrated twice at <u>Converence</u>, first by <u>Frank Swetz</u> <u>& Victor Katz</u>, and more recently by <u>Sue Hawes and Sid Kolpas</u>, the latter in great detail. Largely forgotten until 20 years ago, in 2010 Byrne's <u>Euclid</u> finally became widely available in facsimile form via a handsome <u>Taschen</u> edition. History only generally remembers Byrne as an eccentric British engineer.

What else in mathematics is commonly associated with Ireland? Bearing in mind that practitioners of mathematics in centuries past often also worked in applied mathematics and physics, and mathematics has long haddeep connections to stats, economics and engineering, let's not be hemmed in by modern notions of purity. In approximate chronological order, the following concepts and results stem in some way from Irish people or people working in Ireland:

Boyle's law, Berkeley's criticism of calculus, angular momentum, the method of least squares, the Hamiltonian in mechanics, the Icosian game, Hamiltonian paths, quaternions, octonions, the Hamilton Cayley theorem, inversion in a circle, the curl of a vector field, the Kelvin temperature scale, Stokes' theorem, Navier Stokes equations, much of Boole's work, the Smith normal form of a matrix, Casey's theorem in geometry, the screw theory, Edgeworth series, Lorentz-Fitzgerald contraction, the Baker-Campbell-Hausdorff formula, Cullen numbers, the student t-test, the Geary Khamis dollar, the Henstock-Kurzweil integral and the no-go theorems of Bell and O'Raifeartaigh.

Not to mention the terms electron, potential function, and polytope, and the arrow notation for limits! It was Dubliner John L Synge who worked tirelessly with his University of Toronto colleague John Fields in the early 1930s to set up what became the Fields Medal. Synge was one of a dozen plus Irish mathematics people

#### PAGE 12

who were invited speakers at the International Congress of Mathematics in the first phase of its existence, pre WWII (see the <u>September 2018 blog</u>). (Synge's daughter <u>Cathleen Morawetz</u> served as president of the AMS in the 1990s.) More recent attention-grabbing headlines include the surprising <u>Weaire-Phelan structure</u>, a mathematical analysis of <u>why Guinness bubbles counterintuitively sink</u>, and a proof that Sudoku always <u>needs at least 17 clues</u>.

The reach of Irish mathematical science is wide, and has seen Irish scholars shine at some of the world's leading centers of learning overseas, <u>from Cambridge</u> and Oxford to universities in Paris and Rome, as well as at Cornell, Toronto, <u>Caltech</u>, Berkeley, Chicago, <u>MIT and Harvard</u>, both as grad students or post docs, or as faculty.

Hamilton was the first outstanding Irish scholar in the field to remain in Ireland, others before and for many decades after made their names in England, Scotland, Wales, or the USA. TCD was essentially the only third level institution in Ireland until about 1850, and was basically off-limits to the native Catholic population until over a century after that. The first Irish people to complete doctorates by research in the mathematical sciences in the Republic of Ireland did so <u>as recently the 1950s</u>. Hence, it is inevitable that many Irish men (and in due course women) left their native land in pursuit of mathematical study.

In <u>the period from 1910 to 1960</u>, Irish postgraduates trained overseas with talents as diverse as Picard, Bateman, Levi-Civita, Baker, Whittaker (who had worked at TCD), Hardy & Littlewood, Born, Smithies, Artin, Wright, Hayman, Higman, Besicovitch, and Feller, as well as an impressive array of top notch (and sometimes Nobel prize winning) physicists. The <u>1970s</u> and <u>1980s</u> and recent decades see that list expand to include mentors Hodge, Goldie, Strang, Taussky-Todd, Banchoff, Fröhlich, Conway, Rubel, Fefferman, Uhlenbeck, Thorne, Jones, Stanley, Schneider, Wahba, Lusztig, Taylor, Shimura, Sarnak, Faltings, Daubechies, Thurston, Lenstra, Gowers, Carlsson, Hawking, and Chung. It's only since the 1980s that it has become relatively easy to obtain funding to pursue postgraduate degrees in the Republic of Ireland. (Those studying at Queen's University in Belfast or at one of the University of Ulster campuses had that option roughly a decade earlier.)

Flash back a century to Cornell in 1888: James McMahon from Armagh, who had pursued metaphysics and classical studies at TCD, is believed to be the first Irish person to supervise a mathematical doctoral thesis. He taught mathematics at <u>Cornell for many decades</u>, serving as chair too, and was an early member of what became the American Mathematical Society. Earlier still, <u>Robert Adrain</u> from Antrim moved to New Jersey following the 1798 rebellion in Ireland and was one of the leading lights of academic mathematics in the USA in the early 19th century, publishing the method of least squares before Gauss.



Many of the stories outlined above have remained hidden until quite recently, and are still hard to find evidence for in print or online. The <u>MacTutor website</u> has numerous outstanding biographies of interest, many of them generously added in recent years in response to suggestions. Doctorates completed in Ireland can be found at the excellent <u>Math Genealogical Project site</u> (under Advanced Search enter "Ireland" under Country for those done in the Republic of Ireland or one of "Ulster" or "Belfast" under Name of University for those done in Northern Ireland). However, those completed elsewhere are impossible to detect there as being by Irish candidates (see <u>this blog</u>). Wikipedia has dozens of webpages on relevant people, and volunteer editors there have been very responsive to requests for corrections and additions, but the <u>list of people so designated</u> is wildly unrepresentative for various reasons, a fact that is unlikely to change no matter how many new pages are added.

The Annals of Irish Mathematics & Mathematicians (AIMM) online, <u>http://cardcolm.org/AIMM.html</u>, together with its spinoff pages and blogs is one centralized place where people interested in Irish mathematics can find a great deal of information. It started modestly at the end of 2014, and currently accounts for over 3750 people, the great majority of them from the past two centuries. (That count includes all known PhD students

#### PAGE 13

of Irish advisors, most of whom are non-Irish.) It was created, and is curated daily, by Colm Mulcahy, long of Spelman College, himself a BSs and MSc graduate in mathematical sciences from University College Dublin. One can browse by "decade of first degree" (or equivalent), going back to the 1640s (Robert Boyle, William Brouncker, Charles Willoughby). That early on, things are quite murky as viewed with modern eyes. Birth origins can be uncertain, and educational opportunities at any level in Ireland were extremely limited, so people were either self-educated, schooled at home, or sent to England (or the continent) for training. The AIMM listings ends with graduates from 4 or 5 years ago who have since completed postgraduate work and entered the profession. While the original goal was to include only those who entered academia, it now accounts for all known degree recipients so that it is possible to track the great variety of careers that can result from mathematical training.

The "degree database" is too dense to tease information out of easily, so two years ago <u>monthly blogs</u> were started, now alternating between "Atlas of Irish Mathematician" highlights in even-numbered months (e.g., Limerick in <u>December 2017</u> or Belfast in <u>June 2018</u>), and other features of interest in odd-numbered months (e.g., "Irish Mathematical Society at 40" in <u>December 2016</u> or "Sheila Power (later Tinney), Pioneering Irish Mathematical Physicist" in <u>January 2018</u>).

Strenuous efforts have been made to track all <u>women</u> who have contributed to Irish mathematics, including the <u>pioneers in doctoral studies</u>. A very young Hannah Moylan (1870-1944) from Galway, who earned a Royal University of Ireland degree in mathematics in 1891, contributed solutions to some trigonometry problems in the Educational Times as an undergraduate (see this <u>1888 collection</u>). Over 850 mathematical books by Irish authors are highlighted in the <u>Library of Irish Mathematics</u>. Regular tweets go out at <u>@IrishMathsFacts</u>. <u>Annual printed calendars</u> (listing hundreds of birthdays and highlighting 6 people per month with photos and mini biographies) are produced in Ireland and made available to university faculty and school teachers there.



The Annals of Irish Mathematics & Mathematicians is an ever-evolving project, and there is much that remains to be done. Tracking research output, and not just degrees, is just one future goal that will require a lot of team effort. To date, AIMM has been essentially a one-man labor-of-love. It is the beneficiary of a great deal of input from current and past members of the <u>Irish Mathematical Society</u>, especially retirees with long memories, and has received extensive support from <u>Maths Week Ireland</u>, especially in the form of monthly blog hosting at <u>http://www.mathsireland.ie</u> and annual calendar production and distribution. (Maths Week is the world's largest and most successful mathematics outreach program, which engages over 300,000 children throughout the island of Ireland each October.) It is hoped that, like Peter Lynch's wonderful <u>"That's Maths"</u> <u>column</u> in the *Irish Times*, AIMM can help to bridge the gap between academia and public outreach. AIMM's objectives are to:

- 1. Promote a deeper and inclusive knowledge and appreciation of Irish mathematics and mathematical sciences in general both in academia and educational circles, and among the general public.
- 2. Collect and share on the web basic information about Irish mathematicians down through the ages, in particular in the past two centuries.
- **3.** Create a dynamic electronic archive of Irish mathematics and mathematicians which anyone can enjoy and use for research, and which future generations can maintain and develop further.



Anyone browsing AIMM and the associated blogs will become aware of important names like Oliver Byrne and James McMahon discussed briefly above, and also the remarkable <u>John Casey</u> (one of the earliest Catholics to rise in academic ranks in mathematics in his own country), and Irish born and bred <u>Sophie Bryant</u> (the first woman to have a paper published in the Proceedings of the London

#### PAGE 14

Mathematical Society), along with hundreds of other fascinating stories from the 1600s to the current day.

<u>Frank Murnaghan</u> built up the mathematics department at Johns Hopkins, and authored sixteen books. <u>Jack</u> <u>Todd</u> was a QUB graduate who studied under Littlewood, helped to secure the preservation of Oberwolfach in Germany after WWII, and later spearheaded the use of computers to do numerical analysis at Caltech. Belfast-born <u>Muriel Wales</u> got her University of Toronto PhD in algebra and then worked in atomic energy. Geophysicist and social activist <u>Gerry Gardner</u> had a PhD in relativity from Princeton, and a statistical analysis of his contributed to a US Supreme Court decision.

Detailed biographies of eighteen of the most distinguished players from the past can be found in the essential <u>Creators of Mathematics: The Irish Connection</u> (2000), edited by Ken Houston. Another fine resource is <u>Physicists of Ireland: Passion and Precision</u> (2003) edited by Mark McCartney & Andrew Whitaker.

A modicum of genealogical sleuthing skills can be put to good use in tracking hitherto unrecorded places and dates of birth (and death) as well as career details for less well known people from the distant past. Irish census records from 1901 and 1911—a period when the whole island was under British rule and the majority of the male population listed their occupations as farm hand or laborer—can give fascinating insights into the social backgrounds of several generations of interest. Compare the 1901 entries for Henry Kennedy, son of a Tipperary blacksmith who ended up with multiple postgrad degrees in mathematics and physics from University College Dublin before working in agricultural economics (his son Maurice got a PhD in analysis with Sam Karlin at Caltech), to that of Herbert Tate, son of a Cork city commercial traveler, who graduated from TCD and then spent four decades teaching at McGill University, where he served as chair and wrote several books.

One thing is abundantly clear, looking back at almost four centuries of data pertaining to a modestly sized island. Mathematical talent can blossom anywhere once opportunity is made available: anywhere geographically and anywhere on the poverty to affluence spectrum. Educators and policy makers worldwide please take note.

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Irish Mathematics Calendar 2018



## A PRIZE IN HONOR OF "MARIA GAETANA AGNESI THIRD CENTENNIAL" TO BE AWARDED FOR AN ORIGINAL RESEARCH PAPER ON THE THEME: FEMALE MATHEMATICIANS IN HISTORY

The Società Italiana di Storia delle Matematiche (Italian Society of History of Mathematics), with a generous contribution by Prof. Maria Clara Nucci, announces a **Prize of 2.500 euros** to be awarded to a young scholar's <u>original research paper</u> on the theme:

### Female mathematicians in history

The Prize celebrates "Maria Gaetana Agnesi (1718-1799) in the Third Centennial of her birth".

Italian and Foreign citizens may apply if they are aged less than 40 years old **on October 3, 2018**, and if they have attained a PhD or a Master's Degree at a European or non-European University **between January 1, 2013 and September 30, 2018**.

The Prize Committee may award the Prize jointly to more than one winner.

### Rules

The applicants must fill and sign the application form, and email it together with the pdf file of their original research paper to <u>m.g.agnesi2018@gmail.com</u> not later than October 3, 2018, at midnight (GMT+2).

The submitted original research paper must be written either in Italian or English. Prof. Maria Clara Nucci and two Members nominated by the Board of the Società Italiana di Storia delle Matematiche will decide the winner among the submitted papers.

#### APPLICATION FORM FOR THE PRIZE IN HONOR OF "MARIA GAETANA AGNESI THIRD CENTENNIAL"

Surname	1	Name
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Citizenship:		
Postal Address:		
Email:		
I wish to apply for <b>"MAR</b> attach my own original r	RIA GAETANA AGN research paper enti	<b>VESI THIRD CENTENNIAL</b> " Prize and itled:
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with the supervision of F	Prof(s):	
Date://	Signature	

# The History of Mathematics Special Interest Group of the Mathematical Association of America

is pleased to announce its sixteenth annual

# Student Paper Contest in the History of Mathematics

This contest is open to all undergraduate students  ${}^{\!\!\pi}$ 

Papers will be judged by a panel of specialists for content, originality, and presentation. Typically first and second place winners are chosen.

#### Submission Guidelines

- Topics can be drawn from any field of mathematics.
- Papers can address a single person or topic, or be an historical survey of a topic or school of thought.
- Submissions should be approximately 5000 words (approximately 12 double-spaced 12 pt. pages) in length with font that is easy to read.
- Submissions should be in a single PDF file, including a title page with title of paper, the author, school, and complete contact information.
- Papers should include a full citation list.
- Papers should not draw too heavily from web sources.<sup>®</sup>
- Students submitting a paper need not be currently taking a history of mathematics course.
- All papers should be single-authored.
- Eligible papers are those written in the past year and while the author was an undergraduate.

### Submission Deadline: Saturday, March 23, 2019

Results will be announced via email and on the HOM SIGMAA website in May.

Submissions and questions can be directed to Dr. Amy Shell-Gellasch ashellge@emich.edu

 $<sup>\</sup>pi$  Students who have graduated less than a year ago but wrote their paper while still an undergraduate my also participate.

<sup>&</sup>lt;sup>8</sup> Web sources that give access to print material, such as JTSOR, are completely acceptable.